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Genomic and biotechnological interventions for enhanced utilization of date palm (*Phoenix dactylifera* L.) germplasm

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Abstract

Date palm (*Phoenix dactylifera* L.) belongs to Arecaceae family and considered as the oldest domesticated plant on the globe. Genetically, date palm is strict dioecious evergreen tree which is being cultivated in arid and semi arid regions of the world as an important fruit tree, for providing staple food across the world. Nutritionally, the fruits of date palm are rich sources of vitamins, minerals and carbohydrates which also posses medicinal values. On the other hand, date palm is capable of surviving for longer periods even at extremely adverse environmental conditions with prolonged life span, which admires about its complex genetic makeup. In this context, date palm has tremendous scope to conduct the fundamental and scientific research for bio-prospecting of the stress tolerant genes, understanding the tolerance mechanism and their interactions with natural ecosystem. Furthermore, the developed genomic resources and biotechnological interventions so far in date palm could be useful to enhanced utilization of date palm germplasm for further crop improvement programme. However, to conduct a high through put research on improvement of date palm, it still needs more emphasis on genomic and biotechnological interventions for crop improvement. Therefore, a comprehensive report has been made to collect the information available on genomic and biotechnology in date palm carried out so far and their futuristic approach for improvement in date palm cultivation.

Key words: Arid zone, biotechnology, Date palm, germplasm, genomic

Introduction

Date palm (*Phoenix dactylifera* L.) is considered as the oldest domesticated plant on the globe (Mahmoudi *et al*., 2008). Genetically, date palm is dioecious in nature and belongs to Arecaceae family which posses very long life cycle with prolonged juvenility (El Hadrami *et al.,* 2011). The native place of date palm is unknown but the Arabian Peninsula regions including southern Iraq is considered its origin place (Wrigley, 1995). Date palm is widely cultivated in arid and semi arid regions as an important fruit trees, admires good economic return and considered as "tree of life" for providing staple food across the world (Nixon, 1951). Nutritionally, the fruits of date palm are rich sources of vitamins, minerals and carbohydrates (El Hadrami *et al.,* 2012), besides good medicinal value to cure the cardiovascular disorders (Alhaider *et al.,* 2017). Globally, date palm is cultivated on 1.4 million ha of land with production of 8.5 million tonnes (FAOSTAT, 2016). Iran, Saudi Arabia and Iraq together occupied more area and considered as major producer of date palm. Date palm can survive at very extreme environmental conditions including drought, high temperature and relatively high soil salinity levels (Yaish *et al.,* 2015; 2015). In this context, date palm has tremendous scope to conduct the fundamental and scientific research for mining of stress tolerant genes, understanding the tolerance mechanism and their interactions with natural ecosystem.

When compared to many other commercial fruit trees, relatively little investigations have been made in molecular genetics research of date palm, resulting serious constraint in development of basic information on genetics and genomic tools. However, in recent past, date palm has been subjected to some genomic studies. Consequently, date palm genome along with its mitochondrial and chloroplastic genome has been sequenced recently (Yang *et al.,* 2010; Fang *et al.,* 2012). As the advent of genome sequence initiatives, the size of diploid genome of date palm (2n=2x=36) has estimated between 550 Mb to 658 Mb long (Al-Dous *et al.,* 2011; Al-Mssallem *et al.,* 2013; Hazzouri *et al.,* 2015). Nowadays, the commonly published genome data and the availability of bioinformatics tools provide insights into the tools to identify molecular markers, development of genomic resources and mining of genes for genetic improvement in date palm (Hamwieh *et al.,* 2010; Zhao *et al.,* 2013). Furthermore, the developed genomic resources in date palm could be useful to efficiently assess the genetic diversity, to construct genetic linkage map, to use marker-assisted breeding and boost up the biotechnological research. However, the comprehensive report on genomic and biotechnological areas of date palm is very limited. Therefore, in the present paper, efforts have been made to collect the information available on genomic and biotechnology in date palm carried out so far and their futuristic approach for improvement in date palm cultivation.

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Development of genomic resources

(A) Generation of EST database

Expressed sequence tags (ESTs) are one pass and partially generated end sequences of the cDNA libraries or

transcripts. In other words, these are the bi-product of the cDNA/transcripts sequencing. Though, it is not very high throughput but considered as the first step of gene expression technologies. Now days, a huge amount of EST databases of various plants have been established in public domain. Case by case, they are used for designing the basis of identification of genes as well as development of molecular markers. Since date palm is having a lot of useful agro-economic traits, however, the initiatives of generation of EST database is very limited. Exceptionally, few reports are available in the literatures. In this context, Saidi *et al.* (2010) has generated 159 differentially expressed ESTs from date palm leaves affected by brittle leaf disease. Subsequently, a large collection of EST sequences were identified in date palm using *de novo* next-generation sequencing (Al-Dous *et al.,* 2011). They have generated 28,889 EST sequences and made available in public domain. Additionally, Al-Faifi *et al*. (2017) has also put efforts to generate a large scaled EST sequences. As a result, 6943 high- quality ESTs were generated from a normalized cDNA library of the date palm cv. Sukkari for deciphering the quality parameters and yield performance at field level. Further, the functional annotation of the ESTs showed that the majority of the ESTs are associated with binding (44%), catalytic (40%), transporter (5%), and structural molecular (5%) activities. It was also reported that some ESTs are categorized as stress/defense and fruit development related genes. These newly generated ESTs could significantly enhance date palm EST databases in the public domain and are available to scientists and researchers across the globe. This knowledge will facilitate the discovery of candidate genes that govern important developmental and agronomical traits in date palm. It will provide important resources for developing genetic tools, comparative genomics, and genome evolution among date palm cultivars.

(B) Transcriptome analysis and small RNA identification

Owing to survive under various biotic and abiotic stresses, make date palm as a potential genomic resource for identifying stress tolerant pathway genes. Transcriptome analysis during stressed conditions, though it is very limited in date palm, can became pivotal genomic tool for better understanding the tolerance mechanism behind these stresses in date palm. Few studies are available in this context. For example, Bourgis *et al*. (2011) deciphered the metabolic mechanisms for carbon partitioning using transcriptome analysis in date palm. The results of this investigation revealed that the carbon partitioning in the mesocarp has differed in date palm. Another report by Radwan *et al*. (2015) has recently put emphasis to characterize the salinity tolerance pathway in date palm through RNA-seq analysis. The study suggested that activation of *abscisic acid* signaling pathways through SNF1-related protein kinases 2. Further, key genes of sodium uptake and transport were shown down-regulated during salinity stress, suggested a potential mechanism for decelerating up-take and transport of salt solutes within plant tissues. Similarly, the genome-wide expression analysis of date palm leaf and root tissue during salinity stress revealed the differential expression of salinity stress responsive genes. The elevated levels of NaCl in salt affected tissues provide a foundation for functional characterization of salt stress-responsive genes in the date palm (Yaish *et al.,* 2017). The findings of these reports depicted new information on complex mechanism of date palm against salinity stress.

In the plants species including fruit trees, microRNA (miRNA) genes are known to be very highly conserved in nature (Sun, 2012). Similarly, the small RNAs were found to be conserved in date plam (Xiao *et al.,* 2013). Generally, the miRNA genes are involved in post-transcriptional regulation of gene expression. In the genomic era, numerous miRNA encoding genes were explored in the plant species and stated that the date palm is a potential crop to understand the stress tolerant mechanism. Whether the gene expression during stress conditions is regulated by small RNAs genes in date palm is still not well known?. However, date palm is exploited for involvement of small RNA genes in its gene expression during salinity stress (Yaish *et al.,* 2015) and fruit development stage (Xin *et al.,* 2015).

The Red Palm Weevil (RPW, *Rhynchophorus ferrugineus* Olivier) is a severe problem in date palm cultivation worldwide. In order to identify the differentially expressed genes against red palm weevil, the transcriptome analysis of date palm was carried out (Giovino *et al.,* 2015). In a study, higher transcript abundances of metabolic pathway genes and hormonal crosstalk belonging to auxin, jasmonate and salicylic acid (SA) pathways were observed. Apart from this, transcript analysis of mitochondrial genome was also revealed the functionality and co-regulation of mitochondrial genes in date palm (Fang *et al.,* 2012).

(C) Development of molecular markers

Recently, use of gene-targeting molecular marker approaches to study biodiversity and genetic variations in various plant species has increased the attention of researchers to develop their interest in date palm, especially to carry out phylogenetic studies using these novel marker systems. Thus, numerous molecular marker systems have been developed and extensively used for detecting variability in the germplasms of date palm (Palliyarakkal *et al.,* 2011; Atia *et al.,* 2017; Zhao *et al.,* 2017). Molecular markers are good indicators of genetic distances among the germplasm including land races, cultivars, etc., because DNA-based markers are neutral in the face of selection. In the earlier stage, the employment of multidisciplinary molecular marker has been described in date palm. Such markers are mostly randomly distributed rather than sequence specific in the genome. Recent trends in plant research is towards the use of gene-targeted rather than random DNA markers as inexpensive and speedier estimation of genome sequence lately offer enormous potential for the development of such gene-based markers (Andersen *et al.,* 2003). Gene-based markers are more useful in mapping of quantitative trait loci (QTL), molecular breeding, and gene cloning. The Expressed Sequence Tags (EST)-SSRs are also referred to as genic SSRs. With the advent and availability of genomic resources such as ESTs and genome sequences, a

large number of genic markers have been developed in date palm. Zhao *et al*. (2013) has identified and characterized gene-based molecular markers (EST-SSRs) in date palm. They have utilized a large collection of EST sequences which were generated from *de novo* assembly of the date palm genome. EST-derived SSRs form a valuable genetic marker type, a class of functional markers as a putative function, in mapping candidate genes. Distribution of genic SSRs on the genetic map will show the distribution of genes in the genome. Thus, EST-SSRs have been widely used to construct high-density linkage maps in recent years (Chen *et al.,* 2008; Durand *et al.,* 2010; Ramchiary *et al.,* 2011). Some EST-SSRs associated with phenotype are useful in marker assisted breeding programs (Qi *et al.,* 2010; Zhang *et al.,* 2011). Another important feature of the genic SSR markers is that the unlike genomic SSRs, they are transferable among related species and genera (Varshney *et al.,* 2005). Additional to genic markers, a cDNA start codon-targeted (cDNA-SCoT) marker has been also used for the study of gene expression during salinity stress in date palm (Al-Qurainy *et al.,* 2017). A high degree of variability has been determined by using these markers among the germplasm of date palm under salinity and drought stresses.

(D) Identification of sex linked genomic resources

Initially, sexual propagation was followed in date palm multiplication. However, this method cannot be adopted for commercial propagation of the cultivars of interest in a true-to-type manner due to some genetic constraints. In fact, date palm is a dioecious plant, and sex of the seedlings can be determined only at the time of first flowering which takes 4-5 years (Kharb *et al.,* 2017). Thus, the sex determination at seedling stage is one of the major problems in date palm cultivation worldwide. On the other hand, female plants of date palm are of economic importance as they bear the fruits. Therefore, sex identification at an early stage is highly desirable not only for breeding programmes but also for establishment of commercial orchard. However, the lack of molecular markers in date palm restricts the application of molecular breeding.

At the earlier stages of the research, an extra-heterochromatin region of chromosome was reported on the both arms of the male chromosomes which was considered as sex determinant (Siljak-Yakovlev *et al*., 1996). The technology was applied to differentiate the gender in date palm. Subsequently, date palm gender was differentiating using Fluorescence *In-Situ* Hybridization (FISH) technology by Atia *et al*. (2017). The above mentioned technologies was not succeeded substantially because it required an extensive cytological tasks which is labor intensive, time consuming and need some sophisticated instruments and procedures. Whereas, DNA-based markers are very useful and easy for determination of sex at early stages of the plants. Historically, RFLPs and RAPD markers were effectively used for discriminating the sex-specific trait in date palm (Abdallah *et al.,* 2000; Trifi *et al.,* 2000). However, the utilized RFLP and RAPD markers were not seemed to be reliable because of their cumbersome detection techniques and reproducibility. Therefore, there is a huge gap to determinate the gender prospective in date palm, thereby continuous research efforts are going on in these aspects. It is, therefore, emphasized that the gender specific molecular markers either from male or female plant can solve this problem. In this context, male-specific sequence-characterized amplified region (SCAR) markers to identify sex in date palm at the seedling stage have been reported (Kharb *et al.,* 2017). Amplification of genomic DNA isolated from male and female plants using the SCAR primers results in an amplicon of 406 bp in both female and male samples and a unique amplicon of 354 bp only in male samples. Based on this amplification pattern, the sex of date palm seedlings can be predicted. Similarly, a large number of sex-linked markers have been reported (Table 1) and applied to differentiate the male and female plants at seedling stage.

Besides development of molecular markers for deciphering sex-linked traits, some gene based technology has been developed for sex determination in date palm. Recently, a sex-linked gene *SRY1* was cloned and validated in date palm for differentiating male and female plants (El-Din Solliman *et al.,* 2017). Actually, the *SRY1* gene is male chromosome specific; therefore, it amplified only in male seedlings rather than in female ones. The technology was very efficient to identify male plants in a population at seedling stage (EL-Din Solliman *et al.,* 2017).

Genome sequencing

The sequencing of genome is a fundamental basis for understanding the genetic phenomena of the complex traits of

Table 1. List of sex linked molecular markers developed in date palm.

S. No.	Date palm species	Type of markers	References
1	*Phoenix dactylifera*	RFLP and RAPD	Abdallah *et al*. 2000; Trifi *et al*. 2000
2	*Phoenix dactylifera*	SSR	Maryam *et al.,* 2016
3	*Phoenix dactylifera*	RAPD, SCAR, and SSR	Awan *et al.,* 2017
4	*Phoenix dactylifera*	SCAR	Kharb *et al.,* 2017
5	*Phoenix dactylifera*	RAPD	Ageez *et al.,* 2011
6	*Phoenix dactylifera*	RAPD	Al-Khalifah *et al.,* 2017
7	*Phoenix dactylifera*	ISSR	Al-Ameri *et al.,* 2016
8	*Phoenix dactylifera*	SCAR	Dhawan *et al.,* 2013
9	*Phoenix dactylifera*	SSR	Al-Faifi *et al.,* 2017
10	*Phoenix dactylifera*	SSR and SNP	Mokhtar *et al.,* 2016

a plant. In this context, the genome-wide studies of date palm have been carried out to fulfill the gape for conducting high throughput research in date palm. In recent genomic era, date palm has been subjected to intensive research on genome sequencing. Historically, the first report on nuclear genome sequence of date palm was published in 2011 (Al-Dous *et al.,* 2011). Unfortunately, it covered only ~60% of the genome which represent ~380 Mb (25,059 genes) out of the 658 Mb estimated genome size. However, as a result, they recognized more than 3.5 million polymorphic sites among the nine investigated varieties of date palm (Al-Mssallem *et al.,* 2013). Subsequently, Al-Mssallem *et al*. (2013) has reported the second nuclear genome assembly which is about 605.4 Mb and covers 90% of the date palm genome. To refine the sequencing in terms of complete genome with maximum coverage, a recent report on a whole genome assembly was reported by Hazzouri *et al*. (2015). In this study, they have sequenced 62 cultivars at whole genome level and identified the SNP markers to decipher the population structure in date palm which revealed the geographical domestication of the date palm. Regarding extracellular component of the genome, Yang *et al*. (2010) has reported first on complete chloroplast genome sequence of date palm. Additionally, mitochondrial genome was also assembled by Fang *et al*. (2012) with an approximate length of about 715,001 bp. In nut shell, date palm genome analysis has provided a detailed view on genome-wide structural parameters of genes, histories of genome/gene duplications, genetic diversities of cultivar resources and functional genes in key functional categories. These genomic resources of date palm have high scientific value to generate the complete set of genomic resources, understanding the genome to develop biotechnological interventions.

Genetic transformation and genetic engineering

The sustainable production of date palm is hampered by various challenges including loss of gene pool and climate change. The adverse climatic conditions are the major concern in date palm cultivation and due to the climatic changes, several new diseases and insect-pests have emerged (Saker, 2011). A lot of techniques such as *in-vitro* propagation, tissues culture, somaclonal variation, breeding efforts have been adopted to improve the date palm to overcome the yield and quality reducing factors. However, the efforts carried out were not gained the signified success in these aspects.

The availability of conclusive reports on the expression of economically important transgenes in date palm is very limited so far. The technology towards successful transformation proved to be a more difficult one in date palm. Therefore, the introduction of foreign genes or gene of interest into date palm using genetic engineering is a complex task. However, availability of some successful transformation protocols (Aslam *et al.,* 2015) and genomic resources (Al-Khayri *et al.,* 2015) have created the ways for development of transgenic date palm. The successful infection of embryogenic callus of date palm with *Agrobacterium*, led to the development of the genetic transformation method (Saker *et al.,* 2009). Subsequently, few efforts on successful genetic transformation in date palm have been carried out in recent past (Mousavi *et al.,* 2014; Hassan, 2013; Allam *et al.,* 2017; Solliman *et al.,* 2017). In these reports, the transformation was mainly carried out by using particle bombardment method. The particle bombardment method has several limitations and thus not much reliable method. To overcome the drawbacks of this transformation method, Aslam *et al.* (2015) has made an *Agrobacterium* mediated transformation in date palm. Though, it requires some tissue culture practices to regenerates the transgenic plants which are bit laborious in nature and required technical skills. These efforts can be the fundamental basis for developing protocols of genetic transformation and expressing the agro-economical transgenes in date palm.

In a very recent report, endotoxin *cry3Aa* gene has been transformed into date palm against the coleopteran insect (Badr-Elden *et al.,* 2017). It was found that one transgenic embryogenic callus for both Medjool and Khalas showed a single copy of gene integration. Thus, the report signifies the successful genetic transformation of date palm plant. In a another study, a construct harboring a cholesterol oxidase gene, which renders plants resistance to insect attack, was also introduced into embryogenic date palm callus using particle bombardment system. The tree is a target host for several biotic and abiotic stresses; hence it is necessary to focus on its *genetic transformation* and genetic engineering to overcome these problems in future. However, the transgenic date palm is very far for its releasing as commercial cultivation.

Future prospective

Though, genomic developments in date palm have been flourished in recent past. A sufficient knowledge and scientific informations are gathered by various groups. However, to conduct a high through put research on improvement of date palm, it still needs more emphasis on genomic and biotechnological interventions for crop improvement point of view. The genome editing techniques such as zinc finger nucleases (ZFNs), transcription activator-like effector nucleases (TALENs), and the contemporary clustered regularly interspaced short palindromic repeats (CRISPR) along with CRISPR-associated protein 9 (Cas9) have established their hierarchy in editing plant genomes. It has been successfully applied, either transiently or through stable transformation, for precise genome editing and knockout mutations in the citrus plants (Jia and Wang, 2014), populous (Fan *et al.,* 2015; Zhou *et al.,* 2015), and apple (Nishitani *et al.,* 2016).

Nevertheless, no GE tool has been exploited in date palm genome engineering. The date palm has ability to grow under extremely adverse climatic conditions such as drought, heat, and relatively high levels of salinity. It is imperative that the nature of the existing salt-adaptation mechanism be understood in order to develop future date palm varieties that can tolerate excessive soil salinity. The application of a full range of OMICS technologies, coupled with reverse genetics approaches, aimed toward understanding the stress-adaption mechanism in the date palm. Information generated by these analyses should highlight transcriptional and post-

transcriptional modifications controlling the stress-adaptation mechanisms. As an extremophile with a natural tolerance to a wide range of stresses, the date palm may represent potential and novel genetic resources for understanding the mechanisms of stress tolerance.

Previously, biotechnological approaches, such as plant tissue culture, marker-assisted breeding and DNA finger printing, have been used in date palm genomics but failed to bring a significant improvement. Additionally, conventional breeding programmes in date palm are not cost effective as it need three backcrosses, thus usually takes long time (30 years) for breeding. For the sustainability of date palm, employment of new techniques in date palm breeding programs is highly needed to develop tolerant varieties and enrich the existing germplasm. The genome editing of date palm against various biotic and abiotic stresses can be the way forward to overcome these problems. The modified genome of date palm can regulate the defensive pathway accordingly to create resistance against various pests and diseases. Further, deciphering of genomic information in date palm would help in understanding the role of various genes involved in sex determination, enzymatic reactions controlling fruit ripening, fruit sweetness and other fruit quality parameters. In order to determine the universal efficacy of CRISPR/Cas9, extensive investigation in date palm is also necessary.

References

Abdallah, A.B., Sitti, K., Leporive, P. and Du Jardin, P. 2000. Identification de cultivars de palmier dattier (*Phoenix dactylifera* L.) par l'amplification aleatoire d'AND (RAPD). *Cahiers Agricultures,* 9:103107.

Al-Ameri, A.A., Al-Qurainy, F., Gaafar, A.Z., Khan, S.and Nadeem, M. 2016. Molecular identification of sex in *Phoenix dactylifera* L. using inter simple sequence repeat markers. *Biomed Research International,* 2016:15.

Ageez, A. and Madboly, E.A. 2011. Identification of male specific molecular markers in date palm sewi cultivar. *Egyptian Journal of Genetics And Cytology*, 40:201-214.

Al-Dous, E.K., George, B., Al-Mahmoud, M.E., Al-Jaber, M.Y., Wang, H., Salameh, Y.M., Al-Azwani, E.K., Chaluvadi, S., Pontaroli, A.C., De Barry, J., Arondel, V., Ohlrogge, J., Saie, I.J., Suliman-Elmeer, K., Bennetzen, J.L., Kruegger, R.R. and Malek, J.A. 2011. *De novo* genome sequencing and comparative genomics of date palm (*Phoenix dactylifera*). *Nature Biotechnology,* 29:521527.

Al-Faifi, S.A., Migdadi, H.M., Algamdi, S.S., Khan, M.A., Al-Obeed, R.S., Ammar, M.H. and Jakse, J. 2017. Analysis of expressed sequence tags (EST) in Date Palm. In: Al-Khayri, J., Jain, S., Johnson, D. (eds) Date Palm Biotechnology Protocols Volume II. Methods in Molecular Biology, Vol 1638. Humana Press, NY.

Al-Faifi, S.A., Migdadi, H.M., Algamdi, S.S., Khan, M.A., Al-Obeed, R.S., Ammar, M.H. and Jakse, J. 2017. Development of Genomic Simple Sequence Repeats (SSR) by Enrichment Libraries in Date Palm. In: Al-Khayri J, Jain S, Johnson D (eds) Date Palm Biotechnology Protocols Volume II. Methods in Molecular Biology, Vol 1638 Humana Press, NY.

Alhaider, I.A., Mohamed, M.E., Ahmed, K.K.M. and Kumar, A.H.S. 2017. Date Palm (*Phoenix dactylifera*) Fruits as a Potential Cardioprotective Agent. The Role of circulating progenitor Cells. *Frontiers in pharmacology,* 8:592.

Al-Khalifah, N.S. and Shanavaskhan, A.E. 2017. Molecular Identification of date palm cultivars using random amplified polymorphic DNA (RAPD) Markers. In: Al-Khayri J, Jain S, Johnson D (eds). Date palm Biotechnology Protocols Volume II. Methods in Molecular Biology, Vol 1638. Humana Press, NY.

Al-Khayri, J.M., Jain, S.M. and Johnson, D.V. 2015. Preface. In: Al-Khayri J M, Jain S M, Johnson D V (eds) Date palm genetic resources and utilization. Springer, Dordrecht pp. 5-6.

Allam, M.A. and Saker, M.M. 2017. Microprojectile bombardment transformation of date palm using the insecticidal cholesterol oxidase (*ChoA*) Gene. In: Al-Khayri J, Jain S, Johnson D (eds). Date palm Biotechnology Protocols Volume I. Methods in Molecular Biology, Vol 1637. Humana Press, NY.

Al-Qurainy, F., Khan, S., Nadeem, M., Tarroum, M. and Gaafar, A-R. Z. 2017. Antioxidant system response and cDNA-SCoT marker profiling in *Phoenix dactylifera* L. Plant under Salinity Stress. *International Journal of Genomics,* 2017:1537538.

Andersen, J.B. and Lubberstedt, T. 2008. Functional markers in plants. *Trends in Plant Science,* 8:554560.

Aslam, J., Khan, S.A. and Azad, M.A.K. 2015. *Agrobacterium*-mediated genetic transformation of Date Palm (*Phoenix dactylifera* L.) cultivar "Khalasah" via somatic embryogenesis. *Plant Science Today*, 2:93-101.

Atia, M.A.M., Adawy, S.S. and El-Itriby, H.A. 2017. Date Palm sex differentiation based on Fluorescence In Situ Hybridization (FISH). *Methods in Molecular Biology,* 1638:245-256.

Awan, F.S., Maryam, Jaskani M.J. and Sadia, B, (2017). Gender identification in Date Palm using molecular markers. In: Al-Khayri, J., Jain, S., Johnson, D. (eds) Date Palm Biotechnology Protocols Volume II. Methods in Molecular Biology, Vol 1638. Humana Press, NY.

Chen, C.X., Bowman, K.D., Choi, Y.A., Dang, P.M., Rao, M.N., Huang, S., Soneji, J.R., McCollum, G. and Gmitter, F.G.J.R. 2008. EST-SSR genetic maps for *Citrus sinensis* and *Poncirus trifoliate*. *Tree Genetics and Genomes,* 4:110.

Dhawan, C., Kharb, P., Sharma, R., Uppal, S. and Aggarwal, R.K. 2013. Development of male-specific SCAR marker in Date Palm (*Phoenix dactylifera* L.). *Tree Genetics and Genomes,* 9:11431150.

Durand, J., Bodénès, C., Chancerel, E., Frigerio, J.M., Vendramin, G., Sebastiani, F., Buonamici, A.,

Gailing, O., Koelewijn, H.P., Villani, F., Mattioni, C., Cherubini, M., Goicoechea, P.G., Herrán, A., Ikaran, Z., Cabané, C., Ueno, S., Alberto, F., Dumoulin, P.Y., Guichoux, E., de Daruvar, A., Kremer, A. and Plomion, C. 2010. A fast and costeffective approach to develop and map EST-SSR markers: oak as a case study. *BMC Genomics,* 11:570.

El Hadrami, A. and Al-Khayri, J.M. 2012. Socioeconomic and traditional importance of date palm. *Emirates Journal of Food and Agriculture,* 24:371385.

El Hadrami, A., Daayf, F., Elshibli, S., Jain, S.M. and El Hadrami, I. 2011. Somaclonal Variation in Date Palm. In: Jain, S.M. (eds.), Date Palm biotechnology, pp183-203, Springer.

EL-Din Solliman, M., Mohasseb, H.A.A, Al-Khateeb, A.A., Al-Khateeb, S.A., Chowdhury, K., El-Shemy, H.A. and Aldaej, M.I. 2017. Identification and sequencing of Date-SRY Gene: A novel tool for sex determination of date palm (*Phoenixdactylifera* L.). *Saudi Journal of Biological Sciences,* (In press).

Fang, Y., Wu, H., Zhang, T., Yang, M., Yin, Y., Pan, L., Yu, X., Zhang, X., Hu, S., Al-Mssallem, I.S. and Yu, J. 2012. A complete sequence and transcriptomic analyses of Date Palm (*phoenix dactylifera* l.) mitochondrial genome. *PLoS ONE,* 7:e37164.

FAOSTAT, 2017. http://www.fao.org/faostat/

Giovino, A., Bertolini, E., Fileccia, V., Al Hassan, M., Labra, M. and Martinelli, F. 2015. Transcriptome analysis of *Phoenix canariensis* Chabaud in response to *Rhynchophorus ferrugineus* Olivier attacks. *Frontiers in Plant Science,* 6:817.

Hamwieh, A., Farah, J., Moussally, S., Al-Shamaa, K., Almer, K., Khierallah, H., Udupa, S., Lababidi, S., Malek, J., Aaouine, M. and Baum, M. 2010. Development of 1000 microsatellite markers across the date palm (*Phoenix dactylifera* L.) genome. *Acta Horticulturae,* 882:269277.

Hassan, L. 2013. Successful genetic transformation in date palm (*Phoenix dactylifera* L.). *Journal of the Bangladesh Agricultural University*, 11:171176.

Hazzouri, K.M., Flowers, J.M., Visser, H.J., Khierallah, H.S., Rosas, U., Pham, G.M., Meyer, R.S., Johansen, C.K., Fresquez, Z.A., Masmoudi, K., Haider, N., El Kadri, N., Idaghdour, Y., Malek, J.A., Thirkhill, D., Markhand, G.S., Krueger, R.R., Zaid, A. and Purugganan, M.D. 2015. Whole genome re-sequencing of Date Palms yields insights into diversification of a fruit tree crop. *Nature Communications*, 6:8824.

Al-Mssallem, I.S., Hu, S., Zhang, X., Lin, Q., Liu, W., Tan, J., Yu, X., Liu, J., Pan, L., Zhang, T., Yin, Y., Xin, C., Wu, H., Zhang, G., Abdullah, M.M.B., Huang, D., Fang, Y., Alnakhli, Y.O., Jia, S., Yin, A., Alhuzimi, E.M., Alsaihati, B.A., Al-Owayyed, S.A., Zhao, D., Zhang, S., Al-Otaibi, N.A., Sun, G., Majrashi, M.A., Li, F., Tala, Wang, J., Yun, Q., Alnassar, N.A., Wang, L., Yang, M., Al-Jelaify, R.F., Liu, K., Gao, S., Chen, K., Alkhaldi, S.R., Liu, G., Zhang, M., Guo, H. and Yu, J. 2013. Genome sequence of the Date Palm *Phoenix dactylifera* L. *Nature Communications*, 4:2274.

Jain, S.M. 2012. Date palm biotechnology: current status and prospective-an overview. *Emirates Journal of Food and Agriculture,* 24:386399.

Kharb, P. and Mitra, C. 2017. Early sex identification in Date Palm by male-specific sequence-characterized amplified region (SCAR) markers. In: Al-Khayri J, Jain S, Johnson D (eds) Date Palm biotechnology protocols Vol II. Methods in Molecular Biology, Vol 1638 Humana Press, NY.

Palliyarakkal, M.K., Ramaswamy, M. and Vadivel, A. 2011. Microsatellites in palm (Arecaceae) sequences. *Bioinformation,* 7:347.

Mahmoudi, H., Hosseininia, G., Azadi, H. and Fatemi, M. 2008. *Enhancing date palm processing, marketing and pest control through organic culture. Journal of Organic Systems,* 3:2939.

Maryam, M.J.J., Awan, F.S., Ahmad, S. and Khan, I.A. 2016. Development of molecular method for sex identification in date palm (*Phoenix dactylifera* L.) plantlets using novel sex-linked microsatellite markers. *3 Biotech*., 6:22.

Mokhtar, M.M., Adawy, S.S., El-Assal, S.E.D.S. and Hussein, E.H.A. 2016. Genic and intergenic SSR database generation, SNPs determination and pathway annotations, in date palm (*Phoenix dactylifera* L.). *PLoS ONE,* 11:e0159268.

Mousavi, M., Mousavi, A., Habashi, A.A. and Dehsara, B. 2014. Genetic transformation of date palm (*Phoenix dactylifera* L. cv. 'Estamaran') via particle bombardment. *Molecular Biology Reports,* 41:81858194.

Nixon, R.W. (1951). The date palm-"Tree of Life" in the subtropical deserts. *Economic Botany,* 5:274301.

Qi, X.L., Cui, F., Li, Y., Ding, A.M., Li, J., Chen, G.L. and Wang, H.G. 2010. Molecular tagging wheat powdery mildew resistance gene *pm21* by EST-SSR and STS markers. *Molecular Plant Breeding*, 1: 10.5376/mpb.2010.01.0004.

Radwan, O., Arro, J., Keller, C. and Korban, S. 2015. RNA-Seq transcriptome analysis in date palm suggests multi-dimensional responses to salinity stress. *Tropical Plant Biology,* 8:7486.

Ramchiary, N., Nguyen, V.D., Li, X.N., Hong, C.P., Dhandapani, V., Choi, S.R., Yu, G., Piao, Z.Y. and Lim, Y.P. 2011. Genic microsatellite markers in *Brassica rapa*: development, characterization, mapping, and their utility in other cultivated and wild *Brassica* ralatives. *DNA Research,* 18: 305320.

Saker, M.M. 2011. Transgenic date palm. In: Jain, S.M., Al-Khayri, J.M., Johnson, D.V. (eds) Date Palm biotechnology. Springer, Dordrecht, pp 631650.

Saker, M., Ghareeb, H. and Kumlehn, J. 2009. Factors influencing transient expression of Agrobacterium - mediated transformation of *GUS* gene in embryogenic callus of date palm. *Advances in*

Horticultural Science, 23:150-157.

Siljak-Yakovlev, S., Cerbah, M., Sarr, A., Benmalek, S., Bounaga, N., Coba de la Pena, T. and Brown, S.C. (1996). Chromosomal sex determination and heterochromatin structure in date palm. *Sexual Plant Reproduction,* 9:127132.

Solliman, M.E.D.M., Mohasseb, H.A., Al-Khateeb, A.A., Al-Khayri, J.M. and Al-Khateeb, S.A. 2017. Transient *GUS* gene expression in Date Palm fruit using Agroinjection transformation technique. In: Al-Khayri, J., Jain, S., Johnson, D. (eds) Date Palm biotechnology protocols volume I. Methods in molecular biology, Vol 1637. Humana Press, NY.

Sun, G. 2012. Micro RNAs and their diverse functions in plants. *Plant Molecular Biology,* 80:1736.

Trifi, M., Rhouma, A. and Marrakchi, M. 2000. Phylogenetic relationships in Tunisian date-palms (*Phoenix dactylifera* L.) germplasm collection using DNA amplification fingerprinting. *Agronomie,* 20:665671.

Varshney, R.K., Graner, A. and Sorrells, M.E. 2005. Genic microsatellite markers in plants: features and applications. *Trends in Biotechnology,* 23:4855.

Wrigley, G. 1995. Date palm, In: J. Smartt and N.W. Simmonds (eds.). Evolution of crop plants. 2nd ed. Longman Group, Essex, UK pp. 399403.

Xiao, Y., Xia, W., Yang, Y., Mason, A.S., Lei, X. and Ma, Z. 2013. Characterization and evolution of conserved microRNA through duplication events in Date Palm (*Phoenix dactylifera*). *PLoS ONE,* 8:e71435.

Xin, C., Liu, W., Lin, Q., Zhang, X., Cui, P., Li, F., Zhang, G., Pan, L., Al-Amer, A., Mei, H., Al-Mssallem, I.S., Hu, S., Al-Johi, H.A and Yu, J. 2015. Profiling microRNA expression during multi-staged date palm (*Phoenix dactylifera* L.) fruit development. *Genomics,* 105:242251.

Yaish, M.W. and Kumar, P.P. 2015. Salt tolerance research in Date Palm tree (*Phoenix dactylifera* L.), past, present and future perspectives. *Frontiers in Plant Science,* 6:348.

Yaish, M.W., Antony, I. and Glick, B.R. 2015. Isolation and characterization of endophytic plant growth-promoting bacteria from Date Palm tree (*Phoenix dactylifera* L.) and their potential role in salinity tolerance. *Antonie Van Leeuwenhoek,* 107:1519-1532.

Yaish, M.W., Patankar, H.V., Assaha, D.V.M., Zheng, Y., Al-Yahyai, R. and Sunkar, R. 2017. Genome-wide expression profiling in leaves and roots of Date Palm (*Phoenix dactylifera* L.) exposed to salinity. *BMC Genomics,* 18:246.

Yaish, M.W., Sunkar, R., Zheng, Y., Ji, B., Al-Yahyai, R. and Farooq, S.A. 2015. A genome-wide identification of the miRNAome in response to salinity stress in Date Palm (*Phoenix dactylifera* L.). *Frontiers in Plant Science,* 6:946.

Yang, M., Zhang, X., Liu, G., Yin, Y., Chen, K., Yun, Q., Zhao, D., Al-Mssallem1, I.S. and Yu, J. 2010. The complete chloroplast genome sequence of Date Palm (*Phoenix dactylifera* L.). *PLoS ONE,* 5:e12762.

Zhang, J., Yang, W., Cui, X., Yu, H., Jin, H., Chen, Z. and Shen, T. 2011. Breeding strains of *Panax notoginsent* by using EST-SSR markers. *Zhongquo Zhong Yao Za Zhi,* 36:97101.

Zhao, Y., Williams, R., Prakash, C. and He, G. 2012. Identification and characterization of gene-based SSR markers in Date Palm (*Phoenix dactylifera* L.). *BMC Plant Biology,* 12:237.

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Proximate analysis of processed and unprocessed samples for development of quality composite flour

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Abstract

The present investigation was carried out in the Department of Food Science and Nutrition at Mangalore University, Konaje, Mangalore (Karnataka) during 2017-18. To develop quality composite flour, ingredients like; whole wheat (*Triticum aestivum*), little millet (*Panicum sumatrense*), moth bean (*Vigna aconitifolia*) and mango ginger (*Curcuma amada*) were used. The samples were divided into two categories *i.e.* batch 1 consisting of washed and sundried whole wheat, little millet, moth bean and mango ginger flours and batch 2 consisting of washed, soaked, sprouted and sundried whole wheat, little millet and moth bean flours. Whereas, mango ginger powder was prepared directly after proper cleaning and drying. Based on proximate analysis, the processed sample (batch 2) was selected, where crude fibre, total protein and iron content were higher than unprocessed sample (batch 1). The processed sample was further divided in to two batches based on composition of ingredients. The ratios of different ingredients *i.e*. flour of whole wheat, little millet, moth bean and mango ginger for batch-1 were 50:20:20:10 (Batch 1) and for batch-2 30:30:30:10 (Batch 2), respectively. The comparative studies of both batches further revealed that the composite flour developed in the ratio of 30:30:30:10 of whole wheat, little millet, moth bean and mango ginger, respectively gave better nutritional properties particularly high values of protein, iron, crude fibre, ash content, besides oil absorption and emulsifying activities, which are essential for development of cookies. The replacement of wheat flour and increasing content of little millet and moth bean has improved the quality of composite flour. The use of mango ginger has further added advantage of medicinal properties. From the present investigation, it is suggested that quality composite flour can be prepared by using flour of sprouted whole wheat, little millet, moth bean and mango ginger (un-sprouted) in the ratio of 30:30:30:10, respectively. The cookies prepared by such composite flour will address the problem of anaemia to some extent.

Keywords: Composite flour, cookies, proximate analysis, *Curcuma amada, Panicum sumatrense, Triticum aestivum* and *Vigna aconitifilia*

Introduction

Access and affordability of quality diet to every citizen is a worldwide concern with highest prevalence in developing countries. Nutritional anaemia is a major concern found especially among women of child bearing age, young children, during pregnancy and lactation. It is established that two-third of pregnant and one half of non-pregnant women in developing countries are affected with nutritional anaemia (Swaminathan, 1974). Overall, 72.7 % of children up to the age of three years in urban areas and 81.2 % in rural areas are anaemic (Swaminathan, 1983). By far the most common cause of nutritional anaemia is iron deficiency, and less frequently folate or vitamin-B_{12} (Park, 2017). Iron deficiency can arise due to inadequate intake or poor bioavailability of dietary iron or due to excess losses of iron from the body (Ramchandran, 1978). Women lose considerable amount of iron during menstruation. Some of the other factors leading to anaemia are malaria and hookworm infestations. In addition, mothers who have children at close intervals become anaemic due to additional demands of rapid pregnancies and loss of blood in each delivery. The need for strategic development in the use of inexpensive local resources in the production of staple foods has been promoted by organizations such as Food and Agricultural Organization (FAO) and the United Nations (Awogbenja and Ndife, 2012). This led to the initiation of composite flour programme, the objective of which was to seek ways of substituting flours, starches and protein concentrates from indigenous crops, for as much wheat as possible in baked products (FAO/WHO, 1994).

In fact, composite flours may be considered firstly as blends of wheat and other flours for the production of (1) leavened breads, (2) unleavened baked products, (3) pastas, (4) porridges and (5) snack food or secondly, wholly non-wheat blends of flours or meals, for the same purpose (Chandra *et al*., 2015). The quality of composite flour be supplemented with other locally available cheaper but nutritionally rich ingredients. The legumes usually improve the quality of cereal protein by supplementing them with limiting amino acids such as lysine and sometimes tryptophan and threonine. Among food grains, millets are the cheapest and nutritionally wholesome food for people of all age groups. Besides nutritional properties, the biological activities of mango ginger include antioxidant activity, antibacterial activity, antifungal activity, anti-inflammatory and anti - allergic activity (Policegoudra *et al*., 2011).

For preparation of cookies, the raw material mainly

used is wheat flour, which is most important staple food for more than one third of the world population and contributes more calories and proteins to the world diet than any other cereal crops. It is also an important source of minerals, b-complex, vitamins and dietary fiber (Kumar *et al*., 2011) but generally low in lysine and certain other amino acids. Enrichment of common food products with essential micronutrient especially iron may solve the problem of malnutrition specially anemia. Thus, the formulation of composite flour using whole wheat (cereal), moth bean (pulse), mango ginger (tuber) and little millet (coarse grain) were considered in this investigation as they have a high iron content. The proximate analysis of both processed and unprocessed forms of samples were done to develop composite flour. Further different ratios of composite flour are required to be assessed for standardizing quality composite flour which can be used in preparation of cookies.

Materials and Methods

The investigation was carried out in Department of Food Science and Nutrition at Mangalore University, Mangalore (Karnataka) during 2017-18. The materials and methods used in this investigation are given here under;

(a). For unprocessed and processed samples

In this investigation, all ingredients like whole wheat (*Triticum aestivum*), little millet (*Panicum sumatrense*), moth bean (*Vigna aconitifolia*) and mango ginger (*Curcuma amada*) were procured from a authentic source. The samples were divided into two categories *i.e.* Batch 1 consisting of washed and sundried whole wheat, little millet, moth bean and mango ginger flours and Batch 2 consisting of washed, soaked, sprouted and sundried whole wheat, little millet and moth bean flours. Whereas, mango ginger powder was prepared directly after proper cleaning and drying. The proximate nutritional properties like; total moisture content, ash content, crude fiber, total carbohydrate, total protein, total carbohydrates and iron were studied by following standard methods of (AOAC, 2000).

To determine moisture content of every ingredients, 3g of the sample was weighed in a previously dried petriplate and placed in the oven for 75 minutes. The time was reckoned from the moment the oven attained 120^{0} C after the dishes have been placed. After 75 minutes, the samples were taken out of the oven, cooled and weighed. The sample was placed in oven at half hour intervals until constant weight was achieved. The moisture content was calculated using standard formula and expressed in percentage**.**

$$\text{Moisture content (\%)} = \frac{\text{Initial weight-Final weight}}{\text{Initial weight}} \times 100$$

For total ash content, 1g of sample was weighed accurately into a crucible (which was previously heated to about 600^{0}C and cooled) the crucible was placed on a clay pipe triangle and heated first over a low flame till all the material was completely charred, followed by heating in a muffle furnace for about 3-5 hours at 600^{0}C. It was then cooled and weighed. To ensure completion of ashing, the crucible was again heated in a muffle furnace for half an hour, cooled and weighed. This was repeated till two consecutive weights were obtained as almost equal and the ash was white or grayish white in color. The total ash content was calculated using standard formula and expressed in percentage;

$$\text{Percentage ash content (wet basis)} = \frac{\text{Weight of crucible with ash-Weight of crucible}}{\text{Weight of crucible with sample-Weight of crucible}} \times 100$$

$$\text{Percentage ash content (dry basis)} = \frac{\text{Percentage ash content (wet basis)}}{\text{100-Percentage of moisture}} \times 100$$

To determine total crude fibre, 2 g of sample was boiled with 200 ml of sulphuric acid for 30 minutes. It was filtrated through muslin cloth and washed with boiling water until washing was no longer acidic. It was further boiled with 200 ml of sodium hydroxide for 30 minutes, filtered again through muslin cloth and washed with water ensuring it is no longer alkaline. The residue was removed and transferred to ashing dish (pre weighed dish W_1). The residue was dried at 120±2 ^{0}C for 2 hours, cooled and weighed (W_2). It was ignited at 600±15 ^{0}C for 30 minutes, cooled and weighed (W^3). The percentage of crude fibre in ground sample was calculated using standard formula;

$$\text{Crude fibre (\%)} = \frac{\text{Loss in weight on ignition (W2-W1)-(W3-W1)}}{\text{Weight of sample (g)}} \times 100$$

The total lipid content was determined where 0.5 g of oven dried culture was homogenized with 5 ml of chloroform methanol mixture (2:1) and filtered. The extraction was repeated thrice with the residue till the filter paper was made free from the lipids. To the filtrate, 4 ml of distilled water was added and mixed well. The water soluble impurities were diffused away from the solvent and reached the top position in the separating funnel. Solvent containing lipid (bottom layer) was collected. This filtrate was transferred to the pre-weighed beaker and was dried using an evaporator and thereafter final weight was determined. The difference in initial and final weight gave the total lipid content and expressed in percentage of dry weight.

The total protein content was quantified by TCA acetone extraction. Adopting this method, 2g of fine ground sample was treated with 10 ml of cold TCA-2Mercaptoethenol acetone solution and incubated at a temperature of -20 ^{0}C for one hour. It was then centrifuged at 5000 rpm for 15 minutes and the supernatant was discarded. The pellet was dried and the precipitate was treated with 10% TCA. Then, it was centrifuged to settle the precipitate and the supernatant was discarded. The pellet was re-suspended in 2N sodium hydroxide solution. Thereafter, 0.2, 0.4, 0.6, 0.8 and 1.0 ml of working standard was pipette out into a series of test tubes. The amount of protein present in the sample was calculated using BSA graph and expressed in g 100g^{-1}. Similarly, total carbohydrate content was calculated by Phenol-sulphuric acid method, where 100 g of sample was weighed in a test tube. It

was hydrolyzed by keeping in boiling water bath for three hours with 5 ml of 2.5N HCl and cooled to room temperature. It was neutralized with solid sodium carbonate until effervescence ceases. The volume was made up to 100 ml and centrifuged. The supernatant was collected and 0.2 ml aliquots were used for analysis. One ml of phenol solution was added to each sample and mixed well. After 10 minutes, the content in the test tube were placed in water bath at 25-30 ^{0}C for 20 minutes. Absorbance was measured at 490 nm. The blank was set using 1.0 ml of distilled water. The amount of total carbohydrate present in the sample was calculated using glucose standard graph.

For determination of iron content, 5g of powdered sample was taken in a porcelain crucible and heated over a flame till all the material was completely charred. It was followed by heating in a muffle furnace for about 3-5 hours at 600^{o}C. Then the sample was cooled, moistened with 1 ml distilled water and ash was collected. 5 ml of HCI was added, evaporated to dryness on boiling water bath and this step was repeated again. Then added 4 ml HCI and 1ml distilled water and warmed. It was then filtered into 50 ml volumetric flask cooled and made up the volume. The aliquots were used for estimation of iron in ash solution. 1ml - 5 ml of standard solutions were pipetted out into a series of test tubes. The volume was made up to 5 ml by adding distilled water. Blank is prepared by adding 5 ml of distilled water in a test tube. Test is prepared by taking 1 ml of test solution in test tube and made up to 5 ml using distilled water. Then 30% sulphuric acid was added to all the test tubes making the volume up to 6 ml. Then 1 ml of Potassium persulphate solution and 1.5 ml of Potassium thiocyanate was added to all the test tubes and then incubated for 20 minutes at room temperature. The intensity of the standard is observed at 540 nm against blank. The amount of iron (ferric form) in the sample was calculated using standard curve and expressed as mg/100g of the sample.

(b.) *For composite flour development*

After proximate analysis of both batches samples, the composite flour was developed from processed samples only. Two formulations were made by mixing the ingredients in different ratios. The batch 1 was in the ration of 50:20:20:10 for wheat, moth bean, little millet and mango ginger respectively while the batch 2 was in the ratio of 30:30:30:10 for wheat, moth bean, little millet and mango ginger respectively. The functional properties like bulk density, water and oil absorption capacity, foaming properties, emulsifying properties, swelling properties, percentage solubility, least gelation property of formulated composite flours in different ratios were also studied. While determining, bulk density 100g of the flour by volume was measured in measuring cylinder (250ml) after tapping the cylinder on laboratory slab until no visible decrease in volume was noticed, and based on the weight and volume the bulk density was calculated. The water and oil absorption, foaming capacity and stability, emulsifying activity and stability, swelling power and percent solubility as well as gelation property were determined using standard methods.

Results and Discussion

Proximate analysis of samples

The proximate analysis for different nutritional parameters was carried out for all the samples using standard protocols (Table 1). Among different unprocessed samples, moisture content of mango ginger was maximum (85.00%) and dehydrated moth bean was minimum (5.33%) while in processed samples, it was maximum in wheat (9.70%) and minimum in little millet (6.45%). In fact, moisture determination is one of the most common tests in foods since the water content in foods has an important relationship between shelf life and the chemical, physical and microbiological changes during the storage (Sampaio *et al*.,

Table 1. Nutritional composition of unprocessed and processed samples.

Samples	Moisture (%)		Ash (%)		Crude fibre (%)		Total lipid (%)		Total protein (%)		Total carbohydrate (%)		Iron (mg/100g)	
	US*	PS**	US	PS	US	PS	US	PS	US	PS	US	PS	US	PS
Wheat	7.15	9.70	1.43	1.36	1.71	1.93	1.65	0.95	7.71	8.65	82.30	72.29	3.56	3.68
Moth bean	5.32	8.11	3.66	3.37	4.49	5.06	1.12	0.96	20.60	24.24	56.86	37.05	9.08	10.26
Little millet	6.43	6.45	1.72	1.70	6.41	6.87	2.54	1.23	8.93	8.98	60.53	60.03	7.00	7.40
Mango ginger	85.00	7.22	1.30	0.90	1.00	1.20	1.06	1.01	1.30	1.10	10.00	9.81	3.00	3.00
Mean	29.98	7.87	2.03	1.83	3.40	3.76	1.59	1.04	9.64	10.74	52.42	44.80	6.32	6.07
SD±	39.36	1.40	1.10	1.08	2.51	2.66	0.69	0.13	8.04	9.71	30.43	27.52	3.90	3.39

* US=Unprocessed Samples; ** PS=Processed Samples

2009). In general, moisture content was more in processed samples than unprocessed samples except mango ginger. The ash content was maximum (3.66% and 3.37%) in moth bean and minimum mango ginger (1.03 % and 0.90%), both in unprocessed and processed samples, respectively. The ash content mainly refers to the amount of mineral present in food. The crude fibre content increased in processed samples than unprocessed. The maximum crude fibre content was found in processed little millet (6.87%) followed by moth bean (5.06%) and minimum in mango ginger (1.20%). High fiber content is beneficial for healthy gut, proper absorption of nutrients and also in lowering glucose and cholesterol levels (Tosh and Yada, 2010). The total lipid content was higher in unprocessed samples than processed samples with maximum value of total lipid was 2.54% in little millet and minimum in processed wheat i.e.0.95%. Fat is essential for health but it is important to know the fatty acid profile of foods since a high intake of saturated fat contributes to the development of coronary heart disease and trans fatty acids have also been associated with adverse effects, such as raising low density lipoprotein cholesterol (LDL) and lowering high density lipoprotein cholesterol (HDL) (Tavella, *et al*., 2000).

In general protein content increased in processed samples than unprocessed sample except mango ginger. The protein content of sprouted moth bean was maximum (24.24%), where as it is minimum in mango ginger (1.10%). High protein content has a nutritional importance in most developing countries, where many people especially children can rarely take adequate foods with high protein content because of the costs (Edem, *et al*., 2001), whereas high protein content may be harmful for people suffering from kidney diseases. Among different samples, the carbohydrate content of sun dried wheat sample was maximum (82.3%) and dried mango ginger was minimum (9.81%). This is beneficial for the development of composite flour as the wheat was partially replaced by ingredients such as mango ginger, moth bean and little millet which have lower carbohydrate content than wheat flour, thus decreasing the calories obtained from carbohydrate. The iron content in processed sample was also increased in all ingredients except mango ginger. The highest iron content of processed samples was in moth bean (10.26 mg) followed by little millet (7.40 mg), wheat (3.68 mg) and minimum in mango ginger (3.0 mg). This is only because the sprouted ingredients synthesized more iron in presence of light than unprocessed samples. The mean and standard deviation values showed that there was high variation in different nutritional composition of samples used in present study. This was primarily due genetically dissimilar ingredients were taken for the development of composite flour without compromising with major nutritional composition and added advantage of medicinal attributes by using mango ginger. Overall, processed samples were better than unprocessed samples in view of increased fibre, protein and iron content. Thus, for development of composite flour only processed samples were considered.

Evaluation of composite flour

The nutritional, functional, foaming and emulsifying properties of composite flour was also assessed for both batches separately. The data presented in table 2 shows that average moisture content of batch 2 was higher (3.51%) than batch 1 (2.55%). This is only due to lowering the ratio of wheat flour and increasing the ratio of moth bean and little millet. Low moisture content is beneficial as it ensures long shelf life of the food product (Hussein, *et al*., 2006). The average ash content of batch 2 was also higher (3.69%) than batch 1 *i.e*.,

Table 2. Nutritional, functional, foaming and emulsifying properties of composite flour.

Parameters	Nutritional value		
	Batch-1 (50:20:20:10)	Batch-2 (30:30:30:10)	Percent change Bach-1 over Bach-2
Moisture content (%)	2.55	3.51	+27.35
Ash content (%)	2.92	3.69	+20.87
Crude fibre (%)	2.07	2.78	+25.54
Crude Lipid (%)	6.59	8.31	+20.70
Total carbohydrates (%)	65.22	62.21	-4.62
Total protein (%)	13.94	14.38	+3.06
Total Iron (mg/ 100g)	11.37	18.01	+36.87
Bulk density (g/ml)	6.67	6.67	0.00
Gelation value	36.00	32.00	-11.11
Least percent solubility (%)	0.40	0.40	0.00
Water absorption capacity (ml/ g)	1.80	1.90	+5.26
Oil absorption capacity(ml/ g)	0.60	1.00	+40.00
Foam capacity (%)	10.00	10.00	0.00
Foam stability (%)	40.00	40.00	0.00
Swelling power (g/g)	0.82	0.40	-51.22
Emulsifying activity (%)	1.13	1.16	+2.59
Emulsifying stability (%)	50.00	51.00	+1.96

2.92%. High ash content can be attributed to increase in mineral content (Hussein *et al*., 2006) as the amount of moth bean and little millet flour increased and the amount of wheat flour decreased in batch 2. The average crude fiber content was higher in batch 2 (2.78%) than batch 1 (2.07) which is beneficial for healthy gut, proper absorption of nutrients and also in lowering glucose and cholesterol levels. The average crude lipid content was also high in batch 2 (8.31%) than batch1 (6.59%). The average carbohydrate content of batch 2 was less (62.21%) than batch 1 (65.22%) mainly due to decreased ratio of wheat flour. The average protein content of batch 2 was higher (14.38%) than batch 1 (13.94%). This is only due to higher ratio of moth bean which is low in carbohydrate and high in protein content. Higher total protein content (14.38%) was recorded in batch 2 than batch 1 (13.94%) because of the higher protein containing ingredient. The average iron content of batch 2 was higher (18.01mg) than batch 1 (11.37mg) which fulfils the main purpose of development of iron rich composite flour.

In the present study, various functional properties of flours were also analyzed. The bulk density remained unchanged which was 6.67g/ml for both batches. The bulk density depends on particle size and initial moisture content of flours. The high bulk density suggests their suitability in food preparations. In contrast, low bulk density would be an advantage in the formulation of complementary foods. The gelation value for batch 2 was lower (32%) than batch 1 (36%). The gelling agents in foods are usually polysaccharides and proteins and gelation depends on factors such as temperature, the presence of ions, pH and concentration of gelling agents (Chandra *et al*., 2015). The percentage solubility of both the batches was same *i.e*., 0.4% while water absorption capacity of batch 2 was better (1.9ml/g) than batch 1 (1.8ml/g). High water absorption capacity can be attributed to the presence of high amount of carbohydrate (starch) and fiber in the flour. Water absorption capacity was slightly better in batch 2 which is a critical function of protein in various food products like soups, dough and baked products.

The foaming property was also analyzed with the help of foaming capacity and foam stability for both batches of composite flours. The result showed that foaming capacity as well as the foam stability of both the batches of composite flour was same *i.e*. 10% and 40, respectively. Foam consists of a gaseous phase, a liquid phase and a surfactant. There are different types of foams, among them solid foams are essential for the production of cakes and other baked goods. Swelling property and percentage solubility was also used for analyzing both the flours and it was observed that swelling power of batch 1 was higher (0.82g/g) than batch 2 (0.4g/g).

The oil absorption capacity of batch 2 was higher (1ml/g) than batch 1 (0.6 ml/g). Binding of fat with food components influences the texture and flavor of food. The ability of protein to absorb and retain fat is essential in food formulations such as dough preparation, production of breads, cakes, pastries and doughnuts. Protein being the surface active agents can form and stabilize the emulsion by creating electrostatic repulsion on oil droplet surface. The analysis of emulsion activity (EA) and emulsion stability (ES) of both batches composite flours gave higher emulsion activity of batch 2 (1.16%) than batch 1 (1.13%). The EA of composite flours were found to be significantly increased with decreasing in the proportions of wheat flour. Whereas, emulsion stability can be greatly increased when highly cohesive films are formed by the absorption of rigid globular protein molecules that are more resistant to mechanical deformation. Thus, batch 2 was chosen as quality composite flour which gave better nutritional properties particularly high values of protein, iron, crude fibre, ash content, besides oil absorption and emulsifying activities.

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References

AOAC, 2000. Official Method of Analysis, Association of Official Agricultural Chemists, Washington, D.C. USA, 17th Edition.

Awan, J., Rehman, A., Rehman, S., Siddique, M. and Hashmi, A. 2015. Evaluation of biscuit prepared from composite flour containing moth bean flour. *Journal of Agriculture Science*, 32(1): 199.

Awogbenja, M.D. and Ndife, J. (2012). Evaluation of infant feeding and care practices among mothers in nassarawa egg on local government area of nassrawa state. *Indian Journal of Science Research*, 3(1): 21-29.

Chandra, S., Singh, S. and Kumari, D. 2015. Evaluation of functional properties of composite flours and sensorial attributes of composite flour biscuits. *Journal of Food Science & Technology*, 52 (6): 3681-3688.

Devi, C.B., Kushwaha, A. and Kumae, A. 2015. Sprouting characteristics and associated changes in nutritional composition of cowpea (*Vignaunguiculata*). *Journal of Food Science* and *Technology*, 52(10): 6821-6827.

Edem, D., Ayaste, J. and Itam, E. 2001. Effect of soy protein supplementation on the nutritive value of 'gari' (farina) from Manihot esculenta. *Food Chemistry*, 75: 57-62.

Hussein, H.M., Hussein, M.M. and Danohery, S.T. 2006. The effect of natural formulated functional biscuits on elderly bone health. *Journal of Medical Science*, 6: 937-943.

Kumar, P., Yadava, R.K., Gollen, B., Kumar, S., Verma, R.K. and Yadav, S. 2011. Nutritional contents and medicinal properties of wheat: A Review. *Life Sciences and Medicine Research*, 22:10.

Park, K. 2017. Park's Text Book of Preventive and Social Medicine (24th Edition). Pub. Banarasidas Bhanot Publisher. Pp.1-936.

Policegoudra, R.S., Aradhya, S. M. and Singh, L. 2011. Mango ginger (*Curcuma amanda* Roxb.)- A promising spice for phytochemicals and biological activities. *Journal of Bioscience*, 36(4): 739-748.

Ramchandran, L.K. 1978. Council of Scientific and Industrial Research, New Delhi.

Sampaio, R.M., Marcos, S.K., Moraes, I.C.F. and Perez V.H. 2009. Moisture adsorption behavior of biscuits formulated using wheat, oatmeal and passion fruit flour. *Journal of Food Processing* and *Preservation*, 33(1): 105-133.

Swaminathan, M.S. 1974. Essentials of Food and Nutrition, Pub. Ganesh and Company, Madras, 2017.

Swaminathan, M.S. 1983. Human Nutrition and Diet, Pub. The Bangalore Printing and Publishing Company Limited, Bangalore.

Tavella, M., Peterson. Gracielal, Espeche, M., Cavallero, E., Cipolla, L., Perego, Luis and Caballera, B. 2000. Trans fatty acid content of a selection of foods in Argentina. *Food Chemistry*, 69(2): 209-213.

Tosh, S.M. and Yada, S. 2010. Dietary fibers in pulse seeds and fractions: Characterization, functional attributes and applications. *Food Research International*, 43: 450-460

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Integrated management of Graphiola leaf spot (*Graphiola phoenicis*) in tissue cultured date palm saplings during plant hardening stage

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Abstract

Tissue culture plants of date palm cultivar Barhee produced through somatic embryogenesis at AAU, Anand were primarily hardened and supplied to ICAR- CIAH for secondary hardening and field evaluation. The plants were kept under greenhouse for secondary hardening and further growth and development of plants for achieving transplantable size of plants for field plantation. During the process of plant hardening, the plants were infected by Graphiola leaf spot *(Graphiola phoenicis)* with the symptoms of small spots on both sides of leaves and yellow spore masses on underneath of leaves. The moderate temperature, high humidity inside the green house accompanied by short day and frequently occurrence of fog during winter month favored the development of smut infection. For its management, the leaves of infected plants were pruned out and plants were sprayed weekly with copper oxychloride and bavastin fungicides alternatively. The integrated practices of enhanced photoperiod and light intensity under green house in combination with fungicides application to plants were found very effective to suppress the intensity of disease and its adverse effects on the plants. Using these practices, the plants have been successfully hardened and planted in the field.

Key words: Date palm, graphiola, tissue culture plants.

Introduction

Micropropagation of date palm through somatic embryogenesis and hardening of plantlets are lengthy processes, which require frequent subculturing of several steps and careful attention. Otherwise, casualty rate will be very high. Fifty to ninety percent loss has been reported in date palm plantlets during acclimatization. This disease is caused by the fungal pathogen, *Graphiola phoenicis*. It is a unique fungus, both in appearance and life cycle, but it is widely distributed throughout the date palm-growing world. While numerous palm species have been identified as hosts of this fungus, the disease is most prevalent in Florida on *Phoenix* species, such as *Phoenix canariensis* (Canary Island date palm) and *Phoenix dactylifera* (date palm). It is rarely observed on *Phoenix sylvestris* (wild date palm).

Graphiola leaf spot is caused by *G. phoenicis* (Moug) Poit., which is a smut fungus. It develops sub-epidermal, in small spots on both sides of the pinnae leaves, on the rachis and on the leaf base. The numerous fruiting structures emerge as small-yellow/brown to black sori, 1 to 3 mm in diameter, with two layers. These sori are abundant on three year-old leaves, conspicuous on two year-old, but absent or infrequent on one year-old leaves. This is because of the 10 - 11 month incubation cycle for this pathogen. On a leaf, sori are abundant on apical pinnae, less abundant on the middle section becoming even less on the basal section. The normal 6- 8 year life of date palm fronds will be reduced to 3 years by *Graphiola* disease and heavily infected leaves die prematurely which consequently reduce yield of the palm (Guar, 2000).

Graphiola leaf spot disease is most common in Egypt (Delta region and Fayum) but absent in the less humid oases. In Saudi Arabia, Libya (Edongali, 1996) and Kenya (Kung'u & Boa, 1997), Qatar and Yemen (Sattar et.al 2013), but absent in Iraq. Reports of this disease also originate from Algeria and USA. Around the world it is the most widely spread disease and occurs wherever the date palm is cultivated under humid conditions - mostly marginal date growing areas (Mediterranean coast) but also in the southern most humid regions of Mali, Mauritania, Niger and Senegal.

For field grown palm the control measures Lodha (2003) include leaf pruning coupled with treatment with Bordeaux mixture or any large spectrum fungicide (mancozeb, cupric hydroxide, cupric hydroxide + maneb, or copper oxychloride + maneb + zineb; 3 to 4 applications on a 15-day schedule after, sporulation, have been recommended) . Nixon (1957) and Singh et.al.(1970) reported genetic tolerance in some varieties (Barhee, Adbad, Rahman, Gizaz, Iteema, Khastawy, Jouzi and Tadala) under field condition.

However, no reports are available on the occurrence of smut problem in tissue culture plants of date palm during hardening and its effective control measures.

Materials and Method

Under collaborative project on date palm tissue culture and field demonstration, one hundred sixty plants of Barhee variety were procured from Anand Agricultural University, Anand, Gujarat at secondary hardening stage during the month of November 2015. The plants kept for further hardening, growth and development under greenhouse having temperature 12±2ºC during night and 35±2ºC during day time and 40-60 % RH. During the month of January the plants were infected by Graphiola leaf spot (*Graphiola phoenicis*) with the symptoms of small spots on both sides of leaves and yellow spore masses on underneath of leaves. For its management, the leaves of infected plants were pruned out and plants were sprayed weekly with copper oxychloride 1.0 gm/ l and bavastin 1.0g/l fungicides alone or incombination with extended photoperiod for 16 hrs with 15000 lux light intensity provided by white fluorescent tube lights and incandescent light bulbs. Total 06 spray of fungicides were applied to all plants under experiment.

Result and Discussion

Variation in the incidence of Graphiola leaf spot was clearly observed with all treatments alone or in combination (Table 1). It appears from the study that negligible infection was recorded with combined treatments of Copper oxychloride + Bavastin + Extended photoperiod for 16 hrs and consequently less number of sori on the leaf surface was noticed.

The symptoms (sori) exhibited a drastic reduction of the leaf area covered by the fungus. This is confirmed by Singh et al. (1970), by noticing in reduction in leaf area and decline in chlorophyll level in the leaves due to infection by *Graphiola phoenicis*. Comparison of leaf surface revealed that lower surface of leaf trapped more number of sporidia than the upper surface (Table 1) and therefore, the number of sori was higher and showed significant variation among all treatments. Similarly, the distribution of sori in terms of leaf position was more pronounced to older leaves reported by Lodha (2003).

Temperature ranging from 28-36°C in summer and 10-27°C in winter under green house accompanied by water condensation in the night and early morning hours particularly during winter months were favorable for continue development of infection. According to Sattar et.al.(2013) temperature ranging from 32-38°C in summer and 18-27°C in winter accompanied by heavy dew in the night and early morning hours regardless of duration are favorable for subsequent development of smut infection in date palm.

The improvement of plant health under integerated system by extended photo period over the treatments alone with chemical spray of copper oxychloride and bavostin may be due to enhanced photosynthesis by light under short day and fog conditions prevail in arid region during winter months. Further these results are in close conformity of the findings of Singh et.al.(1970) as reported negative effect of smut on chlorophyll control.

Table 1. Effect of different treatments on smut management, disease incidence and number of sori on both surface of date palm leaves

Treatment	Disease incidence (%)	Number of sori on leaves	
		Upper surface of leaf	Lower surface of leaf
Copper oxychloride	33.33 (35.25)	32.33	42.67
Bavastin	33.33 (35.25)	41.00	62.33
Copper oxychloride + Bavastin	18.33 (25.31)	12.67	20.67
Copper oxychloride+Extended photoperiod for 16 hrs	20.00 (26.57)	0.00	8.00
Bavastin +Extended photoperiod for 16 hrs	13.33 (21.34)	0.00	7.33
Copper oxychloride + Bavastin+ Extended photoperiod for 16 hrs	8.33 (16.60)	0.00	3.67
SEm±	1.23	1.15	24.11
CD5%	3.81	3.53	1.07
CD1%	5.33	4.95	3.30

Table 2. Effect of different treatments on smut management, saplings growth and development

Treatment	Number of leaves per plant	Width of leaves(cm)	Length of leaves (cm)	Plant height
Copper oxychloride	5.33	2.13	20.00	21.33
Bavastin	4.33	1.90	16.33	17.33
Copper oxychloride + Bavastin	5.33	3.13	20.67	23.33
Copper oxychloride + Extended photoperiod for 16 hrs	5.67	3.07	21.33	24.00
Bavastin +Extended photoperiod for 16 hrs	6.67	3.17	23.00	24.33
Copper oxychloride + Bavastin+Extended photoperiod for 16 hrs	7.00	3.27	24.00	26.00
SEm±	0.38	0.26	0.62	0.43
CD5%	1.19	0.81	1.92	1.33
CD1%	1.66	1.13	2.69	1.86

Fig. 1: Healthy tissue cultured plants of Barhee variety

Fig. 2: Graphiola leaf spot (*Graphiola phoenicis*) infected plant. Fruiting bodies of the false smut fungus, on the upper side of the leaf

References

Abbas, E. H. and Abdulla, A. S. 2004. First report of false smut disease caused by *Graphiola phoenic* on date palm trees in Qatar. *Plant Pathology,* 53:815.

Cabrera, R., Hodgson, F., Armas, M. D., Santiago, C. T., Lorenzo, C. D., Prendes, C., & Plata, P. 1990. A fungus disease of canary palm (*Phoenix canariensis* chab.) produced by *Graphiola phoenicis* (Mong) Poit. Fisher in the Canary Islands. *Phytoma Espana, 18*, 21-25.

Cole, G. T. 1983. *Graphiola phoenicis*: A taxonomic enigma. *Mycologia,* 75:93-116.

Edongali, E. A. 1996. Disease of date palms (*Phoenix dactilifera* L.) of Libya. *Arab Journal of Plant Protection,* 14, 41-43.

Elliot, M. L. 2006. Graphiola leaf spot (False smut of palm). *Florida Cooperative Extension Service*. Retrieved from http://edis.ifas.ufl.edu

Elmer, H. S., Carpenter J. B. and L. J. Klotz. 1968. Pests and diseases of the date palm. Part II. Diseases. *FAO Plant Protection Bulletin,* 16:97-110.

Ferrar, K. 2000. Crop profile for dates in California. NSF Center for Integrated Pest Management (Website).http://www.ipmcenters.org/cropprofiles/docs/CAdates.pdf Accessed January 2006.

Graphiola phoenics on date palm trees in Qatar, Plant Pathology 53,815 http://dx.doi.org/10.1111/j.1365-3059.2004.01084.x

Guar, V. K. 2000. Studies on Graphiola leaf spot disease of date palm. *Proceedings of International Conference on "Integrated Plant Disease Management for Sustainable Agriculture", I*, 471-472., New Delhi, India.

Howard, F. Atilano W.R., and Williams D. 1985. Experimental establishment of five date palm cultivars in southern Florida. *Date Palm Journal* 4:91-101.

Lodha, S. 2003. Influence of pinnae position, leaf age and some fungicides on the development of graphiola leaf spot on date palm. *Arab Journal of Plant Protection,* 21, 162-165.

Mehta. N., Gupta, P. C., Tharija, R. K. and Dang, J. K. 1989. Varietal behavior and Efficacy of different fungicides for the control of date palm leaf spot caused by *Graphiola phaenicis*. *Tropical Pest Management, 35*, 117-119. http://dx.doi.org/10.1080/09670878909371336

Nixon, R. W. 1957. Differences among varieties of the date palm in tolerance to *Graphiola* leaf spot. *Plant Disease Reporter,* 41:1026-1028.

Sattar A.M. H., Aulaqi W. A. and Ibrahim R.Y. 2013. Occurrence of false smut on date palm (*Phoenix dactylifera* L.) in the Southern Coastal Plain of Yemen. *Journal of Agricultural Science,* 5(4)22-25

Simone, G. W. 2004. Graphiola leaf spot (false smut). In M. L. Elliot, T. K. Broschat, J. Y. Uchida, & G. W.Simone (Eds.), Compendium Of ornamental palm diseases and disorders (pp. 26-27). St. Paul.MN: *American Phytopathological Society*.

Singh, M. K., Singh, R. and Jeyarjan, R. 1970. Graphiola leaf spot on date palm (*Phoenix dactilifera*), susceptibility of date varieties and effect on chlorophyll Control. *Plant Disease Reporter,* 54: 617-619.

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Effect of integrated nutrient management on growth and yield attributing characters of Bael (*Aegle marmelos*) cv. Narendra Bael-9

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Abstract

The present investigation was carried out at Main Experiment Station, Horticulture, Narendra Deva University of Agriculture and Technology, Kumarganj Faizabad (U.P.) under sodic soil condition during the years 2014-15 and 2015-16 to evaluate the response of organic manure, inorganic fertilizer and biofertilizer on growth, yield and yield attributing characters. The experiment keeps nine treatments *viz.* T1- 100% NPK, T2-50 Kg FYM, T3-50 Kg FYM + 100% NPK, T4-50 Kg FYM + 75% NPK, T5-50 Kg FYM + 50% NPK, T6-50 Kg FYM + 200g each (*Azotobacter*+ PSB), T7-50 Kg FYM + 100% NPK + 200g each (*Azotobacter*+ PSB), T8-50 Kg FYM + 75% NPK + 200g each (*Azotobacter*+ PSB) and T9-50 Kg FYM + 50% NPK + 200g each (*Azotobacter*+ PSB) and these treatments were replicated four times. The growth character like plant height, plant girth and plant spread (East-West and North-South) flowering and fruiting behaviuor like number of flower per shoot, fruit set, fruit retention, fruit yield were noted maximum with minimum fruit drop by the use of 50 Kg FYM + 100% NPK + 200g each (*Azotobacter*+ PSB) followed by the application of T8-50 Kg FYM + 75% NPK + 200g each (*Azotobacter*+ PSB) and T3-50 Kg FYM + 100% NPK than other treatments. The treatment of T2-50 Kg FYM was recorded the lowest results as comparatively all other treatments.

Keywords: Bael, bio-fertilizers, FYM, inorganic fertilizer, NPK, organic manures

Introduction

Bael (*Aegle marmelos*) is one of the medicinal plants of India. It is also known as golden apple or Bengal quince. It is a medium sized deciduous tree belonging to family Rutaceae. Indian peninsula and in Ceylon, Burma, Thailand and Indo-China. The bael tree is indigenous to India and the history of this tree has been made in "Yajurveda". In early Buddhist and Jain literature (8000-325 B.C.), methods of ripening this fruit have been described. It grows wild throughout the low hills of Himachal Pradesh, ascending up to 1000 meters. It is found in plenty in wild forms in the states of Uttar Pradesh, Orissa, West Bengal, and Madhya Pradesh. However, the fruits of the wild trees are considerably smaller than those of the cultivated types grown in the plains.

The fruits are good to taste containing 40 per cent TSS. The Bael tree is one of the most useful medicinal plants of India. All the parts of this tree including stem, bark, root, leaves and fruit at all stages of maturity have medical virtues and have been used in the indigenous medicine for a long time. The ripe fruit is of considerable medical value when it just begins to ripen. The ripe fruit is aromatic, astringent, cooling and laxative. The unripe or half ripe fruit is stomachic, anti-scorbutic, and digestive. Ripe bael fruit is regarded as best of all laxatives. It cleans and tones up the intestines.

Aegle marmelos is one of the most important plants with several medicinal and nutraceutical properties. The unripe or half ripe fruit is perhaps, the most effective food remedy for chronic diarrhea and dysentery. Dried bael or its powder provides the better results. The bael fruit when it is still green, is sliced and dried in the sun. These slices can also be reduced into powder and preserved in air tight bottles. An infusion of bael leaves is regarded as an effective food remedy for peptic ulcer. The bael fruit taken in the form of beverage has also great healing properties because of its mucilage content. This substance forms a coating on the stomach mucosa and thus helps in healing of ulcers.

The continuous applications of huge amount of chemical fertilizers hamper the fruit quality, soil health and generate pollution. The integrated nutrient management paves a way to overcome these problems. Plant nutrient can be supplied from different sources viz., organic manures, crop residues, bio-fertilizers and chemical fertilizers for better utilization of resources and to produce crop with less expenditure, INM is the best approach for sustainable crop production. In this approach all the possible sources of nutrients are applied, based on economic consideration. Organic manures enhance nutrient availability in order to improve the soil health, soil structure and provide environment is conducive for the treatment of soil micro-flora. Potentially of using organic manures along with balanced fertilizers are well established in increasing crop yield and sustained crop production (Nambiar and Abrol, 1992). The

importance of integrated nutrient supply system which involves the combined use of various plant nutrient sources has now assured significance in the field of fruit production. The conjugation use of bio-fertilizers with nitrogenous fertilizers increases the efficiency of nitrogen, improve the soil health and control the soil pollution. It is therefore, necessary to standardize other possible sources of nutrients to a specific soil and agro-climate condition for better plant growth, production and quality of fruits.

Materials and Methods

The present investigation entitled "Effect of Integrated Nutrient Management on Growth and Yeild attributing characters of Bael (*Aegle marmelos*) cv. Narendra Bael-9 in sodic soil condition." was carried out at Main Experimental Station and P.G. Laboratory of the Horticulture, Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (UP). Main Experimental Station, Horticulture, N. D. University of Agriculture & Technology is located 45 km away from Ayodhya city on Ayodhya- Rae Bareily Road. The geographically, university is situated at 26.47^0 N latitude, 82.12^0 E longitude and at altitude of 113.0 meter from sea level in the Indo-Gangatic plain of Eastern Uttar Pradesh, India.

The design of the experiment was Randomized Block Design (RBD) where the 27 different accessions are the 9 treatments and 3 replications. The 20 years old plants of the bael cultivars Narendra Bael-9 having uniform vigour was selected randomly. The experiment keeps nine treatments *viz.* T_1-100% NPK, T_2-50 Kg FYM, T_3-50 Kg FYM + 100% NPK, T_4-50 Kg FYM + 75% NPK, T_5-50 Kg FYM + 50% NPK, T_6-50 Kg FYM + 200g each (*Azotobacter*+ PSB), T_7-50 Kg FYM + 100% NPK + 200g each (*Azotobacter*+ PSB), T_8-50 Kg FYM + 75% NPK + 200g each (*Azotobacter*+ PSB) and T_9-50 Kg FYM + 50% NPK +200g each (*Azotobacter*+ PSB). The experiment was conducted under sodic soil condition to evaluate the response of organic manure, inorganic fertilizer and bio-fertilizer on plant height, plant girth and plant spread (East-West and North-South) and fruit yield. The region falls under sub-humid and sub-tropical climate receiving a mean annual rainfall of about 1200 mm out of which about 85 per cent is precipitated from mid June to end of September. The winter months are cold, dry and occasional frost occurs during the period, hot wind starts from the month of April and continue up to onset of monsoon.

Results and Discussion

Growth behaviours

It is clear from the data presented in Table 1 that soil application of organic manure inorganic and bio-fertilizer gave the best result. The maximum (21.56%) per cent increase in plant height was noted by the soil application of T7-50 kg FYM+ 100% NPK+200g each (*Azotobacter*+PSB) followed with 17.34% increase in plant height by the use of T8-50 kg FYM+75% NPK+200g each (*Azotobacter*+PSB) and 17.10 by the use of T3-50 kg FYM+ 100% NPK during the experiment respectively. The treatment T1-100% NPK and T2-50 kg FYM was recorded minimum results as comparison to other treatments. Whereas the maximum (17.57% and 15.45%) per cent increase in plant girth of bael plant was recorded with the use of T7-50 kg FYM+ 100% NPK+200g each (*Azotobacter*+PSB) followed with the use of T8-50 kg FYM+ 75% NPK+200g each (*Azotobacter*+PSB) and T3-50 kg FYM+ 100% NPK during both the years. The lowest result was recorded under the treatment of T2-50 kg FYM. It seems from the Table that plant spread was found better per cent increase in both the direction (East-West and North-South) by the use of Integrated Nutrient Management. The maximum plant spread (E-W and N-S) were noted with the use of T7-50 kg FYM+ 100% NPK+200g each (*Azotobacter*+PSB) which was found at par with the treatment of T8-50 kg FYM+ 75% NPK+200g each (*Azotobacter*+PSB) (East-West and North-South) and T3-50 kg FYM+ 100% NPK (East-West) followed with the use of T9-50 kg FYM+ 50% NPK+200g each (*Azotobacter*+PSB) during the experiment, respectively. Whereas the treatment comprised 50 kg FYM was recorded lowest result than all other treatments during both the years of investigation. It might be due to the fact that plant growth promoting rhizo-bacteria associated with plant rhizosphere presented or multiplied due to application of bio-fertilizers like PSB, *Azotobacter* and FYM may be responsible for growth promotion directly through the synthesis of phytoharmones, N2 fixation, reduction of membrane potential of the roots, synthesis of some enzymes that nodulate the level of plant hormones as well as the solubilization of inorganic phosphate and mineralization of organic phosphate which makes phosphates available to the plants and the application of Farm Yard Manure, *Azotobacter* and Phosphate Solubilizing Bacteria along with inorganic fertilizers may be due to the increase in soil temperature which accelerates the internal physiology of the developing plants to grow profusely and in a speedy way at its maximum level. Results are in close conformity with the finding of Srivastava (2008), with respect to plant height and girth; He reported maximum plant height in papaya with the use of 100% NPK + FYM+ *Azotobacter* + PSB. Similar significant increase in growth parameters due to Vermicompost have been reported by Tripathi*et al.* (2010) and Nawsheen *et al.* (2006) in strawberry cv. 'Chandler', Bakhs*et al.* (2008) in guava and Sahoo*et al.* (2005) strawberry cv. Sweet Charley. Yadav *et al.* (2007) also reported maximum vegetative growth in aonla with the use of 500g N + 250g P + 250g K +100kg FYM + 200 g each(*Azotobacter*+ *Azospirillum*+ PSB) + 25g Sulphur.

Yield and yield attributing characters

The data presented in the Table shows that the integrated nutrient management significantly influenced the number of flower per shoot in bael. The maximum (127.93 and 121.74) number of flowers per shoot was recorded with the use of T7-50 kg FYM+ 100% NPK+200g each (*Azotobacter*+PSB) followed with the soil application of T8-50 kg FYM+ 75%NPK+200g each (*Azotobacter*+PSB). The treatment T2-50kg FYM shows minimum (78.30 and 80.93) number of flower as comparison to other treatments during the

Table 1. Effect of various treatments on plant morphological parameter

Treatments	Plant height per cent increase	Trunk girth per cent increase	Plant spread per cent increase		Fruit yield kg/tree
			NS	EW	
T_1 -100% NPK	3.15	7.25	7.80	7.66	80.93
T_2 -50kg FYM	2.47	5.94	4.67	5.58	78.30
T_3 - 50 kg FYM + 100% NPK	17.10	13.08	18.08	20.40	107.55
T_4 - 50 kg FYM+75% NPK	12.95	10.72	10.92	17.00	101.98
T_5 - 50 kg FYM+50% NPK	6.93	9.03	8.71	10.31	92.14
T_6 - 50 kg FYM+200g each (*Azotobacter* + PSB)	9.38	9.94	9.63	12.76	96.40
T_7 -50kg FYM+100% NPK+200g each (*Azotobacter* + PSB)	21.56	17.57	20.26	23.43	127.93
T_8 -50 kg FYM+75% NPK + 200g each (*Azotobacter* + PSB)	17.34	15.45	19.01	22.33	121.74
T_9 -50 kg FYM+50% NPK + 200g each (*Azotbacter* + PSB)	15.12	11.89	14.23	18.77	105.88
CD at 5%	1.36	0.56	1.21	0.94	5.16

experiment respectively. This might be due to soil application of organic and in-organic fertilizer which increased the photosynthesis efficiency which reflex on vigorous growth of plants and ultimately remitting profuse flowers.

The data recorded in respect to fruit yield also shows that the addition of organic manure and inorganic fertilizer with bio-fertilizer respond better for fruit yield of bael fruit per plant. The maximum (127.93 kg and 121.74) fruit yield per tree was recorded with the use of T7-50 kg FYM+ 100% NPK+200g each (*Azotobacter*+PSB) which were recorded at par with the soil application of T8-50 kg FYM+ 75%NPK+200g each (*Azotobacter*+PSB) followed with the use ofT3-50 kg FYM+ 100% NPK. The treatment T2-50kg FYM recorded minimum (78.30kg a) fruit yield per tree during the experimentation, respectively.

The enhancement in yield by this treatment mainly because of proper supply of nutrients and induction of growth increases in number of fruits and weight due to better root development, better translocation of water, uptake and deposition of nutrients. Farm Yard manure have immobilized microflora, which function in soil to produce useful products and having immobilized enzymes like protease, lipase, amylase and cellulose which keep on their function of bio-degradation of macro-molecular of agricultural residues in the soil and absorb moisture from the air (Edward, 1998). Ghosh *et al.* (2012) also found same result with the application of FYM 20 kg along with N-400, P-100 and K-300g/year in papaya fruit whereas Kumar *et al.* (2012) reported highest yield of lemon fruit by using 50% NPK + 15 kg vermicompost + 5 kg neem cake. Kumar (2016) reported maximum vegetative growth and yield of strawberry with use of Vermi-compost @ 2.5 t/ha + half dose (recommended dose) of NPK.

References

Baksh, H., Yadav, R., Dwivedi, R. 2008. Effect of INM on growth, yield attributing characters and quality of guava cv. Sardar. *Prog. Agri.*, 8(2):141-144.

Edward, S.I. 1998. Effect of organic manure on soil nutrients andgrowth hormones level of soil. *American J. Soil Sci.*, 68(2):130-145.

Ghosh, S.N., Bera, B., Roy, S., Kundu, A. 2012. Integrated nutrient management in pomegranate grown in laterite soil. *Indian J. of Hort.*, 69(3):333-337.

Kumar, D., Pratap, B., Vishwakarma, G. 2016. Studies on integrated nutrient management on vegetative, flowering and yield attributes of Strawberry (*Fragaria x ananassa* Duch) cv. Chandler. *Eco. Env. & Cons.*, 22(2):647-650.

Kumar, V., Singh, M.K., Singh, M., Dev, P., Mohan B. 2012. Influence of integrated nutrient management (INM) on yield and quality of lemon (*Citrus limon* Burn.) cv. Pantlemon-I under western U.P. conditions. *A. of H,* 5(1):137-139.

Nambiar, K.K.M., Abrol, I.P. 1998. Long term fertilizer experiment in India: An overview. *Fertilizer News*, 34(4):11-26.

Sahoo, S.K., Singh, D.B. 2005. Effect of different levels of biofertilizers on growth yield and quality of strawberry (*Fragaria x ananassa* Duch) cv. Sweet Charlie. *Orissa J.of Hort.*, 33(2):82-85.

Sharma, B.D., Dhandar, D.G., Bhargava, R. 2003. Response of pomegranate (*Punica granatum* L.) to integration of nutrient sources in sandy soil of acid ecosystem. In: *National Symposium on Organic farming in Horticulture for sustainable production* on held during 29-30 August at CISH, Lucknow. 2003, 33-34.

Singh, Nowsheen, Aroosa, S.R., Masarst Shabeena. 2006. Yield and growth of strawberry cv. Senga management system. *Environment and Ecology*, 245(3):651-654.

Srivastava A. 2008. Integrated nutrient management on papaya (*Carica papaya* L.). Ph.D. Thesis. NDUAT, Kumarganj, Faizabad (U.P.).

Tripathi, V.K., Kumar, N., Shukla, H.S., Mishra, A.N. 2010. Influence of *Azotobacter*, *Azospirillum* and PSB on growth, yield and quality of strawberry cv. Chandler, paper presented in National Symposium on *Conservation Hort*., during March, 21-23, 2010 at Dehradoon, 2010: 198-199.

Yadav, R., Singh, H.K., Yadav, A.L. 2007. Effect of integrated nutrient management on productivity and quality of aonla (*Emblica officinalis* Gaertn). *Plant Archives*,7(2):881-883.

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Impact of interventions on knowledge and adoption of improved technologies in Ber cultivation in western Rajasthan

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Abstract

Barmer district of Rajasthan has the potential of growing Ber in an area of more than 450 ha under open/tube well irrigation system and rainfed. The farmers were lacking in technical knowhow about improved technologies in Ber cultivation. The present study was conducted during 2017 to ascertain the knowledge gain and adoption level of thirteen specific technologies demonstrated through various interventions by the KVK during earlier years. Barmer, Chohtan, Baytoo, Balotra, and Gudamalani blocks of Barmer District were taken for study and the respondents were randomly selected at the rate of 20 beneficiary farmers per block. The data were collected through personal contacts (interview) with well-designed questionnaire. The data revealed that the gain in knowledge was more than 50 per cent for technologies viz., time and method of pruning in (training & pruning) of ber (72 %), use of micronutrient (68%), plant protection techniques (spray of insecticide to manage fruit fly), time of planting (65%), method of manure and fertilizer application (58%), drip irrigation (54%) and recommended dose of fertilizer (51%). Similarly, time and method of pruning, plant protection techniques and recommended dose of fertilizer recorded the highest extent of adoption, 63, 56 and 19 per cent, respectively. This could be due to the easiness and effectiveness of technologies in field application and yield enhancement. Though the acquisition of knowledge for the technologies like value addition (58%), Use of micronutrient (68%) and drip irrigation (62 %), was high, the number of farmers adopting these technologies were very low i.e. 31, 25 and 13 percent respectively due to the various reasons.

Key words: Adoption, Ber, knowledge, technology dissemination, time & method of pruning

Introduction

Barmer district of Rajasthan is located in extreme arid zone of Thar Desert in western part of Rajasthan which has the potential of cultivating green gram, moth bean, pearl millet and cluster bean are the major rainfed crops raised in sandy loam soils during monsoon season. Cumim and isbgol are the major irrigated crops while ber, pomegranate, date palm and lasora (Gunda) are the important arid fruit crops. The literacy level of farmers and the technical know-how on advanced crop production practices was poor.

Indian ber or jujube (*Ziziphus mauritiana* Lam.) a member of family Rhamnaceae is one of the most ancient cultivated fruit tree grown in north Indian. Particularly, Punjab, Haryana and Rajasthan. The total area under ber in India is more than 49,000 ha with an annual production of 4, 81,000tons fruits (Horticulture data base, 2017). However, over the year, ber trees start giving diminished yield and smaller fruits of inferior quality after bearing normal crops of 25-30 years. Besides, a large number of seedling plantations of *Ziziphus rotundifolia* also exist in western arid region of Rajasthan and other regions. Three varieties, viz., Seb, Gola and Mundia have been recommended for the arid areas of western part of Rajasthan.

Ber is mainly cultivated in 5 blocks of Barmer district viz., Barmer, Chohata, Baytoo, Sindhari and Gudamalani under open or bore wells and same area in canal irrigation under drip Irrigation. The important varieties under cultivation are Gola, CAZRI Gola, Seb, Umran, Tikadi, Illaichi, Chuhara,Mundia, Aliganj and Jogiya etc. for domestic use and also for export purposes. Therefore farmers were less assured of their crop due to the socio economic factors viz., less affordability towards high cost of inputs, biotic and abiotic stresses.

The KVK focused its extension activities in the five ber growing blocks of Barmer district from 2014-15 to 2017-18 to improve the knowledge level of farmers and adoption of advanced production technologies pertaining to ber cultivation. The KVK demonstrated various technologies through series of interventions in the form of trainings, front line demonstrations, on farm trials, exposure visits, etc. The present study was undertaken to ascertain the gain in knowledge level among the respondents and to study the adoption level of various interventions on ber cultivation and also to find out the reasons for non-adoption of certain

technologies and to suggest suitable alternatives to enhance the income level out of ber cultivation.

Materials and Methods

Most of the interventions were carried out in 15 blocks of Barmer district, but only five blocks viz.,Barmer, Chohtan, Baytoo, Sindhari and Gudamalani were selected for the study, as these block consider hub of ber cultivation in Barmer district. For the selection of respondents, a list of beneficiaries of various programmes of KVK during last three years (2014-15 to 2017-18) was prepared. Out of 245 beneficiaries, randomly 20 farmers were selected each block from Barmer, Chohatan, Baytoo, Sindhari and Gudamalani taking sample of 100 farmers. A questionnaire was prepared and the data were collected through personal interviews with the respondents. The data were processed, tabulated, classified and analyzed in terms of percentage. Total ten package practices were selected to evaluate the farmers' extent of knowledge gained and adoption of ber production technologies as results of various intervention viz., trainings, method demonstrations, front line demonstrations (FLDs), diagnostic visits, advisory services, exposure visits etc..

Results and Discussion

Gain in knowledge

The data presented in table 1 reveals that gain in knowledge on various technologies is based on the series of KVK intervention. The highest gain of 72 per cent was observed in pruning time & method of pruning to improve the yield and quality of ber fruit. This could be due to the frequent trainings and demonstrations conducted by the KVK and because of the easiness of technology in field application. This is in consonance with the findings of Singh *et al.* (2014).Use of micronutrient recorded the knowledge gain to the tune of 68 per cent. Sixty five per cent gain in knowledge was observed towards use of plant protection techniques (spray of insecticide to manage fruit fly) to improve the quality of fruit by avoiding insect pest mainly fruit fly in ber this was in agreement of De Groote *et al.* (2004) and Alagukannan *et al*., (2015). Method of fertilizer application along with FYM to the ber plants recorded the knowledge gain of 58 per cent, as it is very effective, cheaper and easily available. Drip irrigation, recommended dose of fertilizers, value addition (grading), selection of variety and planning and layout of orchard gain in knowledge was observed towards 54%, 51%, 48%, 42% and 38%, respectively. The least gain in knowledge was observed for time of planting as the 61 per cent of the farmers knew the best planting season (July-August) and rest of the 23 per cent of the respondents alone understand the need of July-August this finding of study were in agreement with Alagukannan *et al.,* (2015). These findings were in agreement with Joseph (2008) who reported that the knowledge levels were found to be increased for weeding, fertilizer application, plant protection measures and harvesting practices of maize after attending the training programmes. This might be due to the fact that they were convinced through training programmes about ber production technology by KVK which were designed to import latest knowledge through work experience.

Knowledge with Adoption of Technologies

Extent of adoption

The data (Table 2) revealed that 63 per cent of the farmers adopted time and method of pruning in ber followed by 56 per cent of the farmers adopt the integrated pest management approach for management of fruit fly, 52 per cent of the farmers adopted recommended dose of fertilizer, 45 per cent farmer adopt the selection of improve cultivars of ber, 41% respondent adopt the method of fertilizer and manure application, 36% farmers adopt planning and layout of orchard, 26 percent famers were adopted time of planting season, 23% farmer adopt the value addition and least adoption of drip irrigation was only by 9% of farmers. These

Table 1. Gain in knowledge with respect to ber cultiva tion due to the intervention of KVK

(n=100)			
No. of Technology	Knowledge level (%)		
	Before KVK intervention	After KVK intervention	Gain in Knowledge
Planning and layout of orchard (selection of site method of planting)	30	68	38
Selection of varieties viz., Gola, Seb, Umran, etc.	38	80	42
Time of planting (June-July)	61	84	23
Method of manure fertilizer application	18	76	58
Recommended dose of fertilizer	20	71	51
Use of micronutrients	00	68	68
Time & method of pruning (training & pruning)	08	80	72
Drip irrigation	08	62	54
Plant protection (spraying of insecticide to manage Fruit Fly)	26	91	65
Value addition (grading)	10	58	48

findings were in agreement of Meena and Gupta, (2016),Tandel *et al.,* (2015) and Borate *et al.,* (2012).

Knowledge Acquisition Vs Extent of adoption

The gain in knowledge depends on various factors like easiness of technologies, educational background of the participating farmers, extension approaches handled in technology transfer, farmers' attitude, ability of extension personnel, teaching and learning situation etc. Likewise the extent of adoption of a particular technology relies mainly on easiness and usefulness of the technology besides the socio-economic status, access to the technological inputs etc. Fig.1 reveals the percentage of respondents acquired knowledge on different technologies after KVK intervention and percentage of adoption of ten specific technologies taken for the present study. The present study on percentage gain in knowledge and percentage adoption could certainly generate some useful information for future line of study or the changes needed in existing system of cultivation of ber techniques. About plant protection, 91 per cent of the respondents gained knowledge on advantage of management of fruit fly it was adopted by 77 per cent of the respondents. The similar trend was also noticed in the case of proper time of planting the knowledge gain and extent of adoption was 84 and 77 per cent, respectively. From the data it was evident that the farmers realize the importance of plant protection and time of planting. Present study also supported by Algukannan *et al* (2014).

In contrary to that selection of varieties of knowledge gain and extent of adoption was 80 and 72 percent it was clear that, they acquire knowledge on first generation selection of varieties tools like varieties Gola, Seb and Umran. Similarly the gain in Knowledge in respect time & method of pruning was high (80%) but only 68 per cent of farmers used time and method of pruning in ber orchard. From the interviews made with the respondents, and its practical utilities but they could not adopt it because of their fodder requirement for sheep and goat as sheep and goat rearing is the backbone of agriculture in Barmer district.

The other technologies like application of use of method of manure and fertilizer application, recommended dose of fertilizer, use of micro nutrient, drip irrigation and value addition also adoption among the participating farmers by the various interventions of KVK. In contrary to that the knowledge acquired by the beneficiary farmers was high but its adoption was less for the technologies. This implies that still more awareness on this technology has to be imparted to the farmers and the easy availability of the fruit over in right time should be ensured. This kind of technology would be of promising in getting premium prices for their quality clean fruits as it is being exported directly.

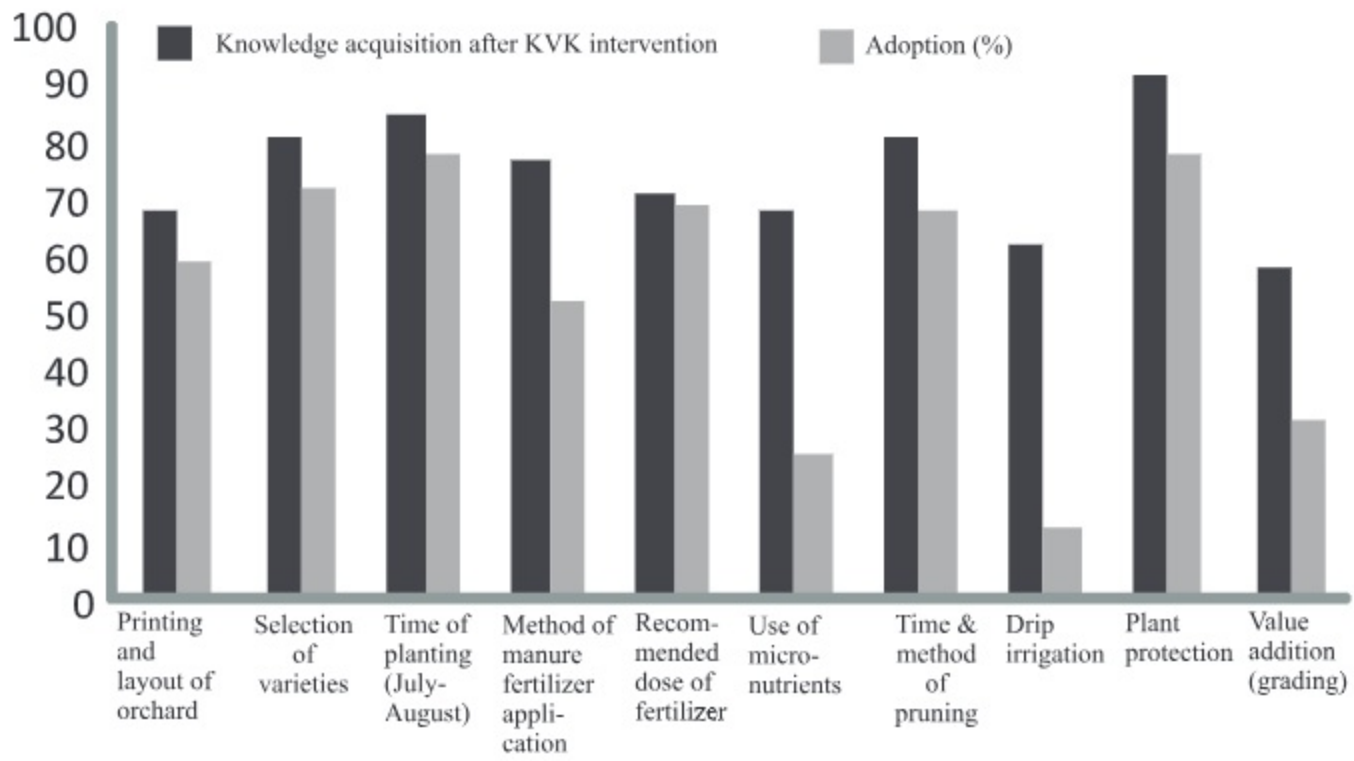

Fig. 1: Knowledge with Adoption of Technologies in ber Cultivation

The findings of the present study reveals that the interventions of KVK, certainly facilitated the knowledge acquisition by the farmers and adoption at higher level in ber cultivation with respect to the technologies viz., proper time of planting, selection of planting material such as varieties viz. Seb, Gola and Umran, time of fertilizer application method of manure and fertilizer application, recommended does fertilizer, use of micro nutrient application, time & method of training pruning, drip irrigation, plant protection (spraying of insecticide to manage fruit fly) and value addition (grading) in ber orchard, The present study also suggests the need of alternatives or further refinement for the technologies like time & method of pruning and use of micronutrient some more awareness is required on use of ber production techniques.

References

Alagukannan G., Velmurugan P. and Ashokkumar M. 2015. Impact of Interventions on Knowledge and Adoption of Improved Technologies in Banana Cultivation. *J. Krishi Vigyan*, 3(2): 54-58.

Anonymous. 2017. Horticulture at a Glance Published by Ministry of Agriculture, GOI.

Borate, H.V., Mahadik, R. P., Hake, A.D. and Sawant, P.A. 2012. Knowledge and adoption of sapota growers in Thane district. *Internat. Res. J. Agric. Eco. & Stat.*, 3 (1) : 159-161.

Changadeya, W., Ambali, J. D. A. and Kambewa, D. 2012. Farmer's adoption potential of improved Banana production Techniques in Malawi. *International J. of Physical and Social Sciences*, 2(4): 32-48.

De Groote, H., Ouma, J. O., Odendo, M. and Mose, L. 2004. Estimation of maize crop losses due to stemborers: Preliminary results of a national field survey in Kenya. In: Integrated approaches to higher maize productivity in the new millennium. Proceedings of the 7th Eastern and Southern Africa regional maize Conference, Nairobi, Kenya, February 11-15, 2002. Friesen, D.K. and Palmer, A.F.E. (eds.). Mexico City: International Maize and Wheat Improvement Centre.

Joseph, R. 2008. Impact of krishivigyankendra trainingprogramme on maize production. Evaluation capacity building in rural resources management: A Manual. Indian Agriculture Research Institute, Pusa, New Delhi.

Kubde, V. R. Bhole, S.R. and Tekale, V.S. 2000. Knowledge and adoption of cultivation and storage practices of potato. *Maharashtra J. Extn. Edu*., 19: 293-298.

Meena, K. C. and Gupta, I. N. 2016. Impact of KVK Training Programmes on Adoption of Garlic Production Technology. *J Krishi Vigyan* (3, October,2016): 124.253.136.240

Tandel, B. M., Prabhu Nayaka, Shah, K. A. and Timbadiya, C.K. 2015. Knowledge level of sapota growers about scientific package of practice. *Agriculture Update* 10(1): 84-85

Singh, A. P., Vaid, A. and Mahajan, V. 2014. Impact of KVK Training programmes and Frontline Demonstrations on Adoption of Pusa Basmati 1121 in Kathua district of Jammu and Kashmir. *J Krishi Vigyan,* 2 (2): 44-48

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Effect of different rooting media on rooting characters of date palm offshoots cv. KCCL-63

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Abstract
Date palm is an important fruit crop of arid and semi-arid regions of India. It is propagated through offshoot and tissue culture. Healthy and uniform offshoots were selected and replicated thrice under factorial concept. IBA treatment (I) (I_1 = 1000 mg l^{-1} IBA; I_2 = without IBA) and types of media (M) (M_1= sandy soil + decomposed FYM; M_2= sandy soil + vermicompost; M_3 = cocopeat; M_4= sandy soil + cocopeat; M_5= sandy soil + sawdust; M_6= sandy soil) were two factors. There were no significant differences with and without application of IBA on number of roots but length of roots have increased on application of IBA. Among the media, cocopeat has shown higher number of roots and root length compared to other medias. Usage of cocopeat along with IBA has shown better results in both root length and number of roots.

Key words: Date palm, Indole-3-butyric acid, offshoots, propagation, rooting media

Introduction
Date palm is one of the most important crops of Kachchh District of Gujarat in India. The region is characterized by low rainfall, high temperature and presence of coastal belt resulting in high salinity in soil and water; high saline tolerance capacity of dates and higher economic return has made it a successful crop of this region (Muralidharan *et al*., 2008). The orchards available in the Kachchh region are of seedling origin, hence exhibit great variability in size, colour, shape, taste and fruits which leads to many issues for marketing and processing of the fruits. Vegetative propagation through offshoots or plantation of tissue culture plants are the only solution to maintain true to type nature. In last two decades the expansion of commercial date plantation has risen significantly and to prepare true to type plants, offshoots are most economical and commonly followed method (Al-Mana *et al*., 1996), although number of offshoots produced per plant, time required for their preparation and success rate are the biggest constraints (Darwesh *et al*., 2013). However, the paucity of tissue cultured plants and its high cost left no other way but to propagate through offshoots. Furthermore, the main concern with offshoots propagation is its low survivability percentage in the field conditions which depend upon so many factors. The survival of offshoot in field is very low. Therefore the present study was conducted involving IBA and rooting medias to improve efficacy and survival percentage.

Offshoots are axillary buds arising alongside of the mother plant. Initially the offshoots are solely dependent on the mother plant and develop only a few roots. When such offshoots are directly transplanted, they show mortality. So, based on this observation, experiment was conducted and offshoots were prepared with different soil mixture to evaluate the best rooting mixture and their influence on vegetative characters. Since, usage of rooting property of auxins is well established (Thiman and Went, 1934), where IBA (Indole-3-butyric acid) is most widely used rooting stimulator (Weisman, *et al.,* 1988), IBA was applied as another factor to understand benefit of auxin treatment on rooting of date palm.

Material and Methods
The experiment was carried out at Date Palm Research Station, S. D. Agricultural University, Mundra-Kachchh, Gujarat, India located at 22°50'22.27" N and 69°43'16.78" E during 2015-16. Temperature ranges from 6° C in December to 45° C in May. Annual average rainfall was 350 mm occurring in July and August. Seven year old mother plants of cultivar KCCL 63 planted at the spacing of 9m x 9m were used. Healthy offshoots of one and a half year age with around same size and weight (approx. 10 kg) were selected for the experiment. The experiment was laid with two factors; first factor (I) is presence of IBA (I_1 = 1000 mg l^{-1} IBA; I_2 = without IBA); second factor(M) different media (M_1= sandy soil + decomposed FYM; M_2= sandy soil + vermicompost; M_3 = cocopeat; M_4= sandy soil + cocopeat; M_5= sandy soil + sawdust; M_6= sandy soil). During preparation of offshoot soil around the offshoot were cleaned, old leaf butts around the offshoot were removed and treated with IBA (as per treatment). Number of leaves were kept as 7 for all the treatments. For preparation of each offshoot, 10-12 kg of media was used.

Each of the treatments was represented by 6 ground offshoots with 3 replications (each replication with two offshoots). Plants were randomly selected having minimum weight of 10 kg among the different mother plants. The bags were tied and filled with different media in the month of October, 2015 and the final observation was taken in the month of September, 2016. The moisture on offshoots were maintained using drip irrigation system and each offshoot received similar amount of water. The experiment was conducted in a randomized block design (RBD) with factorial concept. The results were evaluated as per OPSTAT (Sheoram, *et al.*, 1998). At the time of offshoot removal, they were dugout using a sharp chisel and number of roots, length of the longest roots was recorded. Roots with diameter more than 0.5 cm were counted and recorded.

Result and Discussions

Before planting, observation of root characters was recorded and presented in Table 1. On number of roots, no significant differences were observed between with and without IBA treatment, whereas, length of roots were significantly higher in IBA treated offshoots. However, in context to the earlier experiments by Rizk (2006), Bakr *et al.*, (2010) and Darwesh *et al.* (2013) where higher concentration of IBA treatments have shown better result in root initiation than at lower concentration, which, is showing similarity with our present experiment where lower concentration of IBA (1000 ppm) was used.

Among media, offshoots grown with cocopeat shows maximum number of roots and length of roots. Cocopeat shows better rooting in date palm owing to high water retention capacity and porouness (Hartman *et al.*, 2011; Renuka *et al.*, 2015). The interaction effect of IBA treatment and rooting media on root growth was found significant. Highest rooting was observed in roots with cocopeat as media with IBA application and was found significant with cocopeat as media without IBA application. However, advantage of higher rooting was not observed in survival percentage rejecting our earlier hypothesis. In survival percentage, no role of IBA application was observed. Among the different medias,

Table 1. Effect of different rooting media on plant morphological characters of date palm offshoots

Treatments	Number of roots*	Length of the roots (cm)	Survival Percentage **
I_1 (With 1000 ppm IBA)	7.03(54.44)	27.86	60.24(69.05)
I_{-1} (Without IBA)	6.49(43.27)	32.27	62.42 (71.77)
SEm ±	0.28	1.03	4.62
C.D. @ 5 %	NS	3.03	NS
M_1=sandy soil + decomposed FYM;	5.89(35.33)	23.42	71.14 (82.66)
M_2=sandy soil + vermicompost ;	6.76(46.41)	29.00	71.14(82.66)
M_3 = cocopeat ;	9.91(101.50)	43.75	38.44 (41.83)
M_4=sandy soil + cocopeat ;	5.56(31.33)	30.25	51.52 (58.16)
M_5=sandy soil + sawdust ;	6.75(46.00)	28.83	64.60 (74.50)
M_6=sandy soil	5.08(32.58)	25.16	71.14 (82.66)
SEm ±	0.48	1.77	8.01
C.D. @ 5 %	1.44	5.24	23.64
I_1M_1	5.51(31.00)	25.50	71.14 (82.66)
I_1M_2	5.59(30.33)	27.16	71.14 (82.66)
I_1M_3	11.89(141.00)	43.83	44.98 (50.00)
I_1M_4	5.65(31.00)	24.16	44.98 (50.00)
I_1M_5	7.23(53.16)	22.83	58.06 (66.33)
I_1M_6	6.29(40.16)	23.66	71.14 (82.66)
I_2M_1	6.27(39.66)	21.33	71.14 (82.66)
I_2M_2	7.94(62.50)	30.83	71.14 (82.66)
I_2M_3	7.91(62.00)	43.66	31.90 (33.66)
I_2M_4	5.48(31.66)	36.33	58.06 (66.33)
I_2M_5	6.28(38.83)	34.83	71.14 (82.66)
I_2M_6	5.08(25.00)	26.66	71.14 (82.66)
SEm ±	0.69	2.51	11.32
C.D. @ 5 %	2.04	7.42	NS

*Data are square root transformed. ** Data are arc sine transformed; Data in parenthesis are original value

although cocopeat shows higher rooting but at field level after one year of transplanting shows lower survival percentage. Highest survival percentage was observed with sandy soil + FYM, Sandy soil + Vermicompost and sandy soil alone. However they were found to be all other treatments except cocopeat.

Although rooting is considered important for successful survival after transplanting but observation in the current experiment rejects this hypothesis. It is also observed that no additional benefit is obtained with application of IBA (1000 ppm) in rooting and survival percentage and thus in future higher concentration needs to be evaluated. For better understanding impact of medias, multiple year trails on multiple varieties needs to be done.

References

Al-Mana, F. A., Ed-Hamady, M. A., Bacha, M. A. and Abderlrahman, A. O. 1996. Improvement root development on ground and aerial date palm offshoots. *Principes*, 40(4): 179-181.

Al-Shahib, W. and Marshall, R. J. 2003. The fruit of the date palm: its possible use as the best food for the future? *International Journal of Food Science and Nutrition*, 54(4):247-259.

Darwesh, R. S., Madbolly, E. A. and Gadalla, E. G. 2013. Impact of indole butyric acid and paclobutrazol on rooting of date palm (*Phoenix dactylifera* L.) offshoots cultivar Zaghloul. *Journal of Horticultural Science & Ornamental Plants*, 5(3): 145-150.

Hartmann, H. T., Kester, D. E., Davies, F. T. and Geneve, R. L. 2011. Hartmann & Kester's Plant Propagation: Principles and Practices, Eight edition. Pearson Education Inc.: New Jersey, pp-751-752.

Muralidharan, C. M., Tikka, S. B. S. and Verma, P. 2008. Date palm in Kachchh. Technical bulletin no. 2, SDAU, Date palm Research Station, Mundra.

Renuka, K., Chandrasekhar, R. and Pratap, M. 2015. Effect of different media treatments on rooting of carnation (*Dinathus cryophyllus* L.) cuttings of cv. Baltico under polyhouse condition. *Asian J. Hort*., 10(1): 118-121.

Rizk, S. A. Y., 2006. Some factors affecting on rooting ability of Sewy date palm offshoots in Sewa Oasis, Egypt, 2- Effect of offshoot weight and auxin application on rooting % and growth of Sewy date palm. *Minufiya Journal of Agricultual Research*, 31(4): 1007-1015.

Sheoran, O. P., Tonk, D. S., Kaushik, L. S., Hasija, R. C. and Pannu, R. S. 1998. Statistical software package for agricultural research workers. Department of Mathematics Statistics. CCS HAU, Hisar: 139-143.

Thiman, K. V. and Went, F. W. 1934. On the chemical nature of the root-forming hormone. *Proc. K. Ned. Acad. Wet. Ser. C. Bio. Med. Sci.,* 37: 345-459.

Weisman, Z., Riov, J. and Epstein, E. 1988. Comparison of movement and metabolism of indole-3-acetic acid in mung bean cuttings. *Physiol. Plant,* 74: 556-560.

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Eco-friendly management of fruit borer (*Meridarchis scyrodes* Meyrick) in ber

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Abstract

All the treatments were found significantly superior over control in reducing the fruit borer incidence in ber. Whereas the treatments Profenophos 50 EC 0.05 % (18.33%), NSKE @ 5 % (20.95%) and Azadirachtin 3000 ppm (21.73%) found significantly superior over rest of the treatments in reducing the borer incidence. The healthy fruit yield data revealed that more or less treatment Profenophos 50 EC 0.05 % gave significantly higher yield and was remain at par with NSKE @ 5 % and Azadirachtin 3000 ppm treatments during the year 2008-09 to 2012-13 except the year 2011-12. Similarly in pooled results treatment Profenophos 50 EC 0.05 % give significantly higher yield (41.55 kg/tree.) followed by treatments Azadirachtin 3000 ppm (35.99 kg/tree.) and NSKE @ 5 % (34.79 kg/tree.) Highest gross income of Rs. 115500/ha was recorded in the treatment Profenophos 50 EC 0.05 %. Highest net income of Rs. 96700/ha, additional income of Rs. 46850/ha and ICBR 1:2.49 was recorded in treatment Profenophos 50 EC 0.05 % followed by treatment Azadirachtin3000 ppm @ 25 ml / ltr. (1:1.64).and NSKE @ 5 %(1:1.52).

Key words: Ber (*Ziziphus mauritiana*), eco-friendly management, fruit borer (*Meridarchis scyrodes*),

Introduction

Ber (*Ziziphus mauritiana* Lamk.) is an ancient poor man's drought hardy fruit crop grown in semiarid and arid regions of different states of India. Now-a-day's ber (*Ziziphus maruritiana*) is cultivated under arid zone in large scale. The estimated area in India under regular platation of improved varieties is about 70,000 ha (Pareek, 1996) in major ber growing states are Haryana, Punjab, Uttar Pradesh, Raiasthan, Gujarat, Madhya Pradesh, Bihar, Maharashtra, Andhra Pradesh and Tamil Nadu. Praveen *et al.* (1998) reported that ten insect's species belonging to four different orders were found feeding in ber. Among them the fruit borer (*Meridarchis scyrodes*) and fruit fly (*Carpomuia vesuviana* Bosta) are the important pests. *C. vesuviana* has been observed to damage as much as 80 % of the crop under severe infestations (Cherian and Sunderam, 1941). Infestation starts with the onset of fruit setting. The adult female lays eggs singly by inserting its "ovipositor in the developing fruit. After 2 to 5 days the larva hatches out and starts feeding on the pulp making galleries in it. The excreta of the larva accumulate in the galleries, which may sometimes causing rotting of the fruit. Infested fruit become deformed and their growth becomes checked, a large number of such fruits drop off. There may be 2 or 3 generations of the pest during the active period (Batra, 1953) while the fruit matures (from November to April in north lndia). To prevent infestation prophylactic sprays should be carried out with 0.03 % oxidematon or dimethoate starting from the stage when 70-80 % fruits attain pea size and then repeating the spray at one-month intervals (Pareekh and Vishal Nath, 1996). During the maturity of fruits' it necessary spraying should be done with 0.5 % Malathion at weekly intervals since, malathion has been observed to dissipate quickly in ber fruits decreasing well below the tolerance level of 3 ppm within two days after spraying (Popli *et al.* 1980). Damage by fruit borer (*Meridarchis scyrodes*) has been observed mainly in southern and western lndia, the reddish larvae bore into the fruit and feed on the pulp. So this present investigation was carried out to find out the economical and effective newer insecticides/biopesticides against fruit borer in ber.

Materials and Methods

The experiment was conducted during the year 2008-09 to 2012-13 at All India Co- ordinated Research Project on Arid Zone Fruits, S. D. Agricultural University, Sardarkrushinagar, Gujarat, India. The treatments are (i) Spinosad 45 SC @ 1 ml / l. (ii) Indoxacarb 14.5 SC @ 1 ml / l. (iii) NSKE @ 5 % (iv) Azadirachtin3000 ppm @ 2.5 ml /l. (v) Azadirachtin10,000 ppm @ 1.0 ml /l. (vi) Profenophos 50 EC 0.05 % @ 1.0 ml /l. (vii) Control (No spray). Three sprays of insecticides were made starting from pea size ber fruits at a 15 day interval. The experiment was replicated 4 times in RBD. One hundred fruits per tree were examined at each commercial picking by cutting open to confirm the damage of fruit borer infestation and converted in per cent damage. Damaged and

healthy fruits were also weighted at each picking.

Results and Discussion

(a) Fruit borer incidence

The observations recorded for the infestation of ber fruit borer (Table 1) indicated that during the year 2008-09 all the treatments found significantly superior over control except indoxacarb 14.5 SC and spinosad 45 SC (25.75 and 24.50 %) in reducing the infestation. Among the treatments Profenophos 50 EC 0.05 % (15.42 %) found significantly superior and was at par with NSKE @ 5 % (17.58%), azadirachtin 3000 ppm (18.50%) and azadirachtin 10,000 ppm (22.00%). During the year 2009-10 also all the treatments found significantly superior over control except indoxacarb 14.5 SC (11.66%), and spinosad 45 SC (12.38%) in reducing the infestation of ber fruit borer. Treatment Profenophos 50 EC 0.05 % (6.08%).was found significantly superior than rest of treatment except treatment azadirachtin 3000 ppm (8.44%).

In the year 2010-11 treatments Profenophos 50 EC 0.05 % (8.75%), NSKE @ 5 % (12.38%) and azadirachtin 3000 ppm (14.38%) found significantly superior over control and also were found at par with each other. Treatments azadirachtin 10,000 ppm (22.13%), indoxacarb 14.5 SC (24.75%) and spinosad 45 SC (27.75%) found at par with control in reducing the fruit borer infestation.

During the year 2011-12 all the treatments found significantly superior over control in reducing the ber fruit borer incidence. Treatments Profenophos 50 EC 0.05 % (5.88%), NSKE @ 5 % (6.13%) and azadirachtin 3000 ppm (6.50%) found significantly superior over rest of the treatments in reducing the fruit borer incidence.

Similarly during the year 2012-13 all the treatments except spinosad 45 SC (32.68%) found significantly superior over control in reducing the borer incidence. More or less treatments Profenophos 50 EC 0.05 % (12.74%), NSKE @ 5 % (17.90%) and azadirachtin 3000 ppm (21.90%) found significantly superior over rest of the treatments.

Pooled results also clearly indicated that all the treatments found significantly superior over control in reducing the fruit borer incidence. Whereas the treatments Profenophos 50 EC 0.05 % (18.33%), NSKE @ 5 % (20.95%) and azadirachtin 3000 ppm (21.73%) found significantly superior over rest of the treatments in reducing the borer incidence. Patil and Patil (1997) reported that the dimethoate 30 EC + jiggery solution(at 0.03 + 1.0% concentration) was the most effective treatment against ber fruit borer followed by monocrotophos(at 0.04%) and endosulfan 35 EC (at 0.07%). Rajaram and Siddeswaran, 2006 reported that fenthion 0.1% recorded the lowest mean fruit damage of 26.6% and is at par with endosulfan 0.07% (26.67%) and both are equally effective in controlling the fruit borer and fruit fly complex. He also reported that Azadiractin 1 % and *Ocimum sanctum* extract 1 % are also effective up to 10 days after sprays against these pests.

Table 1. Efficacy of insecticides/ biopesticides against fruit borer in ber during 2008-09 to 2012-13

S. No.	Treatment	Mean per cent infestation of ber fruit borer					
		Year					Pooled
		2008 -09	2009 -10	2010 -11	2011 -12	2012 -13	
1	Spinosad 45 SC @ 1 ml / l.	30.28* (24.50)	21.02 (12.38)	32.04 (27.75)	22.56 (14.25)	35.14 (32.68)	28.21
2	Indoxacarb 14.5 SC @ 1 ml / l.	31.02 (25.75)	22.90 (11.66)	30.06 (24.75)	22.76 (14.63)	32.59 (28.58)	27.87
3	NSKE @ 5 %	25.51 (17.58)	17.97 (9.03)	20.99 (12.38)	14.89 (6.13)	25.38 (17.90)	20.95
4	Azadirachtin –3000 ppm @ 2.5 ml / l.	26.16 (18.50)	17.38 (8.44)	21.97 (14.38)	15.27 (6.50)	27.85 (21.90)	21.73
5	Azadirachtin –10,000 ppm @ 1.0 ml / l.	28.34 (22.00)	19.00 (10.11)	28.08 (22.13)	20.61 (12.00)	30.83 (25.87)	25.37
6	Profenophos 50 EC 0.05 % @ 1.0 ml / l.	23.60 (15.42)	14.85 (6.08)	17.50 (8.75)	14.45 (5.88)	21.27 (12.74)	18.33
7	Control (No spray)	34.37 (31.00)	22.42 (14.22)	33.70 (30.40)	26.08 (19.00)	37.90 (37.28)	30.89
	SEm ±	1.94	0.94	2.10	1.04	1.50	0.71
	C.D. @ 5%	5.75	2.81	6.23	3.00	4.47	2.00
	CV %	13.60	9.76	15.92	10.62	9.98	12.70
	Y x T						NS

Note: *arc sin transformed value Figure in parentheses is original value

(b) Fruit yield

The healthy fruit yield (Table 2) data revealed that more or less treatment Profenophos 50 EC 0.05 % gave significantly higher yield and remain at par with NSKE @ 5 % and azadirachtin 3000 ppm treatments during the year 2008-09 to 2012-13 except the year 2011-12. Similarly in pooled results treatment Profenophos 50 EC 0.05 % give significantly higher yield (41.55 kg/tree.) followed by treatments Azadirachtin 3000 ppm (35.99 kg/tree.) and NSKE @ 5 % (34.79 kg/tree.)

(c) Economics

Data indicated (Table 3) that highest gross income of Rs. 115500/ha , highest net income of Rs. 96700/ha, additional income of Rs. 46850/ha was recorded in treatment Profenophos 50 EC 0.05 % . Highest ICBR 1:2.49 was recorded in treatment Profenophos 50 EC 0.05 % followed by treatment Azadirachtin3000 ppm @ 25 ml / ltr. (1:1.64) and NSKE @ 5 % (1:1.52).

Table 2. Healthy ber fruit yield (kg/tree)

S.No.	Treatment	Healthy ber fruit yield (kg/tree)					
		Year					Pooled
		2008-09	2009-10	2010-11	2011-12	2012-13	
1	Spinosad 45 SC @ 1 ml / l.	22.85	23.90	38.48	23.03	27.31	27.11
2	Indoxacarb 14.5 SC @ 1 ml / l.	19.94	23.32	39.52	22.51	27.42	26.54
3	NSKE @ 5 %	29.04	32.24	51.55	22.93	38.17	34.79
4	Azadirachtin–3000 ppm @ 2.5 ml / l.	27.61	42.05	49.31	23.75	37.28	35.99
5	Azadirachtin–10,000 ppm @ 1.0 ml / l.	25.06	30.19	46.00	22.46	36.12	31.96
6	Profenophos 50 EC 0.05 % @ 1.0 ml / l.	30.79	43.86	62.21	23.65	47.23	41.55
7	Control (No spray)	16.49	21.14	35.54	22.22	24.85	24.05
	SEm ±	0.92	0.93	4.67	0.46	3.14	1.61
	C.D. @ 5%	2.73	2.78	13.87	NS	9.33	5.27
	CV %	7.48	6.04	20.26	4.02	18.44	13.34
	Y x T						NS

Table 3. Economics of different treatments for the control of ber fruit borer.

Sr. No.	Treatment	Yield (kg/ha)	Gross income (Rs/ha)	Total Cost of cultivation (Rs/ha)	Net income (Rs/ha)	Additional income over control (Rs/ha)	ICBR
1	Spinosad 45 SC @ 1 ml / l.	7538	75380	41600	33780	-16070	----
2	Indoxacarb 14.5 SC @ 1 ml / l.	7379	73790	23660	50130	280	1:0.01
3	NSKE @ 5 %	9670	96700	18620	78080	28230	1:1.52
4	Azadirachtin–3000 ppm @ 2.5 ml / l.	10008	100080	19025	81055	31205	1:1.64
5	Azadirachtin–10,000 ppm @ 1.0 ml / l.	8886	88860	19340	69520	19670	1:1.02
6	Profenophos 50 EC 0.05 % @ 1.0 ml / l.	11550	115500	18800	96700	46850	1:2.49
7	Control (No spray)	6685	66850	17000	49850	----	

- Ber price : Rs.10/- per kg Labour charge Rs 120/day (Two labour per spray)
-Cost of FYM+ Chemical fertilizer+ Labour charge = Rs.17000/-
- Cost of Sprays includes cost of insecticides and labour cost for three sprays.
1 Spinosad 45 SC Rs. 13267 per liter 2 Indoxacarb14.5 SC Rs. 3300 per liter
3 Neem seed kernel powder Rs. 10 per kg 4 Azadirachtin3000 ppm Rs. 290 per liter
5 Azadirachtin10,000 ppm Rs. 900 per liter 6 Profenophos 50 EC Rs. 600 per liter

References

Batra, H. N. 1953. Biology and control of *Dacus diversus* Conquillet and *Carpomyia vesuviana* Costa and important notes on other fruit flies in India. *Indian Journal of Agricultural Science*, 23 : 87-112.

Cherian, M. C. and Sunderam, C. V. 1941. *Proceedings of the 20th Indian Science Congress*, III: 191.

Pareek, O. P. 1996. Indian jujube and pomegranate. In 50 years of Crop Science Research in India, eds. Paroda, R. S. and Chadha, K.L., ICAR, New Delhi, India: 557-573.

Pareek, O. P. and Vishal Nath. 1996. Ber. In *Coordinated Fruit Research in Indian Arid Zone - A two decades profile (1976-1995)*. National Research Centre for Arid Horticulture, Bikaner, India: 9-30.

Patil, Praveen and Patil, B. V. 1997 Management of Ber fruit borer, *Meridarchis scyrodes* Meyrick (Carposinidae : Lepidoptera). *Karnataka . J. Agris. Sci*. 10(1) : 52-55

Popli, S., Kathpal, T. S. and Lakra, R. K. 1980. Note on dissipation of malathion residues from jujube fruits and leaves. *Indian Journal of Agricultural Science*, 50(2) : 191-192.

Praveen, Patil, Patil, B.V., Rahman, S.M., Sreenivasa, A. G., Patil, P and Reddy, P. P. 1998. Survey of insect pests of ber in North Karnataka with special reference to management of fruit borer, Meridarchis scyrodes Meyrick. (Ed.) Kumar, N.K K. and Varghese, A. In: Advances in IPM for horticultural crops. Proceedings of the First National Symposium on Pest management in Horticultural Crops: environmental implications and thrusts, Bangalore, India, 15-17 October 1997. : 52-57.

Rajaram, V. and Siddeswaran, K. 2006. Efficacy of insecticides and plant products against the fruit borer and fruit fly in ber under rain fed condition. *Internat. J. Agris. Sci*. 2(2) : 538-540

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Dehydration of karonda (*Carissa carandas* L.) fruits for culinary utilization

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Abstract

Karonda (*Carissa carandas L.*) is an underutilized fruit crop of hot arid and semi-arid region grown commonly as a protective hedge. The storage life of karonda is very short because of its soft flesh and high moisture content. Karonda remains unexploited commercially owing to lack of standardized post harvest and value addition technology. Unripe tender fruits (2.0 to 2.5 g) and mature unripe fruits (4.0 to 4.5 g) were subjected to treatments combination consist of control, blanching for 3 minute and blanching with preservatives treatments of potassium meta bisulphite, citric acid and sodium benzoate each at 0.1 and 0.2 % concentrations for five minutes and dried in sun. Among all the treatments, tender fruits blanched for 3 minute and treated with sodium benzoate 0.1 % were found superior for dehydration of karonda fruits for preparation of powder. Dehydrated karonda powder was found good in organoleptic taste for its tartness and as masala mixture for its typical sour taste. These dehydrated fruits can also be used as mouth freshener and for making chutney.

Key words: *Carissa carandas* L., dehydration, fruit powder, organoleptic quality

Introduction

Karonda (*Carissa carandas* L.) a thorny shrub belongs to family Apocynaceae. It is cultivated as hedges at farm boundary in the arid and semi-arid regions. After establishment, it hardly needs any care and gives yield (8-10 kg/plant) with minimum management. It is tolerant to biotic and abiotic stresses and ideal for growing in the adversity and drought prone areas (Mitra *et al.,* 2006). The fresh fruits of karonda are less popular due to their sour and astringent taste, however are one of the richest sources of iron (0.46-4.95 mg/100 g) and contain appreciable amount of vitamin C (1.6-17.90 mg/100 g), besides other minerals required for human health (Manivasagan *et al*., 2007 and Misra, 2011). Its unripe sour and astringent fruits are used for preparation of vegetable, chutney and pickle locally. Karonda is generally used as a condiment or additive to Indian pickles and spices (Maheshwari *et al*., 2013). Karonda unripe fruit contains high amount of iron 0.83 mg, zinc 1.44 mg, ascorbic acid 17.00 mg, dietary fiber 2.07 g and total phenol 4.27 mg per 100 g of fruits (Hiregoudra, 2012). Karonda fruits are also used in making jelly, jam, squash, tarts and chutney which are of great demand in international market (Wani *et al*., 2013). It also helps to improve the sensorial, nutritional and organoleptic properties of foods (Khan, 2012). The unripe fruit harvested at maturity can be stored for 7 to 10 days at room temperature, but at ripe stage, it can be stored only for 2 to 3 days. Sometimes there is glut in the markets and farmers are not getting reasonable price. There is very meager information available on karonda post harvest and value addition technology particularly dehydration of fruits. The dehydrated fruit product can be stored for longer period. Blanching is used to arrest enzyme activity and associated changes before processing (Brewer *et al*., 1995). In hot arid and semi arid region plenty of sun light is available which can be utilized for dehydration of fruits. Besides, being acidic in nature karonda is not consumed as fresh and table fruit. Since, karonda is a seasonal fruit, its preservation in different products is necessary to avoid its spoilage and to make its availability round the year (Parvathi and Anby, 1997). The dried product not only retains nutritive value but also easy to handle, store and transport for long distances market. Therefore, the present investigation was undertaken to standardize the karonda dehydration technology for culinary utilization.

Materials and Methods

The experiment was conducted at the Post Harvest Laboratory of ICAR-Central Institute for Arid Horticulture for standardization of dehydration technology in karonda. The experiment conducted in factorial completely randomized design with three replications. Two type of fruits *i.e.* F_1-Tender fruits of small size (2.0 to 2.5 g with soft seed) and F_2- Unripe mature fruits of big size (4.0 to 4.5 g with hard seed) and three preservative potassium meta bisulphite (KMS), citric acid (CA) and sodium benzoate (SB) were used in the experiment. There were eight treatment combination namely T_1- Control (without any treatment), T_2- Blanching for 3 min., T_3- Blanching for 3 min.+ KMS 0.1 % for 5 min., T_4- Blanching for 3 min.+ KMS 0.2 % for 5 min., T_5- Blanching for 3 min.+ CA 0.1 % for 5 min., T_6- Blanching for 3 min.+ CA 0.2 % for 5 min., T_7- Blanching for 3 min.+ SB 0.1 % for 5 min. and T_8- Blanching for 3 min.+ SB 0.1 % for 5 minutes. Fresh, healthy tender and mature unripe fruits were harvested for the preparation of powder. After washing, the fruits were blanched

and treated with preservative as per the treatments. The fruits were spread uniformly in aluminium trays and were dried in the sun. The dried fruits were grounded to form powder and sieved through mesh sieve to get uniform samples. Data were recorded on fruits morphological, physico-chemical parameter and fruit powder were evaluated for organoleptic parameters. The ascorbic acid was determined by using 2-6 dichlorophenol-indophenol dye. The acidity was analyzed by titrating with 0.1 N NaOH using phenolphthalein as an indicator Ranganna (1997). Sensory evaluation of the fruit powder was done by following the hedonic rating. Data on morphological and physico-chemical characteristics of fruits were presented in Table 1. Tender fruits had high acidity (3.84 %) as compared to mature unripe fruits (3.15%).

Results and Discussion

The effect of fruit type and preservative treatments on acidity and ascorbic acid content of fruit powder is presented in Table 2. Among fruit type, highest acidity was recorded in fruit powder prepared from tender fruits (4.17 %) which is significantly superior to mature unripe fruits (2.78 %). However, ascorbic acid content was recorded significantly highest in fruit powder prepared from mature unripe fruits (14.25 mg/100 g) as compared to tender fruit powder (12.41 mg/100 g). Similar results were also obtained by Saxena *et al*., (2016) in karonda. Among different treatments of preservatives, highest acidity was recorded in treatment blanching for 3 min.+ KMS 0.2 % for 5 min. (3.77 %) followed by blanching for 3 min.+ KMS 0.1 % for 5 min. (3.74 %) as against minimum in 3.13 in control. Ascorbic acid content (mg/100 g) was found highest in treatment blanching for 3 min.+ KMS 0.2 % for 5 min. (13.52) followed by blanching for 3 min.+ SB 0.1 % for 5 min. (13.44) as against minimum in 3.11 in control. Ascorbic acid was found high in chemically treated fruit powder as compared to control and blanching treatment alone, which are in accordance with results obtained by Gupta *et al*., (2008) in green leafy vegetables. Mulay *et al*., (1994) also reported that KMS

Table 1. Morphological and physico-chemical characteristic of fruits

Morphological characteristic			Physico-chemical characteristic		
Characteristic	Tender fruit	Mature unripe fruit	Characteristic	Tender fruit	Mature unripe fruit
Colour	Light green	Dark purple	TSS ^{0}Brix	6.25	7.69
Fresh weight (g)	2.30	4.12	Acidity (%)	3.84	3.15
Fruit length (cm)	1.80	2.50	Moisture (%)	80.12	78.18
Fruit diameter (cm)	1.30	2.31	Vita. C (mg/100 g)	14.03	17.50
No. of seeds	3.33	3.33	Total phenol (mg/100 g)	4.10	2.32

Table 2. Effect of fruit type and preservative on acidity and ascorbic acid of fruit powder

Treatments	Acidity (%)			Ascorbic acid (mg/100 g)		
	Tender fruit	Mature unripe fruit	Mean	Tender fruit	Mature unripe fruit	Mean
T_1	3.80	2.46	3.13	12.17	14.05	13.11
T_2	3.83	2.45	3.14	12.20	14.12	13.16
T_3	4.42	3.06	3.74	12.57	14.28	13.42
T_4	4.45	3.09	3.77	12.61	14.42	13.52
T_5	4.02	2.69	3.36	12.35	14.19	13.27
T_6	4.13	2.77	3.45	12.35	14.21	13.28
T_7	4.33	2.81	3.57	12.45	14.31	13.38
T_8	4.38	2.89	3.64	12.52	14.36	13.44
Mean	4.17	2.78		12.41	14.25	
SEm±	F=0.05 T=0.11 FxT=0.15			F=0.08 T=0.16 FxT=0.23		
CD at 5 %	F=0.16 T=0.32 FxT= NS			F=0.23 T=0. NS FxT= NS		

pretreatment to leafy vegetable can reduce loss of ascorbic acid. The interaction effect of fruit type and preservative treatments was found non significant and highest value (4.45 %) for acidity was recorded in treatment combination of tender fruit with blanching for 3 min.+ KMS 0.2 % for 5 minutes and lowest values for acidity were recorded in treatment combination of mature unripe fruits with blanching for 3 min. (2.45 %). and mature unripe fruits control (2.46 %) The ascorbic acid content was found highest (14.42 mg/100 g) in treatment combination mature unripe with blanching for 3 min. + KMS 0.2 % for 5 minutes.

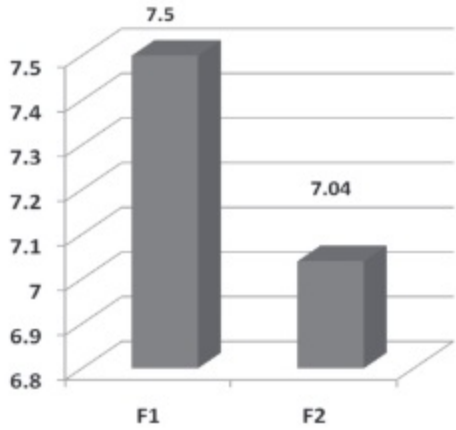
Fruit powder was also subjected to sensory evaluation. Data presented in Table 3 divulged that there was significant effect of fruit type and preservative treatments on organoleptic qualities of karonda fruit powder. Based on score, amongst fruit type, tender fruits was found more acceptable (7.23 and 7.10) as compared to mature fruits (6.93 and 6.86) for colour and texture, respectively. Similar trends for texture were also obtained by Saxena *et al*., (2016) in Pant Sudarshan variety of karonda. The colour of dehydrated mature unripe fruits in the control was brownish black which may be due to changes in phenolic contents affected by non enzymatic browning (Mayer and Harel, 1979). Among different treatments of preservatives, chemical preserves improves colour and texture of fruit powder, highest colour acceptability (7.96) was obtained in treatment blanching for 3 min.+ SB 0.2 % for 5 min. while value for texture was highest (7.70) in blanching for 3 min.+ KMS 0.2 % for 5 min. treatment.

Among interaction effects of fruit type and preservative treatments, highest acceptability for colour with 8.26 score was observed in treatment combination of tender fruit with blanching for 3 min.+ SB 0.1 % for 5 minutes whereas, highest score of texture (7.83) was observed in treatment combination of tender fruit with blanching for 3 min.+ KMS 0.2 % for 5 minutes.

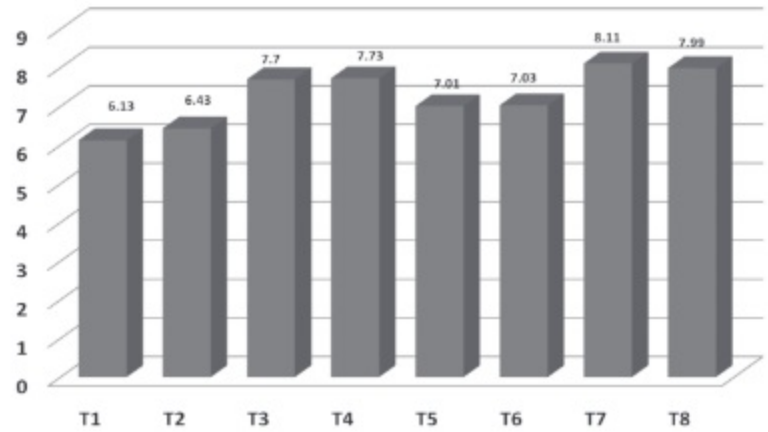
Based on organoleptic evaluation (Fig.1), amongst all fruit types highest acceptability was recorded in powder prepared from tender fruits (7.5) while in preservative treatments blanching for 3 min.+ SB 0.1 % for 5 min. was found more acceptable with highest rating (8.11). Amongst combined effect of fruit type and preservative treatments, highest overall acceptability (8.53) was observed in treatment combination of tender fruit with blanching for 3 min.+ SB 0.1 % for 5 minutes. Similar findings were reported by Saxena *et al*. (2016) with highest acceptability of karonda fruit powder prepared from fruits picked at 70 days after fruit set. It can be concluded that powder prepared from tender karonda fruits treated with blanching for 3 minutes + SB 0.1 % for 5 minutes (Fig.2) was better in terms of colour, overall acceptability and with higher acidity. Dehydrated karonda powder was found mot suitable in organoleptic taste for its tartness and for masala mixture owing to its typical sour taste. These dehydrated fruits can also be utilized as mouth freshener and chutney preparation.

Table 3. Organoleptic evaluation of karonda fruit powder

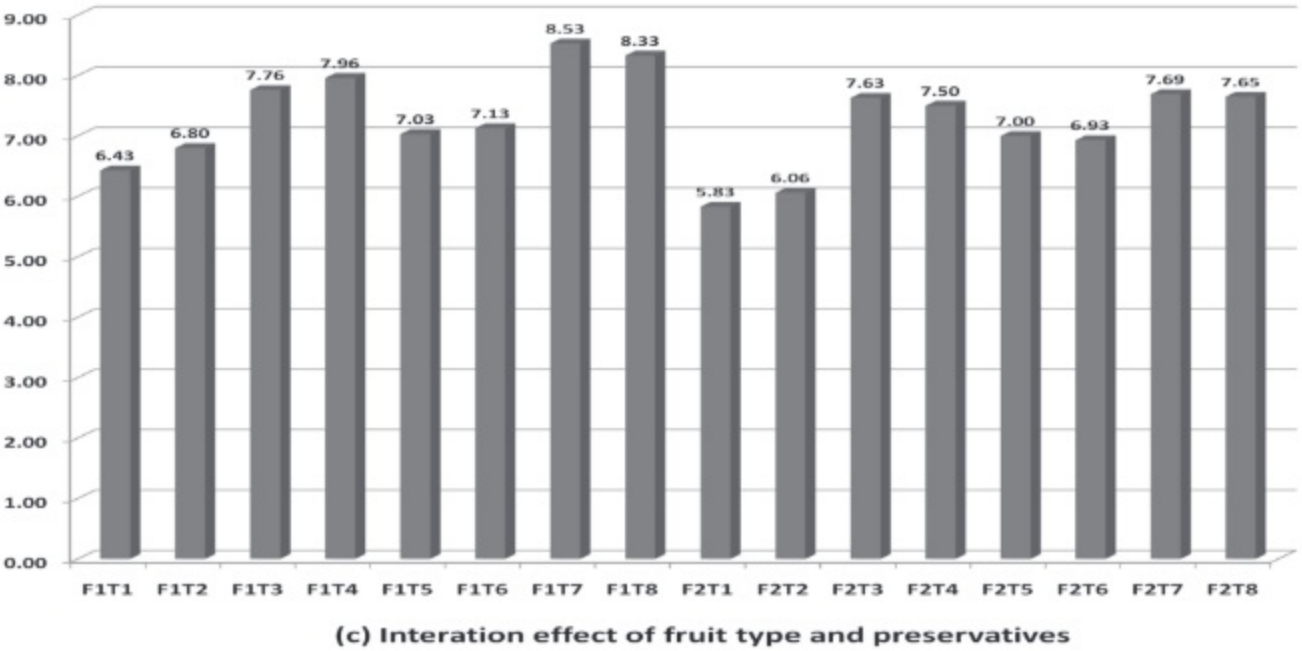
Treatments	Colour			Texture		
	Tender fruit	Mature unripe fruit	Mean	Tender fruit	Mature unripe fruit	Mean
T_1	6.13	5.60	5.86	6.26	5.73	6.00
T_2	6.57	5.80	6.18	6.70	5.93	6.32
T_3	7.47	7.46	7.47	7.60	7.60	7.60
T_4	7.70	7.43	7.57	7.83	7.57	7.70
T_5	6.73	6.70	6.72	6.86	6.83	6.85
T_6	6.83	6.66	6.75	6.96	6.80	6.88
T_7	8.26	7.90	8.08	7.40	7.20	7.30
T_8	8.10	7.83	7.96	7.23	7.26	7.25
Mean	7.23	6.93		7.10	6.86	
SEm±	F=0.019 T=0.039 F xT=0.055			F=0.029 T=0.058 F xT=0.082		
CD at 5 %	F=0.056 T=0.112 F xT= 0.158			F=0.084 T=0.168 F xT= 0.237		



(a) Main effect of fruit type



(b) Main effect of preservatives



(c) Interation effect of fruit type and preservatives

Fig 1. Overall acceptability of karonda fruit powder

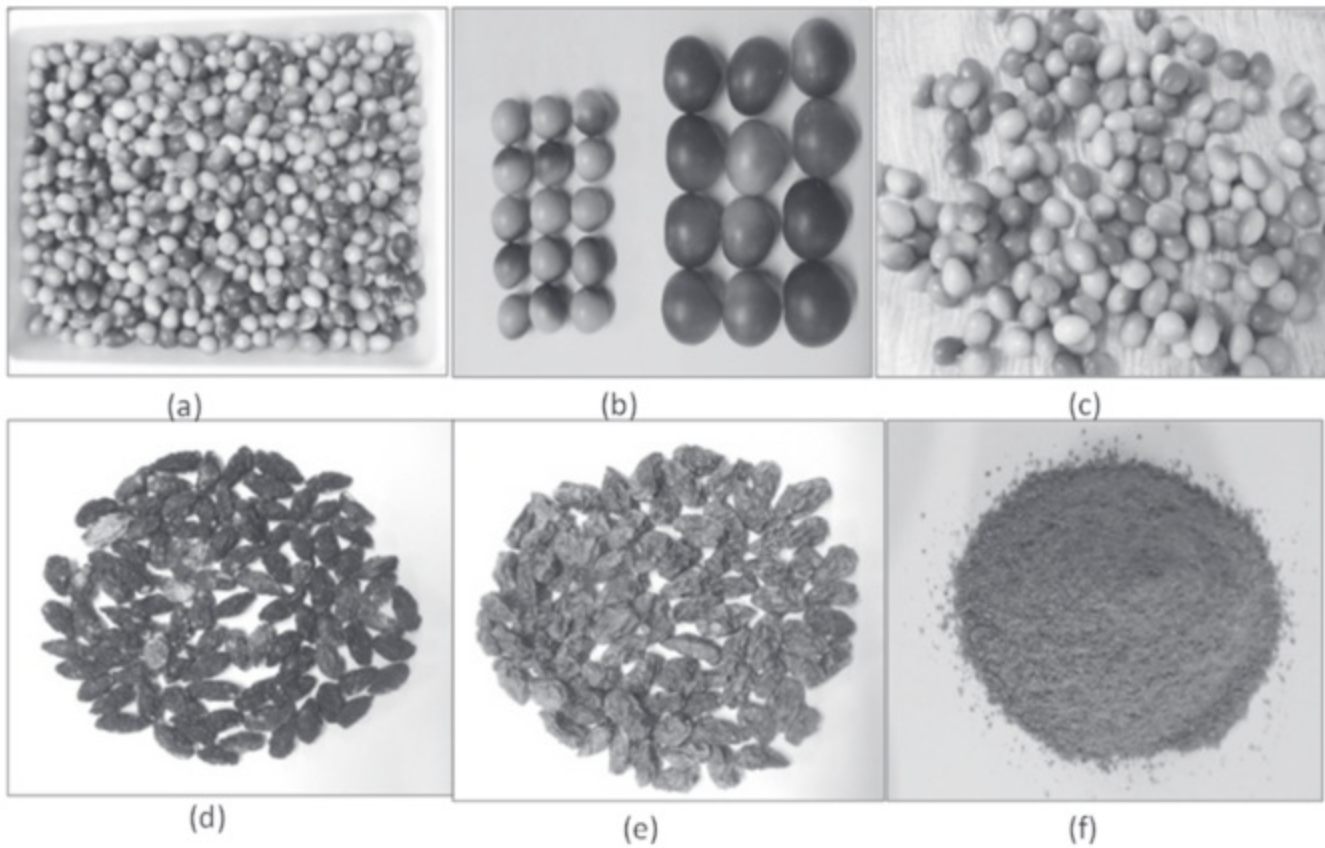


Fig 2. Dehydration of karonda fruits for value addition
(a) Fresh fruits, (b) Tender and mature unripe fruits, (c) Treated fruits, (d) Dehydrated mature unripe fruit (control), (e) Dehydrated tender fruit (blanching for 3 minutes + SB 0.1 % for 5 min.) and (f) Fruits powder

References

Brewer, M.S., Begum, S., and Bozeman, A. 1995. Microwave and conventional blanching methods on chemical, sensory and colour characteristic of frozen broccoli. *J.Food Qual*,18:179-93.

Gupta, S., Lakshmi, J. and Prakash, J. 2008. Effect of different blanching treatments on ascorbic acid retention in green leafy vegetables. *Natural Product Radiance,* 7(2): 111-16

Hiregoudra, V.S. 2012. Physico chemical characteristics, value addition and shelf life of evaluation karonda (*Carissa carandas*). M.Sc. Thesis submitted to the University of Agricultural Sciences, Dharwad.

Khan, R.M. 2012. Osmotic dehydration technique for fruits preservation A review. *Pakistan J. Food Sci*., 22(2):71-85.

Maheshwari, R., Sharma, A. and Verma, D. 2013. Phytotherapeutic significance of Karaunda. *Bull. Environ., Pharmacol. & Life Sci.,* 1 (12): 34- 36.

Manivasagan, S., Kumar, S. Rana, G. S. and Joon, M.S. 2007.Study on qualitative changes in pickles prepared from karonda during storage. *Haryana. J. Hort. Sci.,* 36 (2):44-45.

Mayer, A.M. and Harel, E. 1979. Polyphenol oxidases in plants. *Phytochem.* 18: 193-215.

Misra, K.K. 2011. *Subtropical Fruit Culture,* Kalyani Publishers, New Delhi, pp. 199-223.

Mitra, S.K., Pathak, P.K. and Chakraborty, I. 2006. Underutilized Tropical and Subtropical Fruits of Asia in ISHS *Acta Hortic.* 770: XXVII International Horticultural Congress - IHC2006: International Symposium on Cultivation and Utilization of Asian, Sub-tropical, and Underutilized Horticultural Crops.

Mulay, S.V., Pawar, V.N., Thorat, S.S., Ghate, V.M. and Ingle, U.M. 1994. Effect of pretreatment on quality of dehydrated cabbage. *Indian Food Packer*, 48(5):11-16.

Parvathi, S. and Anby, S. 1997. Karonda delicious. *Indian Hort*., 42(1): 11-13.

Ranganna, S. 1997. Handbook of analysis and quality control for fruit and vegetable products. Tata McGraw Hill Publishing Co. Ltd., New Delhi

Saxena, D., Misra, K.K. and Rai, R. 2016. Studies on suitability of cultivars, picking dates and drying methods for the preparation of karonda (*Carissa carandus* L.) fruit powder. *Indian J. Hort.,* 73(2): 267-273.

Wani, R.A., Prasad, V.M., Hakeem, S.A., Sheema, S., Angchuk, S. and Dixit, A. 2013. Shelf-life of karonda jams (*Carissa carandas* L.) under ambient temperature. *African J. Agric. Res.,* 8 (21): 2447-49.

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Dipcadi erythraeum Webb.& Berth. : A threatened medicinal plant of Thar Desert

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Abstract

Dipcadi, an important genus of family Hyacinthaceae is distributed in tropical regions of the world. Most species of *Dipcadi* are used in folk medicine. *Dipcadi erythraeum* is one such species of Indian Thar desert, which is traditionally used as food during famine and also as a therapeutic herb. Its over exploitation has reduced its populations and it now it stands as threatened. In this paper, the ecology, potential and need for its *in situ* conservation in its native sites are highlighted.

Key words: *Dipcadi erythraeum*, conservation, endemic, threatened species, Thar desert.

Introduction

The genus *Dipacdi* Medic. of family Asparagaceae (formerly Liliaceae and Hyacinthaceae) is distributed in tropical regions. Most of the species of *Dipcadi* are in wild state and await discovery. Jehan *et al*., (2014) reported highest polyphorphism in genus *Dipcadi* with two other genera *Drimia* and *Ledebouria* in family Hyacinthaceae. The genus shows great diversity in India by representing 11 species, of which 9 are endemic and distributed from Himalaya to Peninsular India (VijyaJyothi, 2018). The species viz., *Dipcadi concanense* (Dalz.) Baker, *D. erythraeum* Webb.&Berth.,*D. goaense* Prabhug., D. *krishnadevarya* B.R.P.Rao, *D.maharashtrensis* Deb & Dasgupta, *D. minor* Hook.f, *D. montanum* (Dalz.) Baker, *D. reidii* Deb & S. Dasgupta, *D. saxorum* Blatter, *D. serotinum* (L.) Medic and *D. ursulae* Blatter occur in different parts of India. Most of the species of *Dipcadi* are from Western Ghats and used in folk medicine. Due to increasing biotic interferences, the species of *Dipacdi* are threatened in their natural distribution. *D. erythraeum* is reported as endemic and threatened plant in India (Bhandari and Shringi,1987) and its distribution is restricted to rocky and gravelly soils of north-west Rajasthan (Bhandari, 1990). It is locally known as Bhakar Kanda, Janglipyaz, Kanda, Piaziin, etc. in western Rajasthan. This paper presents the state of research information on *Dipcadi erythraeum* from western Rajasthan and highlights its ecology, potential and need of its *in situ* conservation.

Origin and Distribution

Rawat *et al*., (2011) reported probable amphidiploids origin of *D. erythraeum*. Jehn*et al*., (2014) mentioned that *Dipcadi erythreum* [syn. *Dipcadi unicolor* (Stocks) Baker, *Uropetalum unicolor* Hooker, *Ornithogalaumerythraeum* (Webb. &Berthel.) J.C. Manning &Goldblan, *Uropetalon erythraeum* (Wevbb. &Berthel.)Boiss.] is genetically distinct species and is restricted to hilly desert tracts of Rajasthan indicating that it might be an introduction from Pakistan and Baluchistan. *D. erythraeum* is distributed in tropical countries such as Canary Islands, Egypt and Saudi Arabia, Iran, Iraq, Afghanistan, Pakistan and India. In India it mostlyoccurs in gravelly plains in western Rajasthanin the districts of Barmer, Jaisalmer,Jodhpur and Jalore. It also shows highly restricted and patchy distribution in Kachchh, Gujarat (Joshi *et al*., 2012).

Botanical and Ecological Characteristics

*D. erythraeum*is a scapigerous, bulbous herb, attains about 30 cm height (Fig.1). Bulbs are 15-30mm in diameter and tunicated. Leaves are 5-6, narrowly linear, terete, erect15-20 X 4-6 mm. Scapes are up to 25 cm long, 4-12 flowered. Flowers are greenish in lax raceme (Fig.2). Fruit is a capsule, short stalked, 12-15 mm long and broad (Fig. 1), slightly narrowed at base. Each fruit has three locules; number of seeds per locule varies from 10-17. Seeds are 6-7 mm, orbicular, flat black narrowly winged. Flowering and fruiting occurs during August to September. It produces flowers and fruits in short period of time following monsoon rains.

D. erythraeum occurs in crevices usually along runnels on shallow sandy gravelly soils and in depressions of rocky and gravelly areas of arid range lands in Thar Desert. It occurs more frequently over rocky and gravelly regions where rainwater gets conserved for some period. In its natural habitat, it forms association with grasses, leguminous and non-leguminous perennial herbs. It is associated frequently with perennial grasses like *Dactyloctenium sindicum* Boiss., *Ochthochloa compressa* (Forsk.) Hilu, herbaceous leguminous species like *Indigofera cordifolia* Heyne ex Roth, *Tephrosia uniflora* Pers., and non-leguminous perennial herbaceous species like *Boerhavia diffusa* L., *Tribulus pentandrus* Forsk., *Tribulus terrestris* L.etc. *Glossonema*

varians(Stocks) Hooks. f.is also noticed as associate of *Dipcadi erythraeum*in rocky-gravelly rangelands in Jaisalmer district.

Economic Importance

The bulbs of *D. erythraeum* are used as one of the common food during the famine period in the Thar Desert, and capsules are also eaten (Bhandari, 1990, Jongbloed *et al*., 2003). Although, bulbs are edible in Arab region, it is bitter in taste (Mandaville, 1990). Its bulb are used by inhabitants as herbals. They are used as a substitute and adulterant to Indian squill (*Urginea indica* Kunth), which resemble digitalis in action and used as an expectorant (Ambasta*et al.* 1986). In Bahrain, the leaves are used as alaxative and as an ointment for wounds (Rizk and El-Ghazaly, 1995).

Propagation and Regeneration

It is propagated through seeds, however, also has ability to grow from bulbs. The collection of seed could be made during August-September when fruiting occurs for a short period. Due to very thin nature, the seeds disperse fast through wind. The plant could be established from seeds in the first year. After 3-4 years it becomes bulbiferous and starts flowering and fruit setting to yield seeds.Seeds of *D. erythraeum* sown in the nursery at ICAR-CAZRI, RRS, Jaisalmer showed, 50% germination after five days of sowing. After four month of seed sowing in nursery, seedlings height was ranged from 14.5 to 28.5 cm (average 21.6 cm) with average length of root 3.3 cm. Regeneration growth data recorded in previous year planting from the bulb of *D. erythraeum* in the field showed high regeneration (>90 %) and good flowering/fruiting. Recently, Sagar and Kasera (2019) reported that seeds of *D. erythraeum* pre-treated with growth regulators improved germination and other parameters as compared to control. Among all growth regulators, GA_3 showed best results for seed germination and seedling growth, but higher concentrations of GA_3 retards the germination.

Prospects

Bulbs of *D. erythraeum*are are most important economic part and utility of the bulbs made this species as one of the valuable plant in the arid region. The bulbs are used as food during the famine period which is a common phenomenon in most of the deserts of the world during severe drought, crop failure etc. So, it as an integral part in the diet of people, especially during drought. Due to the similarity in the mode of action of Indian squill (*Urginea indica* Kunth), it could be a good alternative in the near future. Presence of tannins, alkaloids, flavonoids and saponins reported by various workers in different species of *Dipcadi* viz., Adly*et al*., (2015) in *Dipadiserotinum*, Abdulkareem *et al*., (2014) in *D. filamentosa*and Vijya Jyothi *et al*., (2018) in *D. krishnadevarayae*. EL-Shabrawy *et al*., (2016) reported isolation of two flavanolaglycones (kaempferol and quercetin), one flavonol glycoside (quercetin 3-O-rutinoside-7- O-á-rhamnopyranoside), and four C-glycosyl flavones (vitexin, isovitexin, orientin, and isoorientin) from the whole plant of *D. erythraeum*. Recently, Marzouk *et al*., (2019) reported 22 compounds including 14 C-glycocylflavanoids, 6 phenolic acid derivatives (coumaric acid and caffeic acid derivatives) one organic acid and one anthocynanin (delphinine derivatives) from the bulbs of *D. erythraeum* and one of them identified as C-glycocylflavanoids. Further, they mentioned that the presence of C-glycocylflavonid supported that *D. erythraeum* has a closer relationship with the species of Asperagaceae family than Liliaceae.Sagar and Kasera (2016) reported that leaf pigments in *D. erythraeum* were maximum during flowering stage, while remaining parameters in vegetative stage.

Conservation

Genus *Dipcadi* received attention from number of workers in India from conservation point of view. Dasgupta and Deb (1988) emphasized conservation of six species of

Fig. 1: Habit of *D. erythraeum*

Fig. 2: Close up of flower of *D. erythraeum*

Dipcadi as mentioned in Red Data Book. Following this, Rawat (2009) highlighted the genus *Dipcadi* as a disappearing genus. Efforts have been made and *D. concanense* was rediscovered and assessed as Critically Endangered (Mishra and Singh, 2001). Another presumably extinct species i.e. *Dipcadi reidii* was recollected after 127 years from Uttrakhand, India (Rawat and Chandra, 2014). *Dipcadi erythraeum*is reported as a rare, endemic and threatened plant in India and its distribution is restricted to rocky and gravellysoils of north-west Rajasthan. In Gujarat, the species is threatened by habitat degradation and soil erosion (Joshi *et al*., 2012). Even during scanty rains, its perennating bulbs sprout and complete life cycle in gravelly- rocky areasin arid region like Jaisalmer district.

Most of the *Dipcadi* species are habitat specific and need special attention for *in situ* conservation in protected areas. Field studies during the course of study of *D.erythraeum* showed that soil and water conservation measures in its native habitats in gravelly rocky rangeland are one of the important measures for regeneration. The half moon terraces can be constructed in the areas which will facilitate in conservation of rain water and will help in regeneration of the bulbs and also in emergence of new seedlings. These structures will also assist the growth of its associated species i.e. low perennial grasses like *Ochthochloa compressa* (Forsk.) Hilu, *Dactyloctenium sindium* Boiss. and important arid range legumes *Indigofera cordifolia* Heyne ex Roth and *Tephrosia uniflora* Pers.

Further, regulation of grazing of the animals is also much needed during its growth and reproductive stage to avoid the damage of emerged seedlings and also developing the bulbs in natural state in the soil. For this, people participation is very much required and for that people awareness campaigns for such species is the need of the hour.

Conclusion

In situ conservation of *Dipcadi erythraeum* in its natural distribution (western Rajasthan) is the need of the hour for its survival in the climate change scenario. Further, its seedlings or bulbs can be planted in the suitable protected habitats for their multiplication in the natural state. People participation in its conservation is vital to regulate grazing during growth and reproductive period. Mass scale planting in the protected gravelly-rocky areas in the region will not only increase its population but also boosts the herbal sector by incurring the availability of the raw material required as a substitute for *Urginea indica* Kunth.

References

Abdulkareem K.A., Garuba, T., Abdulrasaq, R., Mustapha, O.T. 2014.Studies on the morphology and phytochemical constituents of *Dipcadi filamentosa* in two states of North-Central Nigeria.*J. Chem. Biol. Phys. Sci.,* 4(3):215864.

Adly, F., Moussaid, M., Berhal, C., Razik, A., Elamrani, A.A., Moussaid, H., Bourhim, N. and Loutfi, M. 2015.Phytochemical screening and biological study of ethanol extractives of *Dipcadi serotinum*(L.) Medik. *EJARBLS*, 3(3):1723.

Ambasta, S.P., Ramchandran, K. and Kashyapa, K. 1986. *The Useful Plants of India*. Publication and Information Directorate, C.S.I.R, New Delhi.

Bhandari, M.M. 1990. *Flora of the Indian desert.* M.P.S. Repros., Rajasthan.

Bhandari, M.M. and Shringii, O.P.1987. Conservationof threatened plants of West Rajasthan. In: S.M.Mohnot and M.M. Bhandari, (ed.): *Environmental Degradation in West Rajasthan.*University of Jodhpur, Rajasthan.

Dasgupta, S. and Deb, D.B. 1988. *Dipcadi cocanenser* (Dalz.) Baker, *Dipcadi maharashtrensis* Deb & Dasgupta, *Dipcadi minor* Hook.f., *Dipcadi reidii* Deb & Dasgupta, *Dipcadi saxorum* Blatter (Liliaceae). In :Nayer, M.P. and A.R.K. Shastri (Eds.) Red Data Book of Indian Plants. Vol 2. BSI, Howarh. pp 175-181.

EL-Shabrawy, M.M., Marzouk, M.M., Kawashty, S.A., Hosni, H.A., EI Garf, I.A.and Saleh, N.A. 2016. Flavonoid constituents of *Dipcadi erythraeum* Webb. & Berthel. *Asian Pacific Journal of Tropical Disease*, 6: 404-405.

Jehan, T., Vashishtha, A., Yadav, S.R. and Lakhanpaul, S. 2014. Genetic diversity and genetic relationships in Hyacinthaceae in India using RAPD and SRAP markers. *Physiol. Mol. Biol. Plants*, 20: 103-114.

Jongbloed, M.V.D., Feulner, G.R., Bōer, B. and Western, A.R. 2003. The comprehensive guide to thewildflowers of the United Arab Emirates.Environmental Research and Wildlife Development Agency,Abu Dhabi.

Joshi, P.N., E.B. Joshi and B.K. Jain. 2012. Ecology and conservation of threatened plants in Tapkeshwari Hill ranges in the Katchch Island, Gujarat. *Journal of Threatened Taxa,* 4: 2390-2397.

Mandaville, J.P. 1990. Flora of Eastern Saudi Arabia.Kegan Paul International and NCWCD.

Marzouk, M.M., Elkhateeb, A., Abdel Latif, R.R., Abdel-Hameed, E.S.Kawashty, S.A. and Hussein, S.R. 2019. C-glycosylflavanoid-rich extract of *Dipcadi erythraeum* Webb &Berthel. Bulbs: Phytochemical and anticancer evaluations. *J. Appl. Pharm. Sci*., 9(6): 94-98.

Mishra, D.K. and N.P. Singh. 2001. Endemic lilies of Maharashtra with their revised red list status. *Indian J. Forestry,* 24: 114-118.

Rawat, Deepika, S.K. Sharma, A. Mahmoudi and S.R. Rao. 2011. Cytogenetic rationale for probable amphidiploids origin of *Dipacdierythraeum* Webb. & Berth.- a rare and endemic plant of Indian Thar Desert. *Caryologia,* 64: 75-83.

Rawat, D.S. 2009. *Dipcadi* Medic. (Liliaceae) a disappearing genus in India. *Nat. Acad. Sci. Lett*., 32: 211-212.

Rawat, D.S. and Chandra, S. 2014. Presumed extinct *Dipcadi reidii* (Asperagaceae) recollected after 127 years from Uttrakhand, India. *Rheedea,* 24: 1-4.

Rizk, A.M. and El-Ghazaly, G.A. 1995. Medicinal and poisonous plants of Qatar, Scientific and Applied Research Centre, University of Qatar.

Sagar, A. and Kasera, P.K. 2016.Phytochemcal analysis in *Dipcadi erythraeum* during different developmental stages-An endemic and threatened bulbous medicinal plant from the Indian arid zone.*The Journal of Indian Botanical Society,* 95: 72-75.

Sagar, A. and Kasera, P.K. 2019. Effect of growth regulators on germination of *Dipcadi erythraeum*, an endemic and threatened bulbous medicinal plant.*Nat. Acad. Sci. Lett.* https:/doi.org/10.1007/s40009-018-0763-6.

Vijya Jyothi, M., Salamma, S. ,Bhargav, E., Chaitanya, MVNL and Ravi Prasad Rao, B. 2018. Phytochemical screening, anthelmintic and antioxiodant potential of *Dipcadi krishnadeverayae* (Asparagaceae).*International Journal of Pharmacy and Biological Sciences,* 8: 332-338.

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Effect of organic and inorganic fertilizers on growth and yield of radish (*Raphanus sativus* L.)" cv. Pusa Desi

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Abstract

The present investigation was conducted during 2016-2017 in the Department of Horticulture, Doon (PG) College of Agriculture Science and Technology, Selaqui, Dehradun (UK). The treatments included inorganic fertilizers (recommended dose of NPK, *i.e.* 120:80:100 kg/ha), inoculation of organic manures (recommended dose of FYM and Vermicompost) and their combinations. There was eight treatment including control. The tretments are T_1 (100% FYM), T_2 (100% Vermicompost), T_3 (100% NPK), T_4 (100% FYM + 100% NPK), T_5 (100% FYM + 100% Vermicompost), T_6 (100% FYM + 50% NPK), T_7 (100% FYM + 50% Vermicompost), T_8 (Control).The highest growth and yield parameters was recorded in T_5 treatments and significantly the lowest was recorded in T_8 (Control). The result of the present investigation demonstrated that among different organic and inorganic fertilizers tried, FYM (100%) combined with Vermicompost (100%) can be considered as the best treatment obtaining higher growth and root yield in radish. Under organic cultivation of radish, for obtaining maximum net returns, vermicompost (100%) may be used as an organic source of nutrient.

Keywords: FYM, fertilizers, vermicompost

Introduction

Radish is predominantly a cool season vegetable crop. Being a cool season crop, it is sown during winter from September to January in northern plains. It is an annual or biennial crop depending upon the type for the purpose it is grown (Pcarrd,2007). Radish grow best in full sun in light , sandy loams, with a soil pH of 6.5 to 7.0. The INM system approach utilizers a judicious combination of inorganic fertilizers and organic manures in building soil fertility and to increase the production potential of any crop (Yadav *et al*., 2004).The growth and yield of radish greatly depends on soil and climatic conditions. Different varieties have different soil and climatic requirements for their optimum performance. Hence, for the production of good quality radish optimum fertilization though organic, inorganic and biofertilizers are essential (Dhanajaya, 2007).Vermicast or Vermicompost was identified as the best alternative with regard to industrial and economic viability. It also proved itself as "natures wonder product" to restore soil health and nutritional value in food. The presence of earthworms in soil ecosystems is an indicator of the well-being of a system.Vermicompost provides vital macronutrients (N, P_2O_5, K_2O, Ca, Mg) and micronutrients Fe, Mn,Zn, and Cu) (Tindal, 1993).In recent years use of organic manures like FYM, Vermicompost and neem cake for improving the productivity of crop and maintaining soil fertility and productivity of soil is gaining prominence (Mahokar *et al*., 2007). FYM improves soil physical properties.Chemical fertilizers deteriorate the quality of produce and are expensive too, leading to reduction in net profit and returns of the farmers. Nitrogen is very essential for leafy vegetable production. Its application upholds the overall growth, yield of radish.Being a short duration and quick growing crop, the root growth should be rapid and uninterrupted in radish. Hence, for the production of good quality radish, optimum nutrition through organic, inorganic and bio fertilizers are essential for sustainable production. In view of higher cost of synthetic fertilizers and its contribution to poor health of soil and water it becomes imperative to go for alternative and cheaper source like organic manures (Kumar *et al*., 2014).

Keeping the above facts in view, an experiment is planned with the objective to find out the effect of organic and inorganic fertilizers on growth and yield of radish.

Materials and Methods

A field experiment was conducted at Research Field, Department of Horticulture, DCAST, Dehradun (UK) during the year of 2016-17 with the view to study the effect of different levels of organic and inorganic fertilizers on growth and yield of radish. cv. Pusa Desi. The experiment was laid out in a Randomized Block Design with three replications and consisted of 08 treatments, namely 100% Farmyard manure, 100% Vermicompost, 100% NPK , 100% FYM + 100% NPK , 100% FYM + 100% Vermicompost , 100% FYM + 50% NPK , 100% FYM + 50% Vermicompost and control (water spray).The seeds were dibbled at a distance of 30 X 10 cm between rows and plants. All the recommended agronomic practices and crop husbandry were followed to raise a good crop. Five plants were selected randomly from each net plot to record the observation namely, Plant height (cm), Number of

leaves of plant, Leaf length (cm), Fresh weight (g) of shoot, Dry weight (g) of shoot, Root length (cm), Root diameter (cm), Days to harvest, Fresh root weight (g/plant), Root yield per hectare (q)and Harvest index (%).The data recorded on different parameter during investigation were statically analyzed as per the statistical methods described by (Panse and Sukhatme, 1985).

Result and Discussion

The findings of the investigation has been described and explained with support of relevant research work published by earlier workers on the subject as follows:

Growth parameters

The findings pertaining to growth parameters viz., plant height, number of leaves per plant, leaf length, fresh weight of shoot and dry weight of shoot were observed at 30, 45 days after sowing and at the final harvesting stage. There was significant effect of organic manures, inorganic fertilizers and their combinations on all the growth parameters. Among the treatments, T5(100 % FYM + 100 % vermicompost) recorded the maximum value of plant height(cm), during the different stages followed by T4(100% NPK + 100 % FYM), T7(100 % FYM + 50% Vermicompost), T6(100 % FYM + 50 % NPK), T2(100 % Vermicompost), T3(100 % NPK), T1 (100 % FYM), T8(Control). While the minimum value of plant height was observed with T8(Control) at all the stages of crop growth. The increase in height of plant by the use of vermicompost with integration of NPK may be due to beneficial influence of nitrification inhibition properties of vermicompost in the soil. Besides, it may also be due to rapid elongation and multiplication of cell in the presence of adequate quantity of nitrogen (Barman *et al*., 2014). Similar results were reported by Mahokar *et al.* (2007) and Kumar *et al*. (2014) in radish and Bhattarai and Maharjan (2013) in carrot.

Application of nutrients resulted in significant variation among different treatments for number of leaves per plant during all the growth stage. Highest number of leaves were observed with T5(100 % FYM + 100 % vermicompost) and as same mention the above for plant height. Present studies clearly indicated that vermicompost in combination with 100% recommended dose of FYM played significant role in increasing the growth and ultimately number of leaves in radish. Highest number of leaves in T5 (100 % FYM + 100 % vermicompost) due to slow release of nutrients through vermicompost thus enriching available nutrient pool of the soil that resulting in more number of leaves per plant (Bhattarai and Maharjan, 2013). Similar findings have been reported by Mahokar *et al.* (2007), Kumar *et al*. (2014) and Khalid *et al*. (2015) in radish.

Among treatments, maximum length of leaves per plant was recorded with the treatment T5, which was followed by T4. While, minimum length of leaves per plant was observed under nutrient treatment T8. Highest length of leaves in T5(100% FYM + 100 % vermicompost) due to vermicompost provide the micronutrients such as zinc, copper, iron and manganese etc. in the adequate amount to the plant (Bhattarai and Maharjan, 2013). Similar findings have been reported by Kumar *et al*. (2014) in radish and Rao *et al*. (2009) in onion.

Treatments indicated significant effect on fresh weight of shoot at all the growth stages. Maximum fresh weight of shoot was observed with T5, followed by T4>T7>T6>T2>T3>T1>T8. While the minimum fresh weight of shoot was observed in T8 (Control) at all the stages of crop growth. It was recorded that weight of shoot increased with the increased in days after sowing. The increase in fresh weight of leaves may be due to higher level of nitrogen. The nitrogen is also synthesized in to amino acids which are built in to complex protein and help in promising the luxurious growth of crop (Kumar *et al*., 2014). Similar findings have been reported by Uddain *et al*. (2010) in radish.

The maximum dry weight of shoot was recorded with treatment T5,(100 % FYM + 100 % vermicompost) which was followed by T4, T7, T6, T2, T3, T1, T8 in descending order. While the minimum dry weight of shoot was recorded in case of treatment T8(Control). Similar findings have been reported by Uddain*et al*. (2010) and Kumar *et al*. (2014) in radish.

Yield parameters

Yield parameters of the radish viz., length of root (cm), diameter of root (cm), weight of root (g) per plant, days to harvest, harvest index and yield of root (q/ha) were studied to evaluate the impact of effect of organic manures, inorganic fertilizers and their combinations on all the yield parameters and yield.

Maximum length of root was recorded under the treatment T5(100 % FYM + 100 % vermicompost) and it was followed by T4(100 % NPK + 100 %FYM). While minimum length of root was observed under the treatment T8 (Control). The beneficial effect of combined application of organic manure (vermicompost or compost) and fertilizer might be attributed to the increased efficacy of inorganic fertilizers and supply of all the essential nutrients in a balanced amount owing to their control release coinciding with the stage of root growth (Kumar *et al*., 2014). Similar findings have been reported by Sunandarani and Malareddy (2007) and Kumar *et al*. (2014) in carrot.

Treatments recorded significant effect on diameter of root. Maximum diameter of root was found under the treatment T5, followed by T4, T7, T6, T2, T3, T1 and T8. While the minimum diameter of root radish was observed with T8. These findings are in agreement with those reported by Uddain *et al*. (2010) and Kumar *et al*. (2014) in radish and Kumar *et al*. (2014) in carrot.

Treatments recorded significant effect on days to harvest. Maximum days to harvest was found under the treatment T8(Control) followed by T1,T3,T2,T6,T7,T4 and T5. While the minimum days to harvest was observed with T5(100 % FYM + 100 % vermicompost). These findings are in agreement with those reported by Malik and Kumar (2009) in tomato.

Treatments indicated significant effect on fresh weight of root. Maximum fresh weight of root was observed

with treatment T5. While the minimum fresh weight of root was observed with T8(Control). This was attributed due to solubilizing effect of plant nutrients by the addition of vermicompost leading to increased uptake of NPK. Organic manure plays a direct role in plant growth as a source of all necessary macro and micro-nutrients in available forms during mineralization, improving physical and physiological properties of soil. Similar findings have been reported by Kumar *et al.* (2014) in radish and Kumar *et al*. (2014) in carrot. Yield of root of radish significantly affected by treatments. The maximum yield of root recorded under the treatment T6. While the minimum yield of root was observed with T8. An important feature of vermicompost is that during the processing of the various organic wastes by earthworm, many of the nutrients that it contents are changed to forms that are more readily taken by plants (Degwale, 2016). Similar findings have been reported by Mahokar *et al.* (2007) and Kumar *et al*. (2014) in radish, Kumar *et al*. (2014) in carrot, Rao *et al.* (2009) in onion, Barman *et al.* (2014) and Narayan *et al.* (2014) in potato.

Table 1. Effect of different combination of FYM and vermicompost on morphological and yield parameters

S.No.	Treatments	Plant height (cm)	Number of Leaves per plant	Length of leaves (cm)	Fresh weight of shoot (g)	Dry weight of shoot (g)	Length of root (cm)	Diameter of root (cm)	Day to harvest	Average weight of root (g)	Root yield (q/ha)	Harvest index (%)
1	T1 100% FYM	27.73	11.13	24.27	77.03	7.64	17.07	2.88	59.67	91.19	303.97	56.80
2	T2 100% Vermicompost	28.20	11.30	24.56	79.33	7.75	17.67	2.99	59	93.53	311.89	55.45
3	T3 100% NPK	27.90	11.23	24.45	77.18	7.67	17.30	2.96	59.17	93.57	311.75	54.56
4	T4 100% FYM + 100% NPK	32.53	12.47	27.49	85.87	8.47	18.30	3.48	57.87	101.21	337.34	54.53
5	T5 100% FYM + 100% Vermicompost	35.23	13.50	29.97	91.50	9.20	19.97	3.84	55.17	117.8	392.83	54.52
6	T6 100% FYM + 50% NPK	29.10	11.37	25.20	80.30	7.77	17.83	3.03	58.33	98.78	329.30	54.18
7	T7 100% FYM + 50% Vermicompost	29.67	11.43	25.21	80.33	7.87	17.83	3.11	58	101.08	336.88	54.15
8	T8 Control	26.93	10.93	23.19	76.67	7.43	16.97	2.81	60.33	90.11	300.08	53.99
9	Sem±	0.30	0.36	0.16	0.15	0.17	0.9	0.04	0.04	0.04	0.05	0.05
10	C.D at 5%	0.66	0.78	0.35	0.33	0.36	0.20	0.09	0.09	0.08	0.10	0.11

Harvesting index of radish significantly affected by treatments. The maximum Harvesting index recorded under the treatment T5. While the minimum harvesting index was observed with T8. The response of vermicompost might be due to insufficient amount of organic matter to amend physical and chemical properties of soil at the soil at the experiment site (Degwale, 2016). Similar findings have been reported Shrinivas and Naik (1990) and Narayan *et al*. (2014) in potato.

References

Barman, K.S.; Ram, B. and Verma, R.B. 2014. Effect of Integrated nutrient management on growth and tuber yield of potato (*Solanum tuberosum*) cv. Kufri Ashoka. *Trends Biosci*., 7 (9): 185-187.

Bhattarai, B. P. and Maharjan, A. 2013. Effect of organic nutrient management on the growth and yield of carrot *(Daucus carota* L.*)* and soil fertility status. *Nepalese J. Agric. Sci.,* 11:16-25.

Degwale, A. 2016. Effect of vermicompost on growth, yield and quality of garlic (Allium sativum L.) In enebsesarmidir district, Northwestern Ethopia. *J. Natural Sci. Res.,* 6 (3): 2224- 3186.

Dhananjay. J. 2007. Organic Studies in Radish(Raphanu ssativus L..) varieties. Department of Horticulture College of Agriculture, *Dharwad university of Agriculture Science* , Dharwad-580005.Pp.12-13.

Khalid, M.; Yadav, B.K. and Yadav, M.P. 2015. Studies on the effect of integrated nutrient management on growth and yield attributes of radish (*Raphanus sativus* L.*). Ann. of Hort.* 8 (1): 81-83.

Kumar, P.; Meghwal, P. R. and Painuli, D. K. 2014. Effect of organic and inorganic nutrient sources on soil health and quality of carrot. *Indian J. Hort.,* 71 (2): 222-226.

Kumar, S.; Maji, S.; Kumar, S. and Singh, H.D. 2014. Efficacy of organic manures on growth and yield of radish (*Raphanus sativus L.*) cv. Japanese White. *Inter. J. Plant Sci.,* 9(1): 57-60.

Mahokar, V.K.; Bodkhe, V. A.; Ingle, V.G.; Jadhao B.J. and Gomase, D.G. 2007. Effect of various organic manures on growth and yield of radish.*Asian J. Horti.,* 2(1): 155-157.

Malik, M.F. and Kumar, V. 2009. Influence of INM on growth and yield of tomato. *Ann. Hort.* 2 (2): 221- 223.

Narayan, S., Kanth, R.H., Narayan, R., Khan, F.A., Saxena, A. and Hussain, T. 2014. Effect of planting dates and integrated nutrient management on productivity and profitability of potato (*Solanum tuberosum*) in Kashmir valley.*Indian J. Agron .,* 59 (1): 145-150.

Panse, V.G. and Sukhatme, P.V. 1985. Statistical methods for agricultural workers. *II*nd*Ed., ICAR, Pub. New Delhi*. pp: 258-260.

Pcarrd 2007. Philippine Recommends for Radish Production http://mboard.pcarrd.dost.gov.ph/forum/viewtopic.php?id=11385.

Rao, K. R.; Mushan, L. C.; Mulani, A. C.; Khatavkar, R. S.; Parlekar, G. Y. and Shah, N.V. 2009. Effect of vermicompost on the growth yield of onion (*Allium cepa*).*Karnataka J. Agric. Sci.,* 23 (2): 361-363.

Srinivas.K. and Naik. L.B. 1990. Growth and yield of radish (*Raphinu ssativus* L.) in relation to nitrogen and potash fertilization. *Ind. J. Hortic*., 47: 114-119.

Sunandarani, N. and Mallareddy, K. 2007. Effect of different organic manures and inorganic fertilizers on growth, yield and quality of carrot (*Daucus carota* L.). *Karnataka J. Agric. Sci*., 20 (3): 686- 688.

Uddain, J.; Chowdhury, S. and Rahman, M.J . 2010. Efficacy of different organic manures on growth and productivity of radish (*Raphanus sativus* L.) *IJAEB*., 3 (2): 189-193.

Yadav, B. D., Khandelwal, R, B. and Sharma Y. K. 2004. Ramesh 2013. Effect of INM practices on seed yield and yield contributing characters in radish. P- 74-78.

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Response of integrated nutrient management on vegetative growth and flowering characters of gladiolus (*Gladiolus glandiflorus*) cv. White prosperity

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Abstract

The experiment was conducted in randomized block design with 13 treatments and 3 replications**.** The experimental findings revealed that the treatment T_{11} (75% RDF+ FYM +Azotobacter +PSB) showed better response viz. early sprouting, number of sprouts, number of leaves, fresh and dry weight of plant in and T_{12} (75% RDF+ VC +Azotobacter +PSB) better response viz. plant height, early spike initiation, opening of first floret, duration of flowering, length of spike, diameter of spike, length of rachis, number of florets per spike, diameter of florets, spike yield of gladiolus.

Key word: Flowering characters, Gladiolus. INM, vegetative growth

Introduction

Gladiolus is one of the popular cut flower in India and cut flowers used for vase decoration and preparation of bouquets. The climate in our hills during summer and in the plains during winter is ideal for gladiolus cultivation. Area and production of cut flower in India is 3, 09,000 hectare and 5, 93,000 MT (Anonymous 2016-17). Integrated Nutrients Management (INM) including use of organic manure and biofertilizers along with appropriate dosage of fertilizer is cost effective method to achieve more yield and better quality crop.

Materials and Methods

An experiment was conducted during winter season of 2014-15 and 2015-16 at Main Experiment Station (Horticulture), Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.). The corms of gladiolus variety White Prosperity was obtained from NBRI Lucknow for planting in experimental field. Before planting the corms were dipped in bavistin (0.2%) solution for one hour to reduce the incidence of corm rotting and dried in shade. The experiment was conducted in randomized block design with 13 treatments and 3 replications *viz*. RDF (300: 200: 200 kg NPK/ha), organic manure FYM (20t/ha), vermicompost (5t/ha), poultry manure (5t/ha). Two bio-inoculants PSB (5kg/ha) and azotobacter (5kg/ha) were tested alone in their combination along with graded dose 75% (RDF) and 50% (RDF) were applied in the form of urea, single super phosphate and MOP respectively. Application of half dose nitrogen (N), full dose of phosphorus (P) and potash (K) at the time of sowing of corms. The crop was top dressed with remaining half dose of nitrogen at 40 days after planting. The planting of corms was done on 16/10/2014 and 20/10/2015 at plot size of 2.0x1.0 m distance 20 cm × 40 cm and 6 cm deep in soil during both the years of investigation. Similar technique was adopted in next year of investigation. The data recorded on important vegetative characters viz. sprouting of corm, number of sprouts, plant height, number of leaves, fresh and dry weight of plant and flowering characters viz. days taken for initiation of spike, days taken for opening of first floret, duration of flowering, length of spike, diameter of spike, length of rachis (cm), number of florets / spike, diameter of florets (cm), number of spike/plant, number of spike/ha (Lakh).

Results and Discussion

All the parameters were significantly influenced by application of integrated nutrient management during both the years (Table 1) Integrated nutrient management under the experiment significantly influences the days to complete sprouting of corm and number of sprout. During the study of corms with (75% RDF +FYM +Azotobacter +PSB) found to significantly superior in respect of highest number of sprout, induced earliest sprouting. The better growth recorded due to application of FYM, NPK along with inoculation of biofertilizers may prove to be beneficial to fix the atmospheric nitrogen. The similar findings were also reported by Dubey *et al*. (2003). The maximum plant height was recorded (89.33 and 90.13cm) with application of (75% RDF +VC +Azotobacter +PSB). It is now well demonstrated the role and stimulatory effects on non-symbiotic N-fixing bacteria (Azotobacter) in combination with N-fertilization, because these nutrients are essential for increasing the microbial activity in soil (Gangadharan and Gopinath, 2000). The maximum number of leaves (7.13 and 7.27), fresh weight (103.00 and 103.33g) and dry weight (25.00 and 25.33g) of

plant was recorded with (75% RDF +FYM +Azotobacter +PSB). These growth promoting substances might have resulted in increased cell division and elongation leading to enhanced leaf expansion, thus leading to increase the fresh and dry weight.

The earliest spike initiation (82.47 and 81.53 days), earliest floret opening (100.20 and 98.40), duration of flowering (14.97 and 14.70 days) was found to be enhanced maximum with application of (75% RDF +VC +Azotobacter +PSB). This may be ascribed to easy uptake of nutrients and simultaneous transport of growth promoting substances like cytokinins to the auxiliary buds resulting in breakage of apical dominance. Ultimately, they resulted in better sink for faster mobilization of photosynthesis and early transformation of plant parts from vegetative to reproductive phase. Similar observation was also recorded by. Kukde *et al.* (2006). The maximum length of spike (101.40 and 100.53 cm), diameter of spike (2.01 and 2.06 cm), length of rachis (53.40 and 53.60 cm) and diameter of floret (10.67 cm and 10.93 cm) were recorded with the application of (75% RDF +VC +Azotobacter +PSB). It might be due to synthesis of nitrogenous compounds such as amino acid (Arginin), which is a precursor of polyamines and also function as secondary messenger in flower initiation and development of more number of florets per spike as influenced by phytoharmones due to interaction of bioinoculants with NPK. Similar observations were also recorded by Chaudhary *et al.* (2013) and Dalve *et al.* (2009). The number of spikes per plant and per hectare was reported significantly maximum with application of (75% RDF+VC +Azotobacter +PSB). Ajitkumar (2002) reported that highest flower yield per hectare.

Thus, it may be concluded that treatment (T_{12}) 75% RDF+VC +Azotobacter +PSB ha^{-1} can be recommended to flower growers for gladiolus production in the eastern Uttar Pradesh.

Table 1. Effect of integrated nutrient management on vegetative growth of gladiolus

Treatments		Days taken for complete sprouting		No. of sprouts per corm		Height of plant (cm)		Number of leaves		Fresh weight of plant		Dry weight of plant	
		2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
T_1	RDF (300: 200: 200 kg NPK/ha)	22.33	22.00	1.60	1.53	87.00	86.80	6.20	6.13	99.33	98.33	19.67	19.33
T_2	75% RDF+ FYM+Azotobacter	22.00	21.00	1.53	1.47	85.73	85.57	6.33	6.40	92.00	92.33	21.33	21.67
T_3	75% RDF+VC + Azotobacter	21.00	20.67	1.53	1.60	87.73	89.00	6.60	6.33	97.33	92.67	20.67	21.67
T_4	75% RDF+PM + Azotobacter	21.67	22.33	1.47	1.40	85.93	86.27	5.87	5.93	94.67	94.67	19.33	19.67
T_5	50% RDF+FYM+Azotobacter	23.67	22.67	1.60	1.53	76.80	77.00	6.00	5.67	92.00	93.33	19.33	19.00
T_6	50% RDF+VC + Azotobacter	24.00	22.33	1.60	1.67	81.07	81.27	6.00	6.07	90.67	89.33	18.33	18.67
T_7	50% RDF+PM + Azotobacter	23.33	23.00	1.53	1.60	78.80	78.53	5.80	5.87	97.33	93.33	20.33	21.00
T_8	50% RDF+FYM+Azotobacter+PSB	23.00	22.33	1.67	1.53	86.07	85.93	5.93	6.00	74.67	77.33	18.67	19.33
T_9	50% RDF+VC +Azotobacter +PSB	22.67	22.33	1.73	1.60	83.93	85.47	6.13	6.20	97.33	94.67	20.33	20.67
T_{10}	50% RDF+PM +Azotobacter +PSB	22.67	21.67	1.67	1.67	82.27	82.33	6.13	6.20	94.67	95.67	20.33	20.67
T_{11}	75% RDF+FYM+Azotobacter+PSB	20.00	19.33	1.80	1.87	85.93	86.47	7.13	7.27	103.00	103.33	25.00	25.33
T_{12}	75% RDF+VC +Azotobacter +PSB	21.33	21.67	1.73	1.80	89.33	90.13	6.60	6.67	100.67	99.33	22.67	22.00
T_{13}	75% RDF+PM +Azotobacter +PSB	21.00	21.67	1.73	1.73	87.33	87.53	6.53	6.47	94.33	93.33	19.67	20.00
	SEm	0.67	0.50	0.07	0.07	1.91	1.81	0.21	0.21	2.80	3.35	1.10	0.92
	CD at 5%	1.95	1.46	0.19	0.21	5.56	5.27	0.62	0.61	8.17	9.77	3.21	2.70

Table 2. Effect of integrated nutrient management on flowering characters of gladiolus

Treatments		Days taken for initiation of spike		Days taken for opening of first floret		Duration of flowering (days)		Length of spike (cm)		Diameter of spike (cm)	
		2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
T_1	RDF (300: 200: 200 kg NPK/ha)	89.00	89.20	104.67	103.00	12.40	12.47	100.73	100.53	1.91	1.90
T_2	75% RDF+ FYM+Azotobacter	91.27	91.20	107.53	107.33	13.00	12.87	99.67	99.73	1.91	1.92
T_3	75% RDF+VC + Azotobacter	84.67	85.60	100.87	100.00	13.00	13.07	96.20	96.33	1.91	1.92
T_4	75% RDF+PM + Azotobacter	89.93	91.13	106.33	105.20	12.67	12.73	97.87	98.07	1.89	1.87
T_5	50% RDF+FYM+Azotobacter	89.53	88.67	105.80	105.60	13.07	13.00	95.80	96.40	1.92	1.93
T_6	50% RDF+VC + Azotobacter	93.00	92.93	110.07	108.60	13.53	13.07	96.80	96.93	1.94	1.96
T_7	50% RDF+PM + Azotobacter	93.07	93.07	109.47	108.67	13.13	13.00	93.67	93.60	1.90	1.91
T_8	50% RDF+FYM+Azotobacter+PSB	94.60	94.27	110.87	110.47	13.33	13.00	95.53	95.87	1.90	1.91
T_9	50% RDF+VC +Azotobacter +PSB	91.73	91.33	109.33	109.07	13.73	13.40	95.33	95.67	1.89	1.90
T_{10}	50% RDF+PM +Azotobacter +PSB	90.40	90.73	108.07	107.20	12.93	12.93	93.00	93.40	1.88	1.90
T_{11}	75% RDF+FYM+Azotobacter+PSB	85.00	84.80	104.87	105.07	13.67	13.73	95.40	95.67	1.88	1.89
T_{12}	75% RDF+VC +Azotobacter +PSB	82.47	81.53	100.20	98.40	14.67	14.70	101.40	100.53	2.01	2.06
T_{13}	75% RDF+PM +Azotobacter +PSB	90.20	90.33	105.87	104.87	13.27	13.07	93.93	94.27	1.92	1.93
	SEm	2.17	2.23	2.09	2.18	0.17	0.32	1.28	1.24	0.02	0.03
	CD at 5%	6.34	6.52	6.10	6.36	0.49	0.93	3.75	3.61	0.06	0.09

Table 3. Effect of integrated nutrient management on flowering characters of gladiolus

Treatments		Length of rachis (cm)		Number of florets / spike		Diameter of florets (cm)		Number of spike/plant		Number of spike/ha (Lakh)	
		2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
T_1	RDF (300: 200: 200 kg NPK/ha)	48.00	51.80	14.20	14.00	7.67	7.40	1.53	1.47	1.63	1.56
T_2	75% RDF+ FYM+Azotobacter	45.00	44.27	13.67	13.80	8.47	8.67	1.47	1.40	1.56	1.49
T_3	75% RDF+VC + Azotobacter	49.33	47.47	14.00	14.13	9.20	9.27	1.60	1.67	1.70	1.77
T_4	75% RDF+PM + Azotobacter	46.40	47.93	14.07	14.00	8.40	8.53	1.53	1.40	1.63	1.49
T_5	50% RDF+FYM+Azotobacter	47.20	47.33	13.60	13.67	8.00	8.20	1.47	1.53	1.56	1.63
T_6	50% RDF+VC + Azotobacter	42.33	47.40	13.37	13.60	8.20	8.53	1.53	1.60	1.63	1.70
T_7	50% RDF+PM + Azotobacter	44.53	44.73	13.50	13.63	8.07	8.20	1.47	1.53	1.56	1.63
T_8	50% RDF+FYM+Azotobacter+PSB	45.07	44.67	13.53	13.73	7.93	8.53	1.60	1.47	1.70	1.56
T_9	50% RDF+VC +Azotobacter +PSB	49.07	48.80	13.47	13.67	7.87	8.60	1.60	1.53	1.70	1.63
T_{10}	50% RDF+PM +Azotobacter + PSB	44.67	44.93	13.50	13.70	8.33	8.53	1.67	1.60	1.77	1.70
T_{11}	75% RDF+FYM+Azotobacter+PSB	48.07	48.40	14.00	14.20	9.60	9.60	1.60	1.67	1.70	1.77
T_{12}	75% RDF+VC +Azotobacter +PSB	53.40	53.60	15.80	16.13	10.67	10.93	1.73	1.80	1.84	1.91
T_{13}	75% RDF+PM +Azotobacter +PSB	47.00	47.47	14.67	14.60	9.40	9.73	1.67	1.73	1.77	1.84
	SEm	1.46	1.70	0.34	0.30	0.32	0.29	0.05	0.07	0.06	0.06
	CD at 5%	4.25	4.96	0.98	0.88	0.93	0.84	0.16	0.21	0.18	0.17

References

Ajit Kumar, 2002. Effect of organic and inorganic fertilizers on growth, yield and post harvest life of marigold. *M. Sc. (Agri.) Thesis*, Univ. Agric. Sci., Dharwad (India).

Anonymous, 2016. Indian Horticulture Data base. Ministry of Agriculture Government of India, 85- Institutional, Area, Sector 18, Gurgaon

Chaudhary, N., Swaroop, K., Janakiram, T., Biswas, D. R. and Singh, G. 2013. Effect of integrated nutrient management on vegetative growth and flowering characters of gladiolus. *Indian J of Hort*, 70: 156-159.

Dalve, P. D., Mane, S. V. and Nimbalkar, R. R. 2009. Effect of biofertilizers on growth, flowering and yield of gladiolus. *The Asian J of Hort*, 4: 227-229.

Dubey, R. K. 2003. Efficacy of biofertilizers in gladiolus. Ph.D. thesis submitted to Division of Floriculture and Landscaping. IARI, New Delhi.

Kukde, S., Pillewan, S., Meshram, N., Khobragade, H. and Khobragade, Y. R. (2006). Effect of organic manure and bio-fertilizer on growth, flowering and yield of tuberose cv. Single. *J. Soils and Crops*, 16 (2): 414-416.

Munichaluvaiah, Sreenivas, K.N. and Nagaraja, H.T. 2004. Effect of organic and inorganic manures on flower yield and corm development of gladiolus (*Gladiolus grandiflorus* L.) cv. White Prosperity, Nat. Sym. on Recent Trends and Future strategies in Ornamental Horticulture , *University of Agricultural Sciences, Dharwad, pp: 48*.

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Effect of zinc sulphate, ferrous sulphate and borax on yield and quality of aonla (*Emblica officinalis* Gaertn.) cv. NA-7

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Abstract

The investigation was taken up at MES Horticulture, NDUAT, Ayodhya to improving the fruit yield and enhancing the fruit quality through foliar application of micronutrients in aonla cultivar NA-7. The study revealed that the foliar spray of micronutrient combination of % $ZnSO_4$0.5 % + $FeSO_4$ 0.5%+ Borax0.25 %) significantly increased yield (6.93 tonnes/ha). The yield was almost double as compared to control in the said combination of micronutrients as a result higher benefit cost ratio (3.60) was recorded. Further, the quality parameters of fruits such as higher total sugar, reducing sugar and non-reducing sugar content of fruits was significantly improved without reducing the vitamin C (483.71 mg/100 g) with the above said combination of nutrients. Hence, the micronutrient combination of $ZnSO_4$ 0.5 % + $FeSO_4$ 0.5 % + Borax 0.2 5% holds immense potential as a foliar spray in arresting fruit drop and doubling up the yield in aonla.

Keywords: Aonla, zinc sulphate, borax, foliar spray micronutrient

Introduction

Aonla (*Emblica officinalis* Gaertn.) is an important fruit crop of commercial significance. It is quite hardy, prolific bearer and remunerative even without much care. It belongs to the family Euphorbiaceae. Aonla is an important fruit of future due to its high medicinal and nutritional value. Aonla is the richest source of vitamin "C" among all fruits after Barbados cherry. The aonla fruit contains about three times more protein and 160 times more vitamin "C" as compared to apple. Its fruit is valued as diuretic, laxative, antibiotic and cooling refrigerant. It is well known that calcium play an important role in maintaining quality of fruits and vegetable and calcium treatment helps to retain fruit firmness, increase vitamin C content, decrease storage breakdown and rotting and also decrease browning in fruits. The crop is been cultivated in Sri Lanka, Malaysia and China, etc. In India, it is being cultivated in an area of about 93,000 ha with an annual production of 1077000 MT (Anon., 2017), particularly in the in the salt affected districts of Uttar Pradesh, arid and semiarid parts of Maharashtra, Gujarat, Rajasthan, Karnataka etc,. It is a rich source of vitamin C (500-600 mg/100g) among fruits and ranks second after Barbados cherry (Asengo, 1953).

Aonla growers are experiencing the problem of reduced yield and sometimes reduced quality due to necrosis and fruit drop which is associated with deficiency of boron and other micronutrients. The micronutrients like zinc sulphate and Ferrous sulphate and iron play a vital role in fruit growth and development and their application is found effective to solve these problems. Keeping this in mind the present study was conducted to study the effect of $ZnSO_4$, $FeSO_4$ and Borax on Yield and Quality of Aonla (*Emblica officinalis* Gaertn.) cv. NA-7 at the Main Experiment Station, Horticulture (MES), Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya, U.P.

Materials and Methods

Twenty year old uniform plants of aonla *cv.* NA-7 were used which were spaced at 6m x 6m (277 plants/ha). Fertilizers were applied uniformly as per the recommendations; FYM 25.00 kg/plant (2.5 tonnes/ha) + 75:50:50 g NPK/ plant. Treatment included use of three different nutrients at different combinations; T1 (Control, water spray), T2 ($ZnSO_4$0.5 %), T3 ($FeSO_4$ 0.5 %), T4 (Borax 0.25%), T5 ($ZnSO_4$0.5 % + $FeSO_4$ 0.5 %), T6 ($ZnSO_4$0.5 % + Borax 0.25%), T7 ($FeSO_4$ 0.5 %+ Borax 0.25%), T8 ($ZnSO_4$0.5 % + $FeSO_4$ 0.5 % +Borax 0.25%). Two sprays were taken; one is at the time of flushing and second at sixty days after flushing which coincides with flowering.

The total cumulative yield per plant was recorded with a weighing machine and expressed in kilograms and the yield per hectare. For determination of fruit chemical parameters of fruit viz., titrable acidity (%), total soluble solids (TSS in °Bix), sugars (total, reducing and non-reducing sugars in per cent), ascorbic acid (mg/100 g pulp) content, five healthy fruits from each tree at full maturity stage. Hand refractometer was used for determination of total soluble solids, simple acid- alkali titration method was used for titrable acidity (Ranganna, 1977). Sugars in fruit juice and ascorbic acid (2, 6-dichlorophenol indophenols visual titration method) contents were determined as described by Ranganna (1986).

The experiment was laid out in a completely

randomized block design (RBD) with three replications. Three plants for each treatment were sampled for plant growth, reproductive and yield components. Five fruits were randomly selected for evaluating fruit physical and chemical features. The data were analysed in a completely randomized block design using analysis of variance (ANOVA).

Results and Discussion

The foliar application of micronutrients had significant influence on yield of aonla. The highest fruit yield (24.96 kg tree^{-1}) was recorded with the combined application of $ZnSO_4$ 0.5 %, $FeSO_4$ 0.5 % and Borax 0.25 % (T8). The increase in yield might be due to direct or indirect involvement of micronutrients in photosynthesis, fruit setting, retention, reduction in drop as well as growth and development of fruits caused by foliar sprays of zinc, iron and boron. The application of zinc and boron might have caused rapid synthesis of protein and translocation of carbohydrate which ultimately led to increase in fruit weight which is directly correlated with total yield (Singh *et al.,* 2012). Similar results have been reported in aonla (Ram *et al.,* 1977) and in litchi (Babu and Singh, 2001).
The treatment combination of $ZnSO_4$ 0.5 %, $FeSO_4$ 0.5 % and Borax 0.25 % (T8) resulted in highest cost benefit ratio (3.60) when compared to control (2.51) and other micronutrient combinations (Table 1). The highest cost benefit ratio obtained may be attributed to reduction in fruit drop and nearly two fold increase in the overall yield per plant. The earlier reports on guava (Waskela *et al.,* 2013) also revealed higher cost benefit ratio of 5.02, consequent to the combined application of ZnSO4, FeSO4 and boron.

TSS, titrable acidity and TSS: acid ratios were found statistically non- significant, whereas the higher ascorbic acid content (486.88 mg/100g) was recorded from nutrient combination of zinc 0.5 % and iron 0.5 % (T5) (Table 2). The vitamin C of fruits was appreciably influenced by synthesis of catalytic enzymes stimulated by zinc application. The increase in ascorbic acid might be due to catalytic influence of micronutrients on its bio-synthesis from its precursor glucose 6- phosphate or inhibition of its conversion to dehydroxy ascorbic acid by enzyme ascorbic acid oxidase or both. The present observations are in close agreement with the reports of Pandey *et al.,* (1998) in guava. The highest total sugars (4.94 %) were recorded in micronutrient combination of $ZnSO_4$ 0.5 %, $FeSO_4$ 0.5 % and Borax 0.25 % (T8) (Table 3).

The increase in total sugars of fruit was may be due to significant action of micronutrients on translocation of carbohydrates and photosynthates. This is in conformity with the results of Singh *et al.,* (2002) and Singh *et al.,* (2012), who reported that increase in sugars fraction by the foliar feeding of zinc and boron might be due to their involvement in photosynthesis of metabolites and rapid translocation of sugars from other part of the plants to developing fruits.

The per cent increase in reducing sugars was highest with micronutrient combination of $ZnSO_4$ 0.5 %, $FeSO_4$ 0.5 % and Borax 0.25 % (T8). Increase in reducing sugars have direct link with beneficial effect of micronutrients on conversion of polysaccharides to simple sugars. The similar results were also found from the experiments of Kumar and Shukla (2010), who reported direct and indirect effects of micronutrients on quality of fruits. On the other hand, the highest non reducing sugar was recorded with combined application of $ZnSO_4$ 0.5 % and Borax 0.25 % (T6). The effect of these micronutrients on per cent non reducing sugars was mainly attributed to increased translocation of polysaccharides in mature fruits. These results are in close conformity with the findings of Singh *et al.,* (2012).

This may be concluded from the above highlighted experimental findings of the present investigation due to effect of foliar spray of nutrients revealed that, micronutrient combinations of $ZnSO_4$ 0.5 % + $FeSO_4$ 0.5 % + Borax 0.25 % (T8) was found to be most effective for overall increment of yield, highest cost benefit ratio and quality attributes. The fruit yield was almost double as compared to control. Hence, the above said nutrient combination holds immense potential as a foliar spray for doubling up the yield and to improve quality in aonla.

Table 1. Effect of $ZnSO_4$, $FeSO_4$ and Borax on fruit yield and benefit: cost ratio of aonla cv. NA-7

Treatments	Yield (kg. tree^{-1})	Yield (tonnes ha^{-1})	B: C ratio
T1	14.92	4.11	2.51
T2	18.57	5.12	3.04
T3	15.95	4.43	2.38
T4	18.27	5.04	2.97
T5	19.62	5.41	2.86
T6	22.22	6.12	3.52
T7	21.06	5.83	3.06
T8	24.96	6.93	3.60
S. Em.	1.66	0.46	-
CD at 5%	5.04	1.40	-

Table 2. Effect of $ZnSO_4$, $FeSO_4$ and Borax on quality of fruits of aonla cv. NA-7

Treatments	TSS (°B)	Titrable acidity (%)	TSS : Acid ratio	Vitamin C (mg/100g)
T1	8.38	1.03	8.96	476.48
T2	8.41	1.07	7.99	482.78
T3	8.97	1.02	9.71	485.03
T4	8.58	1.38	6.52	483.51
T5	8.76	1.15	8.87	486.88
T6	8.61	1.22	7.33	482.65
T7	8.51	1.57	5.47	478.17
T8	8.23	1.20	7.94	484.71
S. Em.±	0.35	0.25	1.62	1.47
CD at 5%	NS	NS	NS	4.45

Table 3. Effect of $ZnSO_4$, $FeSO_4$ and Borax on quality of fruits of aonla cv. NA-7

Treatment	Total sugar (%)	Reducing sugars (%)	Non reducing sugars (%)	Sugar: Acid ratio	Storage life (Days) (at room temperature
T1	3.76	2.31	1.47	4.05	5.33
T2	4.30	2.30	1.99	3.96	7.00
T3	3.94	2.29	1.66	4.22	6.67
T4	4.41	2.37	2.03	3.31	6.33
T5	3.94	2.51	1.42	4.04	5.67
T6	4.85	2.69	2.17	4.16	7.67
T7	4.41	2.72	1.70	2.85	6.67
T8	4.94	3.01	1.93	4.91	7.33
S. Em. ±	0.23	0.06	0.23	-	-
CD at 5%	0.68	0.18	0.70	NS	NS

References

Anonymous, 2017, NHB-Database-2017, nhb.gov.in/area production/html.

Asengo, C. F., 1953, The story of West Indian Cherry, Bull. *Del collegio, de quimicosde, Puret Rico.,* 10: 8-11.

Kumar, S. and Shukla, B. A., 2010, Improvement of old ber *cv.* Gola orchard through bunding and micronutrients management. *Indian J. Hort.*, 67 (3): 322-327.

Meena, D., Tiwari, R. and Singh, O.P., 2014, Effect of nutrient spray on growth, fruit yield and quality of aonla, *Annals of Plant and Soil Research*, 16(3): 242- 245.

Pandey, D. K., Pathak, R. A. and Pathak, R. K., 1998, Studies on the foliar application of nutrients and plant growth regulators in Sardar Guava I- Effect on yield and fruit quality. *Indian J. Hortic.*, 45 (3-4): 197-202.

Panwar, R. D., Saini, R. S., Kaushik, R. A. and Yamdagni, R., 1995, Effect of micronutrients on fruit retention, yield and quality of aonla *cv.* Banarasi under rainfed condition. *Haryana J. Hortic. Sci.*, 22 (1-2): 250-251.

Ranganna, S., 1977, Manual of analysis of fruits and vegetables products. Tata Mcgrow Hill Pub. Co. Ltd., New Delhi. p. 255.

Ranganna, S., 1986, Handbook of analysis and quality control for fruit and vegetable products. Second edn. Tata McGraw-Hill Pub. Co. Ltd., New Delhi, India

Singh, H. K., Srivastava, A. K., Dwivedi, R. and Kumar, P., 2002, Effect of foliar feeding of micro-nutrients on plant growth, fruit quality, yield and internal fruit necrosis of aonla (*Emblica officinalis* Gaertn.) *cv.* Francis. *Prog. Hort.*, 33 (1): 80-83.

Singh, J. K., Prasad, J. and Singh, H. K., 2007, Effect of micro-nutrients and plant growth regulators on yield and physic-chemical characteristics of aonla fruits in *cv.* Narendra Aonla-10. *Indian J. Hort.*, 64 (2): 216-218.

Singh, P. C., Gangwar, R. S. and Singh, V. K., 2012, Effect of micronutrients spray on fruit drop, fruit quality and yield of aonla *cv.* Banarasi, *Hort. Flora Research Spectrum*, 1(1): 73-76.

Waskela, R. S., Kanpure, R. N., Kumawat, B. R. and Kachouli, B. K., 2013, Effect of foliar spray of micronutrients on growth, yield and quality of guava (*Psidium guajava* L.) *cv.* Dharidar. *International Journal of Agricultural Sciences*, 9 (2): 551-556.

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Evaluation of guava (*Psidium guajava* L.) germplasm under semi-arid environment of central Gujarat

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Abstract

The growth, yield and fruit quality characters of twenty one germplasm including varieties of guava were evaluated during the winter season of 2018-19. Plant growth habit of most of the guava genotypes found to be upright growing followed by Semi spreading and spreading. Plant height was observed higher in CHESG-11 followed by CHESG-5 whereas plant spread and stem diameter were higher in CHESG-16 and CHESG-24 respectively. The highest yield tree^{-1} was recorded in fruit yield/tree was recorded in CHESG-21 followed by CHESG-15 while the minimum fruit yield was found in Dhawal. All the evaluated germplasm had white flesh except Lalit, CHESG-2, CHESG-15, CHESG-16, CHESG-21 and CHESG-24. The maximum fruit weight was observed in MPUAT-2 (322.33 g) while the minimum fruit weight was recorded in Dhawal (97.66 g) followed by MPUAT-1 (106.83 g). The maximum fruit length was recorded in CHESG-21 (8.82 cm) followed by Thai guava (8.22 cm) while the highest width was found in MPUAT-2 (8.71 cm) followed by Thai guava (8.22 cm). MPUAT-2 also recorded the maximum seed core diameter (6.0 cm) and pulp thickness (1.70 cm). The highest 100 seed weight was noted in VNNR Vihi1 (1.97 g) followed by CHESG-2 (1.56 g) while it was recorded least in CHESG-15 (0.87 g). The highest TSS was recorded in Dhawal (20.0 ^{0}Brix), however, the highest TSS:acidity was observed in CHESG-15 (29.64).The maximum acidity (0.95 %) and ascorbic acid (283.20 mg100 g^{-1}) were recorded in CHESG-21 while the minimum acidity (0.49 %) and ascorbic acid (67.98 mg/100 g) were found in L-49 and CHESG-28 respectively.

Keywords: Environment, evaluation, germplasm, guava

Introduction

The guava (*Psidium guajava* L.) popularly known as apple of tropics, belongs to the family Myrtaceae, extensively cultivated in the tropical and sub tropical parts of India. Owing to its high nutritive value, wider adaptability to diverse agro-climatic conditions, early and prolific bearing with a high monetary return (Mishra *et al.*, 2018), guava is becoming popular as a commercial crop in western part of India. The fruit is a rich source of vitamin C, calcium, iron, pectin and is common raw material in fruit processing industry. In India, it is the fourth and fifth most important fruit crop by area and production, respectively. It occupies an area of 0.27m ha with a total production of 3.67 mt. In Gujarat, it is mainly grown in Ahmadabad, Vadodara, Anand, Bhavnagar, Rajkot and Bharuch districts with a total production 140.80 thousand tonnes from an area of 10.80 thousand ha; the average productivity is 13.0 t ha^{-1} (Anonymous, 2014). Guava exhibits high levels of genetic diversity due to prevalence of seed propagation (Mishra *et al.*, 2018). Therefore, survey was conducted in different parts of Gujarat to select elite seedlings from existing heterozygous seedling population having desirable horticultural traits. Selected genotypes were collected in the form of air-layers during 2016-17 and planted in the field gene repository for evaluation on the basis of growth, yield and quality characters.

Materials and Methods

Twenty one genetically diverse genotypes including cultivars were evaluated for growth, yield and fruit quality attributes at the ICAR-CIAH, Bikaner regional station CHES, Godhra planted during 2016-17 at a spacing of 5 m x 5 m in randomized block design, replicated thrice. Winter crop 2018-19 was taken for recording the data on fruit yield and quality attributing characters. Three uniform trees of each genotype/cultivar was selected for recording observations on growth in terms of plant height (m), stem diameter (cm) and plant spread (m). Average fruit weight (g) was calculated by weighing the fruits in an electronic balance. The yield (kg tree^{-1}) was obtained through the weighing the harvested fruits. However, for measuring physical parameters like fruit weight, seed weight and fruit size were recorded as per standard procedures with the help of an electronic balance and vernier caliper respectively. The total soluble solids (TSS) were determined with Hand Refractometer (0-32°Brix). The tritratable acidity (%) and ascorbic acid content were determined by method of AOAC (1980). The average data were subjected to statistical analysis as per the method outlined by Gomez and Gomez (1984). Least significant difference at 5% level was used for testing the significant differences.

Results and Discussion

Plant growth habit of most of the guava genotypes found to be upright (CHESG-2, CHESG-4, CHESG-5, CHESG-11, CHESG-15, CHESG-19, CHESG-24, CHES-28, Sweta, Dhawal, MPUAT-2) followed by Semi spreading

(CHESG-1, CHESG-21, CHESG-23, Allaahabad Safeda, Lalit, VNR Vihi1, Thai guava, MPUAT-1 and spreading (CHESG-16, L-49). The maximum plant height was recorded in CHESG-5 (3.0 m) followed by CHESG-5 (2.80 m) and CHESG-15 (2.76 m) while the minimum plant height was noted in Sweta (1.46 m). However, the maximum plant spread was observed in both the directions (N-S 2.98 m and E-W 3.0 m) in CHESG-16 followed by CHESG-5 and MPUAT-1 in N-S direction (1.80 m) whereas in E-W direction, it was found in CHESG-15 and MPUAT-2 (2.73 m). The minimum plant spread in both the directions was found to be in Lalit (1.60 & 1.66 m). However, the maximum stem girth was recorded in CHESG-24 (7.53 cm) followed by CHESG-11(7.11 cm) while the minimum stem girth was measured in Thai guava (Table 1). Genetic makeup of the plants and adaptability of diverse genotypes under different climatic conditions could be the possible reason for the wide variation with respect to growth and plant spread. The results of present findings are in agreement with Babu *et al.* (2007) and Singh *et al.* (2016).

Significantly the maximum number of fruits tree^{-1} was observed in CHESG-21 (85) followed by MPUAT-1 (75) and CHESG-15 (65) and it was found minimum in Dhawal and MPUAT-2 (16.66). Whereas the maximum fruit yield tree^{-1} was recorded in CHESG-21 (13.57 kg) followed by CHESG-15 (10.03 kg) while the minimum fruit yield was found in Dhawal (1.68 kg). All the evaluated germplasm had white flesh except Lalit, CHESG-2, CHESG-15, CHESG-16, CHESG-21 and CHESG-24 (Table 1). The rich diversity in these characters may be due to highly heterozygous and diverse genetic background of parents (Singh *et al*., 2016, Mishra *et al.*, 2018).

Physico-chemical characters of all the evaluated germplasm are depicted in Table 2. The maximum fruit weight was observed in MPUAT-2 (322.33 g). Although, fruit weight = 200 g was recorded in CHESG-21, CHESG-28, Thai guava and VNR Vihi1. However, the minimum fruit weight was recorded in Dhawal (97.66 g) followed by MPUAT-1 (106.83 g). The maximum fruit length was recorded in CHESG-21 (8.82 cm) followed by Thai guava (8.22 cm) while the highest width was found in MPUAT-2 (8.71 cm) followed by Thai guava (8.22 cm). However, the minimum fruit length and width were observed in MPUAT-1 (5.25 cm) and Dhawal (5.44 cm) respectively. MPUAT-2 recorded the maximum seed core diameter (6.0 cm) and pulp thickness (1.70 cm). However, Thai guava, VNR Vihi1, CHESG-28, CHESG-2, and CHESG-23 recorded pulp thickness = 1.50 cm. The highest 100 seed weight was noted in VNNR Vihi1 (1.97 g) followed by CHESG-2 (1.56 g) while it was recorded least in CHESG-15 (0.87 g). Similar variations in fruit size, seed core dia, pulp thickness and seed weight among diverse guava genotypes were reported by Yadav and Shankar (2007) and Mishra *et al.* (2018).

Table1. Vegetative growth characters, pulp colour and yield of guava germplasm.

Germplasm	Growth habit	Plant height (m)	Canopy spread		Stem girth (cm)	No. of fruits/tree	Yield/tree (kg)	Pulp colour
			N-S (m)	E-W (m)				
CHESG-1	Semi spreading	2.43	2.55	2.61	5.53	55.66	8.11	White
CHESG-2	Upright	2.26	2.07	2.26	6.42	30.0	5.33	Pink
CHESG-4	Upright	2.08	2.17	2.62	4.51	40.0	6.45	White
CHESG-5	Upright	2.80	2.8	2.7	5.67	46.66	7.99	White
CHESG-11	Upright	3.00	2.58	2.7	7.11	28.33	4.35	White
CHESG-15	Upright	2.76	2.53	2.73	6.01	65.0	10.03	Pink
CHESG-16	Spreading	2.66	2.98	3	7.06	22.33	3.52	Pink
CHESG-19	Upright	2.23	2.58	2.4	4.78	41.66	5.61	White
CHESG-21	Semi spreading	2.40	2.5	2.4	5.28	85.0	13.57	Pink
CHESG-23	Semi spreading	2.13	2.2	2.23	5.01	21.66	3.51	White
CHESG-24	Upright	2.4	2.53	2.43	7.53	20.0	3.83	Pink
CHESG-28	Upright	1.90	1.93	1.76	4.26	25.0	5.61	White
Allahabad Safeda	Semi spreading	2.02	2.53	2.3	4.57	23.33	3.05	White
L-49	Spreading	1.80	2.5	2.48	4.63	60.0	11.15	White
Lalit	Semi spreading	1.86	1.6	1.66	3.96	35.0	3.57	Pink
Sweta	Upright	1.46	1.73	1.9	3.74	26.6	3.08	White
Dhawal	Upright	2.16	1.96	2.32	5.37	16.66	1.68	White
Thai Guava	Semi spreading	1.80	2.25	2.43	3.45	45.0	11.33	White
VNR Vihi1	Semi spreading	1.96	2.06	2.17	4.35	40.0	10.01	White
MPUAT-1	Semi spreading	2.38	2.8	2.73	4.6	75.0	7.99	White
MPUAT-2	Upright	2.60	2.7	2.8	5.52	16.66	5.39	White
Sem±	-	0.08	0.12	0.14	0.33	2.19	0.59	-
CD 0.05	-	0.22	0.34	0.4	0.94	6.26	1.70	-
CV (%)	-	5.96	8.65	10.1	10.92	9.73	16.05	-

There was a significant difference among the varieties with regard to chemical quality characteristics of guava fruits (Table 2). The highest TSS was recorded in Dhawal (20.0 ^{0}Brix) followed by CHESG-11(19.50 ^{0}Brix) while the minimum TSS was observed in MPUAT-1 (12.83 ^{0}Brix) followed by CHESG-1 (13.33 ^{0}Brix). The maximum acidity (0.95 %) and ascorbic acid (283.20 mg/100 g) were recorded in CHESG-21 while the minimum acidity (0.49 %) and ascorbic acid (67.98 mg/100 g) were found in L-49 and CHESG-28 respectively. However, the highest TSS:acidity was observed in CHESG-15 (29.64) followed by L-49 (28.79) while it was found minimum in CHESG-16 (16.91). Similar kind of variation is recorded by Singh *et al.* (2016), Mishra *et al.* (2018) in guava and Mishra *et al.* (2018) in acid lime.

Based on the present findings, guava genotypes like CHESG-15 and CHEsG-21and cultivar L-49 found better in terms of yield and fruit quality parameters. The above findings are preliminary and needs to be studied further.

Table 2: Physico-chemical characters of guava germplasm.

Germplasm	Fruit weight (g)	Fruit length (cm)	Fruit width (cm)	Seed core dia. (cm)	Pulp thickness (cm)	100 seed weight (g)	TSS (^{0}B)	Acidity (%)	TSS:acidity	Ascorbic acid (mg/100 g)
CHESG-1	146.28	7.56	6.20	3.73	1.30	1.08	13.33	0.53	26.61	155.58
CHESG-2	176.83	6.27	6.84	4.66	1.56	1.54	15.16	0.76	19.98	265.97
CHESG-4	159.83	6.19	6.87	4.96	1.28	1.19	17.50	0.74	23.48	252.23
CHESG-5	172.33	6.57	6.56	4.73	1.16	1.23	17.50	0.75	23.23	183.76
CHESG-11	155.0	8.18	6.18	3.53	1.36	1.25	19.50	0.86	22.67	192.46
CHESG-15	154.0	6.07	6.60	4.07	1.23	0.87	17.16	0.58	29.64	201.86
CHESG-16	156.66	6.04	6.44	4.76	1.46	0.96	16.63	0.76	22.28	230.85
CHESG-19	134.83	7.85	5.86	3.43	1.26	0.99	15.33	0.70	21.92	213.81
CHESG-21	215.66	8.82	7.16	4.66	1.33	1.22	16.16	0.95	16.91	283.20
CHESG-23	161.50	8.02	6.42	3.80	1.50	1.13	15.93	0.57	27.77	177.76
CHESG-24	190.50	6.44	7.06	4.60	1.46	1.45	14.6	0.69	21.17	174.47
CHESG-28	227.16	7.66	7.15	4.43	1.56	1.27	15.63	0.64	24.46	67.98
Allahabad Safeda	132.16	5.75	6.05	4.50	1.33	1.29	15.26	0.69	22.15	192.74
L-49	190.93	6.95	6.37	4.10	1.28	1.42	14.06	0.49	28.79	193.81
Lalit	126.16	5.75	6.05	3.86	1.20	0.94	14.66	0.53	27.51	146.83
Sweta	115.73	6.17	5.91	3.53	1.26	0.93	14.96	0.77	19.33	162.51
Dhawal	97.66	5.63	5.44	3.33	1.23	1.41	20.00	0.74	26.81	91.66
Thai Guava	257.66	8.22	7.81	4.70	1.53	1.28	15.23	0.64	23.82	69.81
VNR Vihi1	251.17	7.61	7.73	4.5	1.63	1.97	14.33	0.73	19.67	158.74
MPUAT-1	106.83	5.25	5.93	3.40	1.23	1.24	12.83	0.60	21.34	200.57
MPUAT-2	322.33	8.14	8.71	6.00	1.70	1.27	14.00	0.60	23.36	282.52
Sem±	13.38	0.24	0.19	0.14	0.05	0.04	0.62	0.04	1.55	9.11
CD (0.05)	38.26	0.69	0.55	0.42	0.15	0.12	1.77	0.11	4.45	26.04
CV (%)	13.34	6.03	4.99	5.98	6.86	6.16	6.81	9.74	11.48	8.5

References

Anonymous. 2014. Indian Horticulture Data Base. 2014. NHB, Ministry of Agriculture, Govt. of India, Gurugram. pp. 42-48.

AOAC. 1980. Official Methods of Analysis of Association of Official Agricultural Chemists, Association of Official Agricultural Chemists, Benjamin Franklin Station, Washington, DC, USA.

Babu, K.D., Singh, A. and Yadav, D.S. 2007. Performance evaluation of red and white fleshguava hybrids under midhill altitude of Meghalaya. *Acta Hortic*., 735: 95-98.

Dubey, P.S., Huda, M.N. and Singh, S. 2000. Studies on growth behavior of guava germplasm under Sabour conditions for rainy season fruiting. *Indian J. Hort.*, 57: 326-328.

Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedure for Agricultural Research, 2nd edn., John Wiley and Sons Inc., New York. pp. 680.

Mishra, D.S., Singh, S., Singh, A.K., Yadav, V., Appa Rao, V.V. and Saroj, P.L. 2018. Assessment of genetic diversity in guava. *Indian. J. Hort*., 75(3):362-368.

Mishra, D.S., Singh, S., Singh, A.K. and Yadav, V. 2018. Genetic variability in acid lime accessions from central Gujarat. *Indian. J. Hort*., 75(4):703-708.

Singh, A., Kumar, S. and Kulloli, R.N. 2016. Performance evaluation of guava (*Psidium guajava* L.) introductions in arid conditions of western Rajasthan. *Ann. Arid Zone*, 55(1&2): 25-28.

Yadav, L.P. and Shankar, G. 2007. Exploiting genetic diversity in guava (*Psidium guajava* L.) from Allahabad and surrounding areas.*Pl. Gen. Resour. News Lettr*.,149: 14-16.

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Genetic diversity in phalsa (*Grewia subinaequalis* D.C.) under semi- arid ecosystem of western India

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Abstract

An investigation was undertaken to evaluate the performance of 10 genotypes of phalsa at experimental farm of Central Horticultural Experiment Station (ICAR-CIAH), Vejalpur, Panchmahal (Godhra), Gujarat under rainfed hot semi-arid ecosystem of western India during 2015 and 2016. These genotypes were studied to observe the variability in respect to flowering, fruiting and fruit quality attributes under hot semi-arid conditions. The period of full bloom was recorded in February and March in all the genotypes. Fruit set percent was noted highest (58.53) in CHESP-9, whereas fruit ripening started from 1st week of April and continued up to 1st week of May in different genotypes. Flower length, flower breadth, calyx tube length, calyx tube breadth, petal length, petal breadth, stamen length, ovary length and ovary breadth ranged between 25.30-30.20mm, 60.15-69.18mm, 3.64-4.18mm, 4.63-5.22 mm, 7.89-8.25mm, 4.95-5.21mm, 8.84-9.94 mm, 3.94-4.16 mm, 7.00-7.15mm respectively. The maximum fruit yield (3.28 kg/ plant), TSS (20.12^0 Brix), total sugar (12.42% was recorded in CHESJ-9. Based on the various desired horticultural traits, the genotypes, CHESP-9 and CHESP-7 were found to be promising.

Key words: Acidity, divergence, fruit set, genetic

Introduction

The phalsa (*Grewia subinaequalis* D.C.) belongs to the family Tiliaceae. Its fruit is mildly acidic and rich source of Vitamin A, C and minerals. It is mostly used as fresh fruit and has cooling effect. The unripe phalsa fruits alleviate inflammation and are also being administered in respiratory, cardiac, and blood disorders. The ripe phalsa fruits are consumed fresh, in desserts, or processed into refreshing fruit and soft drinks enjoyed during summer months in India.

It is one of the important rainfed semi-arid fruit crops, rich in nutrients, hardy in nature, having good processing potential with wider adaptability to grow under varied climatic conditions**.** Gradually, it is attaining its position among the important fruits of India.

It is a heterozygous, cross-pollinated fruit crop and as such existing seedling population exhibits diversity, which aids in the selection of the superior desirable genotypes. Elite genotypes were collected from diversity rich areas based on the horticultural traits and evaluated under field condition to identify elite genotypes having earliness, precocity in bearing, high yielding, high pulp content and suitability for commercial cultivation at closer spacing. Such variations were observed in terms of flowering, fruiting, yield and fruit quality attributes in jamun, chironji, mahua, tamarind, bael, custard apple and khirni in different agro-climatic conditions (Patel *et al*., 2005, Singh *et al.,*2006, Singh and Singh, 2005, Singh *et al.,* 2007, Singh *et al.,* 2008, Singh and Singh, 2012, Singh *et al*., 2014, Yadav *et al*., 2017 , Malik *et al*., 2012 and Malik *et al*., 2013). The plant can tolerate drought conditions for shorter period as well as heavy rainfall conditions. Present investigation was carried out to find out variability in plant growth, flowering, fruiting and fruit quality attributes of different genotypes of phalsa to identify suitable genotypes for commercial cultivation.

Materials and Methods

The experiment was carried out at 113 m above msl, latitude 22° 41' 38" N and longitude 73° 33' 22" E which is characterized by hot semi-arid climate. The annual rainfall is mainly confined to three months (July- September) and actual mean precipitation is about 750 mm with 32 numbers of rainy days. The mean summer temperature prevails at 32.9^0 C while the mean winter temperature 21.3^0 C indicating that the area falls under hyperthermic soil regime. The mean annual maximum and minimum temperature varies from 42 - 44^0 C (May) and 8 - 12^0 C (January), respectively. The experimental soil type was having available N (151.25 kg/ha), P (8.22 kg/ha) and K (143.50kg/ha) and organic carbon (0.33%), while EC and pH, bulk density and hydraulic conductivity of soil were 0.14 dSm^{-1}, 7.50, 1.42g/cc and 0.29 cm/hr, respectively. The soil depth of experimental field ranged from 0.65 to 1.0 m derived from mixed alluvial basalt, quartzite, granite and layers of limestone which falls under semi-arid hot climate.

A total of 10 genotypes planted, established through cutting, was laid out in randomized block design with 3 replications. Observations on flowering, fruiting and fruit quality attributes were observed during 2015 and 2016 and mean data were subjected to statistical analysis. Ten shoots spread over four directions on each tree were tagged and observations on floral traits were recorded. Forty fruits were

randomly selected from all the directions of the plant for fruit quality attributes. Total soluble solids, vitamin C and sugars were analyzed by the methods as outlined by AOAC (1980). The mean data were statistically analyzed as per method suggested by Gomez and Gomez (1984).

Results and Discussion

The data on flowering and fruiting of different genotypes depicted in Table 1 showed significant differences in respect to flowering and fruit set of the plants. In general, peak period of flowering was observed in the month of February and March in all the genotypes and these genotypes exhibited considerable variations. It was noted in 2nd week of February in CHESP-1, CHESP-3, CHESP-6, CHESP-7and CHESP-9. Flowering took place in 3rd week of February in CHESP-2. It was observed in 4th week of February in CHESP-5, and CHESP-10 (Table 1). Flower bud differentiation is influenced by the prevailing agro- climatic conditions of the area. More or less similar findings have been reported by earlier workers in different fruit crops viz., jamun (Patel *et al*., 2005), jamun (Singh and Singh, 2012), bael (Singh *et al.,* 2014), khirni (Singh *et al*., 2016b), mahua (Singh and Singh, 2005) under different climatic conditions.

Table 1 clearly indicates the significant variation in the per cent fruit set which varied from 0.12 to 58.53 cm in all the genotypes of phalsa. The maximum fruit set was recorded in CHESP-9 (58.53%) followed by CHESP-2 (55.50%) and CHESJ-6(55.12%), while it was recorded minimum in CHESP-1 (50.12%). Variation in fruit set may be due to genetic makeup and their adaptability to varied climatic conditions. These findings are in accordance with results as reported by Singh *et al*. (2010) in chironji.

Fruits reached at the ripening stage in April and May in different genotypes. The earliest ripening took place in 1st week of April in CHESP-2, while CHESP-1 ripened at the last in 1st week of May (Table 1). Such variations in fruit ripening have been reported in different fruit crops like chironji (Singh *et al*., 2016a) and bael (Singh *et al*., 2014). In all the genotypes, significant variation was observed for flower size, calyx tube size, petal size, stamen and style length (Table 2). The minimum flower length (25.30 mm) was observed in CHESP-2 and the maximum length was recorded in CHESP-5 (30.20 mm), whereas calyx tube length ranged between 3.73-4.18 mm being the maximum in CHESP-7. The maximum petal length was recorded in CHESP-7 and it was noted minimum in CHESP-3. Wide variation in stamen length was observed which ranged between 8.84-9.94 mm. Differences for ovary size and petal breadth could not reach the level of significance among the genotypes. Such variations in floral organs of fruit crops have been reported by Singh *et al*. (2014) in bael under different agro-climatic conditions..

Variability recorded in yield and fruit weight is presented in Table 1. Results of study revealed significant differences in yield and fruit weight among the genotypes. Yield per plant was recorded the maximum in CHESJ-9 (3.78kg/ plant) followed by CHESJ-7 and it was recorded the lowest in CHESP-1 (2.32kg/plant). The maximum fruit weight was recorded in CHESP-4 (1.93g) followed by CHESP-8 (1.90g), while it was recorded lowest in CHESP-5 (1.25g). Variation in fruit yield and weight in various fruit crops have been reported by Singh *et al.* (2014) in bael, under rainfed semi-arid conditions of western India. Pulp content was recorded maximum in CHESP-1 (93.02%), closely followed by CHESP-4 (90.67%) and CHESP-7 (88.88%), it was found to be the minimum in CHESP-3 (81.08%).

Phalsa fruits are also rich source of total soluble solids, sugars and vitamin C, and these values varied significantly in different genotypes (Table 3). Total soluble solids and total sugar content of fruits ranged from 13.42 to 16.60^{0}Brix and 10.00 to 12.92%, respectively in different genotypes. The maximum total soluble solids was found in CHESP-2 (16.60^{0}Brix), closely followed by CHESP-7 (15.80 ^{0}brix) and CHESK-8 (15.50^{0}Brix), it was found least in CHESP-4 (13.42^{0}Brix). The highest total sugar content was also recorded in CHESP-2 (12.92%), followed by CHESP-7 (11.80%) and CHESP-8 (11.50%) and it was recorded least in CHESP-4(10.20%). Vitamin C content recorded the maximum in CHESP-9 (19.12mg/100g) and it was noted the lowest in CHESP-5 (16.90 mg/ 100g). Malik *et al.* (2012) and Singh *et al*. (2016b) have also recorded the remarkable

Table 1. Plant growth, flowering and fruiting pattern of phalsa genotypes (Mean data 2015 and 2016).

Genotype	Initiation of flowering	Peak period of flowering	End of flowering	Fruit set (%)	Ripening time	Fruit yield/ Plant (kg)	Fruit weight (g)
CHESP-1	1st week February	2nd week February	1st week March	50.12	1st week May	2.32	1.72
CHESP-2	2nd week February	3rd week February	1st week March	55.50	1st week April	2.50	1.54
CHESP-3	1st week February	2nd week February	1st week March	54.17	2nd week April	2.65	1.35
CHESP-4	3rd week February	1st week March	3rd week March	50.17	4th week April	2.20	1.93
CHESP-5	2nd week February	4th week February	2nd week March	52.15	4th week April	2.42	1.25
CHESP-6	1st week February	2nd week February	1st week March	55.12	4th week April	2.65	1.77
CHESP-7	1st week February	2nd week February	1st week March	53.25	3rd week April	3.28	1.65
CHESJ-8	3rd week February	1st week March	3rd week March	51.24	3rd week April	2.70	1.90
CHESP-9	1st week February	2nd week February	3rd week March	58.53	2nd week April	3.78	2.15
CHESP-10	2nd week February	4th week February	2nd week March	54.22	4th week April	2.83	1.50
CD P=(0.05)	----	------	-----	0.28	----	0.31	0.11

variability in relation to fruit quality attributes of khirni. Based on the horticultural traits studied, the genotypes, CHESJ-7 was found to be promising under rainfed hot semi-arid conditions of western India.

Table 2. Floral traits and pollen characters in different phalsa genotypes. (Mean data 2015 and 2016)

Genotypes	Flower length (mm)	Flower breadth (mm)	Length of calyx tube (mm)	Breadth of calyx tube (mm)	Petal length (mm)	Petal breadth (mm)	Stamen length (mm)	Ovary length (mm)	Ovary breadth (mm)	Style length (mm)
CHESP-1	26.92	60.15	3.73	4.80	8.20	5.02	9.22	3.98	7.10	7.13
CHESP-2	25.30	60.24	3.94	4.74	8.24	5.12	8.84	3.94	7.12	7.18
CHESP-3	27.24	62.29	3.96	4.63	7.89	4.95	9.00	3.90	7.14	7.15
CHESP-4	28.32	65.13	3.86	5.22	8.12	5.00	9.94	3.95	7.10	7.17
CHESP-5	30.20	69.18	4.16	5.20	8.22	5.11	9.15	3.95	7.15	7.14
CHESP-6	26.25	60.23	3.64	4.93	8.25	5.21	9.26	4.16	7.15	7.11
CHESP-7	30.03	65.02	4.18	4.75	8.32	5.13	9.53	4.05	7.13	7.15
CHESJ-8	29.03	66.12	4.13	5.07	8.23	5.10	9.32	4.10	7.10	7.10
CHESP-9	28.20	65.50	4.11	5.12	8.20	5.00	9.40	4.00	7.12	7.00
CHESP-10	28.02	64.11	4.03	5.20	8.10	5.10	9.30	4.10	7.00	7.12
CD P=(0.05)	0.11	0.09	0.07	0.06	0.08	NS	0.05	NS	NS	0.04

Table 3. Fruit quality attributes of phalsa genotypes (Mean data 2015 and 2016)

Genotype	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Pulp weight (g)	Pulp percent	TSS (Degree Brix)	Acidity (%)	Total sugar (%)	Vitamin C (mg/100 g)
CHESP-1	1.72	0.81	0.96	1.60	93.02	14.95	3.14	10.90	18.13
CHESP-2	1.70	0.77	0.90	1.40	82.35	16.60	3.19	12.92	18.43
CHESP-3	1.85	0.90	0.92	1.50	81.08	14.90	3.18	10.80	18.13
CHESP-4	1.93	0.86	0.91	1.75	90.67	13.42	3.17	10.20	18.07
CHESP-5	1.75	0.80	0.91	1.49	85.14	14.50	3.11	11.35	16.90
CHESP-6	1.77	0.80	0.90	1.50	84.74	14.60	3.12	10.30	17.80
CHESP-7	1.80	0.79	0.93	1.60	88.88	15.80	3.14	11.80	18.11
CHESJ-8	1.90	0.89	0.96	1.63	85.78	15.50	3.18	11.50	17.60
CHESP-9	2.15	0.88	0.98	1.80	83.72	15.12	3.12	11.42	19.12
CHESP-10	1.80	0.82	0.94	1.56	86.66	14.02	3.20	10.00	18.15
CD P=(0.05)	0.11	0.12	0.09	0.20	0.25	0.20	0.01	0.43	1.10

References

AOAC. 1980. *Official Methods of Analysis of Association of Official Agricultural Chemists*, Association of Official Agricultural Chemists, Benjamin Franklin Station, Washington, DC, USA.

Gomez, K. A. and Gomez, A. A.1984. *Statistical Procedure for Agricultural Research* (2nd Edn.), John Wiley and Sos Inc., New York.

Malik, S. K., Choudhary, Ravish, Kumar, S., Dhariwal, O. P., Deswal, R. P. S. and Chaudhary, R. 2012. Socio-economic and horticultural potential of Khirni [*Manilkara hexandra* (Roxb.) Dubard]: a promising underutilized fruit species of India. *Genetic Reso. Crop. Evol.,* 59:1255-65.

Malik, S. K., Kumar, S., Choudhary, Ravish, Kole, P.R., Chaudhary, R. and Bhat, K.V. 2013. Assessment of genetic diversity in khirni [*Manilkara hexandra* (Roxb.) Dubard]:An important underutilized fruit species of India using random amplified polymorphic DNA markers. *Indian J. Hort.,* 70: 18-25.

Patel, V. B., Pandey, S. N., Singh, S. K. and Das, Bikash, 2005. Variability in *jamun* (Syzygium *cuminii* Skeels) accessions from Uttar Pradesh and Jharkhand. *Indian J. Hort.,* 62:244-47.

Singh, A. K., Singh, Sanjay, Singh, R. S., Joshi, H. K. and Sharma, S. K. 2014. Characterization of bael (*Aegle marmelos*) varieties under rainfed hot semi-arid environment of western India. *Indian J. Agric. Sci.,* 84:1236-42.

Singh, Sanjay and Singh, A. K. 2005. Genetic diversity in *mahua* (*Bassia latifolia*) under semi arid ecosystem of Gujarat. *Indian J. Agric. Sci.,* 75**:** 519-23.

Singh, Sanjay, Singh, A. K. and Apparao, V. V. 2006. Genetic diversity in *Chironji* (*Buchanania lanzan* Spreng) under semi arid ecosystem of Gujarat. *Indian J. Agric. Sci.,* 76:695-698.

Singh, Sanjay Joshi, H. K., Singh, A. K., Lenin, V., Bagle, B. G. and Dhandar, D. G. 2007. Reproductive biology of jamun (*Syzygium cuminii* Skeels) under semi-arid

tropics of Western India. *Hortic. J.,* 20:76-80.

Singh, Sanjay, Singh, A. K. and Joshi, H. K. 2008. Genetic variability for floral traits and yield attributes in tamarind. *Indian J. Hort,*. 65: 328-331.

Singh, Sanjay, Singh, A. K., Joshi, H. K., Lata, K., Sisodia, P. S. and Bagle, B. G. 2010. Floral biology studies in *Buchanania* under semi- arid ecosystem of western India. *Indian J. Hort.,* 67:161-68.

Singh, S. and Singh, A. K. 2012. Studies on variability in jamun (*Syzygium cuminii* Skeels) from Gujarat. *Asian J. Hort.,* 7: 186-189.

Singh, Sanjay, Singh, A. K., Appa Rao, V. V. and Bhargava, R. 2016 a. Genetic divergence in chironji (*Buchanania lanzan*) under semi-arid ecosystem of western India. *Indian J. Agric. Sci.,* 86: 550-55.

Singh, Sanjay, Singh, A. K., Appa Rao, V. V. and Bhargava, R. 2016b. Genetic divergence in khirni [*Manilkara hexandra* (Roxb.) Dubard] under semi-arid ecosystem of western India. *Indian J. Agric. Sci.,* 86: 337-41.

Yadav, V., Singh, A. K., Singh, Sanjay and Appa Rao, V. V. 2017. Variability in custard apple (Annona squamosa) genotypes for quality characters from Gujarat. Indian J. Agric. Sci., 87 : 1627-32.

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Studies on stooling in bael (*Aegle marmelos* Correa) under semi-arid conditions

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Abstract

The study on stooling on bael was conducted to find out the the efficacy of 1000-7000ppm concentration of IBA on rooting behavior in stool layers at CHES (ICAR-CIAH), Vejalpur, Panchmahals (Godhra), Gujarat during the 2015-16.Among the different concentration tried, the highest number of primary root (15.34), secondary roots (69.80), root biomass (6.05g), survival per cent in nursery (24.24) and field condition (19.72) was recorded in the stool layers treated with IBA 5000 ppm, whereas the maximum length of primary roots (34.75cm), diameter of primary (1.50mm) and secondary roots (0.73 mm) was observed in the shoots (stool layers) treated with IBA 7000 ppm. However survival per cent in nursery and field condition ranged between 10.25-24.24 and 5.17-19.72 per cent, respectively. Stool layers which were not treated with IBA could not survive in nursery as well as under field condition. Different concentration of IBA significantly influenced the rooting in stool layers over control under rainfed semi-arid conditions.

Key words: Bael, primary root, root biomass, stooling

Introduction

Bael (*Aegle marmelos* Correa) is an important indigenous fruit of India and known since ancient times. It is grown in various parts of South East Asia including India, Sri Lanka, Pakistan, Myanmar, Bangladesh, Thailand and most of the South-East Asian countries. In India, bael is being grown throughout the country and is known by other vernacular names like *bael, bela, bili, bilva, belo, maredu, vilwam, sriphal*, golden apple, Indian quince and Bengal quince (John and Stevenson, 1979). It is found growing in sub-tropical, tropical, arid and semi-arid regions of the country. It is grown in temple premises of the Lord Shiva and fruits are used as important ingredients of holy pyre (*havan*). It is a nutritious and medicinal fruit plant, which is most suitable to grow in water scarce areas of the country. Its fruit is highly nutritive, and rich in riboflavin, vitamin A and carbohydrate. Various chemical constituents' *viz*., alkaloids, coumarins and steroids have been identified and isolated from different parts of bael plants. Ripe and mature fruits are used for making various value added products and all parts of tree is used in various *ayurvedic* formulation. The commercial method of bael multiplication is patch budding and soft wood grafting (Singh *et al.,* 2014 and 2018), but for production of uniform rootstocks, stooling is an alternative mothod for mass multiplication clonal rootstocks. Keeping these in view, an attempt was made to find out response of IBA on rooting and survival of stools under rainfed hot semi-arid conditions.

Materials and Methods

The experiment was carried out at Experimental Farm of Central Horticultural Experiment Station, Godhra, Gujarat during 2015-16. *Deshi* plants of Goma Yashi were sawed off just a height of 15-20 cm above the ground level in the month of April (2nd week) to encourage the emergence of new shoot growth from the stump. Normal cultural practices were followed during the period of experimentation. Owing to commencement of high temperature and availability of soil moisture, a large number of new shoots were induced. When the shoots attain a height of 45-50 cm, acquired uniform pencil thickness, a circular ring bark of 2.5 cm wide was removed in the first week of July. The exposed portion of ring was rubbed gently in order to remove cambium without causing injury to wood. The lanoline containing different concentration (100, 2000, 3000, 4000, 5000 and 7000 ppm) of IBA were smeared thoroughly on and around the upper portion of girdled shoots. A set of shoots without IBA treatment was taken as control. In all the cases, the ringed portion was covered with soil up to height of 10-15 cm above the ringed shoots to cover the basal portion of each shoot followed by mounded portion was moistened and covered with organic mulch to avoid moisture loss and flashing out of soil owing to rain. The soil was kept moist throughout the stooling period through irrigation whenever needed. In the second week of September, *i.e.* 65 days after stooling, the soil was carefully removed so as to expose the ringed portion. Each rooted shoot was detached from the mother plant carefully. While removing the stool layers from mother plant, the rooted shoots as much as possible soil was allowed to adhere to the roots. The shoots were headed back before separating from the stump in order to maintain the root shoot ratio. The experiment for survival and growth characters under nursery was analyzed in factorial RBD. Observations on rooting and root characters were

recorded before transplanting. In each treatment, rooted shoots were transplanted in the nursery and survived stools were shifted to field conditions.

Results and Discussion

Results of study divulged that the different concentration of IBA influenced the rooting behaviour and survival of stool layers (Fig. 1, 2, 3 and 4). In general, different levels of IBA increased the rooting in stools in bael over control. Results of study revealed that the application of IBA enhanced the number of primary and secondary roots in the shoots treated with IBA than control. The highest number of primary roots per stool layers was recorded in IBA 5000 ppm (15.34) followed by IBA 4000 ppm (13.20) and was recorded the least in control (4.40). Similarly, the number of secondary roots (69.80) was recorded the highest in same treatment (IBA 5000ppm) followed by IBA 4000ppm (60.65), IBA 6000ppm (57.78) and it was recorded the lowest in control (15.20), among the different concentration of IBA tried. This finding is in agreement with results reported by Rymbai and Sathynarayan (2010) in guava. IBA at 7000 ppm concentration also recorded the maximum primary root length (34.75 cm) and secondary root length was recorded the maximum in IBA 5000ppm (7.90cm) closely followed by IBA7000ppm (7.70cm) and minimum of the same was recorded in control (6.32 and 2.65cm). More or less similar results have been reported by Tyagi *et al.,* (2004) and Mishra *et al.,* (2007) in guava. Diameter of primary (1.50 mm) and secondary (0.73mm) roots was recorded in stool layers treated with IBA7000 ppm followed by IBA 6000 ppm (1.30 and 0.65mm) whereas these parameters were recorded the lowest in control (0.75 and 0.40 mm). The length of root was recorded the maximum in the shoots treated with IBA 7000 ppm, but the fresh root biomass (6.05g) was recorded highest in the shoots treated with 5000 ppm followed by IBA 6000 ppm and the same was recorded the least in control (3.02g) (Fig.5). Less survival under nursery and field conditions might be influenced by climatic conditions prevailing under hot semi-arid conditions. The survival per cent in nursery ranged between 10.25-24.24 being the maximum in the stool layers treated with IBA 5000 ppm and the lowest in IBA 1000 ppm whereas not a single stool layer could be survived in nursery which was not treated with IBA. Such effects may be due the longer roots and disturbed secondary and tertiary roots during separation from mother plants. These findings are in consonance with the results of earlier workers (Dutta and Mitra, 1991; Bhagat *et al.,* 1999; Mishra *et al.,* 2007). More or less similar results have been reported by Lal *et al.,* (2007), Saroj and Pathak (1994), Rymbai. and Sathynarayan (2010), Singh (1998), Ahmed *et al.,* (2007) under different agro-

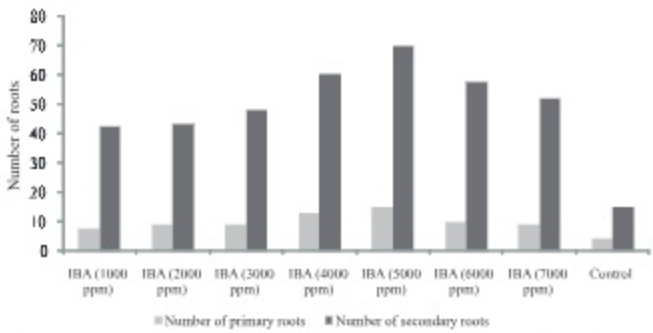

Fig.1: Rooting behavior under different concentration of IBA under hot semi-arid condition.

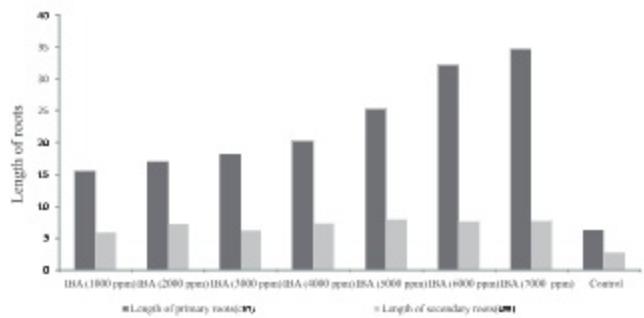

Fig.2: Length of roots under different concentration of IBA under hot semi-arid condition.

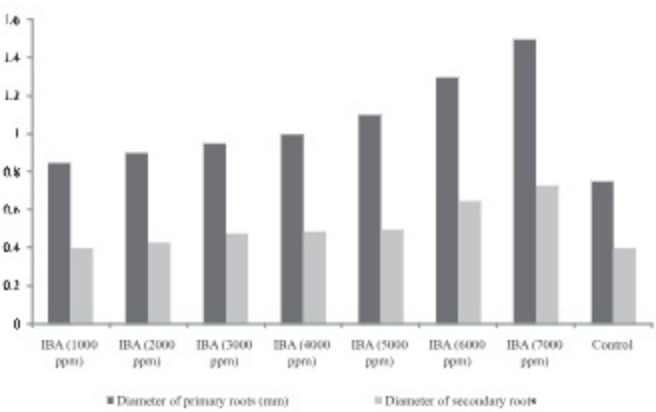

Fig.3: Diameter of roots under different concentration of IBA under hot semi-arid conditions.

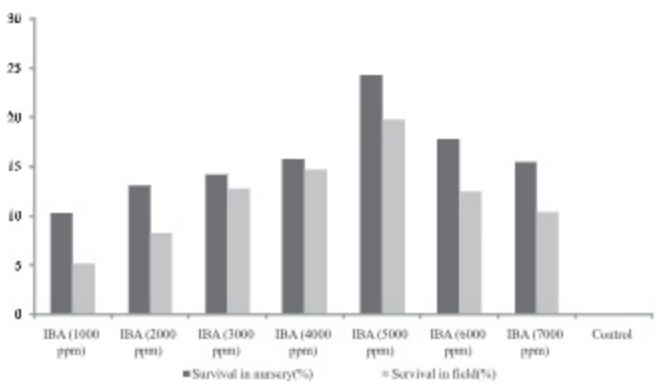

Fig.4: Survival per cent of stool layers under nursery and field condition

climatic conditions.

Based on the observation, it may be inferred from the study that the application of IBA is effective in inducing the rooting and promoting root characters in stool layers in bael. Among different concentration of IBA applied, application of IBA at 5000 ppm concentration proved to be most effective for rooting, root characters and survival in nursery and field conditions under hot semi-arid conditions of western India. However survival was very less under nursery and field conditions which reflect that the work on this aspect needs to be intensified for recommendation and commercial exploitation.

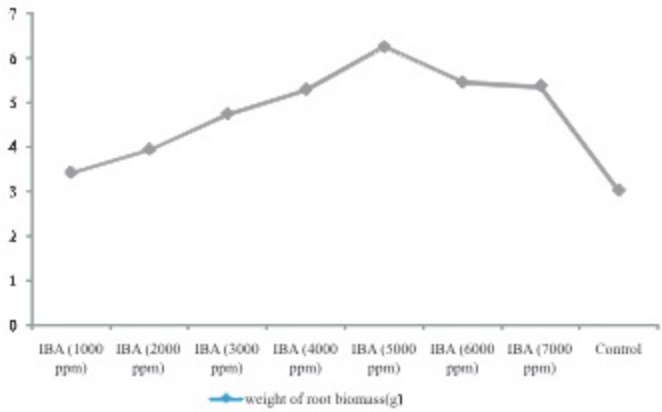

Fig. 5. Root biomass under different concentration of IBA in stool layers under hot semi arid conditions.

Fig. 6. Views of rooting behavior in different concentration of IBA in bael stool layers

References

Ahmad, M. F., Iqbal, U. and Khan, A.A. 2007. Response of different environments and dates of patch budding on success in walnut. *Indian J. Hort.,* 64: 286-89.

Bhagat, B. K., Jain B. P. Singh, C and Chaudhary B. M. 1999. Studies of guava (*Psidium guajava* L.) cv. Sardar by ground layering in polybags. *Orissa J. Hort.,* 27: 19-21.

Dutta, P. and Mitra, S. K. 1991. Effect of etiolationon stooling of guava (*Psidium guajava* L.). *Indian Agriculturist,* 35: 101-5.

Johns, L. and Stevenson, V. 1979.*The complete book of fruit.* Anqus and Roberson Publications.

Lal, S., Tiwari, J. P., Awasthi, P. and Singh, G. 2007. Effect of IBA and NAA on rooting potential of stooled shoots of guava (*Psidium guajava* L.)cv. Sardar. *Acta Hort.*, 735: 193-96.

Mishra, D., Lal, B. and Pandey, D. 2007. Clonal multiplication of *Psidium species* with moundlayering. *Acta Hort.,* 735: 339-42.

Rymbai, H. and Sathynarayan. 2010. Effect of IBA concentration of IBA on guava stooling and plant let survival under open and polyhouse conditions. *Indian Journal of Horticulture*, 67(special issue):443-446.

Saroj, P. L. and Pathak, R. K. 1998. Propagation of *Psidium* species through stooling. *Indian Journal of Horticulture*, 55(3):183-189.

Singh, A. K. 2018.Propagating arid fruit commercially. *Indian Horticulture,* 63 (5):82-88.

Singh, A. K., Singh, Sanjay, Singh, R. S., Contractor, K. and Makwana, P. 2014. *In-situ* patch budding for better establishment of bael in rainfed areas, *Indian Horticulture,* 59 (5)*:* 24-25.

Singh, D. K. 1998. Regeneration of guava (*Psidium guajava* L.) cultivars by stooling with the aid of Paclobutrazol. *Ann. Agric. Res.*, 19: 317-20.

Singh, G., Gupta, S., Mishra, R. and Singh, A. 2007. Technique for rapid multiplication of guava (*Psidium guajava* L.). *Acta Hort.,* 735: 177-83.

Tyagi, S. K. and Patel, R.M. 2004. Effect of growth regulators on rooting of air layering of guava (*Psidium guajava* L.) cv. Sardar. *The Orissa J. Hort.,* 32: 58-62.

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Effect of foliar application of manganese and ferrous on vegetative growth, fruit yield and quality of mandarin (*Citrus reticulata* Blanco) *cv.* Kinnow

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Abstract

A field experiment was conducted at Krishi Vigyan Kendra, Chittorgarh and Department of Horticulture, Rajasthan College of Agriculture, MPUAT, Udaipur during 2016-2017. The results revealed that all treatments (except T_1) significantly increased the vegetative growth, fruit yield and quality attributes. The maximum increase in shoot length (78.87 %), canopy area E-W (4.75 %), canopy area N-S (4.27 %), and tree height (9.49 %) recorded in treatment T_9 (1.0 % $MnSO_4$ + 1.0 % $FeSO_4$) over the treatment T_1(control). The maximum fruit diameter (7.96 cm & 6.37 cm), fruit weight (170.13 g), fruit retention (69.74 %), yield plant^{-1} (78.23 kg) was recorded in treatment T_8 (1.0 % $MnSO_4$ + 0.5 % $FeSO_4$) closely followed by treatment T_9 and minimum in treatment T_1(control). The maximum TSS (10.93 °B), TSS:Acid (14.39), ascorbic acid content (27.08 mg/100 g), juice content (41.05 %), and minimum acidity (0.76 %) was recorded in treatment T_8 (1.0 % $MnSO_4$ + 0.5 % $FeSO_4$) closely followed by treatment T_9compare to control.

Key words: Ferrous, foliar application, fruit yield, manganese, quality

Introduction

Mandarin (*Citrus reticulate* Blanco) is most common among citrus fruits grown in India. It is originated from South Eastern Asia (China). Major producing states of mandarin are Punjab, Madhya Pradesh, Andhra Pradesh, Maharashtra, Rajasthan, Assam, and Karnataka. It is grown widely in many districts of Rajasthan particularly in Jhalawar, Sriganganagar, Hanumangarh, Bhilwara, Chittorgarh, Kota and Baran (Anon. IHD, 2014).

Kinnow Mandarin is one of the most important and finest variety of mandarin grown especially in north India. It is the first generation hybrid of king mandarin (*C. nobilis* Lour) and willow leaf mandarin (*C. deliciosa* Tenora) (Sharma *et al.*, 2007). It has great importance among north Indian growers and a large acreage is being brought under its cultivation particularly in Punjab, Haryana, Rajasthan and Himachal Pradesh (Khurdiya and Lotha., 1994).Its pulp is used to make delicious desserts, jams and sauces and the skin can be used to make cosmetics and essence. It has lycopene and flavonoids, which are known to reduce prostate and breast cancer, viral affects and cholesterol level and improve capillary activity. It is rich in fiber, which is important for production and maintenance of collagen (Sharma *et al.*, 2007).

Productivity of citrus trees depends on many abiotic (climate, site, soil, nutrition, and irrigation management) and biotic (rootstock, cultivar, insect pest and disease management) factors. Among them, adequate supply of micronutrients is most important to produce good quality fruits (Babu and Yadav, 2005). Generally, farmers are not applying nutrients in balanced quantity, and therefore, some healthy orchards are turning into unproductive orchards with poor yield and poor quality of the produce. The fruit grower's mainly apply macro nutrients (N, P and K) in kinnow plants and give little attention towards micronutrients. High pH and calcareous soil hinders the availability of micronutrients applied through soil placement. Therefore, kinnow plants show micronutrient deficiency symptoms like interveinal chlorosis, reduced growth of young shoot and mottling of leaves (Sharma *et al.*, 1990). Keeping in view of the importance of kinnow mandarin, the study has been carried out to see the effect of micronutrients on its vegetative growth, fruit yield and quality.

Material and Methods

The experiment was carried out at Krishi Vigyan Kendra, Chittorgarh and Department of Horticulture, Rajasthan College of Agriculture, MPUAT, Udaipur during 2016-17. Eight year old, twenty seven uniform and healthy kinnow mandarin trees grafted on rough lemon (*Citrus jambhiri* L.) root stock planted according to square system of layout at 5 m x 5 m distance and grown under uniform soil conditions were selected. The experiment consisted of 9

treatments comprising T_1 - (water spray), T_2 - (0.5% Manganese sulphate), T_3 - (1.0% Manganese sulphate), T_4 - (0.5% Ferrous sulphate), T_5 - (1.0 % Ferrous sulphate), T_6 - (0.5 % $MnSO_4$ + 0.5 % $FeSO_4$), T_7 - (0.5 % $MnSO_4$ + 1.0 % $FeSO_4$), T_8 - (1.0 % $MnSO_4$ + 0.5 % $FeSO_4$), T_9- (1.0 % $MnSO_4$ + 1.0 % $FeSO_4$) applied at fruit set and pea size stage of fruits through foliar spray. These treatments were evaluated under RBD replicated thrice with adopting uniform cultural schedules during the experimentation.

The vegetative growth parameters like shoot length, canopy area, stem girth and tree height were observed before the application of treatment and after the application of treatment and expressed in percent increase. For shoot length, five newly emerged uniform sized shoots were randomly selected and tagged in each treatment and measured with the help of meter scale. Stem girth was measured on ½ feet upper portion from ground level with the help of meter scale and tree height was measured from the base of stem to first newly emerged leaf of the growing shoot with the help of meter scale and expressed in percent increase. The fruit diameter (equatorial and polar) was measured by the help of vernier caliper. Fruit weight was measured with the help of an electronic balance. The per cent fruit retention was calculated on the basis of initial number of fruit set and fruits harvested at maturity. The yield plant^{-1}was recorded on the basis of mature fruits were harvested periodically in each treatment separately and the weight was recorded with the help of electronic balance then the total yield (kg/plant) was calculated. The quality attributes such as TSS were determined by using a hand refractometer, acidity was determined by diluting the known volume of clean juice against standard N/10 sodium hydroxide solution using phenolphthalein as an indicator (A.O.A.C., 2007).TSS:Acid was calculated by dividing the value of total soluble solids content (%) by per cent acidity. Ascorbic acid was determined by diluting the known volume of clean juice and titrated against 2, 6-dichlorophenol indophenol dye solution.

Results and Discussion

Effect of manganese and ferrous on vegetative growth

The data on vegetative growth attributes such as

Table 1. Effect of manganese and ferrous on vegetative growth attributes of kinnow mandarin

Treatments	Shoot length (cm)		Canopy spread (m) E-W		Canopy spread (m) N-S		Stem girth (cm)		Tree height (m)	
	B.T.	A.T. (%)	B.T.	A.T. (%)	B.T.	A.T (%)	B.T.	A.T. (%)	B.T.	A.T. (%)
T_1	44.8	70.25 (56.80)	4.47	4.61 (3.24)	4.48	4.61 (2.99)	52.00	56.20 (8.12)	4.25	4.52 (6.51)
T_2	37.2	64.55 (73.52)	4.39	4.56 (4.00)	4.24	4.39 (3.72)	48.60	53.00 (9.25)	4.03	4.35 (8.13)
T_3	47.8	79.05 (66.31)	4.54	4.73 (4.27)	4.58	4.74 (3.58)	59.30	64.00 (7.92)	4.22	4.57 (8.34)
T_4	37.2	64.10 (72.31)	4.34	4.50 (3.77)	4.58	4.73 (3.42)	53.60	58.00 (8.20)	4.31	4.60 (6.93)
T_5	43.2	73.20 (69.44)	4.07	4.25 (4.49)	4.17	4.34 (4.14)	49.00	53.50 (9.31)	3.86	4.20 (8.96)
T_6	46.2	78.30 (69.48)	4.53	4.71 (4.01)	4.34	4.51 (4.07)	48.30	53.00 (9.73)	4.42	4.78 (8.21)
T_7	44.4	77.10 (73.64)	4.63	4.81 (4.08)	4.31	4.49 (4.22)	34.00	37.30 (9.83)	4.26	4.64 (9.01)
T_8	43.4	77.00 (77.41)	4.69	4.88 (4.24)	4.34	4.52 (4.26)	57.60	64.60 (8.68)	4.29	4.68 (9.20)
T_9	46.4	83.00 (78.87)	4.37	4.57 (4.75)	4.40	4.58 (4.27)	56.60	61.80 (9.18)	4.52	4.93 (9.49)
SEm±		1.86		0.10		0.09		0.47		0.20
CD (p=0.05)		5.58		0.31		0.28		NS		0.61

Table 2. Effect of manganese and ferrous on fruit yield attributes of kinnow mandarin

Treatments	Fruit diameter (cm)		Fruit weight (g)	Fruit retention (%)	Yield plant^{-1}(kg)
	Equatorial	Polar			
T_1	6.49	5.51	134.88	58.00	62.26
T_2	7.05	5.97	139.85	68.42	63.49
T_3	6.74	5.70	143.76	67.97	65.02
T_4	6.97	5.59	150.86	67.70	69.06
T_5	6.67	5.90	148.31	68.50	67.22
T_6	7.31	6.08	151.81	67.65	69.68
T_7	7.37	5.97	159.81	69.00	75.07
T_8	7.96	6.37	170.13	69.74	78.23
T_9	7.45	6.09	164.27	68.80	77.26
SEm±	0.18	0.16	5.14	1.64	2.65
CD (p=0.05)	0.54	0.48	15.41	4.91	7.93

shoot length (cm), canopy area (m), stem girth (cm) and tree height (m) were recorded and presented in Table 1. The highest increase in shoot length (78.87 %), canopy area E-W (4.75 %), canopy area N-S (4.27 %), and tree height (9.49 %) were recorded in treatment T_9 (1.0 % $MnSO_4$ + 1.0 % $FeSO_4$) over the treatment T_1(control). It might be due to that manganese and ferrous are major contributor to various biological systems including photosynthesis, respiration, and nitrogen assimilation. Further, involvement of Mn as activates decarboxylase, dehydrogenase and oxidase enzymes in plants which are important in photosynthesis, nitrogen metabolism and nitrogen assimilation. The greater production of photosynthesis increase the vegetative growth attributes of plant. Results are similar to those achieved by El-Saida (2001) in Washington navel orange, Ingle *et al.* (2002) in acid lime and Sarolia *et al*. (2007) in guava.

Effect of manganese and ferrous on fruit yield attributes

The Table 2 showed that maximum fruit diameter (7.96cm & 6.37 cm), fruit weight (170.13 g), fruit retention (69.74 %),yield plant^{-1} (78.23 kg), were recorded in treatment T_8 (1.0 % $MnSO_4$ + 0.5 % $FeSO_4$) closely followed by treatment T_9 over the treatment T_1(control). It might be due to that manganese is involved in photosynthesis, efficient use of N, protein metabolism and enzyme activation. Iron acts as a catalyst in oxidation/reduction reactions, involved in respiration, photosynthesis and the reduction of nitrate and sulfate. It is also a cofactor in many enzymes. These are leads to more fruit retention and yield. The present results were supported by the findings obtained by Ghosh and Besra (2000) revealed that zinc + boron + iron influenced highest fruit retention (78.6 %) and fruit plant^{-1} (205) in sweet orange cv. Mosambi. Mn is required in the process of photosynthesis (Mengel and Kirkby, 1987) and Fe plays a key role in several enzyme-systems, in which haeme or haemin is the prosthetic group (Khurshid *et al*., 2008).

Effect of manganese and ferrous on fruit quality

Table 3 revealed that maximumTSS (10.93 °B), TSS:Acid (14.39), ascorbic acid content (27.08 mg/100 g), juice content (41.05 %), and minimum acidity (0.76) was recorded in treatment T_8 (1.0 % $MnSO_4$ + 0.5 % $FeSO_4$) closely followed by treatment T_9 over the treatment T_1(control). The improvement in quality of fruit is might be due to the fact that nutrients directly play an important role in plant metabolism. Manganese activates decarboxylase, dehydrogenase and oxidase enzymes in plants which are important in photosynthesis, nitrogen metabolism and nitrogen assimilation. It is an essential element in respiration and involved in the destruction or oxidation of indole-3-acetic acid (Singh, 2014). The decrease in fruit acidity owing to the application of their treatments might be because of the acids that might have been quickly converted into sugars and its derivatives. The increase in juice percentage due to manganese and ferrous application can be attributed because it might have regulated the water relations in plants. The augmentation of ascorbic acid percentage of kinnow fruit might have been due to higher synthesis of nucleic acid, on account of maximum availability of plant metabolism. The findings of present study are in accordance with those of Ghosh and Besra (2000) in sweet orange cv. Mosambi, Monga and Josan (2000) in kinnow mandarin, Perveen and Haffez-ur-Rehman (2000) in sweet orange, Aboutalebi and Hassanzadeh (2013) in sweet lime and Kaur *et al.* (2015) in kinnow mandarin for various qualities attributes.

Table 3. Effect of manganese and ferrous on fruit quality of kinnow mandarin

Treatments	TSS (^{0}Brix)	Acidity (%)	TSS:Acid	Ascorbic acid (mg/100 g)	Juice content (%)
T_1	9.90	0.90	11.00	19.81	35.96
T_2	10.10	0.89	11.34	23.42	36.10
T_3	10.80	0.89	12.13	21.62	37.00
T_4	10.50	0.78	13.45	21.62	37.06
T_5	10.70	0.88	12.15	23.42	38.47
T_6	10.70	0.83	12.89	25.22	38.63
T_7	10.80	0.84	12.85	27.02	39.55
T_8	10.93	0.76	14.39	27.08	41.05
T_9	10.90	0.77	14.15	27.02	40.88
SEm±	0.20	0.01	0.14	0.35	0.60
CD (p=0.05)	0.60	0.04	0.43	1.06	1.81

References

A.OA.C. 2007. In: Official Methods of Analysis. Association of official Agricultural Chemicals. Benjamin Franklin Station, Washington, DC.

Aboutalebi, A. and Hassanzadeh, H. 2013. Effects of iron and zinc on sweet lime (*Citrus limmettoides*) fruit quantity and quality in calcareous soils. *International Journal of Farming and Allied Sciences*, 2(18): 675-677.

Anonymous. 2014. Indian horticulture data base, 2014. National Horticulture Board, Gurgaon, Haryana (India), pp. 4-5, 61-65.

Babu, K.D. and Yadav, D.S. 2005. Foliar spray of micronutrients for yield and quality improvement in Khasi mandarin (*Citrus reticulate* Blanco.). *Indian Journal of Horticulture*, 62(3): 280-281.

El-Saida, S.A.G. 2001. Effect of some growth regulators and zinc sulphate treatments on yield and quality of Washington Navel orange. *Annals of Agricultural Science,* 39: 1199-1212.

Ghosh, S.N. and Besra, K.C. 2000. Effect of zinc, boron and iron spray on yield and fruit quality of sweet orange *cv*. Mosambi grown under rainfed laterite soil. *Indian Agriculturist*, 44: 147-151.

Ingle, H.V., Kokate, S.S., Athwale, R.B. and Katole, S.R. 2002. Effect of foliar application of zinc and iron on growth, yield and quality of acid lime. *Indian Journal of Citriculture,* 1(1): 43-45.

Katyal, J.C. 2004. Role of micronutrients in ensuring optimum use of macronutrients. IFA International Symposium on Micronutrients, Feb. 23-25, New Delhi, India, pp: 3-17.

Kaur, N., Monga, P.K., Arora, P.K. and Kumar, K. 2015. Effect of micronutrients on leaf composition, fruit quality and yield of kinnow mandarin. *Journal of Applied and Natural Science*, 7(2): 639-643.

Kazi, S.S., Ismail, S. and Joshi, K.G. 2012. Effect of multi-micronutrient on yield and quality attributes of the sweet orange. *African Journal of Agricultural Research,* 7(29): 4118-4123.

Khurdiya, D.S and Lotha, R.E. 1994. Effect of juice extraction from Kinnow mandarin on the composition and quality of juice pomace and peel. *Journal of Food Science & Technology,* 71: 307-330.

Khurshid, F., Khattak, R.A. and Sarwar, S. 2008. Effect of foliar applied (Zn, Fe, Cu & Mn) in citrus production. *Science Technology & Development*, 27(1&2): 34-42.

Mengel, K. and Kirby, E.A. 1987. Principles of Plant Nutrition, pp: 453-461. International Potash Institute, Berns, Switzerland.

Monga, P.K. and Josan, J.S. 2000. Effect of micronutrients on leaf composition, fruit yield and quality of Kinnow mandarin. *Journal of Applied Horticulture,* 2(2):132-133.

Perveen, S. and Haffez-ur-Rehman. 2000. Effect of foliar application of zinc, manganese and boron in combination with urea on the yield of sweet orange. *Pakistan Journal of Agriculture Research*, 16(2): 135-141.

Sarolia, D.K., Rathore, N.S. and Rathore, R.S. 2007. Response of zinc sulphate and iron sulphate spray on growth and productivity of guava (*Psidium guajava* L.) *cv*. Sardar. *Current Agriculture,* 31(1/2): 73-77.

Sharma, K.K., Sharma, K.N. and Nayyar, V.K. 1990. The effect of copper and zinc sprays on leaf nutrient concentration in Kinnow mandarin (*Citrus reticulata* x *Citrus deliciosa*). *Indian Journal of Horticulture*, 60(4): 278-80.

Sharma, S., Singh, B., Rani, G., Zaidi, A.A., Hallan, V., Nagpal, A. and Virk, G.S. 2007. Production of Indian citrus ringspot virus free plants of Kinnowemploying chemotherapy coupled with shoot tip grafting. *Central European Agriculture Journal*, 8: 1-8.

Singh, B.P., Gupta, A.K. and Chundawat, B.S. 1978. Effect of various treatments on storage of Kinnow fruits. *Punjab Horticulture Journal,* 18(5): 61-65.

Singh, J. 2014. Basic Horticulture, pp. 170- 171, 173. Kalyani Publishers, New Delhi.

Sourour, M.M. 2000. Effect of foliar application of some micronutrient forms on growth, yield, fruit quality and leaf mineral composition of Valencia orange trees grown in North Sinai. *Alexandria Journal of Agricultural Research*, 45(1): 269-285.

Short Communication

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Khirni chuhara: A phytochemically rich nutritional substitute for tribal farmers

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The Khirni or Rayan botanically known as *Manilkara hexandra (Roxb.)Dubard* is an economically multipurpose tree of the family Sapotaceae. The tree is medium size, evergreen with spreading growth habit. It bears oval, sweet edible fruit with one or more seeds. It is commercially used as a rootstock for vegetative propagation of sapota in different parts of the country. The fruit is good source of iron, sugars, minerals, protein and carbohydrate etc. The plant can tolerate drought conditions if occurs for some time as well as heavy rainfall conditions. Hot semi- arid zone is characterized by the low annual rainfall (750 mm) and the rainy spells are confined to 3 wet months (July to September) and the remaining parts of the year are dry months. The rains are also erratic and often come in a few storms of short duration which results in great runoff without charging the soil moisture profile resulting into water stress in soil during major parts of the year. Arid and semi-arid regions have peculiar eco-climatological features in which several major agronomical crops fail to sustain. It is very hardy and thrives well on rocky and gravelly soils.

Panchmahal is a tribal populated district of the Gujarat. Climatologically it comes under semi-arid zone. This region is endowed with plenty of scattered khirni plants in nearby villages and on the fringes of the cultivable land. Fresh fruits produced in these areas are sold locally by the rural people at very cheap rate. Tribal people collect the fruits and it is sold to local traders @ Rs 20 to 30 per kg. Famers were not adopting any technology for value addition of fresh khirni fruits. KVK, Panchmahal observed these problems and organized training programme for value addition of khirni fruit with the collaboration of ICAR-C.H.E.S., Godhra.

A total of 6 genotypes were used for chemical analysis. The experiment was laid out in completely randomized design with 3 replications, observations on fruit quality attributes were observed and data were presented in the table. Fruits were randomly selected for fruit quality attributes. Total soluble solids, Vitamin C, total sugar and carotene were analyzed by the method by AOAC (1980). The mean data were statistically analyzed as per method given by Gomez and Gomez (1984). Ten farm women were trained as panelists to evaluate the product. Each farm women was asked to taste the coded samples and score each product for preference on a five -point scale, ranging from "most preferred" (preference score = 5) to the "least preferred" (preference score = 1). This process was repeated three times and the results were recorded for statistical analysis. The data statistically calculated as per method given by Snedecor and Cochran (1994).

For sun drying of fruits, the flow chart is as under:

Fresh ripened fruits sorting washing sun drying for one week (42 ° C) cleaning of dried latex from skin of fruits application of castor oil (50 ml/ kg fruits) storage in glass jar.

The fruit weight ranged from 3.21-4.40g and it was found to be highest in Thar Rituraj, followed by CHESK-11 and CHESK-13. Khirni fruits are rich source of total soluble solids, sugars, vitamin C and carotene and these values varied significantly in different genotypes. Total soluble solids and total sugar content of fruits ranged from 22.21 to 24.30^0 Brix and 15.90 to13.70 % respectively, in different genotypes.

The highest Total soluble solids (TSS) was recorded in Thar Rituraj (24.30^0 Brix) followed by CHESK-11 and CHESK-13. Maximum total sugar content was found in Thar Rituraj (15.90%), closely followed by CHESK-11 and CHESK-13. Vitamin C content was found to be highest in CHESK-13(32.26 mg/ 100g) closely followed by CHESK-14 (30.25) and Thar Rituraj (28.20 mg/ 100g), whereas CHESK-12 recorded the lowest (26.10 mg/ 100g). Ram and Singh (2003), Singh *et al.* (2010) and Singh and Singh, 2012 have also recorded the variation in fruit quality attributes in different *bael*, *chironji* and jamun genotypes. Carotene content varied from 4.90-5.90 mg/100g being highest in Thar Rituraj, closely followed by CHESK-13 and CHESK-12. The remarkable variability was observed in relation to fruit quality attributes of tamarind (Lata et al., 2018). Dried fruits after one year recorded 64.20^0 Brix T.S.S., 45.70 % total sugar and 1.30 % acidity.

The data presented in table 2 revealed that the overall highest grade (3.52) was given up to 4th month of storage by the panel, followed by 6 and 12 months after storage. For appearance, product got maximum score (3.50). The highest score (3.60) for texture of product was given after 2 and 4 months of storage. The preference mean scores for flavor of the product was noted to be maximum (3.40) up to 4th day of storage. The highest score (3.65) for the taste of the product was found on 2nd and 4th month of storage. The similar findings were also reported by Lingappa, *et al*. (1993), Shankaracharya (1998) and Ulrich (1970) in tamarind. The similar findings

also reported by Lata, *et al*. (2006 and 2018) in turmeric and tamarind. Khirni fruits are wildly available in western India including Panchmahal.

Tribals and other rural people consume the fruits during fruiting season for a short period of 20- 30 days. Fruits are full of antioxidants but due to its poor storability, spoilage loss is very high, hence efforts were made for its preservation. KVK Panchmahal tried to preserve the fruits through sun drying with castor oil polishing on the fruit. This is very cost effective and eco friendly technology. It may be used by the tribal, resource poor farmers and other farming community. It needs further popularization of this technology for precision use of this phytochemical rich fruit as a nutritional substitute in off season also. Further efforts may be made for development of small equipments for solar drying so that product may be refined and be expanded throughout the country

Table 1. Fruit quality attributes of Khirni (Fresh fruits).

Genotypes	Fruit weight (g)	TSS (Degree Brix)	Acidity (%)	Total sugar (%)	Vitami C (mg/100 g)	Carotene (mg/100 g)
Thar Rituraj	4.40	24.30	0.37	15.90	28.20	5.90
CHESK-11	4.30	23.40	0.36	15.60	27.10	5.58
CHESK-12	3.40	22.50	0.38	15.00	26.10	5.59
CHES K-13	3.52	23.10	0.33	15.20	32.26	5.80
CHESK-14	3.36	22.21	0.34	13.70	30.25	5.13
CHESK-15	3.21	22.96	0.29	13.98	27.12	4.90
CD(P=0.05)	0.11	1.10	0.10	0.42	0.53	0.31

Table 2. Preference mean scores for dried khirni chuhara

Product during storage	Appearance	Color	Texture	Flavor	Taste	Over all	Grading
After 2 months	3.50	3.50	3.60	3.40	3.65	3.52	I
After 4 months	3.50	3.50	3.60	3.40	3.65	3.52	I
After 6 months	3.40	3.40	3.50	3.30	3.60	3.44	II
After 8 months	3.40	3.40	3.50	3.30	3.50	3.40	II
After 10 months	3.30	3.40	3.50	3.30	3.40	3.38	III
After 12 months	3.30	3.40	3.50	3.30	3.40	3.38	III

References

A.O.A.C. 1980. *Official methods of Analysis*. Association of official Agricultural Chemists. 13th Edn.Washington, D.C.

Gomez K. A and Gomez A. A.1984. Statistical Procedure for Agricultural Research (2nd Edn.), John Wiley and Sons Inc., New York.

Lata, K., Ahmed, Z., Sinha, S.K., Singh, A.K. and Medhi, R.P. 2006. Ready to serve (RTS) recipes of raw turmeric: A study on its potential for employment generation. Proceedings of National workshop on Integrated development of spices organized at CARI, Port Blair pp. 77-79.

Lata, Kanak, Kumar, Raj and Singh Sanjay 2018. Value addition of tamarind: An option for livelihood of tribal people of Panchmahal. *Indian J. Arid Hort*., 13: 91-93.

Lingappa, K. Padshetty, N. S. and Choudhari, N.B. 1993. Tamarind vermouth- a new alcoholic beverage from tamarind. *Indian Fd. Packer*, 47 (1):23-26.

Ram D and Singh I S. 2003. Physico chemical studies on *bael* (*Aegle marmelos* Correa) fruits. *Progessive Hort.,* 35: 199-01.

Shankaracharya, N.B. 1998. tamarind Chemistry, technology and uses a critical appraisal. *Journal of food Technology*, 35 (3):193-208.

Snedecor, G.W. and Cochran, W. G. 1994. Statistical Method, 7th Edn. Oxford IBH Publishing Co., Calcutta, India.

Singh Sanjay, Singh A. K., Joshi H. K., Lata K, Sisodia P. S. and Bagle B. G. 2010. Floral biology studies in *Buchanania* under semi- arid ecosystem of western India. *Indian J. Hort.*, 67:161-68.

Short Communication

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Determination of maturity indices for harvesting of pomegranate cv. Bhagawa

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Pomegranate (*Punica granatum* L.) is an important fruit crop of arid and semi-arid regions of the world with immense medicinal and nutritional value (Pal and Babu, 2015). It's a diploid (2n=2x=16) perennial shrub from the family 'Lythraceae' (sub-family: Punicoideae). The versatile adaptability and built-in drought tolerance paves the way for its sustainability under marginal lands. It is believed to have originated from Iran and highly adapted to climatic conditions of India. In India, it is cultivated over 2.16 lakh ha with a production of 25.67 lakh tonnes/annum and a productivity of 11.56 t/ha during 2016-17 (NHB, 2017).In pomegranate, Bhagawa, Ruby, Arakta and Mridula are some of the popular cultivars of pomegranate which are commercially cultivated in different states of India (Jadhav and Sharma, 2007) and these cultivars vary in their maturity period depending on the prevailing climatic condition.Of late, Bhagawa has become the predominant cultivar occupying major area under cultivation as it has huge export demand due to its attractive red skin, red arils, seed mellowness, bold arils etc.

The maturity has been divided into two categories viz., physiological maturity and horticultural maturity. Physiological maturity is the stage when a fruit is capable of further development or ripening when it is harvested i.e. ready for eating or processing. Horticultural maturity refers to the stage of development when plant and plant part possesses the prerequisites for use by consumers for a particular purpose. i.e. ready for harvest.Determination of maturity indices help ensure sensory quality (flavor, colour, aroma and texture) and nutritional quality, ensure an adequate shelf life, facilitate scheduling harvest and packing operations besides facilitating marketing over the phone or through internet.

Fruits harvested too early may lack flavour and may not ripen properly. Being 'non-climacteric' crop, fruits of pomegranate should be harvested once they attain maturity in the plant itself (Pal and Babu, 2014). At the same time late harvesting should be avoided as it limits the market life of fruits and increases the incidence of physiological disorder, Internal breakdown. So, it is essential to harvest the fruits of pomegranate at right stage of maturity to ensure better quality and optimum market life of harvested fruits. Hence, an experiment was conducted with the objective of determining the maturity indices for harvesting of pomegranate cv. Bhagawa.

The experiment was undertaken at the Hiraj Experimental Farm of ICAR-National Research Centre on Pomegranate, Solapur during 2015-16 and 2016-17. The crop regulation was done during mrigbahar by withholding the water during January- February months. Standard practices of bahar treatment viz., pruning, defoliation, manuring, etc were followed. The flowers were tagged during anthesis and fruit samples were drawn after fruitset at 15 days interval for physico-chemical analysis. During the fag end of maturity, the fruit samples were drawn at narrow interval of 3-5 days period so as to fix up the appropriate maturity indices under Solapur conditions.

Fruit weight was recorded using the electronic weighing scale. Fruit length and diameter, aril length and aril diameter were recorded using digital Vernier caliper. 100 aril weight was recorded using precision electronic balance. Total soluble solids content (TSS) was measured using Digital Refractometer (Atago, Japan Make) by placing a drop of juice on the prism which indicate how much a light beam will be slowed down when it passes through the fruit juice and recorded as °Brix. The tritrable acidity was determined through titration against 0.1N NaOH using phenolphthalein indicator (Ranganna, 1978). Brix-acid ratio was determined by dividing the TSS with Titrable acidity. The statistical analysis was carried out by following the standard procedure (Panse and Sukhatme, 1985).

A perusal of data given in Table 1 reveals that fruit weight ranged from 24.87 to 286.60g/ fruit. The increase in fruit weight was significant from 15 days after full bloom to 180 days after full bloom (313.33g). Beyond 180 days, there was no significant difference in the increase in fruit weight. This is in corroboration with the findings of Babu *et al*. (2014). Fruit length was found to range from 34.89 mm to 81.56mm during the different stages of fruit growth and development. The fruit length kept on increasing from 15 Days after full bloom (DAFB) (34.89mm) to 180 DAFB (81.56mm). The fruit length was maximum on 180 DAFB (81.56mm) and it remained constant afterwards. Similarly, the fruit diameter also had an upward trend and it recorded 82.59mm on 180DAFB. Similar results were also reported by Godara *et al*. (1989)

100 aril weight is an important trait in determining the aril size (boldness of arils). The 100 aril weight increased from 3.99g on 15 DAFB to 34.03g on 180 DAFB. The 100 aril weight increased significantly from 15 DAFB to 180 DAFB.

Beyond 180 days, there was a slight decrease in the 100 aril weight.

100 aril juice volume was about 1.30 ml on 15 DAFB. It increased significantly with the advancement of growth and development of fruits. On 180 DAFB, the juice recovery from 100 arils was about 23.00ml.

Aril length was found to increase from 15 DAFB to 180 DAFB. On 15 DAFB, it was 6.11mm, whereas it was 10.29mm on 180 DAFB. Similarly, aril width was also increasing from 15 DAFB (3.17mm) to 180 DAFB (6.48mm). This is in line with the findings of Mir et al., (2007) who also studied different physic-chemical properties of pomegranate.

Total soluble solids (TSS) content ranged from 8.22 to 15.95°B during the fruit growth and development period (Fig.1). On 15 DAFB, the TSS was minimum (8.22°B) and it attained the maximum on 180 DAFB (15.95°B). There was a significant increase in the TSS content of juice from 15 DAFB to 180 DAFB. Similar findings were also reported by Mir *et al*. (2012).

The titrable acidity content ranged from 0.64 to 0.50% during the fruit growth and development period (Fig. 2). On 15 DAFB, the TSS was highest (0.64%) and it attained the lowest level on 180 DAFB (0.50%). There was a significant decrease in the TSS content of juice from 15 DAFB to 180 DAFB which followed a downward trend. This is in line with the findings of Mir *et al.* (2007) and Babu *et al.* (2014).

The sugar acid or TSS acid ratio is often better related to palatability of fruit than either sugar or acid level alone. The brix acid ratio was ranging from 12.84 to 33.90 during the period of fruit growth and development. On 15 DAFB, it was 12.84, which showed a significant increase upto 180 DAFB (32.96). Beyond 180 days, this showed a slight decline (32.60)

Table 1. Determination of maturity indices for pomegranate variety Bhagawa

Sampling period (Days after full bloom)	Fruit weight (g)	Fruit length (mm)	Fruit dia (mm)	100 aril weight (g)	100 aril juice volume (ml)	Aril length (mm)	Aril width (mm)
15	24.87	34.89	33.52	3.99	1.30	6.11	3.17
30	43.31	52.34	50.28	5.99	1.95	6.16	4.10
45	76.81	56.57	52.66	10.56	3.67	7.52	4.76
60	120.58	64.64	65.19	16.81	9.17	8.36	5.46
75	156.48	68.11	67.04	18.52	12.00	8.79	5.79
90	187.77	69.50	68.71	20.65	13.50	9.05	6.06
105	213.05	71.72	70.90	22.12	15.00	9.52	6.18
120	234.42	73.70	72.86	24.58	16.33	9.80	6.26
135	255.70	75.12	74.86	28.42	18.83	10.01	6.38
150	268.64	78.11	77.05	31.67	20.00	10.17	6.40
165	279.06	79.08	79.75	32.83	21.60	10.25	6.42
180	285.33	81.50	82.54	34.03	23.00	10.29	6.48
185	286.60	81.56	82.59	34.01	22.80	10.29	6.48
CD(p=0.05)	10.08	3.76	1.02	0.54	0.78	0.24	0.13

From the above it can be concluded that the maturity indices for harvesting the fruits of pomegranate variety Bhagawa under Solapur conditions of Maharashtra is as detailed below:

S.No	Characteristics	Maturity index
1	Days after full bloom	180 days
2	100 aril weight	34.03 g
3	TSS	15.95°B
4	Titrable acidity	0.50%
5	TSS/acid ratio	33.90

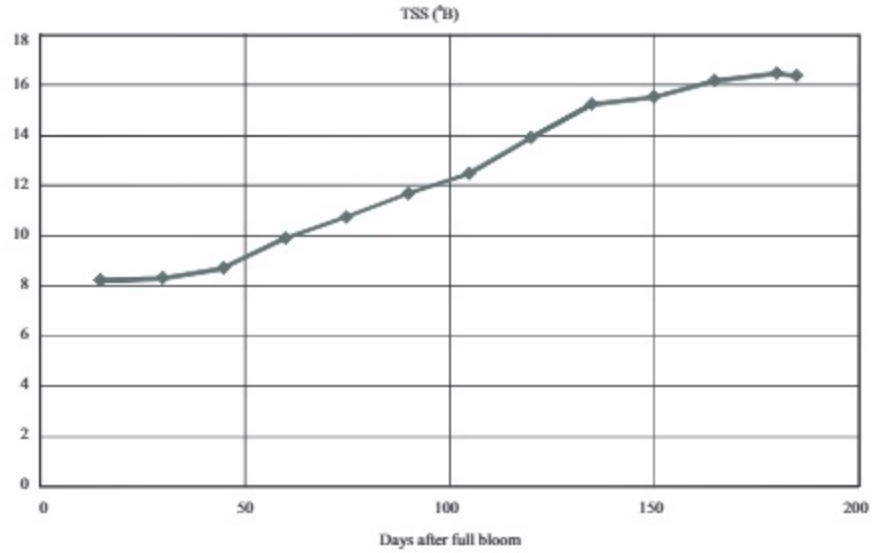

Fig. 1: Total soluble solids content of pomegranate cv. Bhagawa

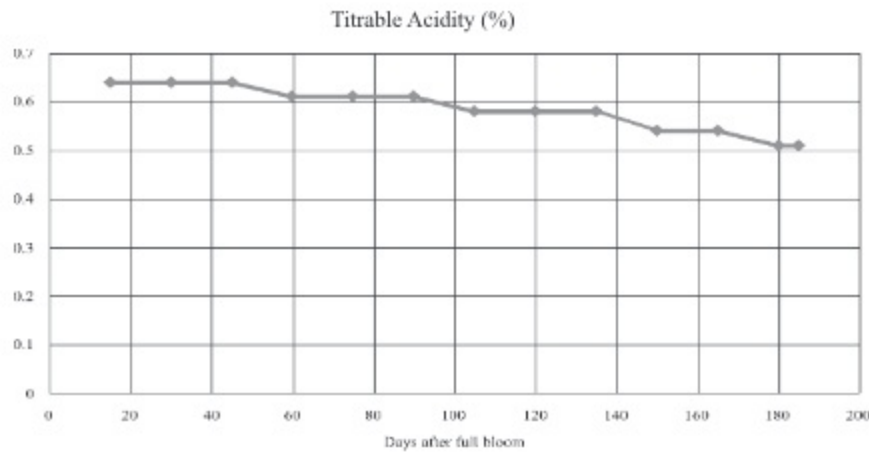

Fig. 2 : Titrable acidity of pomegranate cv. Bhagawa

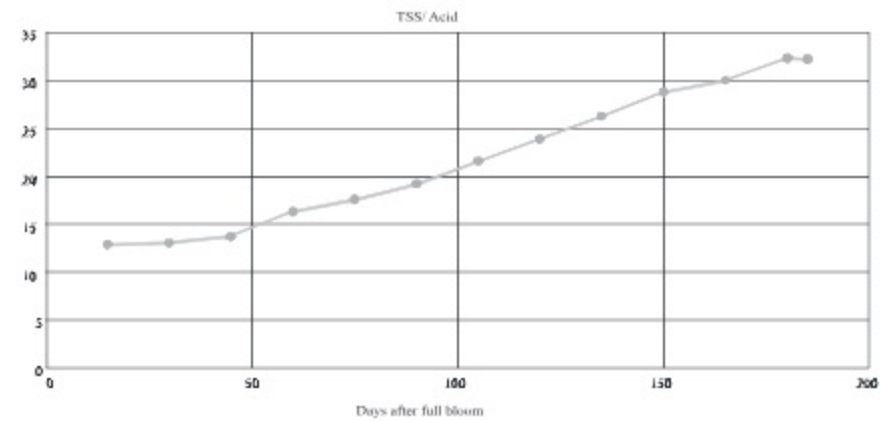

Fig. 3 : TSS/Acid ratio of pomegranate cv. Bhagawa

References

Babu, K.D., Gaikwad, N., Singh, N.V., Maity, A., Suryawanshi, S.K., Pal, R.K. and Chandra, R. 2014. Determination of maturity indices for harvesting of pomegranate cv. Bhagawa. In : Souvenir National seminar-cum-exhibition on Pomegranate for nutrition, livelihood security and entrepreneurship development, December 05-07, 2014. ICAR-NRC on Pomegranate, Solapur, pp.284.

Godara, P.K., Godara, N.R. Jitender, K., Surinder, K.,. Kumar, J. And Kumar, S. 1989. Quality assessment of pomegranate cultivars. *Res. Dev. Reporter*, 6 : 76-80

Jadhav, V.T. and Sharma, J. 2007. Pomegranate cultivation is promising. *Indian Horticulture,* Pp. 30-31.

Mir, MM, Sofi, AA, Ahmad, I and Beigh, MA. 2007. Performance of pomegranate cultivars under Karewa belts of Kashmir velley. *SKUAST. J. Res*., 9:104-108.

Mir, MM, Umar, I, Mi SA, Rehman, MU, Rather, GH and Banday, SA. 2012. Quality evaluation of pomegranate crop A review. *International Journal of Agriculture and Biology,* 14 (4): 658-667

NHB. 2017. Indian Horticulture Database, National Horticulture Board, Gurgaon.

Pal, R.K. and Babu, K.D. 2014. Postharvest management and total utilization of pomegranate (*Punicagranatum* L.).In : Souvenir National seminar-cum-exhibition on Pomegranate for nutrition, livelihood security and entrepreneurship development, December 05-07, 2014. ICAR-NRC on Pomegranate, Solapur pp.252-261.

Pal, R.K. and Babu, K.D. 2015. Pomegranate. In: Managing postharvest quality and losses in horticultural crops.(Chadha, K.L. and Pal, R.K. Eds.) Daya Publishing House, New Delhi, pp.517-533.

Panse, V.G. and Sukhatme, P.V. 1985. Statistical methods for agricultural workers. ICAR, New Delhi.

Ranganna, S. 1986. Handbook of analysis and quality control for fruit and vegetable products. Second Edition. McGraw Hill Education (India) Pvt Ltd., New Delhi.

Short Communication

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Influence of weather parameter on the seasonal incidence of major sucking insect pests of okra during *Kharif* season

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Okra [*Abelmoschus esculentus* (L.) Moench] commonly known as Bhendi or lady's finger, belongs to family Malvaceae is an important vegetable crop grown in India. Besides India, it is grown in many tropical and subtropical parts of the world. Tender fruits of okra are used as vegetables or in culinary preparations as sliced and dried pieces. It is also used for thickening gravies and soups, because of its high mucilage content. The roots and stems of okra are used for cleaning cane juice (Chauhan, 1972). It is the best source of iodine and calcium and also good source of proteins, vitamins, minerals, carbohydrates, iron, potassium and acids *viz*., rhamnose (22%), galacturonic acid (27%) and amino acid (11%). In India, the crop occupies an area of 511 thousand hectares with annual production of 6219 thousand metric tonnes. In Rajasthan, it is grown in 3.40 thousand hectares with an annual production 10.50 thousand metric tonnes and productivity of 3090 kg ha^{-1} (Anonymous, 2018).

As many as 72 species of insect-pests have been recorded to infest this crop (Rao and Rajendran, 2003). The sucking pests cause significant damage to the crop. Among these leafhopper and whitefly are more serious (Atwal, 1994) and transmit certain viral diseases. Moreover, they cause a great damage by sucking the plant sap. Pests cause 35 to 40 per cent crop yield losses and ultimately increase the level of damage up to 60 to 70 per cent in optimal conditions (Salim, 1999).The leafhopper, *Amrasca biguttula biguttula* (Ishida) sucks the cell sap from lower surface of the leaves and injects toxic substance in it, resulting in yellowing and curling of leaf margins and stunted plant growth. The severe infestation causes burning of leaves which fall down later and results 40 to 60 per cent decrease in yield (Narke and Suryawanshi, 1987).The whitefly, *Bemisia tabaci* (Genn.) also sucks the cell sap from the leaves which lowered vitality of the plants. It excretes honeydew on which sooty mould develops, which interferes with the process of normal photosynthesis. Consequently, the growth of plant is adversely affected. This insect transmits viral diseases and acts as vector of 'yellow vein mosaic' virus in the plants (Nath *et al,* 1992).The prevalence and build up of these pests in mostly governed by weather parameters like temperature, relative humidity and rainfall. For effective management of sucking pest, study on the influence of the various factors responsible for population fluctuation on a crop might assist in prediction of its occurrence in a given area. Thus the knowledge of the influence of weather parameter on sucking pest will have to develop a forecasting system and to implement timely plant protection measures. Therefore, the present investigation was undertaken on incidence of major sucking insect pests of okra.

Field experiment was conducted on incidence of major sucking insect pests of okra during *Kharif* 2018 at Horticulture farm of S.K.N. College of Agriculture, Jobner (Rajasthan). The seeds of okra crop were sown at the rate of 10 kg ha^{-1} in all experimental plots. Before sowing seeds were treated with Thiram @ 2.0 g kg^{-1} seed. Okra variety, Arka Anamika was sown in five plots of 2.25 x 1.8 m^2 size keeping row to row and plant to plant distance of 45 cm and 30 cm, respectively. The crop was raised under normal recommended of practices and left for natural infestation of desired pest. No plant protection measures were taken throughout the crop season.The population of insect pests and natural enemies were recorded at weekly interval right form their appearance to last picking of fruits of the crop. The population of sucking insect pests, *viz*., leafhopper and whitefly were recorded in early morning hours by visually counting (absolute counting). For this, five plants were randomly selected and tagged in each plot. The population of leafhopper, *Amrasca biguttula biguttula* (Ishida) was recorded by counting both nymphs and adults as per method described by (Rai and Satpathy, 1999). Counting of the leafhopper was done on three leaves, *i.e.* top, middle and bottom of each tagged plant.The population of Whitefly, *Bemisia tabaci (Genn.)* were recorded by counting both nymphs and adults visually on three leaves selected from the top, middle and bottom of each tagged plant. For counting the whitefly population, the leaf was held at the petiole by thumb and fore finger and thumbed until the entire underside of leaf was clearly visible. With the help of magnifying lens, the whitefly present on the lower side of leaf was counted. The weather parameters, *viz*., weekly maximum and minimum temperatures, relative humidity and rainfall in different standard weeks during the crop season were recorded at meteorological observatory, Department of Agronomy, S.K.N. College of agriculture, Jobner. The relationship between leafhopper and whitefly with weather parameter were worked out.

The data presented in Table 1 and Fig. 1, revealed that the infestation of leafhopper commenced from 23rd July (3.60 leafhoppers/ three leaves). The population gradually increased and reached to peak (28.60 leafhoppers/ three leaves), in the

10th September (37th SMW) when the maximum temperature, minimum temperature, relative humidity and rainfall was 30.0°C, 21.0°C, 74.0 per cent and 1.6 mm, respectively. A gradual decline in the pest population was evident thereafter. The present findings are collaborates with that of Kumawat *et al*. (2000) and Khating *et al*. (2016) who reported that the population of leafhopper commenced from the fourth week of July and reached to maximum in second week of September. The findings are partially collaborate with Mohanasundaram *et al*. (2011) and Davada *et al*. (2016) who reported that the population of leafhopper commenced from the second week of July and reached to maximum in first week of September. The correlation studies indicated that the infestation of leafhopper on okra crop showed significant positive correlation with relative humidity (r = 0.583) and significant negative correlation with maximum temperature (r = -0.681) while, non-significant correlation with minimum temperature (r = 0.139) and rainfall (r = 0.205). The present findings are conformating with that of Davada *et al*. (2016), Nagar *et al*. (2017), Nimbalkar *et al*. (2017) and Siddartha *et al*. (2017) who reported that the population of *A. biguttula biguttula* showed positive significant correlation with relative humidity. Further, Khating *et al*. (2016) and Nagar *et al*. (2017) reported that the population of leafhopper showed non-significant correlation with minimum temperature and rainfall which also corroborates with the present findings.

The data revealed that the whitefly population was also initiated from fourth week of July (30th SMW). The first observation, recorded on 23rd July the population of whitefly was low (3.40 whiteflies/ three leaves). The population gradually increased and reached to the peak (27.00 whiteflies/ three leaves) on 10th September (37th SMW). A gradual decline in the pest population was seen thereafter *i.e.* 3.80 whiteflies per three leaves in last observation *i.e.* on 1st October (40th SMW) and observed in traces thereafter. The present findings are corroborates with that of Khating *et al*. (2016) who reported that the population of whitefly commenced from the fourth week of July and its population reached to maximum in second week of September. The findings are partially collaborate with Kumawat *et al*. (2000) who reported that the population of whitefly commenced from the fourth week of July and reached to maximum in fourth week of September. The correlation studies indicated that the infestation of whitefly on okra crop showed significant positive correlation with relative humidity (r = 0.568) and significant negative correlation with maximum temperature (r = -0.682) while, non-significant correlation with minimum temperature (r = 0.125) and rainfall (r = 0.215). The present findings are conformating with that of Nagar *et al*. (2017) and Potai *et al*. (2018) reported that the population of *B. tabaci* showed positive significant correlation with relative humidity. Further, Pachori *et al*. (2016), Pandey and Koshta (2017) and Patel *et*

Table 1. Seasonal incidence of major sucking insect pests of okra in relation to abiotic factors

S. No.	Date of observation	Standard Meteorological Week (SMW)	Temperature (^{0}C)		Average relative humidity (%)	Total Rainfall (mm)	Mean population	
			Maximum	Minimum			Leafhoppers / 3 leaves	Whiteflies / 3 leaves
1	23.07.2018	30	31.4	24.0	79	39.8	3.60	3.40
2	30.07.2018	31	34.0	24.2	62	0.00	5.00	5.80
3	06.08.2018	32	32.8	24.9	77	13.6	12.40	11.00
4	13.08.2018	33	34.4	24.7	72	14.6	15.20	14.20
5	20.08.2018	34	31.2	23.8	80	48.4	18.60	18.40
6	27.08.2018	35	31.5	24.0	77	34.0	22.80	21.60
7	03.09.2018	36	30.5	22.9	81	33.0	25.20	24.20
8	10.09.2018	37	30.0	21.0	74	01.6	28.60	27.00
9	17.09.2018	38	34.2	20.2	63	00.0	14.40	13.20
10	24.09.2018	39	32.8	19.1	64	19.8	8.00	8.20
11	01.10.2018	40	36.7	18.9	51	00.0	3.20	3.80
Correlation Coefficient with Leafhopper			-0.681*	0.139NS	0.583*	0.205NS	-	-
Correlation Coefficient with Whitefly			-0.682*	0.125NS	0.568*	0.215NS	-	-

* Significant at 5% level of significance NS= Non-significant

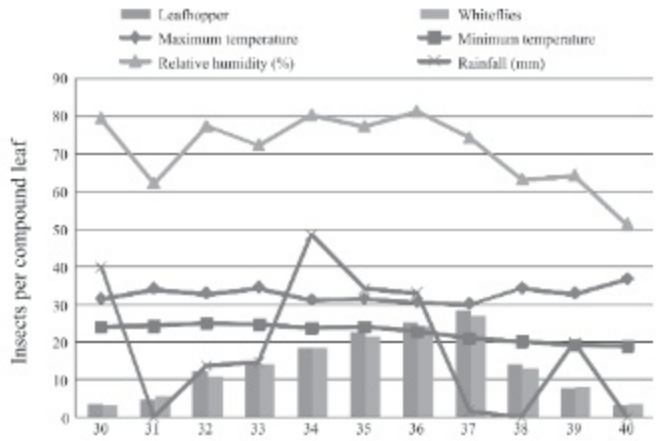

Fig. 1: Seasonal incidence of major sucking insect pests of okra in relation to abiotic factors

al. (2018) reported that the population of whitefly showed non-significant correlation with minimum temperature and rainfall which also support with the present findings.

References

Anonymous 2018. Okra: Area under cultivation. National Horticulture Board.

Chauhan, DVS. 1972. *Vegetable production in* India. 3rd Ed., Pub. Ram Prasad and Sons, Agra.

Davada, A.Y., Vekaria, M.V., Dodia, D.A., Patel, R.K. and Rabari, P.H. 2016. Seasonal incidence of leafhopper in okra under North Gujarat conditions. *AGRES-An International e-journal,* 5 (3): 320-324.

Khating, S.S., Kante, G.B. and Dhainje, A.A. 2016. Seasonal incidence of sucking pests of okra along with natural enemies in Khandesh region of Maharashtra. *Asian Journal of Bioscience,* 11 (2): 269-272.

Kumawat, R.L., Pareek, B.L. and Meena, B.L. 2000. Seasonal incidence of leafhopper and whitefly on okra and their correlation with abiotic factors. *Annals of Biology,* 16 (2): 167-169.

Mohanasundaram, A. and Sharma, R.K. 2011. Abundance of pest complex of okra in relation to abiotic and biotic factors. *Annals of Plant Protection Sciences,* 19 (2): 288-290.

Nagar, J., Khinchi, S.K., Naga, B.L., Sharma, S.L., Hussain, A. and Sharma, A. 2017. Effect of abiotic factors on incidence of sucking insect pests and their major natural enemies of okra. *Journal of Entomology and Zoology Studies,* 5 (3): 887-890.

Narke, C.G. and Suryawanshi, D.S. 1987. Chemical control of major pests of okra. *Pesticides*, 21 (1): 37-42.

Nath, V. and Sinha, S.R. 1992. IPM in okra through neonicotinoids insecticides and their mixtures. *Annals of Plant Protection Sciences,* 19 (1): 33-36.

Nimbalkar, N.A., Bade, B.A., Kadam, M.B. and Lad, D.B. 2017. Effect of abiotic factors on incidence of leafhoppers and bioefficacy of some newer insecticides and biopesticides against leafhoppers on okra. *International Journal of Pure and Applied Bioscience,* 5 (3): 1044-1049.

Pachori, R., Rajesh, A., Sharma, A.K., Thakur, A.S. and Mandloi, R. 2016. Impact of weather factors on the incidence of major insect pests of okra. *International Journal of* Agricultural Sciences, 8 (3): 981-983.

Pandey, S.A., and Koshta, V.K. 2017. Effect of the abiotic factors on major insect pests in okra, Abelmoschus esculentus. *International Journal of Chemical Sciences,* 5 (3): 540-544.

Patel, G.P., Tayde, A.R., Gupta, K. and Navneet. 2018. Population dynamics of leafhopper and whitefly on okra. International Journal of Chemical Studies, 6 (3): 2063-2066.

Potai, A. and Chandrakar, G. 2018. Studies on the seasonal incidence of major insect pests and its natural enemies on okra and their correlation with weather parameters. *International Journal of Current Microbiology and Applied Sciences,* 6: 204-210.

Rai, S. and Satpathy, S. 1999. Influence of sowing date and insecticides on the incidence of leafhopper and fruit borer on okra. *Vegetable Science*, 26 (1): 74-77.

Rao, N.S. and Rajendran, R. 2003. Joint action potential of neem with other plant extracts against the leafhopper, *Amrasca devastans* (Distant) on okra. *Pest Management and Economic Zoology*, 10 (2): 131-136.

Salim, M. 1999. Diversity: role in integrated pest management. *Science, Technology and Development*, 18: 26-31.

Siddartha, D., Kotikal, Y.K., Venkateshalu and Durdundi, S. 2017. Seasonal incidence of sucking pests of okra. *Global Journal of Bioscience and Biotechnology,* 6 (2): 245-250.

Short Communication

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Morinda (Noni) fruits: Nutritional substitute in poultry production

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Backyard poultry farming is considered to be a profitable complementary enterprise in agriculture and constitutes an important activity for accelerating the tribal economy. Feed supplements in poultry production has significant role to improve the productivity of chicks. Now a day the food safety and security is more seriously considered than before. The medicinal plants and herbs have been used for many years in the treatment of various diseases in animals and human beings. The use of medicinal plants extracts in poultry for growth and immunity has been reported by many workers (Narimani-Rad *et al.*, 2011; Javed *et al.*, 2009). Now-a-days, medicinal plants extracts are used in animal feed as growth promoters. Due to prohibition of most of the antimicrobial feed additives in animal/ poultry feed and also due to their residual effects in animals/ poultry, plant extracts are becoming more popular. These feed additives act as antibacterial, antioxidant, anticarcinogenic, antifungal, analgesic, insecticidal, anticoccidial and growth promoters and these plant extracts compete with the synthetic drugs. Morinda commonly known as noni has a rich history in Ayurveda and grows widely throughout the coastal regions of many countries. Its fruit and leaves have been consumed as traditional foods in some area of Southeast Asia and in the Pacific islands. Reports suggested that the fruit has been used as a feed supplement for livestock and poultry (Sunder *et al.*, 2011). Mroinda commonly known as Noni, has been used for treatment of various kinds of illnesses and as a growth tonic in human being (Bruggnecate, 1992; Solomon, 1999). Morinda is a minor forest produce, it belongs to Rubiaceae family its Sanskrit name is 'Ayushka' means longevity. Phytodiversity in morinda is quite wide spread over species in the genus Morinda, Intra-species variation is also large. The species found in Gujarat especially in Panchmahal district is *Morinda tomentosa* locally known as 'Aledi'. It is found naturally growing in forest areas on the field's bund, road side and waste land mostly in Jambughoda, Halol, Kalol, Ghogamba, and Godhra Talukas of Panchmahal district. These talukas are tribal dominated. As tribal people depend on their surrounded natural resources for their day to day requirement like food, feed, fodder, fuel fiber, fragrant and phytomedicine. They use almost all parts of Morinda for different purposes viz. root paste is applied for antidote against venom of poisonous insects, its decoction is used to cure chronic skin diseases, leaves are used with worm oil for control of swelling and muscular pain, leaves ash is also made into paste in oil base and applied on wounds and boil, seeds are used as poultice. Its bark and wood are used to make yellow color. Kite festival is one of the very famous festivals of Gujarat among all communities. Most of the tribal people used Morinda barks to dye the kite thread. Its timber is used for making poles and pillars and handles of farm implements because of strong and light weight. Its fragrant and beautiful flowers are offered to God and used to decorate the houses. Villagers of these areas eat ripened Morinda (Aledi) fruits. In view of importance of Morinda (Noni), the study was conducted to find out the effect of Morinda (Noni) dried fruits powder as feed supplementations on growth and health performance of poultry chicks under backyard system of rearing.

An experiment was conducted at KVK, Panchmahals under the semi- arid condition of Gujarat, India, to assess the effect of Noni fruit (Morinda) supplementation on growth of poultry chicken under backyard rearing system. Forty Pratap Dhan chicken chicks of two week of age were randomly distributed equally in two groups i.e. Chicks of T1 (Control group) were maintained under backyard with basal diet and T2 (Morinda feed supplementation group) Chicks were maintained under backyard with basal diet plus 2 percent dried morinda fruit powder. Commercial maize-rice based standard poultry feed were used as basal ration. The herbal based feed supplementation was prepared by using dried ripped morinda fruit powder and mixed with commercial poultry feed. The birds were fed *ad libitum* and provided with plentiful clean drinking water. No medication and deworming were given throughout the experiment. The given flocks are being monitored by the KVK personals for proper maintenance of health of birds. The birds were reared under back yard management system throughout the entire periods of study. Individual body weight was recorded at two week intervals. The data pertaining to various parameters were calculated and analyzed as advocated by Sendecor and Cochran, 1994.

The data regarding mean body weight of poultry chicken at 2 to 20 weeks of age are presented in Table 1. It is evident from the results that feeding of dry ripened fruit powder of *Morinda tomentosa* with basal diet was found very effective to enhance the body weight and reduced the mortality. It is due to the higher nutritive value of Noni fruit and developed the immunity against the common diseases of the poultry chicks. It was observed that the body weight of 4

weeks old chicks was found to be 261.77 ± 6.39g in the *Morinda* fed group while it was recorded 252.41 ± 7.44g under control group. At the age of 20 weeks, the body weight of poultry chicks was recorded 1756.19 ±56.37and 1416.32 ± 0.028g in group T1and group T2, respectively. The body weight in group T2 was higher as compared to control group. The average age at first egg laying in Pratap Dhan chickens under morinda supplementation and control group was recorded 151.49±1.10 and 167.36±2.13 days, respectively. It seems that Morinda fruits are very effective in terms of anti oxidants and nutrients (vitamins, mineral and other nutrition's) Sodhi, 2011 reported that noni fruits contained 150 nutraceuticals and other medical activities constitutes including enzymes, alkaloids, phyto nutrients, minerals and vitamins which might have been responsible for enhancing the body weight of poultry chicks.

Observations were also recorded on the percentage of mortality rate during the course of the study. The mortality in chicken during the period from 6 to 20 weeks and 21 to 40 weeks of age was recorded 12.60 and 5.32 and 7.33 and 2.71 per cent, respectively. However, there was no mortality after 40 weeks of age. it may be due to the development of immunity power in the body of chicks. An immune modulatory polysaccharide rich substance from the fruit juice of Morinda has also been reported by Hirazummi and Fuussasawa (1999). Lata *et al*., (2009) also reported that dry fruits powder of *Morinda citrifolia* were very effective for production, reproduction and health of poultry.

It may be concluded that feeding of 2 percent dried morinda fruit powder with basal diet was very effective to enhance the body weight and to develop the immunity against the common diseases of poultry chicks. Birds are healthy and more productive with feeding dried *Morinda* fruits powder and people readily accepted this new intervention because *Morinda* is well known plants and easily accessable.

Table 1: Effect of Noni fruit supplement on performance of poultry chicks.

Parameters	Group I (control)	Group II (NFS*)
	Overall	Overall
2 week body weight (g)	156^{a}±21	150^{a}±0.17
4 week body weight (g)	252.41^{a}±7.44	261.77^{a}±6.39
6 week body weight (g)	344.31^{a}±7.84	385.37^{b}±8.87
8 week body weight (g)	462.48^{a}±10.02	614.12^{b}±8.57
10 week body weight (g)	625.45^{a}±22.68	779.61^{b}±16.48
12 week body weight (g)	882.35^{a}±17.13	1060.57^{b}±19.24
14 week body weight (g)	928.13^{a}±0.02	1185.55^{b}±26.42
16 week body weight (g)	1136.34^{a}±0.11	1396.78^{b}±46.56
18 week body weight (g)	1323.39^{a}±0.03	1562.85^{b}±50.61
20 week body weight (g)	1416.32^{a}±0.028	1756.19^{b}±56.37
Age at first egg laying (days)	167.36±2.13	151.49±1.10
Per cent mortality from 6 to 20 week of age	12.60	5.32
Per cent mortality from 21 to 40 week of age	7.33	2.71

Figures with different superscript in raw differ significantly $P < 0.05$, * Noni Fruit supplementation

Table 2. Effect of Noni fruit supplement on egg production and egg quality parameters of chicken

Parameters	Group I Mean ± SE	Group II (NFS*) Mean ± SE
40 weeks egg production	43.67^{a}±0.51	52.33^{b}±0.55
Egg weight at 28 weeks of age (g)	42.46^{a}±0.39	48.62^{b}±0.46
Egg weight at 40 weeks of age(g)	50.23^{a}±0.42	54.28^{b}±0.43
Albumen weight (g)	27.73±0.41	30.16±0.48
Albumen percentage	55.21±0.32	55.57±0.31
Yolk weight (g)	17.62±0.21	18.92±0.23
Yolk percentage	35.09±0.34	34.86±0.29
Shell weight	4.87±0.09	5.19±0.06
Shell percentage	9.70±0.13	9.57±0.11

Figures with different superscript in raw differ significantly $P < 0.05$, * Noni Fruit supplementation

Reference

Fugh-Berman, A. 2003. The 5 minute herbal and dietary supplement consult. Philadelphia Lippincott. pp. 236-237.

Harpreet Sodhi. 2011. Noni: The Leadre of Wellness Industry; Compendium of National Seminar on "Noni: Cultivation,Value Addition and Promotion in Gujarat State Pp 44-46.

Hirazummi, A. and Fuussasawa, E. 1999. An immunomodulatory poly-saccharideric susbstance from fruit juice of Morinda citrofolia (Noni) with anti-tumar activity. *Phytotherapy Research*, 13:380-387.

Javed, M., Durrani, F.R., Hafeez, A., Khan, R.U. and Ahmad, I. 2009. Effect of aqueous extract of plant mixture on carcass quality of broiler chicks. *ARPN J. Agric. Biol. Sci*., 4: 37-40.

Lata, K., Singh, D.R., Srivastava, R.C. and George, Z. 2009. A success story of women empowerment: Feeding of Morinda Citrofolia for successful poultry farming; Noni Search, Fourth National Symposium on Noni for empowerment and prosperity. Page 77.

Lata, K. and Sanjay Singh 2011. Awareness of Morinda in the tribal farmers of Panchmahal District; Compendium of National Seminar on "Noni: Cultivation,Value Addition and Promotion in Gujarat State; Page 41-43.

.Bruggnecate, J.T. 1992. Native plants can heal your wounds. Honululu StarBulletin Local News, Feb 2.

Snedecor, G.W. and Cochran, W. G. 1994. Statistical Method, 7th Edn. Oxford and IBH Publishing Co., Calcutta, India.

Narimani-Rad, M., Nobakht, A., Shahryar, H.A., Kamani, J. and Lotfi, A. 2011. Influence of dietary supplemented medicinal plants mixture (ziziphora, oregano and peppermint) on performance and carcass characterization of broiler chickens. *J. Med. Plants Res*., 5: 5626-5629.

Solomon, N. 1999. The tropical fruit with 101 medicinal uses, NONI juice. 2nd ed. Woodland Publishing.

Sunder, J., Kundu, A., Singh, D.R., Jeyakumar, S. and Srivastava, R.C. 2011. Effect of feeding of Morinda citrifolia fruit juice on growth, production and immune response in *Nicobari fowl*. *Indian J. Anim. Sci*., 81: 68-71.

Short Communication

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Management of leaf gall midge and stem capsule borer in aonla

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The aonla (*Emblica officinalis* Geartn) belonging to family Euphorbiaceae and sub family Phyllanthoidae is an important indigenous fruit tree of india. It has great medicinal and nutritional value. It is also now- a days gaining popularity among farmers and consumers and has immense potential of cultivation in arid and wasteland. In Rajasthan, it is being cultivated in area of 1,565 ha with an annual production of about 11,187 tons (Anon, 2017). The aonla fruits are a rich source of Vitamin C. The special attribute is its capacity to retain Vitamin C even in a dried stage which is not possible in other fruits. One part or other is used in the cure of cough, bronchitis, jaundice, diabetes, dyspepsia, diarrhea and fever. Fruit pulp contains 14 g of carbohydrate, 0.5 g protein, 1.2 g iron, 0.3 mg vitamin B and 600 mg of Vitamin C per 100g. The probable centres of origin are the South and Central India, Sri Lanka, Malaysia and South China. Though aonla is a subtropical fruit, it thrives very well and comes to yield in tropical humid conditions also. Aonla was supposed to be free from major insect and disease menace. With lapse of time and intensification of its cultivation, number of insects and diseases has started feeding and infecting at various stages and causing considerable damage. Lal *et al*. (1996), Haseeb *et al*. (1990, 2000), and Jhala *et al*. (2003) reported occurrence of fruit borer, midge and leaf cutting weevil for the first time in northern and western India. Though, it is considered to be a hardy fruit crop, not less than 30 insect and mite species have been recorded feeding on this scared tree from different places, mostly from India (Lakra, 1996). Aonla is a widely cultivated arid fruit crop and severely affected by stem capsule borer (*Betousa stylophora* Swinhoe) and leaf gall midge (*Asphondylia phyllanthi* Felt) causing having losses in fruit yield. The larva of *Betousa stylophora* feeds inside the gall on the succulent woody tissues and pushes out excreta through a small hole at one end, kept guarded by a mesh work of silken threads. There is only one larva in each gall which remains confined in an ellipsoidal cavity carved out in gall. The mature galls measure 20-26 mm in length and 10-15 mm across. The gall is a hollow swelling/localized tumescence of the tender shoot, irregular, roughly, spindle shaped- resembling 'Snake charmer's flute'. In the beginning of the infestation terminal shoots swell, which increases in size with the passage of time, full size galls can be seen in the month of October-November.

Asphondylia is a large genus, with a world-wide distribution. It comprises medium- or large-sized, brown, red or black coloured midges, which breed by preference in leaf and flower galls. Seven Indian species of this genus have been described so far. In Rajasthan, the area under aonla cultivation has increased over years and farmers are facing the problem of insect -pests. The present investigation were carried out to find out estimation of avoidable losses caused by leaf gall midge and stem capsule borer in aonla orchards under arid region of Rajasthan.

The experiment was carried out at Asalpur farm, SKN College of Agriculture, Jobner, Distt- Jaipur (Rajasthan) for six consecutive years (2012-2017). The experiment was consisted of four treatments including untreated check with Randomized Block Design (RBD) using aonla variety "Krishna NA-5" with five replications. Four plants were selected in each replication. The treatment were T_1 : Leaf gall midge control (stem capsule caterpillar infested)-Three foliar sprays with Imidachloprid 17.8 SL@0.3 ml/ltr starting from March at 20 days interval. T_2 : Stem capsule caterpillar control (Leaf gall midge infested) Two sprays of spinosad 45 SC @ 0.1 ml/lt at monsoon initiation at 20 days interval followed by removal of twigs (infested). T_3 : Leaf gall midge and stem capsule caterpillar control (T_1+T_2) and T_4 : Untreated checked (infestation of both).

For observation on leaf gall midge, *Asphondylia phyllanthi* three branches were selected and tagged. Observations on leaf gall midge were recorded by observing five twigs on each branch. Number of damaged (having folded leaflets) and healthy leaves, 30 days after completion of three spray and overall fifteen leaflets per plant were observed and then percent damaged leaves due to leaf gall midge was worked out.

After thirty days completion of all sprays from these three branches damage intensity (%) were recorded on five leaves on each branch and then percent damaged leaves due to leaf gall midge was worked out.

For observation on stem capsule caterpillar, *Betousa stylophora*, three branches were selected and tagged. Per cent damage twig due to stem capsule caterpillar, *Betousa stylophora* was worked out by counting of total as well as damaged twig (twig having capsule made by the pest) of per tagged three branches per tree, 30 days after the treatments. The insecticides imidachloprid 17.8 SL@0.3 ml/ltr used in treatment (T_1) and spinosad 45 SC @ 0.1 ml/lt were used in treatment (T_2) and both the insecticide were used in treatment

(T_3) and untreated check were tested in present investigation. One prophylactic spray was made before appearing the pest and subsequent spray made after appearance of damage symptoms on leaf by leaf gall midge and on twig by stem capsule caterpillar. The percent damage of leaf gall midge was recorded on the basis of damaged and healthy leaves and data obtained in percentage were statistically analyzed for analysis of variance after transforming the data into angular transformation values (Bliss,1937). The percent damage of stem capsule caterpillar was recorded on the basis of damaged and healthy leaves and data obtained in numbers were statistically analyzed for analysis of variance after transforming the data into v$\underline{X}$+0.5 values. (Bliss,1937)

The infestation of *Betousa stylophora* was started from June month and relatively higher in the month of July and maximum incidence was observed during September month. The pest survives till the end of December month. The female lays eggs singly on the surface of twigs and shoots of new flush in June-July, preferably near or at the growing tips of branches. The larval activity slows down during winter but the larva resume feeding with the onset of spring season and becomes full grown by April- May.

The infestation of *Asphondylia phyllanthi* were observed on the leaves and shoots in *orchards , the* galls were formed between February and May, and maximum incidence was observed during September month and were oval, scaly, hollow, soft, dehiscent and sessile. The infestation damaged the auxiliary buds, inhibiting growth and normal branching.

On the basis of pooled data (2012-2017) revealed that minimum number of capsule caterpillar damage was found in (T_3) imidachloprid 17.8 SL @0.3 ml/lt and spinosad 45 SC @ 0.1 ml/lt followed by removal of infested twigs treated plot (3.23) in number in comparison to followed by individual plot treated with (T_2) spinosad 45 SC @ 0.1 ml/lt followed by removal of infested twigs (5.03) in number and (T_1) imidachloprid 17.8 SL @0.3 ml/lt (12.27) in number. The treatment (T_3) imidachloprid 17.8 SL @0.3 ml/lt and spinosad 45 SC @ 0.1 ml/lt was found significantly superior over rest of the treatment and at par with the treatment (T_2) spinosad 45 SC @ 0.1 ml/lt in their efficacy for the control of capsule caterpillar damage in aonla.

Minimum number of leaf gall midge damage was found in (T_3) imidachloprid 17.8 SL @0.3 ml/lt and spinosad 45 SC @ 0.1 ml/lt treated plot (9.72%) in comparison to followed by individual plot treated with (T_1) imidachloprid 17.8 SL @0.3 ml/lt (16.82%) and (T_2) spinosad 45 SC @ 0.1 ml/lt (37.39). The treatment (T_3) imidachloprid 17.8 SL @0.3 ml/lt and spinosad 45 SC @ 0.1 ml/lt was found significantly superior over rest of the treatment in their efficacy for the control of leaf gall midge damage in aonla (Table 1). These results were in agreement with Bharpoda et al. (2009) and Patel et al. (1999) who reported that *Betousa stylophora* Swinhoe was a major pest of aonla and cause maximum infestation of *B. stylophora* during second fortnight of August and also reported that pest commenced from first fortnight of June. Nayar *et al*. (1976) and Uma and Verghese (2008) reported a gall formers on aonla crop and cause damage. The treatment (T_3) was found significantly superior over rest of the treatment including untreated plot for the control of both the pest occurring on aonla crop, twig damage by stem capsule caterpillar and leaf damage by leaf gall midge in aonla.

Table 1. Comparative incidence of different pests (2012-2017)

Treatments	2012		2013		2014		2015		2016		2017		Pooled 2012 -2017	
	Capsule caterpillar damage (Number)*	Leaf gall midge damage (Percentage)**	Capsule caterpillar damage (Number)*	Leaf gall midge damage (Percentage)**	Capsule caterpillar damage (Number)*	Leaf gall midge damage (Percentage)**	Capsule caterpilla damage (Number)*	Leaf gall midge damage (Percentage)**	Capsule caterpillar damage (Number)*	Leaf gall midge damage (Percentage)**	Capsule caterpillar damage (Number)*	Leaf gall midge damage (Percentage)**	Capsule caterpillar damage (Number)*	Leaf gall midge damage (Percentage)**
T_1	10.80 (3.77)	27.18 (23.87)	11.40 (3.44)	15.00 (22.88)	12.40 (3.58)	15.48 (23.12)	14.40 (3.83)	15.86 (23.52)	13.20 (3.68)	13.37 (21.42)	11.40 (3.45)	14.01 (21.94)	12.27 (3.63)	16.82 (22.79)
T_2	4.00 (1.28)	57.37 (49.40)	3.40 (1.96)	31.00 (34.06)	4.40 (2.20)	31.04 (33.91)	6.20 (2.58)	34.86 (36.16)	6.40 (2.61)	35.86 (6.75)	5.80 (2.50)	34.20 (35.74)	5.03 (2.19)	37.39 (32.67)
T_3	2.80 (0.91)	21.37 (27.40)	2.20 (1.62)	11.00 (19.53)	3.40 (1.91)	9.91 (18.34)	3.40 (1.97)	6.01 (14.13)	4.00 (2.09)	5.21 (13.13)	3.60 (2.00)	4.79 (12.10)	3.23 (1.75)	9.72 (17.44)
T_4	25.75 (7.12)	81.43 (70.91)	24.80 (5.02)	45.00 (41.92)	25.80 (5.12)	44.16 (41.63)	26.20 (5.15)	40.49 (39.49)	29.20 (5.40)	43.34 (41.25)	31.00 (5.68)	44.43 (41.79)	27.13 (5.58)	49.81 (46.17)
SEM ±	0.93	1.81	0.12	0.16	0.11	0.33	0.09	0.62	0.14	0.62	0.16	0.36	0.16	0.35
CD at 5%	2.81	5.63	0.37	0.48	0.34	0.99	0.27	1.86	0.42	1.88	0.47	1.09	0.44	0.96

*One month after treatment ** One month after 3 spray

Values given in Parentheses are v$\underline{X}$+0.5 and angular transformed values.

References

Anonymous, 2017. State wise area and production of aonla fruit crop in Rajasthan state. Directorate of Horticulture, Rajasthan State.

Bliss, C.L. 1937. Angles corresponding to percentage. Plant Protection. No.12,Leningrad.

Bharpoda, T.M., Koshiya, D.J. and Korat, D.M. 2009. Seasonal occurance of insect-pests on aonla (*Emblica officinalis* Geartn) and their natural enemies. *Karnataka J. Agric. Sci*., 22(2) : 314-318.

Haseeb, M., S.R. Abbas, R.P. Srivastava and S. Sharma. 1990. New records of insect pest of aonla. *Narendra Dev J. Res*., 5(1): 116-19.

Haseeb, M., S.R. Abbas, R.P. Srivastava and S. Sharma. 2000.

Studies on insect pests of aonla (*Emblica officinalis*). *Plant Proc. Sci.*, 8(1): 85-88.

Jhala, R.C., T.M. Bharpoda, M.G. Patel, V.B. Patel and J.R. Patel. 2003. Survey on insect pest and their natural enemies occurring in aonla orchard under middle Gujarat condition. Paper presented in Nat. Seminar on production and utilization of aonla, organized by *All India Aonla Growers Association*, Salem, Tamil Nadu, India.

Lakra, R.K. 1996. Some important pests of fruit crops of arid regions and their management. *Proc. Natln. Symp. Arid Horticulture, Horticulture Society of Haryana,* CCSHAU, Hisar. pp 144-147.

Lal, M.N., G.C. Joshi and S.S. Singh. 1996. Studies on incidence of *Inderbala* spp. *Cerciaphis indica* on aonla in eastern Uttar Pradesh. *Prog. Hort., 28(1-2) 66-75.*

Nayar, K.K.; Ananthakrishnan, T.N. and David, B.V. 1976.General and Applied Entomology. Tata Mc. Graw Hill Publishing Company Limited, New Delhi, India. 517 p.

Patel, M.G.,Patel, G.P.,Shekh, A.M., Patel, J.R., Patel, H.R. and Patel, M.J.1999. Effect of abiotic weather on twig damage in amla (*Emblica officinalis*) by *Betousa stylophora. Indian Journal of Agricultural Sciences*, 69 (10) : 715-717.

UMA, M.S. and Verghese, A. 2008. An overview of some plant galls of selected trees in India. *Pest Management in Horticultural Ecosystems*, Vol. 14. No.2 pp 110-121.

Short Communication

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Effect of stored pollen on fruit set, yield and quality of Date palm cv. Halawy under hot arid conditions

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Date palm (*Phoenix dactylifera* L.; family-Arecaceae) is one of the most suitable hardy fruit tree for semi arid and hot arid regions. Pollen plays an important role in fruit production in date palm as it is dioceous plant. The male and female flowers borne on separate plant and the spathes opened according to genetic features and environmental conditions. At present, area of date palm is increasing in the states of Rajasthan,Gujarat, Haryana, Punjab, Tamil Nadu, etc and problem of availability of pollen grains on time is new constraints in date palm cultivation. Flowering occurs 10-15 days early in male than female. But it has been observed that last 3-4 years flowering in male palm is late than female palms due to change in climate and prolong winter season. However, seedling populations are not found in other parts of country except Kachchh region of Gujarat.

Date palm plantations are economically important because it requires minimum care and it has vast potential in arid regions of Rajasthan, Punjab and Haryana as well as coastal belts of Gujarat. Limited work has been conducted on pollen and its effect on fruiting in date palm. The farmers are facing problem of availability of pollens at time of pollination due to scarcity of male palms. The identification of male palm producing high amount of pollen is essential to solve the problem and an elite male palm (CIAH/DP/M-3) has been identified (Singh *et al,* 2018) which has potential to produce 640g pollen grains/tree. The proper storage environment and temperature is necessary to maintain the viability of pollens (Maryam *et al*, 2015). Therefore, major emphasis should be given on pollen production as well proper storage for next season use. Keeping in view, a study on effect of pollen storage temperature on fruit set and yield was undertaken in date palm cv. Halawy in hot arid region.

The experiment was conducted at ICAR-CIAH, Bikaner during 2017-18 to find out the effect of pollen storage environment on fruiting in date palm cv. Halawy under hot arid conditions. The pollens were collected from male germplasm palm tree and stored under refrigerator (4-5 ^{0}C) and at ambient temperature (25-30^{0}C) in room. The pollens collected during 2016 stored under ambient room temperature (T-3) and refrigerator (4-5^0 C) in air tight vials (T-2) and were used for pollination and compared with fresh pollen (T-1). Pollination was done manually after opening of spathes during morning hours and after pollination bunches were covered with muslin cloth bags. Fruit set were counted in second week of April. The experiment was laid out in Completely Randomized Design having 4 replications. The trees were maintained with common cultural practices during the fruiting season. The data were analysed in CRD to determine the effect at 5% level of significance.

After opening of spathes, the pollination was completed during second week of March . Manual pollination was done during morning hours in all treatments. The data pertaining to fruit set in date palm cv. Halawy is presented in Table 1 and a significant difference was observed among the treatments. Spathes opening was not synchronized hence pollination was done as and when spathes were opened and covered by cloths bag.

The data presented in Table 1 showed that a significant variation in fruit set percentage and the maximum fruit set (89.45%) was observed under fresh pollen treatment followed by pollen stored under refrigeration (84.20%). Results showed that different storage conditions had effect on fruit set . The low fruit set (66.6%) was recorded under pollen stored under room temperature. Low fruit set percentage may occur due to decrease in viability of pollen during storage period. Similar findings have reported by Sharma *et al* (2018) in cv. Barhee. The difference in viability of pollens among the cultivars have been also reported by Maryam *et al,* (2015). The pollen stored under cryopreservation gave best result than refrigerated pollen was conventionally stored for long period in date palm (Atteeyeh,2012).

The pea size fruit drop was noticed more under T-3 treatment which may possibly be due to improper pollination and poor fertilization. The maximum number of berry/strand was observed under treatment T-2 (18.25) followed by treatment with fresh pollen (17.35). Moreover, there was no significant difference in number fruits per strand. The size of fruits, length and weight were significantly affected by different type of stored pollens used for pollination. Variation in number of berry per strand and fruit yield has also been reported by Shafique *et al.* (2011) in date palm. The fruit yield in date palm is directly depends upon size of bunch, weight of berry, number of bunches/palm and number of fruits per strands. The fruit yield was affected significantly and higher yield (39.98kg) was recorded under fresh pollen treatment followed by 39.00kg under treatment T 2. The lowest fruit yield ((35.10kg) was recorded under T 3 possibly due to low fruit set and fruit drop. Further, the cause of low fruit yield may due to poor viability of pollens stored under room temperature conditions. It has been reported that pollen stored under room

temperature lost the most of their viability between the 2 or 3 month of storage (Roumani and Salem, 2018). Pollen viability extended over time when pollen was stored under low temperature. However, the fruit size, weight, flesh and seed weight significantly affected by pollen source *i.e.* superior male as reported by Shafique *et al.* (2011) in date palm cv. Dhakki. Fruit quality was also assessed and total soluble solids (TSS) of fruits at *doka* stage were not affected by the treatments. There was no significant difference in weight of stone (Table 1).

It has concluded that fresh pollen is most suitable for pollination to achieve higher percentage of fruit set, yield and quality of fruits in date palm followed by pollen stored under refrigeration (4 ^{0}C). The pollen stored at ambient temperature in room was showed low percentage of fruit set and yield.

Table 1. Effect of stored pollen on fruit set, yield and quality in date palm cv. Halawy

Pollen types	Date of pollination	Fruit set (%)	No. of fruits/ strands	Weight (g)	Fruits Length (cm)	Width cm,	Yield (kg)	Weight of stone (g)	TSS ^{0} Brix
Fresh (T-1)	10.3.2017	89.45	17.25	6.35	2.57	1.80	39.98	0.98	37.80
Stored at 4 ^{0c} in refrigerator (T-2)	19.3.2017	84.20	18.25	4.86	2.35	1.70	39.00	0.86	35.20
Stored at ambient temperature (25-30^{0} C) (T-3)	17.3.2017	66.59	16.75	5.93	2.35	1.65	35.10	0.93	36.25
SEm±	--	0.16	0.86	0.06	0.05	0.60	0.76	0.03	1.05
C.D. at 5%	--	0.50	--	0.20	0.17	--	2.69	--	--

References

Atteeyeh, A. F. 2012. Effect of storage method on date palm and Pistachio pollen viability. *Jordan Jour. Agri. Sci*., 8:573-582.

Maryam Jaskani, M. Jaffer., Fatima Biques, Hyder, M. S. Naqvi, S. A., Naffee, M, Rashid Ahmed, and Khan, I. A. 2015. Evaluation of pollen viability in date palm cultivars under different storage temperature. *Pak. J. Bot.,*47(1):377-81.

Roumani,Messaouad and Ahmed Salem 2018. The effect of pollen storage temperature on pollen viability, fruit set and fruit quality of six date palm cultivars. *Scientia Horti*., 236:279-283.

Shafique, M., Khan, A.S., Malik, A.U. and Ahmed, Iftikhar. 2011. Influence of pollen source and pollination frequency on fruit drop, yield and quality of date palm (*Phoenix dactylifera* L.) cv. Dhakki. *Pak. J. Bot,* 43(2):831-839.

Sharma, K. M., Muralidharan, C.M . and Devsi, A. Baidyavadra. 2018. Pollen storage of date palm in different container and temperature. In. Book of Abstract. NCAH, CIAH, Bikaner, p12.

Singh, R. S., Bhargava, R, Meena, R. and Sharma, B. D. 2018. Evaluation of male date palms *Phoenix dactylifera* L) for pollen production under hot arid conditions. *Indian Journal of Arid Horticulture*, 13: 39-41.