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# Breeding of $F_1$ hybrids in muskmelon: Accomplishment and Prospects

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**Abstract**

Heterosis breeding has been extensively explored and utilized in muskmelon. Being cross pollinated crop and its ability to produce plenty of seeds per fruit facilitates heterosis breeding and make it economically viable. Presence of different pollination mechanisms *like* monoecy, gynoecy and genetic male sterility could be effectively explored for economic production of $F_1$ hybrids. A large number of varieties have been developed through continuous inbreeding and selection without losing vigour, which is unexpected in cross pollinated crops. Now there is need to give the attention to develop high quality (TSS) and disease resistant hybrids utilizing economic tools.

**Key Words: Muskmelon, heterosis, $F_1$ hybrid**

## Introduction

Heterosis breeding is one of the most efficient tools of plant breeders to exploit the genetic diversity. Munger (1942) was the first to observe hybrid vigour in muskmelon. Since then, sporadic attempts have been made to observe the performance of heterotic effect in this crop. In India, Punjab Hybrid-1 was the first commercial muskmelon hybrid, which has been developed by utilizing ms-1 gene (Nandpuri *et al.*, 1982). Later on, Pusa Rasraj (Kesavan *et al.*, 1987) and MH-10 (Lal and Dhaliwal, 1993) were developed by exploiting monoecy and gynoecy, respectively. Muskmelon is enriched with great variability and therefore, heterosis breeding can be efficiently utilized to produce hybrids providing high yield and quality fruits (Pandey *et al.*, 2005). Robinson *et al.* (1976) observed variability in vine length (1-10 m), fruit weight (10 g-10 kg), flesh TSS (3-18 per cent) and flesh acidity (pH 3-7). High yield and uniform fruit shape and size, as well as consistently excellent quality, are prerequisites for the release of superior melon varieties/hybrids (Feyzian *et al.*, 2009). Moreover, there is a need to develop suitable hybrids, which may be utilized on commercial scale. Because of cross-compatibility and evident heterosis for agronomic traits, muskmelon is well suited for heterosis breeding (Dhaliwal, 1997). The present review emphasized on need to exploit hybrid vigour in muskmelon.

## Sex forms and pollination behaviour

Muskmelon (*Cucumis melo* L.) is predominantly an andromonoecious (hermaphrodite and staminate flowers) but gynoecious (only pistillate flowers) or monoecious (pistillate and staminate flowers) sex forms have also been reported (Dhaliwal, 1997). Anthesis takes place at around 5.30 am and stigma is receptive 12 hours before to the day of anthesis. Duration of pollen fertility is between 5.00 am to 2.00 pm and dehiscence of anther takes place between 5.00 to 6.00 am. Early morning pollination is desirable for maximum fruit setting. It is a strictly cross pollinated crop and honey bees are the chief insect pollinators. However, their andromonoecious sex form of most commercial varieties provides the probability of selfing. Cucurbits are highly cross pollinated but do not suffer from inbreeding depression (Allard, 1960). Hybrid vigour is not depressed is muskmelon due to continuous inbreeding and most of the cultivars have been developed through inbreeding and selection (Scott, 1933). Varying amount of out-crossing has been reported in muskmelon and it depends on the genotypic behaviour, sex form, isolation distance, wind direction, bee activity, seasonal influences, etc. Whitaker and Bohn (1952) reported that average range of cross pollination vary from 20 to 30 per cent. Foster (1968) using 'g-1' and 'ms-2' genes in a hybrid seed production study, found the extent of out-crossing among male fertile andromonoecious plants (24.6 per cent), male fertile monoecious plants (58.4 per cent), male sterile andromonoecious plants (99.0 per cent) and male sterile monoecious plants (99.6 per cent).

## Targeted traits for hybrid development

More and Seshadri (1998), Peter and Swamy (2006) and Pitrat (2009) advocated the following breeding goals for muskmelon breeding programme. High yield and uniform fruit shape and size, are prerequisites for superior melon hybrids. An early and tough netted skin fruit having small seed cavity are the important traits. Being dessert fruit, quality parameters, especially TSS, flesh thickness, texture and colour should be taken into account. The sugar content should vary from 11-13 per cent but not less than 10 per cent. The hybrid should be resistance to biotic stresses *viz.*, powdery

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mildew, downy mildew, cucumber mosaic virus and fruit fly.

**Manifestation of heterosis**

Muskmelon has the advantage of producing a large number of seeds in a single cross coupled with lesser requirement of seed for planting per unit area. Munger (1942) was first to report heterosis in muskmelon and observed 30% higher yield and uniform fruits. The hybrids generally showed heterosis for earliness (Gaurav *et al.*, 2000 and Choudhary *et al.*, 2003). Significant and desirable heterosis for flesh thickness has been observed by Chadha and Nandpuri (1980), Dhaliwal and Lal (1996) and Choudhary *et al.* (2003).

Munshi and Verma (1999) found promising combinations (Pusa Madhuras x Hara Madhu, Pusa Sharbati x Pusa Madhuras, Pusa Madhuras x Ravi and Pusa Madhuras x T-96) for earliness and fruit yield per plant. Significant heterobeltiosis has also been recorded by Gurav *et al.* (2000) in Kavit x Bhang, Hara Madhu x Pusa Madhuras and Jam B x Jam D for fruit yield and yield contributing traits and emphasized the need to exploit the same crosses in muskmelon breeding. Lal and Kaur (2002) observed desirable heterosis in MS-1 x NDM-15 for TSS, WI-998 x NDM-15 for yield per vine and WI-998 x DMDR-3 for resistance to downy mildew. Heterobeltiosis upto the extent of 44.44 per cent (*ms*-1 x Hara Madhu) for fruit yield per plant have been reported by Choudhary *et al.* (2003). Subramanian (2008) recorded heterobeltiosis for fruit yield and number of fruits per vine in melon cross involving ARY x AJ (C5). Heterosis for total soluble solids was reported by Chadha and Nandpuri (1980), Dhaliwal and Lal (1996), Munshi and Verma (1999), Lal and Kaur (2002), Choudhary *et al.* (2003) and Moon *et al.* (2006). More and Seshadri (1980) observed 50 hybrids and found that $M_1$ x Mix Top Mark, $M_1$ x Golden Perfection, $M_2$ x Yauco Treat, $M_2$ x PMR-6 and $M_2$ x Top Mark superior over better parents for earliness, yield and quality attributes.

Heterobeltiosis for days to female flower, fruit maturity, fruits per plant, fruit weight, flesh thickness, fruit yield and sugar content was observed by Chadha and Nandpuri (1980), Dixit and Kalloo (1983), Mishra and Seshadri (1985), Randhawa and Singh (1990), Singh and Randhawa (1990), Dhaliwal and Lal (1996), Munshi and Verma (1997), Lal and Kaur (2002), Choudhary *et al.* (2003) and Subramanian (2008). Mishra and Seshadri (1985) crossed 2 genetic male sterile lines with 32 andromonoecious varieties and reported heterosis over better parent for cross combinations ms-1 x Harela (31.3%) for yield, ms-2 x Pusa Madhuras (13.5%) for TSS and ms-1 x Persiiski-5 for earliness (19.0%) and early yield (43.47%). It is possible that heterosis has contributed to a yield increase for specific cultivars. The overall quality and percentage of marketable yield over total has also increased as a result of breeding efforts (Gusmini and Wehner, 2008). Quality character (especially TSS) is highly influenced by environmental factors; hence, it is not possible to fix it within architectural limits even in pure varieties. Since its inheritance and expression is very complex, it is necessary to find out whether $F_1$ hybrids can prove superior to the pure bred varieties and heterozygosity *per se* can bring about the genetic balance necessary in the manifestation of this quality attributes. Besides, growing season in some parts of north India is limited and hence earliness is much sought after here to avoid pre-monsoon showers which deteriorates the fruit quality and invites many diseases (More and Seshadri, 1998).

Resistance against certain specific diseases can also be transmitted to the hybrids. Foster (1960) transmitted crown blight resistance to $F_1$ hybrids. Resistance had been reported to be dominant (Dhillon and Wehner, 1991), which might be utilized in the breeding programme. Kesavan and More (1987 & 1991) utilized three monoecious lines ($M_1$, $M_2$ and $M_3$) in hybrid programme and identified four promising hybrids resistance to powdery mildew along with desirable horticultural characters.

**Exploitation of monoecy**

Generally muskmelon is andromonoecious but some genotypes have monoecious sex form. Monoecism has been assessed for its use in heterosis breeding and excludes emasculation (More *et al.*, 1980 and Kesavan and More, 1991). They also advocated the use of monoecious lines in hybrid seed production which reduces the time required by 50 per cent and enhance fruit set 40-70 per cent as compared to 5-10 per cent in andromonoecious parent. Monoecious character was controlled by a single pair of recessive genes. Considering the problems associated with use of male sterile gene(s) for production of muskmelon hybrids (maintenance of single recessive gene due to heterozygous condition and problem of identifying and rouging of 50 per cent male fertile plants from the female row at the time of flowering) and also to overcome the problems of andromonecious sex form. More *et al.* (1980) developed four monoecious lines ($M_1$, $M_2$, $M_3$ and $M_4$) for commercial utilization in heterosis breeding. Main problem in using monoecious lines in heterosis breeding is undesirable linkage between genes controlling sex expression and fruit shape (Risser, 1984). Due to this limitation, $F_1$ hybrids with round fruits cannot be obtained. This problem is also found in Pusa Rasraj, hence this hybrid is not accepted commercially, due to its undesirable fruit shape and poor external appearance (Sandha and Lal, 1999).

**Exploitation of gynoecy**

Gynoecious lines produce only female flowers and ensure 100 % pure hybrid seed production. Peterson *et al.* (1983) was first to develop gynoecious line in muskmelon from the progeny of gynomonoecious lines *i.e.*, monoecious x hermaphrodite cross. Such lines can be maintained through the stimulation of male flowers by chemicals. The use of silver compounds like silver nitrate

at 100-200 ppm (More and Seshadri, 1987) has been used successfully to induce perfect flowers in gynoecious lines for their maintenance. The chief advantage of using gynoecious lines over *ms* lines in heterosis breeding is the tedious job of identification and rouging of 50 per cent male fertile plants from the mixed population can be avoided. Therefore, Loy *et al.* (1979) advocated the use of gynoecious lines in hybrid seed production. Lal and Dhaliwal (1993) used WI-998, a gynoecious line in hybrid production and reported that it has good combining ability for yield and earliness but was average combiner for TSS per cent. A cross between WI-998 x Hara Madhu *i.e.*, MH-10 was found promising and was released for commercial cultivation in Punjab during 1995. It is not only early and high yielding but also has good transport quality.

Dhaliwal and Lal (1996) evaluated a large number of crosses involving monoecism, gynoecism and male sterility in the female parent. The cross W-321 x N-233 was out yielded in comparison to Punjab Hybrid-1 (check) by more than 50 per cent and was also significantly earlier. Thus, the hybrid W-321 x N-233 has good potential for commercial exploitation. This cross should be commercially viable as it involves gynoecious female parent, which can be conventionally maintained by inducing maleness with the help of growth regulators (More and Seshadri, 1987). It has been observed that gynoecious lines are poor in TSS, so it is essential to improve the TSS level of available gynoecious lines through selection for the production of better quality hybrids. The instability of gynoecious lines at high temperature also poses a problem in their utilization.

**Exploitation of male sterility**

Male sterility has also been utilized in heterosis breeding of muskmelon (Nandpuri *et al.*, 1974 and Mishra and Seshadri, 1988) and exploited commercially by Nandpuri *et al.* (1982) in the form of Punjab Hybrid-1. The cost of muskmelon $F_1$ seed is 15-30 times high than the open pollinated varieties. Thus male sterile genes offer the potential of lower the cost of hybrid seeds. Male fertile plants are rogued out and mature fruits are harvested from male sterile plants only to obtain seeds. This seed will provide male fertile and male sterile plants in 1:1 ratio, serves as a stock seed to repeat the cycle. The same seed is used for hybrid seed production by altering the parental lines in the ratio of 3:1 (female: male). However, 50 % male fertile plants have to be removed at the appearance of first male flower from the female rows. Fruits develop on male sterile plants will produce hybrid seed (Kumar and Dhaliwal, 1991). The efficiency of male sterility can be considerably increased if the plants are identified only in the seedling stage using marker genes. Male sterility in muskmelon has been reported by several researches (Bohn and Whitaker, 1949; Bohn and Principe, 1964 and Foster, 1968). Sterility is governed by a single recessive nuclear gene. Presently five recessive nuclear male sterile genes (*ms*-1, *ms*-2, *ms*-3, *ms*-4 and *ms*-5) are known. The genetic male sterile line *ms*-1 was identified (Bohn and Whitaker, 1949) and is the only line commercially utilized in India (Nandpuri *et al.*, 1982). The development of Punjab Hybrid-1 (*ms*-1 x Hara Madhu) has been developed by PAU, Ludhiana (Nandpuri *et al.*, 1982).

**Prospects**

Good characteristics of a muskmelon variety are thick skin, thick flesh with good consistency and mild musky flavour, attractive outer colour, small or negligible hollowness of fruit, and resistant to powdery mildew, downy mildew, cucumber mosaic virus and fruit fly. Presence of considerable variability in the crop, if explored and collected, can be made use to develop such line (s) with the above good characteristics. Prospect of exploiting heterosis in muskmelon is very high. There is need to identify specific combinations which exhibit heterosis for economic characters. The use of growth regulators can also go a long way to increase productivity. As India is a secondary centre of muskmelon wide genetic variability exists which need to be maintained and exploited by the breeders.

Priority should be given to develop multiple disease resistant hybrids. Stable monoecious and gynoecious lines should be developed so that hybrid seed can be produced economically. The future research on heterosis breeding in muskmelon should concentrate on the development of suitable male sterile lines with suitable genetic markers *viz.*, green glabrous and yellow green leaves at early stage, which may be utilized on commercial scale.

**Conclusion**

Muskmelon is ideally suited for heterosis breeding because of its cross pollination behaviour and heterosis for economic traits. In hybrids, it is possible to combine large number of desirable genes. Such types of combinations are very difficult to achieve with the help of inbreeding and selection. When the resistance is controlled by dominant genes, the insect pest, disease and stress resistant hybrids can be developed more steadily than open pollinated varieties. With the availability of perfect out-crossing systems like male sterility and gynoecy the production of hybrid seed either manually or by use of monoecy can be discarded. It is not possible to produce 100 per cent pure seed utilizing male sterility but contamination by self or sib seed can be minimized by taking strict care at the time of identification and by incorporating tightly linked marker genes to rogue out 50 per cent fertile plants. The later would also help in reducing the cost of hybrid seed. Availability of gynoecious line in muskmelon has brightened the scope of heterosis breeding in this crop. The cost of hybrid seed produced by exploiting gynoecy is certainly be much less than any other method. But TSS content of such lines needs to be improved so as to develop hybrids superior to existing varieties or hybrids. Recently the sources of

resistance have now been identified against diseases like powdery mildew and can be exploited in the form of disease resistant hybrids.

**References**


Allard, R.W. 1960. Principles of Plant Breeding. John Willey and Sons, Inc., New York.

Bohn, G.W. and Principe, J.A. 1964. A second male sterility gene in the muskmelon. *Journal of Heredity.* 55: 211-225.

Bohn, G.W. and Whitaker, T.W. 1949. A gene for male sterility in the muskmelon (*C. melo* L.). *Proceedings of American Society of Horticulture Science.* 53: 309-314.

Chadha, M.L. and Nandpuri, K.S. 1980. Hybrid vigour studies in muskmelon. *Indian Journal of Horticulture.* 37(3): 276-282.

Choudhary, B.R., Dhaka, R.S. and Fageria, M.S. 2003. Heterosis for yield and yield related attributed in muskmelon (*Cucumis melo* L.). *Indian Journal of Genetics and Plant Breeding.* 63(1): 91-92.

Dhaliwal, M.S. 1997. Heterosis breeding in muskmelon-a review. *Agricultural Reviews.* 18(1):35-42.

Dhaliwal, M.S. and Lal, T. 1996. Genetics of some important characters using line x tester analysis in muskmelon. *Indian Journal of Genetics and Plant Breeding.* 56(2): 207-213.

Dhillon, N.P.S. and Wehner, T.C. 1991. Host plant resistance in insects in cucurbits-germplasm resources, genetics and breeding. *Tropical Pest Management.* 37: 421-428.

Dixit, J. and Kalloo, G. 1983. Heterosis in muskmelon (*Cucumis melo* L.). *HAU Journal of Research.* 13: 549-553.

Feyzian, E., Dehghani, H., Rezai, A.M. and Javaran, M.J. 2009. Diallel cross analysis for maturity and yield related traits in melon (*Cucumis melo* L.). *Euphytica.* 168: 215-223.

Foster, R.E. 1960. Breeding for disease resistance and variety. In: *Cantaloupe Research in Arizona. Arizona University Report.* 195: 1-4.

Foster, R.E. 1968. $F_1$ hybrid muskmelon, 5. Monoecism and male sterility in commercial seed production. *Journal of Heredity.* 59(3): 205-207.

Gurav, S.B., Wavhal, K.N. and Navale, P.A. 2000. Heterosis and combining ability in muskmelon (*Cucumis melo* L.). *Agricultural University Journal of Maharashtra.* 25(2): 149-152.

Gusmini, G. and Wehner, T.C. 2008. Fifty-five years of yield improvement for cucumber, melon, and watermelon in United States. *HortTechnology.* 18(1):9-12.

Kesavan, P.K. and More, T.A. 1987. Powdery mildew resistance in $F_1$ hybrid in muskmelon. In: *National Symposium on Heterosis Exploitation, Accomplishment and Prospects.* Prabhani, Maharashtra. October 15-17. p. 54.

Kesavan, P.K. and More, T.A. 1991. Use of monoecious lines in heterosis breeding muskmelon (*Cucumis melo* L.). *Vegetable Science.* 18: 59-64.

Kumar, J.C. and Dhaliwal, M.S. 1991. Techniques of developing hybrids in vegetable crops. Agro-Botanical Publishers, Bikaner, Rajasthan.

Lal T and Dhaliwal, M.S. 1993. In: Symposium on Heterosis Breeding in Crop Plants: Theory and Application, Ludhiana.

Lal, T. and Kaur, R. 2002. Heterosis and combining ability analysis for improvement horticultural traits and reduction to downy mildew in muskmelon (*Cucumis melo* L.). *PAU Journal of Research.* 39(4): 482-490.

Loy, J.B., Natti, T.A., Zack, C.D. and Fritts, S.K. 1979. Chemical regulation of sex expression in a gynomonoecious line of muskmelon. *Journal of American Society of Horticulture Science.* 104(1): 100-101.

Mishra J.P. and Seshadri V.S. 1985. Male sterility in muskmelon. II. Studies on heterosis. *Genet. Agr. 39:* 367-376.

Mishra, J.P. and Seshadri, V.S. 1988. Male sterility in muskmelon (*Cucumis melo* L.). I. Studies on combining ability. *Indian Journal of Genetics and Plant Breeding.* 48(3): 347-354.

Moon, S.S., Munshi, A.D., Verma, V.K. and Sureja, A.K. 2006. Heterosis for biochemical traits in muskmelon (*Cucumis melo* L.). *SABRAO Journal of Breeding and Genetics.* 38(1): 53-57.

More, T.A., Seshadri, V.S. and Sharma, J.C. 1980. Monoecious sex forms in muskmelon. *Cucurbit Genetics Co-operative Report.* 3: 32-33.

More, T.A. and Seshadri, V.S. 1980. Studies on heterosis in muskmelon (*Cucumis melo* L.). *Vegetable Science.* 7: 108-117.

More, T.A. and Seshadri, V.S. 1987. Maintenance of gynoecious muskmelon with silver thiosulphate. *Vegetable Science.* 14: 138-142.

More, T.A. and Seshadri, V.S. 1998. Improvement and cultivation of muskmelon, cucumber and watermelon. In: *Cucurbits.* Nayar, N.M. and More, T.A. (eds.). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, pp. 169-186.

Munger, H.M. 1942. The possible utilization of first generation muskmelon hybrids and an improved method of hybridization. *Proceedings of American Society of Horticulture Science.* 40: 405-410.

Munshi, A.D. and Verma, V.K. 1997. Studies on heterosis in muskmelon (*Cucumis melo* L.). *Vegetable Science.* 24(2): 103-106.

Munshi, A.D. and Verma, V.K. 1999. Combining ability in muskmelon (*Cucumis melo* L.). *Indian Journal of Agricultural Sciences.* 69(3): 214-216.

Nandpuri, K.S., Singh, S. and Lal, T. 1974. Study on the comparative performance of $F_1$ hybrids and their parents in muskmelon. *PAU Journal of Research.* 11(3): 230-238.

Nandpuri, K.S., Singh, S. and Lal, T. 1982. Punjab

Hybrid- A new variety of muskmelon. *Progressive Farming*. 18: 3-4.

Pandey, S., Rai, M. and Singh, B. 2005. Genetic variability and character association in muskmelon (*Cucumis melo* L.). *Indian Journal of Plant Genetic Resources*. 18:212-216.

Peter, K.V. and Swamy, K.R.M. 2006. Advances in breeding of vegetables. In: Proceedings of II[nd] National Plant Breeding Congress held at TNAU, Coimbatore from 1-3 March, 2006. pp 1-23.

Peterson, C.E., Owens, K.E., Rowe, K.E. and Rowe, P.R. 1983. Wisconsin-998 muskmelon germplasms. *Horticultural Science*. 18: 116.

Pitrat (2009). Melon. In: Vegetables I (Asteraceae, Brassicaceae , Chenopodiaccae and Cucurbitaceae). Edited by Prohens J. and Nuez F., Spinger International Edition, Spinger (India). pp 283-316.

Randhawa, K.S. and Singh, M.J. 1990. Assessment of combining ability, heterosis and genetic variance for fruit quality characters in muskmelon (*Cucumis melo* L.). *Indian Journal of Genetics and Plant Breeding*. 50(2): 127-130.

Risser, G. 1984. In: *Proceedings of 3[rd] Eucarpia Meeting on Cucumis and Melons* held at Plovdiv, Bulgaria in July 1984. pp. 100-103.

Robinson, R.W., Munger, H.M., Whitaker, T.W. and Bohn, G.W. 1976. Genes for cucurbitaceae. *Horticultural Science*. 11: 554-568.

Sandha, M.S. and Lal, T. 1999. Heterosis breeding in muskmelon-a review. *Vegetable Science*. 26(1):1-5.

Scott, G.W. 1933. Inbreeding studies with *Cucumis melo* L. *Proceedings of American Society for Horticultural Sciences*. 29: 485.

Singh, M.J. and Randhawa, K.S. 1990. Assessment of heterosis and combining ability for quality traits in muskmelon. *Indian Journal of Horticulture*. 47(2): 228-232.

Subramanian, D. 2008. Studies on heterosis expression and association of fruit yield and yield component characters among five intervarietal crosses of Vellari melon (*Cucumis melo* L.). *Madras Agricultural Journal*. 95(1-6):24.

Whitaker, T.W. and Bohn, G.W. 1952. *Proceedings of American Society for Horticultural Science*. 60: 391-396.

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# Study on nutrient status of aonla orchard soils in Sikar district of Rajasthan

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**Abstract**

Studies were conducted on the mineral nutrition status of aonla fruit orchards located in Sikar district of Rjasthan. Electrical conductivity was found to be in normal range and soil pH was in the high ranging from 7.70 to 9.18. The organic carbon content and available nitrogen of aonla orchard soils were found low whereas available phosphorus, available iron, zinc, copper, and manganese were found low to medium. Available potassium was found medium whereas available sulphur was found low in range. The soils were found medium to high in exchangeable Ca and Mg. There was wide variation found in the calcium carbonate percentage at different soil depths in orchards.

**Key words:** Aonla, orchards, nutrient status.

## Introduction

India is second largest producer of fruits after china with 49.29 million tonnes production from 4.96 million ha area (Anonymous, 2005). India has large arid zone covering an area of 317090 sq. km scattered mainly in the north-west parts of country and Rajasthan alone covers 62.00 per cent of area under arid zone. In Rajasthan, fruit cultivation is practised over an area 19795 ha and total production is 238475 tonnes (Anonymous, 2005).The area of Sikar district forms a part of Thar desert which covers an area of 774244 square kilometres situated in the North Eastern Rajasthan. The district has moderate climate with seasonal temperature variation with scanty rainfall to the magnitude of 450-500 mm per annum during normal rainfall years. The high temperature (up to 48$^0$C) along with high wind velocity, low soil fertility status, low water retention capacity of soil, high soil pH, salinity, calcium carbonate concretion in sub soil etc. are hard impediment in successful cultivation of many fruit crops in arid region. Increasing the production of fruits thus has sufficient scope in arid region of Rajasthan. In Sikar district, the area under fruit crops is 0.002 lac ha with production of 0.02 lac metric tonnes (Anonymous, 2005). There is a vast potential of increasing area under fruit cultivation in arid region of Rajasthan provided irrigation facilities are available. These areas are suitable for cultivation of fruit crops such as aonla, ber, beal citrus, pomegranate etc. Presently Sikar district has nearly 2,12,096 lac hectares irrigated area through tube wells/wells. Irrigation facilities has opened great avenues for cultivation of fruit crops likes ber, aonla, bael, lime, pomegranate, datepalm, guava, jamun, karonda, phalsa etc, besides traditionally grown fruits such as Ker (*Capparis decidua*), Gonda (*Cordia myxa*), Pilu (*Salvadora oleiodes*), Khejri (*Prosopis cineraria*) etc. Inspite of all vagaries, the farmers of Sikar district has shown tremendous response towards fruit cultivation particularly of ber, bael, lime and aonla fruits.

Aonla is an important fruit crop which has high nutritive and medicinal value. It is one of the richest source of vitamin 'C' ranging from 500 to 1500 mg/100 g pulp (Chandra and Chandra, 1997). Fruits are also rich in pectin and minerals like iron, calcium, phosphorus. The aonla has been recommended by Ayurveda for balanced diet and sound health and is important ingredient of triphala and chavanprash. Due to multipurpose uses, the demand of aonla fruits is increasing day by day. Because of wide adaptive nature, this fruit crop is mainly grown on dry land and waste land soils where major nutrients are deficient and limited irrigation facilities are available. Its cultivation has become quite popular in arid irrigated regions of Rajasthan, owing to its high nutritive and medicinal value and having higher productivity even in the wasteland. It is also a value added horticultural crop which has bright future prospects for export, particularly to European countries.

In Indian fruit industry, poor nutrition is the major cause of low orchard efficiency resulting poor productivity and poor fruit quality. Sufficient information on nutrient management in fruit crops has been generated, but response and requirement of nutrients of perennial fruit crops vary markedly in a particular area depending on soil and climatic conditions and also depend on growth, bearing habit, age, root stock and management practices. Balanced nutrition of fruit crops is paramount importance particularly in arid areas having largely sandy soils of poor fertility status. For knowing the exact status of mineral nutrition in the fruit trees, survey of the orchards for their fertility status and plant nutrients is done. A number of nutritional surveys have been conducted on various fruit crops in northern and western states of the country viz., Punjab, Haryana, Himachal Pradesh and Maharashtra to study fertility status of soil. Studies on nutritional survey of arid fruits in Rajasthan are meagre inspite of their great importance and relevance. Therefore, present investigation was conducted to survey the fruit orchards in Sikar district of Rajasthan to gain information about their nutrient status.

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**Materials and methods**

A detailed soil survey during the year 2007-2008 was conducted in Sikar district of Rajasthan. Orchards were selected in such a way that these can represent general conditions of area under study. Eight orchards were selected covering different tehsils viz. Laxmangarh, Reengus, Danta Ramgarh and Piparali.The details of locations and name of the fruit growers are given below.

Soil samples were collected from fruit orchards, on the basis of variability and orchard performance at different locations of Sikar district. Thereafter, from each selected orchards, three soil profiles, based on soil fertility variation and plant performance were taken up. The sampling was done in each profile up to depth of 120 cm i.e. 0-15, 15-30, 30-45, 45-60, 60-75, 75-90, 90-105 and 105-120 cm. from orchards. The soil samples were analysed for organic

| Name of fruit grower | Location | Tehsil |
|---|---|---|
| Shri Balbir Singh | Rashidpura | Laxmangarh |
| Shri Dana Ram | Rehnawa | Laxmangarh |
| Shri Raju Sen | Laxmangarh | Laxmangarh |
| Shri Puran Mal Shartma | Sargoth | Reengus |
| Shri Roopchand Pipliwal | Pachar-I | Danta Ramgarh |
| Shri Kana Ram | Pachar-II | Danta Ramgarh |
| Shri Panna Ram | Pachar-VI | Danta Ramgarh |
| Govt. Nursery | Palsana-I | Piparali |

carbon, available nitrogen, available phosphorus and available potash by Walkley and Black rapid titration method (Jackson, 1973), Alkaline permanganate method (Subbiah and Asija, 1956), Olsen's method (Olsen *et al.*, 1954) and Flame photometer method (Jackson 1973), respectively. The available Fe, Cu, Zn, and Mn were extracted with DTPA solution as per Procedure of Lindsay and Norvell (1978) and were determined by atomic absorption spectrophotometry. Exchangeable Ca and Mg were determined by method given by Richards, 1954. Available sulphur was determined by the method given by Chesnin and Yien, 1957.

**Results and Discussion**

**Organic carbon, electrical conductivity and pH of soil**

The organic carbon status of aonla orchard soils was generally poor. It varied from 0.056 to 0.171 per cent with a mean value of 0.118 for all the depths. The data presented on organic carbon content of orchard soils showed a decreasing trend with increase in depths. As per the ratings given by Muhr *et al.* (1963), the soils having organic carbon <0.5 per cent organic carbon have been categorized under low category. All the aonla orchard soils were found low in organic carbon content. Low content of organic carbon in the soils of Sikar district appears to be mainly due to the type of climate of the region. It is difficult to build up organic matter in the soils of arid regions on account of high temperature which causes rapid oxidation of organic matter.

The electrical conductivity of aonla orchard soils ranged from 0.050 to 0.360 $dsm^{-1}$ with a mean value of 0.189 $dsm^{-1}$ for all the depths. The electrical conductivity of different aonla orchard soils revealed a decreasing trend with increase in depth. As per the limits given by Muhr *et al.* (1963), the soils have been categorized into three i.e. 1, 1-2 and >2 mm hos/cm for normal, critical for germination and severe injury to crops. Data indicated that all the aonla orchard soil samples were having electrical conductivity values less than 1 $dsm^{-1}$. A comparative low conductivity value of most of the soils may be attributed to leaching of soluble salts from the soil column, being high permeability of light textured soils.

The pH of soils was found to be high as it ranged from 7.70 to 9.18 with mean value of 8.49 for all the soil depths. The relatively high pH of these orchard soils might be due to their fairly high base saturation.

**Nutrient status of aonla orchard soils**

The available nitrogen content ranged between 68.00 to 121.00 kg $ha^{-1}$ with a mean value of 97.62 for all the depths. The data presented on available nitrogen content of orchard soils showed a decreasing trend with increase in depths (Table 1. As per the ratings given by Tandon (1992), the soils having <125 mg $kg^{-1}$ have been categorized under low category. All the aonla orchard soils were found low in available nitrogen content. The cause of low available nitrogen content in all these soils had been due to the absence of natural vegetation, low organic carbon, low precipitation and high temperature which aggravates decomposition of organic matter by enhancing oxidation and aeration. The results of present study are in confirmation with those reported by Bhatnagar *et al.* (2000) and Rohitash (2007).

The available phosphorus content varied from 9.08 to 32.01 kg $ha^{-1}$ with a mean value of 23.00 for all the depths. The data presented on available phosphorus content of orchard soils showed a decreasing trend with increase in depths. As per the ratings given by Tandon (1992), the soils having <10.26 mg $kg^{-1}$ have been categorized under low soils whereas those having 10.26 to 25.85 mg $kg^{-1}$ falls under medium category. A close examination of data revealed that available phosphorus was low in 13 per cent

Table 1. Nutrient status of aonla orchard soils of Sikar district of Rajasthan

| Soil depths/ characters | 0-15 cm. | | 15-30 cm. | | 30-45 cm. | | 45-60 cm. | |
|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Range | Mean | Range | Mean | Range | Mean |
| pH | 7.70 8.83 | 8.21 | 7.83 8.93 | 8.38 | 7.88 8.97 | 8.45 | 7.93 9.02 | 8.50 |
| EC(dsm$^{-1}$) | 0.360 0.093 | 0.239 | 0.080 0.317 | 0.215 | 0.073 0.303 | 0.205 | 0.070 0.297 | 0.196 |
| OC(%) | 0.091 0.171 | 0.136 | 0.089 0.168 | 0.133 | 0.083 0.161 | 0.128 | 0.078 0.157 | 0.123 |
| N(kgha$^{-1}$) | 85.0 121.0 | 106.13 | 81.0 118.0 | 104.13 | 79.0 116.0 | 101.38 | 76.0 112.0 | 98.38 |
| P(kgha$^{-1}$) | 11.39 32.01 | 25.56 | 10.28 31.07 | 24.56 | 9.82 28.87 | 23.12 | 9.72 28.64 | 22.82 |
| K(kgha$^{-1}$) | 124.0 162.0 | 139.0 | 121.0 158.0 | 135.50 | 118.0 152.0 | 131.50 | 114.0 147.0 | 127.75 |
| Ca(cmolekg$^{-1}$) | 2.59 3.81 | 3.35 | 2.67 3.89 | 3.43 | 2.71 3.94 | 3.49 | 2.76 3.99 | 3.53 |
| Mg(cmolekg$^{-1}$) | 1.49 1.94 | 1.82 | 1.47 1.96 | 1.84 | 1.50 1.98 | 1.85 | 1.53 2.00 | 1.88 |
| S(mgkg$^{-1}$) | 6.31 8.60 | 6.91 | 6.28 8.56 | 6.86 | 6.02 8.23 | 6.67 | 5.80 8.31 | 6.37 |
| Fe(mgkg$^{-1}$) | 2.50 6.51 | 4.56 | 2.47 6.48 | 4.54 | 2.46 6.48 | 4.51 | 2.44 6.44 | 4.47 |
| Zn(mgkg$^{-1}$) | 0.357 0.990 | 0.663 | 0.340 0.973 | 0.642 | 0.313 0.953 | 0.621 | 0.293 0.927 | 0.599 |
| Cu(mgkg$^{-1}$) | 0.177 0.493 | 0.295 | 0.163 0.467 | 0.278 | 0.150 0.443 | 0.262 | 0.140 0.420 | 0.246 |
| Mn(mgkg$^{-1}$) | 1.84 5.19 | 3.26 | 1.69 5.09 | 3.15 | 1.62 5.01 | 3.08 | 1.57 4.95 | 3.02 |
| $CaCO_3$ (%) | 2.58 3.96 | 3.51 | 2.63 3.99 | 3.53 | 2.68 4.02 | 3.52 | 2.71 3.96 | 3.56 |
| Soil depths/ characters | 60-75 cm. | | 75-90 cm. | | 90-105 cm. | | 105-120 cm. | |
| | Range | Mean | Range | Mean | Range | Mean | Range | Mean |
| pH | 7.98 9.07 | 8.56 | 7.51 9.11 | 8.52 | 8.06 9.15 | 8.64 | 8.09 9.18 | 8.67 |
| EC(dsm$^{-1}$) | 0.067 0.287 | 0.186 | 0.063 0.273 | 0.176 | 0.060 0.257 | 0.160 | 0.050 0.237 | 0.141 |
| OC(%) | 0.071 0.150 | 0.116 | 0.067 0.143 | 0.110 | 0.061 0.137 | 0.105 | 0.056 0.131 | 0.098 |
| N(kgha$^{-1}$) | 75.0 111.0 | 96.38 | 73.0 108.0 | 94.25 | 71.0 106.0 | 91.75 | 68.0 103.0 | 88.63 |
| P(kgha$^{-1}$) | 9.96 28.09 | 22.55 | 9.64 27.58 | 22.17 | 9.48 27.21 | 21.80 | 9.08 26.96 | 21.49 |
| K(kgha$^{-1}$) | 110.0 143.0 | 124.25 | 108.0 140.0 | 120.75 | 105.0 135.0 | 117.25 | 101.0 130.0 | 113.38 |
| Ca(cmolekg$^{-1}$) | 2.79 4.02 | 3.56 | 2.82 4.17 | 3.60 | 2.86 4.26 | 3.64 | 2.49 4.29 | 3.68 |
| Mg(cmolekg$^{-1}$) | 1.57 2.03 | 1.91 | 1.65 2.09 | 1.98 | 1.64 2.16 | 2.02 | 1.75 2.20 | 2.07 |
| S(mgkg$^{-1}$) | 5.12 8.21 | 6.09 | 5.08 8.17 | 6.05 | 5.05 8.14 | 6.02 | 5.03 8.10 | 5.99 |
| Fe(mgkg$^{-1}$) | 2.41 6.38 | 4.43 | 2.38 6.35 | 4.39 | 2.32 6.30 | 4.34 | 2.28 6.25 | 4.34 |
| Zn(mgkg$^{-1}$) | 0.270 0.903 | 0.574 | 0.237 0.880 | 0.551 | 0.233 0.843 | 0.532 | 0.203 0.770 | 0.519 |
| Cu(mgkg$^{-1}$) | 0.130 0.407 | 0.233 | 0.123 0.377 | 0.216 | 0.120 - 0.357 | 0.202 | 0.110 0.330 | 0.183 |
| Mn(mgkg$^{-1}$) | 1.51 4.90 | 2.97 | 1.46 4.84 | 2.91 | 1.42 4.78 | 2.84 | 1.36 4.73 | 2.79 |
| $CaCO_3$ (%) | 2.74 3.97 | 3.60 | 3.11 4.01 | 3.69 | 3.15 4.07 | 3.73 | 3.21 4.12 | 3.78 |

whereas, 87 per cent orchards were medium in respect to available phosphorus in aonla orchards. The low to medium availability of phosphorus might be due to the presence of high pH, low organic carbon, calcareousness, low precipitation, high temperature and light textured coarse sandy soils. The results of present investigations are in accordance with those reported by Bhatnagar *et al.*(2000) and Sharma and Mahajan (1990).

The available potassium content ranged between 101.00 to 162.00 kg $ha^{-1}$ with a mean value of 126.17 for all the depths. In the present study, the available potassium content of orchard soils showed a decreasing trend with increase in depths. As per the ratings given by Tandon (1992), the soils having <58.03 to 149.55 mg $kg^{-1}$ falls under medium category. All the soil samples of aonla were medium in available potassium. A satisfactory potassium status of the studied area might be due to the presence of potash bearing minerals (muscovite, biotite and feldspar) which on weathering slowly release potash. Bhatnagar *et al.* (2000) reported similar results.

The exchangeable calcium content varied from 2.59 to 4.29 cmol $kg^{-1}$ with a mean value of 3.53 for all the depths. The exchangeable magnesium content of these orchard soils ranged from 1.47 to 2.20 cmol $kg^{-1}$ with a mean value of 1.92 for all the depths. In the present study, the exchangeable calcium and magnesium content of orchard soils showed a increasing trend with increase in depths. All the soil samples drawn from aonla orchards were found high in exchangeable calcium and magnesium content. The high exchangeable calcium content in all these soils could be because of calcareous nature of the soils which further due to in accumulation i.e. of exchangeable calcium in the profile zone. Being high in base saturation all the soil samples of aonla orchards were found having fairly good amount of exchangeable magnesium content. Bhatnagar *et al.* (2000) and Rohitash (2007) reported similar results.

The available sulphur content ranged between 5.03 to 8.60 mg $kg^{-1}$ with a mean value of 6.37 for all the depths. The data presented on available sulphur content of orchard soils showed a decreasing trend with increase in depths. Based on the ratings given by Tandon (1992), the soils having less than 10 mg $kg^{-1}$ falls under low category, those having more than 10 mg $kg^{-1}$ falls under medium category. All the soil samples of aonla orchards were found low in available sulphur content. The low content of these soils may be due to high temperature, low precipitation, very low organic matter and light textured coarse sandy soils. The findings reported by Bhatnagar *et al.* (2000), Kumar (2004) and Rohitash (2007) are almost similar to the results of present investigations.

The DTPA extractable iron content ranged between 2.28 to 6.51 mg $kg^{-1}$ with a mean value of 4.44 for all the depths. The data presented on DTPA extractable iron content of orchard soils showed a decreasing trend with increase in depths. As per the ratings given by Tandon (1992), the soils having <4.5 mg $kg^{-1}$ falls under deficient category and those having >4.5 mg $kg^{-1}$ falls under sufficient category. A close examination of data revealed that DTPA extractable iron was deficient in 50 per cent, whereas 50 per centper cent orchards were sufficient in respect to DTPA extractable iron in aonla orchards. The deficient to sufficient status of iron found in the soil might be due to calcareousness, low organic carbon content, light textured coarse sandy soils. Similar observations were reported by Bhatnagar *et al.* (2000) and Bhatnagar and Chandra (2003).

The DTPA extractable zinc content ranged between 0.203 to 0.990 mg $kg^{-1}$ with a mean value of 0.587 for all the depths. The data presented on DTPA extractable zinc content of orchard soils showed a decreasing trend with increase in depths. As per the ratings given by Tandon (1992), the soils having less than 0.6 mg $kg^{-1}$ falls under deficient category, those having 0.6 to 1.2 mg $kg^{-1}$ falls under sufficient category. Fifty per cent soil samples of aonla orchards were deficient in DTPA extractable zinc. Remaining 50 per cent soil samples of aonla orchards were sufficient in DTPA extractable zinc. This range of zinc in soils might be due to the presence of quartz, feldspar or the exchange complex being such as to have sites saturated with Ca/Mg under alkaline soil reaction. Calcareous nature and low organic matter are some of the other properties where low levels of zinc are anticipated. Similar findings were reported by Sharma and Bhandari (1995) and Kameriya (1995).

The DTPA extractable copper content ranged between 0.110 to 0.493 mg $kg^{-1}$ with a mean value of 0.238 for all the depths. The data presented on DTPA extractable copper content of orchard soils showed a decreasing trend with increase in depths. As per the ratings given by Tandon (1992), the soils having <0.2 mg $kg^{-1}$ falls under deficient category, those having >0.2 mg $kg^{-1}$ falls under sufficient category. Fifty per cent soil samples of aonla orchards were deficient in DTPA extractable copper. Remaining 50 per cent soil samples of aonla orchards were sufficient in DTPA extractable copper. The deficient to sufficient available copper status of orchard soil might be due to high pH, calcareousness, lower organic carbon and light textured coarse sandy soils. The present results are in accordance with those reported by Baser and Lodha (1971) who reported that available copper status in sandy soils of Rajasthan varied from 0.05 to 2.38 ppm.

The DTPA extractable manganese content ranged between 1.36 to 5.19 mg $kg^{-1}$ with a mean value of 3.00 for all the depths. The data presented on DTPA extractable manganese content of orchard soils showed a regular decreasing trend with increase in depths. As per rating given by Tandon (1992), the soils having <2 mg $kg^{-1}$ falls under deficient category while those having >2 mg $kg^{-1}$ falls under sufficient category. Twenty five per cent soil samples drawn from surface soil depth of aonla orchards were deficient and 75 per cent were sufficient in DTPA extractable iron in the present study. Results of DTPA extractable manganese in all the orchards clearly indicate that deficiency of manganese in the fruit orchards is now coming. Another in the present study only 1/4th orchards have shown deficient. The deficiency of DTPA extractable manganese might be due to the presence of high $CaCO_3$

content and low organic carbon content. These results are in accordance with those reported by Bhatanagar *et al.* (2000); Bhatnagar and Chandra (2003), Kumar (2004) and Rohitash (2007).

The calcium carbonate percentage ranged between 2.58 to 4.12 with a mean value of 3.61 for all the depths. Calcium carbonate percentage increased with the increasing depths. It indicates that the calcium leached down from surface soil to sub-surface soils accumulated in the form of calcium carbonate as secondary carbonate. A comparative high calcium carbonate content of soil might be due to dominance of alkaline earth carbonates in the soils. Similar results were also observed for arid and semi arid regions by Bhatnagar *et al.* (2000), Kumar (2004) and Rohitash (2007).

**References**


Anonymous, 2005. Horticultural Data Base. National Horticultural Board, Ministry of Agriculture, Govt. of India.

Anonymous, 2005. SREP prepared by ATMA district Sikar, pp. 6-7.

Bhatnagar, P. and Chandra, A. and Gupta, P.K. 2000. Studies on nutrient status of fruit orchard soils in Bikaner district of Rajasthan. *Curr. Agric.* 24 (1-2): 119-122.

Bhatnagar, P. and Chandra, A. 2003. Distribution of micronutrient cations in arid irrigated orchard soil profiles of western Rajasthan. *Journal of Eco-physiolog.* 6(3-4): 93-100.

Baser, B.L. and Lodha, P.S. 1971. Available micronutrients in sandy soils of Rajasthan. *Annals Arid Zone.* 10 : 93-94.

Chandra, Atul and Chandra, Anju. 1997. Production and Post harvest technology of fruits. NBS, Bikaner, pp. 280.

Chesnin, L. and Yien, C.H., 1957. Proc. Soil Sci. Amer. 15 : 149.

Jackson, M.L. 1973. Soil chemical analysis. *Asia Publishing House,* Bombay.

Kameriya, P.R. 1995. Characterization of soil of Agroclimatic zone of transitional plain of Inland drainage (Zone II-A) of Rajasthan. Ph.D. Thesis, RAU, Bikaner.

Kumar. 2004. Studies on yield and qualitative attributes of Ber (*Zizyphus marutiana* Lamk) and pomegranate (*Punica granatum* L.) as affected by nutritional status of orchards. M.Sc. Thesis, RAU, Bikaner.

Lindsay, W.L. and Norvell, W.A. 1978. Development of DTPA soil test for zinc, manganese and copper. *Soil Sci.Soc.Am. J.* 42 : 421-428.

Muhr, G.R., Datta, N.P., Shankara, Subramoney, N., Lecy, V.K. and Donahue, R.L. 1963. Soil testing in India. U.S.D.A. Publication. pp. 120.

Olsen, S.R., Cole, V.C., Watanable, F.S. and Dean, L.A. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. *Cir. U.S. Dept. Agric.* pp : 939

Richards, L.A. 1954. Diagnosis and improvement of saline and alkali soils. U.S.D.A., Handbook No. 60, Washington, D.C.

Rohitash. 2007. Role of soil nutrient status on nutrient content and fruit yield of aonla. M.Sc. Thesis, Rajasthan Agricultural University, Bikaner.

Sharma, J.C. and Bhandari, A.R. 1995. Mineral nutrient status of Apple orchards in Himachal Pradesh. *J. Indian Soc. Soil Sci.* 43: 236-241.

Subbiah, B.V. and Asija, G.L. 1956. A rapid procedure for the determination of available nitrogen in soils. *Curr. Sci.* 25: 259-260.

Sharma, V.K. and Mahajan, K.K. 1990. Studies on nutrient status of mandarin orchards in Himachal Pradesh. *Indian J. Hort.* 47 (20): 180-185.

Tandon, H.L.S. 1992. Fertilizer Development and Consultation Organization, A Bhanot Corner, 1-2 Pompers Enclave, New Delhi. Pp 202-204.

Walkley, A. and Black, I.A. 1947. Rapid titration method for organic carbon of soils. *Soil Sci.* 37 : 29-32.

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# Effect of temperature, relative humidity and botanicals on *Alternaria* and *Aspergillus* fruit rots in ber fruits.

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**Abstract**

The disease severity due to *Alternaria alternata* and *Aspergillus niger* was highest at 25 and 30 °C, respectively. The temperature and relative humidity influenced the development of fruit rots due to *A. alternata* and *A. niger* symptoms ranges tested. Severity of *Alternaria* fruit rot was maximum at 25 °C and 100 per cent relative humidity while severity of *Aspergillus* fruit rot was maximum at 30 °C and 100 per cent relative humidity. Neem oil and groundnut oil used as pre-inoculation treatment effectively reduced the severity of *Alternaria* fruit rot. In case of *Aspergillus* fruit rot neem oil and castor oil treated fruits showed minimum severity of fruit rot. Post- inoculation treatment of neem oil was quite effective in reducing the *Alternaria* and *Aspergillus* fruit rots. Pre or post- inoculation treatments of leaf extracts of *Azadirachta indica* and *Ocimum sanctum* provided effective control of both *Alternaria* and *Aspergillus* rots of ber fruits.

**Key words**: *Zizyphus mauritiana, Alternaria alternata, Aspergillus niger,* ber, fruit rots.

## Introduction

Ber (*Zizyphus mauritiana* Lamk.) belongs to the genus *Zizyphus* of the family Rhamnaceae includes about 40 species in tropical and sub-tropical region. Two species of ber such as Zizyphus *jujube* Mill. known as Chinese date and *Z. mauritiana* Lamk., known as Indian jujube or ber are most important in terms of distribution and economic viability (Lyrene, 1979 and Abbas, 1997). Mostly, ber cultivation is common in water deficient and low rainfall areas of Rajasthan, Gujarat, Maharashtra, Haryana, Bihar, Andhra Pradesh, Madhya Pradesh and Uttar Pradesh. Fruit rots due to *Alternaria alternata* and *Aspergillus niger* are important problems of ber orchards and markets in arid and semi- arid regions of the country. *A. alternata* and *A. niger* fungi cause serious losses in ber fruits during storage and marketing in arid region including Bikaner market. Not much work has been done on post- harvest fungal deterioration in ber fruits. The present paper reports the effect of temperature and relative humidity on development of fruit rots due to *A. alternata* and *A. niger* and also influence of botanicals on management of these two pathogens.

## Materials and methods

### Effect of temperature on development of disease

Mature fruits of ber were brought from markets and orchards, surface sterilized with dipping them in 0.1 per cent mercuric chloride solution for 1-2 minutes followed by three washing with sterilized distilled water and inoculated with the pathogens. The inoculum was taken from 7 days old cultures of the fungus grown in perti dishes. A hole of 2 mm diameter and 2 mm depth was made with the help of sterilized cork borer. The 2 mm disc cut of the inoculum was inserted in the hole and the host pulp was replaced on the hole, which was corked out earlier. The inoculated fruits were incubated at 20, 25, 30 and 35 °C temperature. The inoculated ber fruits were covered by a thin layer of sterilized cotton saturated with sterilized water. These inoculated ber fruits were kept in fresh surface sterilized polythene bags. The mouth of bags were loosely tied with the help of rubber band and incubated at 26±1 °C temperature.

### Effect of relative humidity on development of disease

Surface sterilized ber fruits were inoculated with uniform amount of inoculum of two test pathogens viz., *Alternaria alternata* and *Aspergillus niger* with the sterilized cork borer wounding method. The method of incubation and assessment were same as mentioned earlier. The inoculated fruits were subjected to different levels of relative humidity viz., 50, 60, 70, 80, 90 and 100 per cent levels of relative humidity at 26±1 °C temperature. The inoculated fruits were accommodated in a desiccator which contained sulphuric acid ($H_2SO_4$) solution to produce a particular level of relative humidity (Buxton and Mellanby, 1934). The desicators were sealed with greese and kept at 26±1 °C temperature.

### Management of diseases

### Oil treatment

Fruits were surface sterilized and inoculated separately with both the test pathogens by cork borer wounding method. Four vegetable oils viz., mustard oil, groundnut oil, castor oil and neem oil were used in the study. These four test oils were smeared on the fruit surface with the help of cotton swab. In pre-inoculation treatment, the fruits were first smeared with test oil and then inoculate. While in case of post-inoculation treatment, the fruits were first inoculated and then smeared with the oils. The interval between inoculation and smearing with oils or *vice-versa* was 12 hours.

**Plant extract treatment**

Leaf extracts of *Azadirachta indica* A. Juss., *Vinca rosea* Linn., *Withania somnifera* Dunal. and *Ocimum sanctum* Linn., were tested against fruit rots of ber due to *Alternaria alternata* and *Aspergillus niger* separately. Leaves were first washed with sterile distilled water and then air dried. Weighed amount of plant material was homogenized in a tissue homogenized. One ml of sterile distilled water was used for each gram of leaves. The material was homogenized for 5 minutes and the mixture was filtered through muslin cloth followed by filtration through Whatman No. 1 filter paper. Surface sterilized fruits were inoculated with both test pathogens separately. Each plant extract was tested in both pre- and post-inoculation treatments for both of the pathogens. In pre-inoculation treatments, the fruits were first dipped in the test plant extracts for 10 minutes and then inoculated. While in the post- inoculation treatments, the fruits were first inoculated with the individual pathogens and then treated with the test plant extracts. The interval between inoculation and treatment with plant extracts or *vice-versa* was 12 hours. There were four replications in each treatment. Controls were maintained. The method of inoculation of fruits was same as mentioned earlier. The experiment was arranged in Completely Randomized Design. Data on severity of the rots were recorded on 4$^{th}$ and 8$^{th}$ day of inoculations with the assessment key suggested by Mayee and Datar (1986).

**Results and Discussion**

**Effect of temperature and relative humidity on severity of fruit rots**

Temperature had profound effect on fruit rots like *Alternaria* rot and *Aspergillus* rot. The maximum rotting severity of *Alternaria alternata* was recorded at 25 °C. While it was quite less at either low temperature (20 °C) or at high temperature (35 °C). In case of *Aspergillus niger,* the fruit rot severity was highest at 30 °C followed by 25 °C and it was lowest at 20 °C (Table 1). Temperature ranges from 20- 30 °C reported to be optimum for the rapid development of fruit rot chillies caused by *Alternaria alternata, Aspergillus niger, Colletotrichum capsici, Drechslera australiensis, Fusarium moniliforme* and *Fusarium solani* (Datar, 1995). Similarly, temperature ranges of 25- 30 °C was found conducive in developing fruit rots of guava due to *Rhizopus* sp. (Patel and Pathak, 1996). The severity of the fruit rots increased with the increasing levels of RH tested in the present investigation. The maximum severity of *Alternaria* fruit rot was at 100 percent RH followed by 90 percent RH after 8 days of inoculation. Similar observations were also recorded in case of *Aspergillus* rot in ber. The severity of rotting was quite high at 90-100 percent RH on both 4$^{th}$ and 8$^{th}$ day of inoculations. The rotting severity due to both the pathogens was quite low at 50 percent RH (Table 2). High RH mostly favours the infection and disease development by fungal pathogens in fruits (Chopra *et al.*, 1993, Ved Ram and Dharamvir, 1996). It may be due to enhanced conidial germination, infection and decreased host resistance at higher RH. In the present studies, both *Alternaria* fruit rot and *Aspergillus* fruit rot were most severe at high level of RH on 4$^{th}$ and 8$^{th}$ day of inoculation.

**Effect of oils**

The severity of fruit rots induced by the pathogens viz. *Alternaria* and *Aspergillus* was significantly reduced by all the test oils used in pre- and post- inoculation experiment. Neem oil was most effective, but it was at par with ground nut oil, and it was significantly better over the castor and mustard oils in reducing the disease severity of *Alternaria* fruit rot in pre-inoculation treatment (Table 3). In case of *Aspergillus* fruit rot, the neem oil also found to be most effective and was at par with castor oil but it was significantly better than groundnut and mustard oil in reducing the severity of fruit rot. The data recorded in post-inoculation treatments recorded that neem oil treatment was significantly better than mustard and groundnut oil in reducing the severity of fruit rot due to *A. alternata.* In case of *Aspergillus* fruit rot, neem oil also provided effective control as compared to other oils tested (Table 4). Effectiveness of commercial oils against storage rots of different fruits has been reported by various workers (Aulakh and Grover, 1968, Raoof and Om Prakash, 1983, Vyas and Pathak, 1995). In the present investigation neem oil used in pre-and post- inoculation treatments proved most effective protection against both fruit rots.

**Effect of leaf extracts**

*Azadirachta indica* treatment was found most effective against both the rots in pre- and post- inoculation treatments. *Ocimum sanctum* was found to be next best treatment against these two post- harvest rots. While the performance of *Withania somnifera* pre- and post-inoculation treatment was relatively low in protecting both kind of rots *Alternaria* and *Aspergillus* rots in ber fruit (Tables 5 & 6).

The efficacy of plant extracts against fungal rots in many other fruits and vegetables have been reported. (Bisht and Kamal, 1994, Srivastava and Lal, 1997, Dargan and Saxena, 2002, Meena, *et al.*, 2009). The efficacy of *Azadirachta indica* and *Ocimum sanctum* against the fungal pathogens involved in post- harvest rots in fruits and vegetables have also been reported (Sinha and Saxena, 1989, Ahmed and Prasad, 1995). Looking to residual toxicity and other side effects of pesticide, the use of oils and botanicals in the management of post- harvest rots of ber fruits should be encouraged.

Table 1. Effect of temperature treatment on severity of fruit rots in ber

| Temperature | *Alternaria alternata* severity (%) | | *Aspergillus niger* severity (%) | |
|---|---|---|---|---|
| | 4th day of inoculation | 8th day of inoculation | 4th day of inoculation | 8th day of inoculation |
| 200 C | 9.00 | 16.00 | 9.00 | 15.00 |
| | (17.45)* | (23.57)* | (17.45)* | (22.78)* |
| 250 C | 16.00 | 27.50 | 13.25 | 22.75 |
| | (23.58) | (31.63) | (21.34) | (28.49) |
| 300 C | 13.50 | 21.00 | 18.50 | 28.00 |
| | (21.55) | (27.27) | (25.47) | (31.95) |
| 350 C | 8.75 | 14.25 | 11.50 | 19.25 |
| | (17.20) | (22.17) | (19.59) | (26.02) |
| S.Em+ | (0.33) | (0.21) | (0.32) | (0.23) |
| CD at 5 % | (1.00) | (0.65) | (0.99) | (0.70) |

*Figures in parentheses are angular transformed values.

Table 2. Effect of different levels of relative humidity on severity of fruit rots in ber

| Relative humidity (%) | *Alternaria alternata* severity (%) | | *Aspergillus niger* severity (%) | |
|---|---|---|---|---|
| | $4^{th}$ day of inoculation | $8^{th}$ day of inoculation | $4^{th}$ day of inoculation | $8^{th}$ day of inoculation |
| 50 | 3.75 | 7.50 | 6.00 | 10.00 |
| | (11.08)* | (15.89)* | (14.15)* | (18.43)* |
| 60 | 7.50 | 11.25 | 10.25 | 15.00 |
| | (15.86) | (19.59) | (18.67) | (22.78) |
| 70 | 10.00 | 14.00 | 12.50 | 18.50 |
| | (18.41) | (21.76) | (20.70) | (25.47) |
| 80 | 12.50 | 17.50 | 16.00 | 21.75 |
| | (20.69) | (24.72) | (23.58) | (27.80) |
| 90 | 15.00 | 23.25 | 18.00 | 25.50 |
| | (22.77) | (28.83) | (25.10) | (30.33) |
| 100 | 16.25 | 24.00 | 21.00 | 26.00 |
| | (23.76) | (29.32) | (27.45) | (30.65) |
| S.Em± | (0.75) | (0.43) | (0.36) | (0.40) |
| CD at 5 % | (2.22) | (1.28) | (1.08) | (1.19) |

*Figures in parentheses are angular transformed values.

Table 3. Effect of pre- inoculation treatment with oils on severity of fruit rots in ber

| Oils | *Alternaria alternata* severity (%) | | *Aspergillus niger* severity (%) | |
|---|---|---|---|---|
| | $4^{th}$ day of inoculation | $8^{th}$ day of inoculation | $4^{th}$ day of inoculation | $8^{th}$ day of inoculation |
| Mustard oil | 5.00 (12.91)* | 8.00 (16.35) | 6.50 (14.76) | 9.00 (17.45) |
| Groundnut oil | 3.00 (9.99) | 5.50 (13.55) | 5.00 (12.88) | 7.25 (16.36) |
| Neem oil | 2.75 (9.54) | 4.00 (11.72) | 3.25 (10.38) | 4.50 (12.24) |
| Castor oil | 3.25 (10.51) | 5.50 (13.79) | 3.75 (11.14) | 5.25 (13.07) |
| Control | 15.50 (23.28) | 25.00 (30.00) | 17.00 (24.35) | 26.50 (30.98) |
| S.Em± | (0.64) | (0.64) | (0.51) | (0.63) |
| CD at 5% | (1.93) | (1.94) | (1.55) | (1.90) |

*Figures in parentheses are angular transformed values.

Table 4. Effect of post- inoculation treatment with oils on severity of fruit rots in ber

| Oils | *Alternaria alternata* severity (%) | | *Aspergillus niger* severity (%) | |
|---|---|---|---|---|
| | 4th day of inoculation | 8th day of inoculation | 4th day of inoculation | 8th day of inoculation |
| Mustard oil | 5.00 (12.91)* | 8.00 (16.35) | 6.50 (14.76) | 9.00 (17.45) |
| Groundnut oil | 3.00 (9.99) | 5.50 (13.55) | 5.00 (12.88) | 7.25 (16.36) |
| Neem oil | 2.75 (9.54) | 4.00 (11.72) | 3.25 (10.38) | 4.50 (12.24) |
| Castor oil | 3.25 (10.51) | 5.50 (13.79) | 3.75 (11.14) | 5.25 (13.07) |
| Control | 15.50 (23.28) | 25.00 (30.00) | 17.00 (24.35) | 26.50 (30.98) |
| S.Em+- | (0.64) | (0.64) | (0.51) | (0.63) |
| CD at 5% | (1.93) | (1.94) | (1.55) | (1.90) |

*Figures in parentheses are angular transformed values.

Table 5. Effect of pre- inoculation treatment with leaf extracts on severity of fruit rots in ber

| Leaf extracts | *Alternaria alternata* severity (%) | | *Aspergillus niger* severity (%) | |
|---|---|---|---|---|
| | 4th day of inoculation | 8th day of inoculation | 4th day of inoculation | 8th day of inoculation |
| *Vinca rosea* | 3.50 (10.77)* | 5.75 (13.86) | 7.00 (15.31) | 11.00 (19.36) |
| *Withania somnifera* | 6.00 (14.17) | 8.50 (16.95) | 4.25 (11.86) | 6.25 (14.47) |
| *Azadirachta indica* | 3.00 (9.90) | 4.75 (12.56) | 3.50 (10.77) | 5.00 (12.89) |
| *Ocimum santum* | 3.25 (10.32) | 5.75 (13.84) | 4.00 (11.48) | 6.00 (14.01) |
| Control | 14.50 (22.38) | 24.00 (29.33) | 18.50 (25.47) | 27.00 (31.30) |
| S.Em+- | (0.69) | (0.47) | (0.67) | (0.54) |
| CD at 5% | (2.09) | (1.41) | (2.03) | (1.61) |

*Figures in parentheses are angular transformed values.

Table 6. Effect of post- inoculation treatment with leaf extracts on severity of fruit rots in ber

| Leaf extracts | *Alternaria alternata* severity (%) | | *Aspergillus niger* severity (%) | |
|---|---|---|---|---|
| | 4th day of inoculation | 8th day of inoculation | 4th day of inoculation | 8th day of inoculation |
| *Vinca rosea* | 8.00 (16.31)* | 11.50 (19.82) | 10.00 (18.43) | 14.00 (21.68) |
| *Withania somnifera* | 9.50 (17.95) | 14.00 (21.97) | 8.25 (16.69) | 12.00 (20.26) |
| *Azadirachta indica* | 5.00 (12.91) | 7.00 (15.33) | 5.25 (13.23) | 8.50 (16.94) |
| *Ocimum santum* | 5.75 (13.86) | 8.25 (16.57) | 6.50 (14.76) | 9.00 (17.45) |
| Control | 17.00 (24.34) | 26.25 (30.82) | 16.50 (23.96) | 28.00 (31.95) |
| S.Em+- | (0.34) | (0.31) | (0.34) | (0.31) |
| CD at 5% | (1.02) | (0.92) | (1.03) | (0.95) |

*Figures in parentheses are angular transformed values.

**References**


Abbas, M.F. 1997. Jujube In: Post- harvest physiology and storage of tropical and subtropical fruits. (Ed. S.K. Mitra), CAB International. pp. 405-415.

Ahmad, S.K. and Prasad, J.S. 1995. Efficacy of foliar extracts against pre- and post- harvest of sponge gourd fruits. *Letters Appl. Microbio.* 21: 373-375.

Aulakh, K.S. and Grover, R.K. 1968. Ripe fruit rots in tomato and their control by oils. *Pl. Dis. Reptr.* 52: 555-559.

Bisht, S.S. and Kamal. 1994. Garlic extract, an antifungal treatment for the control of storage rot of apple. *Proc. Nat. Acad-India.* 64 BII: 233-234.

Buxton, P.A. and Mellanby, K. 1934. Measurement and control of humidity. *Bull Ento. Res.* 25: 171-175.

Chopra, S., Metha, A. and Mehta, P. 1993. Fruit rot of *Emblica officinalis, Prunus domestica* and *Citrus medica* caused by *Aspergillus niger*. *Indian J. Mycol. Pl. Pathol.* 23 (2): 129-134.

Dargan, P. and Saxena, S.K. 2002. Effect of extract of *Withania somnifera* on fruit rot of tomato caused by *Aspergillus niger* in presence of *Drosophila busckii*. *Indian Phytopath.* 55 (1): 112-113.

Datar, V.V. 1995. Pathogenicity and effect of temperature on six fungi causing fruit rot of chilli. *Indian J. Mycol. Pl. Pathol.* 25 (3): 195-197.

Lyrene, P.M. 1979. The Jujube Tree (*Zizyphus jujube* Mill.) *Fruit variety J.* 33: 100-104.

Mayee, C.D. and Datar, V.V. 1986. Phytopathometry Tech. Bulletin. 1 (Special Bulletin-3). Maradhawada Agriculture University, Prabhni (Maharashtra).

Meena, O.P., Godara, S.L., Rathore, G.S. and Vijay Pal. 2009. Eco-friendly management of post- harvest fruit rot of guava caused by *Pestalotiopsis palmarum*. *J. Mycol. Pl. Pathol.* 39 (3): 445-448.

Patel, K.D. and Pathak, V.N. 1996. Temperature and relative humidity in relation to development of Rhizopus rot of guava fruits. *Indian J. Mycol. Pl. Pathol.* 26 (1): 9-13.

Raoof, M.A. and Om Prakash. 1983. Evaluation of fixed oils for the control of black rot of mango fruits. *Indian J. Mycol. Pl. Pathol.* 10: 348-349.

Sinha, P. and Saxena, S.K. 1989. Effect of treating tomatoes with leaf extracts of certain plants on the development of fruit rot caused by *Aspergillus niger* in presence of *Drosophila busekii*. *J. Phyto. Res.* 2: 97-101.

Srivastava, A.K. and Lal, B. 1997. Studies on bio fungicidal properties of leaf extracts of some plants. *Indian Phytopath.* 50 (3): 408-411.

Ved, Ram and Dharamvir. 1996. Effect of temperature and relative humidity of fungal deterioration of banana fruits. *Indian J. Mycol. Pl. Pthol.* 26 (3): 302-304.

Vyas, R.K. and Pathak, V.N. 1995. Management of Aspergillus rot of mango fruit. *Indian J. Mycol. Pl. Pathol.* 25: 1-2.

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# Effect of plant growth regulators on yield and quality of ber (*Zizyphus mauritiana* Lamk.) in semi-arid conditions

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**Abstract**

The present *investigation* carried out to know the response of plant growth regulators on different cultivars of ber in semi-arid condition as prevailing high temperature and low humidity climatic situations in such regions are major hindrance of good yield. Experiment was conducted with 21 treatments and each treatment was replicated three times under Randomized Block Design. The *experiment comprised three cultivars of ber viz., Gola, Kaithli and Umran and three plant growth regulators (NAA, 2,4-D and GA$_3$) with two concentration of each viz., 15 and 30 ppm and one control (water spray).* The result *showed* that among PGRs spray of 2,4-D @ 30 ppm and among cultivars, cv. *Umran* exhibited significant *influence on most of yield and quality parameters with maximum net return and B: C ratio except fruit weight, fruit diameter, TSS and sugars of ber fruits.*

**Key words:** PGRs, 2,4-D, GA$_3$, NAA, ber, quality, semi-arid condition, *etc.*

## Introduction

Indian jujube or ber (*Zizyphus mauritiana* Lamk.) is one of the most ancient and common fruit which is indigenous to India, South-Western China and Malaya. It belongs to family Rhamnaceae and is tetraploid (2n = 48) in nature. In India, ber is being cultivated on an area of about 87674 hectare with the production of 8,94,848 metric tonnes (Raturi, 2001), is an important fruit crop of semi-arid conditions of Madhya Pradesh, Bihar, Punjab, Haryana, Gujarat and *Rajasthan states.* Ber is popularly known as king of fruits of these regions and "poor man's fruit". It being a hardy crop can be grown on marginal lands with less water where other crops do not grow economically. The fruits of ber are generally consumed fresh as well as in dried and preserved form as candy, jam, jelly and marmalade. It is highly nutritious which contains ascorbic acid 90 -280 mg 100 g$^{-1}$, vitamin 'A' 55 mg 100 g$^{-1}$, thiamine 0.13 mg g$^{-1}$, riboflavin 0.19 mg 100 g$^{-1}$, total soluble solids 17-20 %, acidity 0.21 %, â carotene 81 µg 100 g$^{-1}$, protein 0.8 g 100 g$^{-1}$, fat 0.3 g 100 g$^{-1}$, carbohydrates 17 g 100 g$^{-1}$, calcium 4 mg 100 g$^{-1}$, phosphorus 9 mg 100 g$^{-1}$ and iron 1.8 mg 100 g$^{-1}$. Plant growth regulators act as metabolic sink for the diversion of metabolites from one part to other parts of the plant leading regulation of flowering, thinning of flower and fruit, improvement of fruit set and size and prevention of pre-harvest fruit drop (Singh, 1990).

## Materials and methods

The present *study* was carried out at Asalpur Horticulture Research Farm, S.K.N. College of Agriculture, Jobner during year 2006-07. The trees of uniform size, vigorous, bearing stage and of approximately 20 years age were selected. A single tree was kept as a unit for each treatment having three replications. The experiment comprised of 21 treatments consisting of three cultivars viz., Gola, Kaithli and Umran and seven of PGRs (NAA, 2,4-D and GA$_3$ with two concentration of each viz., 15 and 30 ppm and one control i.e. water spray). Two sprays of plant growth regulators and water were made on all three cultivars of ber at 50 per cent of the flower opened stage and one month later.

One kg fresh and mature golden yellow coloured fruits from each tree of ber were brought to the PHT Laboratory, *department of Horticulture, Jobner* to record the observations like fruit weight, fruit diameter, yield, pulp : stone ratio and quality parameters like TSS (determined by Zeiss$^{Tm}$ hand refractometer on percentage basis at 20C), ascorbic acid content of fruits by using metaphosphoric acid and 2,6 dichlorophenol-indophenol dye solution (A.O.A.C., 1990) and total sugars was determined by using Anthrone reagent method (Dubois *et al.*, 1951). The data recorded for physical and chemical parameters were analysed *statistically* using analysis of variance techniques (Cochran and Cox, 1950).

## Results and discussion

Experimental findings exhibited that *application* of NAA, 2, 4-D and GA$_3$ had great and significant impact on fruit set percentage, fruit retention and yield (Table 1 & 2). Spray of 2, 4-D @ 30 ppm recorded significantly more fruit set, fruit retention and finally yield per plant as well as yield per hectare in comparison to control and rest of the treatments. The favourable influence of applied growth regulators on these characters may be ascribed to their physiological effect on metabolic processes of the plant. Application of auxins like, NAA and 2, 4-D might be improved the auxin level of the ovary which have a positive

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effect on fruit set in ber. These findings are in accordance with that of Bankar and Prasad (1990) and Singh *et al.* (2001) in ber. Spray of $GA_3$, NAA and 2, 4-D (30 ppm of each) significantly reduced the fruit drop (Table 1). The minimum and significant reduction in fruit drop (56.54 %) was observed under 2, 4-D applied @ 30 ppm followed by $GA_3$ applied @ 30 ppm (57.03 %) and NAA @ 30 ppm (57.21 %) over control (67.58 %). The reduction in dropping of fruit might be due to supply of sufficient auxin or auxin like precursor for developing fruits as reported in navel orange (Lima and Davies, 1984). The results obtained in present investigation are also in line with findings of Singh *et al.* (2001) and Yadav (2002) in ber.

Significant effect of different levels of plant growth regulators was observed on weight, diameter and pulp stone ratio of ber fruits (Tables 1 & 2). The application of $GA_3$ @ 30 ppm resulted in production of highest and significantly more weight, diameter and pulp stone ratio of fruits, whereas, application of $GA_3$ (15 ppm), NAA (15 and 30 ppm) and 2,4-D (15 and 30 ppm) were found statistically at par to it (Table-1). The increase in fruit weight and diameter may be due to enhancement in either flesh or stone or both (Grewal *et al.*, 1993). These results are in concurrence with that of Singh and Chohan (1984) in citrus.

Table 3 indicates that total soluble solids and total sugars were significantly altered by different levels of plant growth regulators. Application of $GA_3$ @ 30 ppm resulted in production of highest and significantly more TSS and total sugars, which was *statistically* at par to 2,4-D (30 ppm), NAA (30 ppm) and $GA_3$ (15 ppm). The *increase in TSS and total sugars of treated fruit juice might be due to the increase in mobilization of carbohydrates from the source to the sink (fruits) by auxin and gibberellin treatments.* These results are in agreement with the findings of Bhati and Yadav (2003) in ber. *Among different plant growth regulators, maximum ascorbic acid content (137.40 mg / 100 g pulp) was recorded under treatment 2,4-D (30 ppm) followed by NAA (30 ppm), where ascorbic acid content was 133.27 mg / 100 g pulp.* This could be attributed to the possible catalystic influence growth regulators on biosynthesis of ascorbic acid from sugars or inhibition of oxidative enzymes or both. Similar results were propounded by Bhati and Yadav (2003) in ber.

The results further *revealed* that cv. Umran in comparison to *Kaithli* and Gola, responded significantly better for the parameters of yield *viz.*, per cent fruit set, per cent fruit drop, per cent fruit retention, fruit weight, fruit diameter, pulp: stone ratio and fruit yield *per plant* and per hectare and *quality viz., total soluble solids (TSS), ascorbic acid and total sugar reducing and non-reducing sugars* (Table 1 to 3). These *improvements* manifested due to higher biomass production in cultivar Umran over *Kaithli* and Gola. The significant *increase in biomass production under cultivar Umran could be ascribed to its higher genetic potential, which might have facilitated larger canopy development, more fruit set, fruit retension and finally higher yield with minimum fruit drop. Such results were* also observed by Sharma *et al.* (1990).

*Being at par with Umran, cv Gola recorded higher values of TSS, ascorbic acid and total sugars over cv. Kaithli.* The variation in these parameters might be due to genetic characteristics of cultivar and prevailed environmental conditions. The variation in quality parameters in different cultivars were also observed by Pandey *et al.* (1990).

*Application of 2, 4-D @ 30 ppm registered highest and significantly more net return (Rs 104484/-) and B: C ratio (3.54:1) over rest of the treatments (Table 3). Net return and B: C also altered significantly with different cultivars. Maximum net return (Rs 126244/-) and benefit: cost ratio (4.07:1) was obtained in cultivar Umran followed by cultivar Gola, while, minimum cv. Kaithli.*

Table 1. Effect of plant growth regulators fruit set, fruit drop, fruit retention and fruit diameter of different ber cultivars

| Treatments | Fruit set (%) | Fruit retention (%) | Fruit drop (%) | Fruit diameter (cm) |
|---|---|---|---|---|
| Plant growth regulators | | | | |
| $P_0$ (control) | 10.76 | 32.42 | 67.58 | 2.92 |
| $P_1$ (NAA 15 ppm) | 17.48 | 40.52 | 59.48 | 3.19 |
| $P_2$ (NAA 30 ppm) | 18.02 | 42.79 | 57.21 | 3.29 |
| $P_3$ (2, 4-D 15 ppm) | 17.76 | 40.85 | 59.15 | 3.23 |
| $P_4$ (2, 4-D 30 ppm) | 18.30 | 43.46 | 56.54 | 3.31 |
| $P_5$ ($GA_3$ 15 ppm) | 16.29 | 40.19 | 59.81 | 3.32 |
| $P_6$ ($GA_3$ 30 ppm) | 17.63 | 42.97 | 57.03 | 3.46 |
| SEm ± | 0.27 | 0.60 | 0.88 | 0.05 |
| CD (P=0.05) | 0.78 | 1.72 | 2.51 | 0.16 |
| Cultivars | | | | |
| $C_1$ (Gola) | 15.68 | 37.52 | 62.57 | 3.34 |
| $C_2$ (Kaithli) | 15.73 | 39.21 | 60.97 | 2.93 |
| $C_3$ (Umran) | 19.00 | 44.92 | 55.08 | 3.47 |
| SEm ± | 0.42 | 0.92 | 1.34 | 0.08 |
| CD (P=0.05) | 1.20 | 2.63 | 3.83 | 0.24 |

C = Cultivars P = Plant growth regulators

Table 2. Effect of plant growth regulators on fruit weight, pulp stone ratio, fruit yield per plant and fruit yield per ha of different ber cultivars

| Treatments | Fruit weight (g) | Pulp : stone ratio | Fruit yield per plant (kg) | Fruit yield ha$^{-1}$ (tonne) |
|---|---|---|---|---|
| Plant growth regulators | | | | |
| $P_0$ (control) | 12.29 | 12.78 | 82.93 | 12.94 |
| $P_1$ (NAA 15 ppm) | 13.15 | 14.38 | 90.74 | 14.16 |
| $P_2$ (NAA 30 ppm) | 13.35 | 14.37 | 93.13 | 14.53 |
| $P_3$ (2, 4-D 15 ppm) | 13.39 | 14.29 | 91.11 | 14.21 |
| $P_4$ (2, 4-D 30 ppm) | 13.52 | 14.29 | 95.81 | 14.95 |
| $P_5$ ($GA_3$ 15 ppm) | 13.44 | 14.45 | 91.03 | 14.20 |
| $P_6$ ($GA_3$ 30 ppm) | 13.59 | 14.54 | 94.62 | 14.76 |
| SEm + | 0.19 | 0.26 | 1.46 | 0.23 |
| CD (P=0.05) | 0.54 | 0.74 | 4.16 | 0.65 |
| Cultivars | | | | |
| $C_1$ (Gola) | 13.43 | 14.60 | 76.24 | 11.89 |
| $C_2$ (Kaithli) | 11.27 | 13.16 | 85.56 | 13.35 |
| $C_3$ (Umran) | 15.04 | 14.72 | 112.22 | 17.51 |
| SEm ± | 0.29 | 0.40 | 2.23 | 0.35 |
| CD (P=0.05) | 0.82 | 1.13 | 6.36 | 0.99 |

C = Cultivars P = Plant growth regulators

Table 3. Effect of plant growth regulators on TSS, ascorbic acid, total sugars and net return and B: C ratio of different ber cultivars.

| Treatments | TSS (%) | Ascorbic acid (mg/ 100g pulp) | Total sugar (%) | Net return | B: C ratio |
|---|---|---|---|---|---|
| Plant growth regulators | | | | | |
| $P_0$ (control) | 17.89 | 111.99 | 10.46 | 86884 | 2.98 |
| $P_1$ (NAA 15 ppm) | 19.33 | 129.44 | 12.40 | 97575 | 3.33 |
| $P_2$ (NAA 30 ppm) | 20.06 | 133.27 | 12.71 | 100708 | 3.41 |
| $P_3$ (2, 4-D 15 ppm) | 19.40 | 128.80 | 12.37 | 98115 | 3.34 |
| $P_4$ (2, 4-D 30 ppm) | 20.23 | 137.40 | 12.81 | 104484 | 3.54 |
| $P_5$ ($GA_3$ 15 ppm) | 20.02 | 124.10 | 12.89 | 93509 | 2.77 |
| $P_6$ ($GA_3$ 30 ppm) | 20.43 | 129.82 | 13.10 | 93870 | 2.44 |
| SEm ± | 0.34 | 2.15 | 0.23 | 1540 | 0.050 |
| CD (P=0.05) | 0.97 | 6.13 | 0.65 | 4389 | 0.142 |
| Cultivars | | | | | |
| $C_1$ (Gola) | 21.17 | 111.58 | 12.82 | 87629 | 2.83 |
| $C_2$ (Kaithli) | 17.59 | 129.71 | 11.80 | 75475 | 2.44 |
| $C_3$ (Umran) | 20.11 | 142.20 | 12.55 | 126244 | 4.07 |
| SEm ± | 0.52 | 3.29 | 0.35 | 2353 | 0.076 |
| CD (P=0.05) | 1.48 | 9.36 | 1.00 | 6705 | 0.216 |

C = Cultivars P = Plant growth regulators

**References**


A.O.A.C. 1990. Official and Tentative Methods of Analysis. Association of Official Analytical Chemists, 18th Edition, Washington, D.C.

Bankar, G.J. and Prasad, R.N. 1990. Effect of gibberellic acid and NAA on fruit set and quality of fruit in ber cv. Gola. *Progressive Horticulture.* 22 (1-4): 60-62.

Bhati, B.S. and Yadav, P.K. 2003. Effect of foliar application of urea and NAA on quality of ber cv. Gola. *Haryana Journal Horticultural Science.* 32 (1-2): 32-33.

Cochran, W.G. and Cox, G.M. 1950. Experimental Designs. Publication of John Willey Inc. New York. 106-110.

Dubois, M., Gilles, K., Hamitton, J.K., Robers, P.A. and Smith, F. 1951. A colorimetric method for determination of sugar. *Nature.* 16: 167.

Grewal, S.S., Singh, G., Dhillon, W.S. and Singh, G. 1993. Effect of growth regulators on fruit drop and quality of fruit in ber (*Zizyphus mauritiana* Lamk). *Punjab Horticultural Journal.* 33 (1-2): 76-83.

Lima, O.J.E. and Davies, F.S. 1984. Growth regulators, fruit drop, yield and quality of Naval orange in Florida. *Journal of American Society Horticulture Science.* 109 (1): 81-84.

Pandey, R., Pathak, R.A. and Pathak, R.K. 1990. Physico-chemical changes associated with growth and development of fruits in ber (*Ziziphus mauritiana* Lamk.). *Indian Journal of Horticulture*. 47(3): 266-270.

Sharma, V.P., Raja, P.V. and Kore, V.N. 1990. Flowering, fruit set and fruit drop in some ber (*Ziziphus mauritiana* Lamk) varieties. *Annals of Agriculture Research*. 11 (1): 14-20.

Singh, A. 1990. Fruit physiology and production. Kalyani Publishers, New Delhi. pp. 258-274.

Singh, M.I. and Chohan, G.S. 1984. Effect of various plant growth regulators on granulation in citrus cv. Dancy Tangerine. *Indian Journal of Horticulture*. 41 (3-4): 221-224.

Singh, R., Godara, N.R., Singh, R. and Dahiya, S.S. 2001. Responses of foliar application of growth regulators and nutrients in ber cv. Umran. *Haryana Journal of Horticultural Science*. 30 (3-4): 161-164.

Yadav, B. 2002. Studies on the effect on NAA, urea and zinc on fruit drop, yield and quality of ber (*Zizyphus mauritiana* Lamk) cv. Umran. M.Sc. Thesis, CCS Haryana Agricultural University, Hisar.

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# Studies on blue mould rot of kinnow (*Citrus reticulata*) due to *Penicillium italicum* Wehmer in relation to temperature, relative humidity and biochemical parameter

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**Abstract**

Five different post-harvest rots i.e. blue mould rot, green mould rot, sour rot, core rot and stem-end rot were prevalent in kinnow fruits during the survey period *viz.*, December, 2009 to March, 2010 in fruit markets of Bikaner, Rajasthan. The blue mould rot was most predominant during February 1, 2010 to March 1, 2010. The average incidence of all the five rots studied ranged from 5.17 to 5.32 per cent during first fortnight of March, 2010. The cork-borer injury method of inoculation proved to be most effective in developing blue mould rot in kinnow fruits. The severity of blue mould rot was maximum at 25°C closely followed by 20°C. While, it was lowest at 30°C. The disease severity increased with the increase in relative humidity. It was highest at 100 per cent RH and lowest at 50 per cent RH. The levels of total soluble solids, acidity, ascorbic acid, total soluble sugar, reducing sugar and non-reducing sugar decreased in kinnow fruits with the increase in the severity of blue mould rot. Maximum reduction in total soluble solids, acidity, ascorbic acid, total soluble sugar, reducing and non-reducing sugars was observed in fruits having more than 75 per cent disease severity.

**Key words:** Kinnow, blue mould rot, *Penicillium italicum*, temperature, relative humidity,TSS, acidity, ascorbic acid, total soluble sugar,

## Introduction

Kinnow is a hybrid of mandarin group of citrus, which belongs to order Geraniales, family *Rutaceae* and sub-family Aurantoideae. It is a cross between the King sweet orange (*Citrus nobilis* Lour) and Willow leaf mandarin (*Citrus deliciosa* Ten.) made in 1915 at Citrus Research Centre, Riverside, University of California (Frost and Krug, 1942; Thind *et al.*, 2006). It was first introduced in India during early 1940 at the fruit experiment station of Punjab Agricultural College and Research Institute, Lyallpur (Singh *et al.*, 1978). An healthy kinnow plant may yield about 600-700 fruits as compared to single sweet orange plant which yield about 200 fruits. India is the leading producer of citrus fruit with an area of 9.23 lakh hectares with production of 86.08 lakh tones annually (Anonymous, 2009). Kinnow is grown mainly in the state of Punjab, Rajasthan, Haryana, Himachal Pradesh, Jammu & Kashmir and Uttar Pradesh. In Sriganganagar district of Rajasthan, it is grown in an area of 8650 hectares having production of 25000 M.T. (Anonymous, 2008).

Infection of these pathogens leads to quantitative and qualitative losses in kinnow fruits. The fruits may also be infected in orchard right from the setting to harvesting stage leading to fruit dropping due to pre-harvest stemend rot and incipient pre-harvest infection causing subsequent post- harvest rotting during storage and transit (Naqvi, 1993; Pathak, 1980; Sharma and Alam, 1998). The optimum period of harvesting of kinnow fruits is mid-January to mid-February when the fruits attain TSS/acid ratio of 12:1 to 14:1. The conservative estimation on post-harvest losses of kinnow fruits has been reported to be around 25-30 per cent (Singh *et al.*, 2002). Out of the total post-harvest losses of kinnow fruits, 80-90 per cent losses are due to the fungal diseases (Dris *et al.*, 2001).

The present paper reports the effect of temperature and relative humidity on disease severity of blue mould rot caused by *Penicillium italicum* Wehmer and biochemical changes in blue mould infected kinnow (*Citrus reticulata*) fruits.

## Materials and methods

### Methods of inoculation

Four methods of inoculation were compared in this experiment. Healthy mature fruits were used in all the experiments. The kinnow fruits were surface sterilized by dipping in sodium hypochlorite solution (1%) for 1-2 minutes followed by three washings with sterile distilled water and inoculated with the test fungus. The inoculum consisted of a 2 mm diameter disc cut away from the periphery of 7 day-old culture of the fungus grown in Petridishes. Each treatment was replicated for four times having three kinnow fruits in each replication.

**(a) Cork-borer injury method**

A shallow injury of 2 mm depth was made with the help of a sterilized cork-borer. The inoculum was inserted in the injured portion and the host tissue was replaced.

**(b) Rubbing method**

Two fruits were rubbed with each other for a while and the inoculum was placed on the rubbed area of fruit

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surface.

**(c) Scrapping method**

The fruit skin was injured by scrapping with a sterilized razor blade and the fungal inoculum was placed on the injured surface.

**(d) Pin-pricking method**

Fruit skin was pierced 6-7 times with the help of sterilized needle. The inoculum was placed on the pierced area with the fungal growth facing the fruit surface.

**(e) Inoculation on uninjured surface**

The inoculum was placed on uninjured fruit surface with the fungal growth facing the fruit surface.

**Effect of temperature on blue mould severity**

Cork-borer injury method was followed in this experiment. The fruits were incubated at 15, 20, 25, 30, and 35° C. The experiment was conducted following Completely Randomized Design (CRD) with three replications. The incidence and severity of fruit rots were calculated as follows: Fruit rot incidence (%) = (Number of infected fruits / Total number of fruits observed) X 100. The disease severity was calculated on the basis of per cent infected area (Mckinney's, 1923). Disease severity (%) = (Sum of all numerical ratings / No. of fruits observed X Maximum grade) X 100

**Effect of relative humidity (RH) on blue mould severity**

The effect of six different levels of RH *viz.*, 50, 60, 70, 80 and 90 per cent on severity of blue mould rot of kinnow was studied. Cork-borer injury method was followed for rot development. Solution of different concentrations of sulphuric acid ($H_2SO_4$) was used to maintain different levels of RH according the procedure described by Waller *et al.* (2002). The inoculated fruits were placed in desiccators containing sulphuric acid solution to provide a particular level of relative humidity. The desiccators were then sealed with greese and kept at 25±1°C. This experiment was conducted following CRD keeping three replications. The severity was calculated as described earlier.

**Determination of total soluble solids**

TSS was determined as °brix by placing a drop of juice on the prism of refractometer. The values were corrected to 20° C with the help of a temperature correction chart (Ranganna, 2000).

**Determination of acidity**

The acidity of juice samples was determined by titration method (A.O.A.C., 1980). For this purpose, 10 ml filtered juice from each of rotted as well as healthy fruits was taken and diluted to 100 ml by adding distilled water. Ten milliliter aliquot of diluted juice was taken and titrated with 0.1 N NaOH using 1 per cent phenolphthalein as indicator. The appearance of faint pink colour was considered as the end point. The acidity of juice was expressed as percentage of citric acid, which was calculated as follows: Acidity (%) = (Titre value X 0.1 N NaOH X Volume made up of diluted juice X 0.06404 / Volume of sample taken for estimation X Volume of aliquot taken for determination) X 100

**Determination of ascorbic acid**

The following reagents and procedure were used for the estimation of ascorbic acid in rotted as well as healthy fruits (A.O.A.C., 1980).

Standardization of dye factor

Diluted 5 ml of standard ascorbic acid solution with 5 ml of 3% HPO, solution. Titrated with the 2,6-dichlorophenol-indophenol dye solution till faint pink color persisted for at least 10-15 seconds. Calculated the dye factor (mg of ascorbic acid per ml of the dye) by using the following formula (A.O.A.C., 1980): Dye factor = (0.5 / Titre value) X 100

**Preparation of sample and titration**

.Ten milliliter of filtered juice from rotted as well as healthy fruits each was taken and it was diluted with 90 ml 3% Metaphosphoric acid (HPO3) solution to make the final volume of 100 ml and then filtered. Ten milliliter of this aliquot was taken in a beaker and then titrated with the standard dye till faint pink colour persisted for at least 10-15 seconds which was considered as end point. The results were expressed as mg of ascorbic acid per 100 ml of juice and calculated as follows (A.O.A.C., 1980): Ascorbic acid (mg 100 ml?') = (Titre value X Dye factor X Volume made up of diluted juice / Volume of sample taken X Volume of aliquot taken for determination) X 100.

**Determination of sugars**

**Total soluble sugar**

Total sugar content was determined by colorimetric method using anthrone reagent (Dubois et al., 1951). One ml of diluted fruit juice sample (100 times) and 4 ml of anthrone reagent was transferred to test tube and then heated for 20 minutes in a water bath, cooled to room temperature and absorbance was measured at 630 nm on Spectronic-20. The amount of sugar present in the sample was determined from standard curve and expressed as percentage basis.

**Reducing sugar**

Reducing sugar content was measured by following Nelson's modification of 'Somogyi's method' (Somogyi, 1952) using arseno-molybdate colour forming reagent and two copper reagent 'A' and 'B'. One ml of juice sample (100 times diluted) was added to 1 ml of mixture of copper reagents, prepared from 24 part of copper reagent 'A' and 1 part of copper reagent 'B' solutions. This mixture in test tubes was heated in boiling water bath, cooled and than 1 ml colour-forming reagent was added. The absorbance was measured at 620 nm on Spectronic-20. The value was plotted against a standard curve prepared from glucose solutions. The figures were expressed on percentage basis.

**Non- reducing sugar**

Subtraction of reducing sugars from the total soluble sugars in the juice and after multiplying the values with the factor (0.95) gave the amount of the non-reducing sugars present in samples.

Non-reducing sugar (%) = (%Total soluble sugar - %Reducing sugar) x 0.95

**Results and Discussion**

**Effect of inoculation methods on severity of blue mould rot**

The data presented in Table 1showed that cork-borer injury method of inoculation was most effective in developing blue mould rot in kinnow fruits as compared to other methods. The disease severity was less after four days of inoculation in all the four methods tested. After eleven days of inoculation, the maximum disease severity (76.67%) was recorded in cork-borer injury method followed by pin-pricking method (52.22%) and it was minimum (19.44%) in rubbing method of inoculation. The inoculation without injury remained rot after on 4, 7 and 11 days of incubation.

The present study showed that cork-borer injury method was more effective in developing blue mould rot in kinnow fruits in comparison to other methods of inoculation. Similar observations were also recorded by Sharma (2002) in case of green mould of kinnow caused by P. digitatum and Choudhary (2009) in fruits rot of lime caused by Colletotrichum gloeosporioides.

**Effect of temperature on severity of blue mould rot**

The severity of blue mould rot was maximum at 250C closely followed by 200C and it was lowest at 300C. Symptoms of the disease did not appear at 35oC temperature. There was no significant difference in disease severity recorded at 20 and 250C after 4 and 7 days of inoculation. However, the severity was significantly higher at 250C as compared to 200C after 11 days of inoculation (Table 2).

Table 1. Effect of different inoculation methods on severity of blue mould rot of kinnow fruits after 4, 7 and 11 days of inoculation

| Method of inoculation | Disease severity (%) after (days) | | |
|---|---|---|---|
| | 4 | 7 | 11 |
| Cork-borer injury | 31.67 (34.24)* | 58.33 (49.80) | 76.67 (61.13) |
| Pin-pricking | 18.89 (25.74) | 43.33 (41.17) | 52.22 (46.26) |
| Scrapping | 11.67 (19.94) | 19.44 (26.15) | 31.67 (34.24) |
| Rubbing | 7.22 (15.58) | 10.56 (18.95) | 19.44 (29.48) |
| Inoculation on uninjured surface | 0.00 | 0.00 | 0.00 |
| S.Em. ± | 0.72 | 0.64 | 1.72 |
| CD (P=0.05) | 2.25 | 2.01 | 5.42 |
| CV (%) | 6.48 | 4.06 | 8.71 |

*Figures in parentheses are angular transformed values.

Table 2. Effect of temperature on severity of blue mould rot of kinnow fruits after 4, 7 and 11 days of inoculation

| Temperature (±1 °C) | Disease severity (%) after (days) | | |
|---|---|---|---|
| | 4 | 7 | 11 |
| 15 | 21.11 (27.36)* | 41.11 (39.87) | 52.22 (46.28) |
| 20 | 29.44 (32.86) | 53.89 (47.24) | 71.67 (57.85) |
| 25 | 31.67 (34.24) | 58.33 (49.80) | 76.67 (61.13) |
| 30 | 8.33 (16.72) | 12.22 (20.41) | 13.89 (21.84) |
| 35 | 0.00 | 0.00 | 0.00 |
| S.Em. ± | 0.68 | 0.82 | 0.77 |
| CD (P=0.05) | 2.16 | 2.60 | 2.42 |
| CV (%) | 5.33 | 4.54 | 3.56 |

*Figures in parentheses are angular transformed values.

**Effect of relative humidity (RH) on severity of blue mould rot**

The results presented in Table 3 clearly indicate that the disease severity increased with the increase in RH in all the three observation days i.e. 4, 7 and 11 days after inoculation. The disease severity was highest at 100 per cent (76.67%) followed by 90 per cent RH (65.56%). While, it was lowest (33.33%) at 50 per cent RH (Table 3).

The results revealed that severity of blue mould rot was higher at 20 to 25°C temperature. While, the severity was less at higher temperature. It was also observed that the severity of blue mould was higher at relative humidity level of 90 to 100 per cent. Maximum decay of different fruits by various pathogens was recorded at 15 to 30°C (Bhargava, 1972 and Pathak, 1980). The incidence of blue mould rot of kinnow has been also reported to be greater at 25°C and 100 per cent relative humidity (Godara, 1994). The present study also indicated that a drastic reduction of the severity occurred at higher temperature or low humidity. More studies arerequired to ascertain the effect of temperature and relative humidity alone and in combinations on pathogenesis of *P. italicum* in kinnow fruits.

**Effect on total soluble solids (TSS)**

**A perusal of data presented in Table 4 indicated** that the levels of total soluble solids decreased significantly in the kinnow fruits with the increase in the severity of blue mould rot. TSS was significantly less in fruits having more than 50 per cent disease severity. It was quite less at 50-75 per cent disease severity. While, it was highest (12%) in control (healthy) fruits. The TSS content was quite higher at lower level of rot i.e. at disease severity below 25 per cent (Table 4).

**Effect on acidity**

The data revealed that the level of acidity significantly decreased in infected kinnow fruits with the increase in severity of blue mould rot. The maximum acidity (1.11%) was recorded in control fruits. The acidity was quite high at low level of disease severity i.e. 1-10 per cent. It was lowest (0.41%) in fruits having more than 75 per cent disease severity (Table 4).

**Effect on ascorbic acid**

The content of ascorbic acid in kinnow fruits decreased with the increase in severity of blue mould. The results presented in Table 4 showed that the ascorbic acid content was highest in control i.e. uninoculated healthy fruits. Significant decrease in ascorbic acid content was recorded at disease severity range 10-25 per cent and above. While minimum ascorbic acid content was observed at more than 75 per cent disease severity level (Table 4).

**Effect on total soluble sugar**

Gradual reduction of total soluble sugar was recorded with the increase in severity of blue mould rot. Initially it was highest in control and slightly decreased at low level of disease severity i.e. 1-10 per cent. It was lowest (5.58%) at discase severity level more than 75 per cent (Table 5).

**Effect on reducing sugar**

The data presented in Table 5 clearly revealed that the reducing sugar content was significantly less in rotted fruits as compared to control. Like total soluble sugar, the amount of reducing sugar decreased with the increase in level of disease severity. It was significantly lower in fruits having disease severity range 50-75 per cent and above (Table 5).

**Effect on non-reducing sugar**

The results showed that non-reducing sugar content was less in blue mould infected fruits as compared to healthy fruits. Again, it was significantly less in infected fruits having different severity grades. It was lowest in fruits which exhibited more than 75 per cent severity. Further, the non-reducing sugar content was statistically at par in infected fruits having disease severity ranged from 1-10 to 50-75 per cent (Table 5).

It was recorded during present investigation, the biochemical constituents of kinnow fruits like TSS, acidity and ascorbic acid were significantly reduced in rotted fruits as compared to healthy ones. Further, the magnitude of reduction of these constituents was considerably higher in fruits having more than 50 per cent disease severity. These results are in conformity with the previous reports of reduction in the amount of TSS, acidity and ascorbic acid in rotted as compared to healthy fruits of sweet orange (Kapur *et al.*, 1992 and Sharma, 2007), mosambi (Singh and Sinha, 1982) and mandarin orange (Dutta *et al.*, 2009). The reduction in the amount of these constituents in the rotted fruits might be attributed to their utilization by the fungus or their degradation by the enzymes. The amount of total soluble sugar, reducing and non-reducing sugars in rotted kinnow fruits was also found to be reduced considerably as compared to healthy ones during the present investigations. Similarly, the depletion in sugar content has also been reported in infected citrus fruits like kinnow (Ramanjulu and Reddy, 1989, Kapur *et al.*, 1992 and Sharma, 2007), mosambi (Singh and Sinha, 1982). Sharma, *et al.*, 1992 gave the following Physico-chemical characteristics of kinnow fruits weight 139.0 g, size of fruit 5.0-7.9 x 6.0-9.7 cm, peel thickness 0.61 cm, peel (%) 27.99, rag (%) 20.97, juice (%) 51.04, TSS (%) 11.50, acidity (%) 0.905, TSS/acid ratio 12:1 and vitamin 'C' (mg/100 ml juice) 23.51 of fruits. The decrease in sugar content in infected tissues might be due to enzymatic brake down of soluble carbohydrates and utilization of these sugars by the fungus during the process of pathogenesis (Cheema *et al.*, 1974 and Dutta *et al.*, 2009).

Table 3. Effect of different levels of relative humidity on severity of blue mould rot of kinnow fruits after 4, 7 and 11 days of inoculation

| Relative humidity (%) | Disease severity (%) after (days) | | |
|---|---|---|---|
| | 4 | 7 | 11 |
| 50 | 10.56 (18.95)* | 18.33 (25.34) | 33.33 (35.26) |
| 60 | 12.78 (20.93) | 22.22 (28.11) | 40.56 (39.54) |
| 70 | 13.33 (21.39) | 24.44 (29.62) | 50.00 (45.00) |
| 80 | 13.89 (21.86) | 26.67 (31.08) | 56.11 (48.51) |
| 90 | 16.67 (23.68) | 32.22 (34.58) | 65.56 (54.07) |
| 100 | 31.67 (34.24) | 58.33 (49.80) | 76.67 (61.13) |
| S.Em. ± | 0.65 | 0.72 | 0.74 |
| CD (P=0.05) | 2.01 | 2.23 | 2.28 |
| CV (%) | 4.80 | 3.79 | 2.71 |

*Figures in parentheses are angular transformed values.

Table 4 Effect of blue mould rot on total soluble solids, acidity and ascorbic acid contents in kinnow fruits

| Disease severity (%) | Total soluble solids (°Brix) | Acidity (%) | Ascorbic acid (mg/100 g fruit) |
|---|---|---|---|
| 1-10 | 11.17 | 0.98 | 17.19 |
| 10-25 | 9.83 | 0.90 | 7.81 |
| 25-50 | 8.83 | 0.77 | 7.03 |
| 50-75 | 7.33 | 0.64 | 4.95 |
| Above 75 | 7.00 | 0.41 | 2.99 |
| Control (Healthy) | 12.00 | 1.11 | 25.00 |
| | 0.18 | 0.03 | 0.53 |
| CD (P=0.05) | 0.55 | 0.08 | 1.65 |
| CV (%) | 3.33 | 5.66 | 8.54 |

Table 5. Effect of blue mould rot on total soluble sugar, reducing sugar and non-reducing sugar contents in kinnow fruits

| Disease severity (%) | Total soluble sugar (%) | Reducing sugar (%) | Non-reducing sugar (%) |
|---|---|---|---|
| 1-10 | 7.13 | 3.20 | 3.73 |
| 10-25 | 6.82 | 2.95 | 3.68 |
| 25-50 | 6.44 | 2.64 | 3.61 |
| 50-75 | 5.84 | 2.20 | 3.46 |
| Above 75 | 5.58 | 1.97 | 3.42 |
| Control (Healthy) | 8.69 | 4.38 | 4.09 |
| | 0.07 | 0.11 | 0.13 |
| CD (P=0.05) | 0.23 | 0.33 | 0.39 |
| CV (%) | 1.89 | 6.35 | 6.03 |

**References**


A.O.A.C. 1980. Official and tentative method of analysis. Assoc. Agric. Chem. 12th ed., Washington, D.C. USA.

Anonymous. 2008. Annual Report, Directorate of Horticulture, Govt. of Rajasthan, Jaipur, pp. 8.

Anonymous. 2009. Indian Horticulture Database - 2009. Ministry of Agriculture, Govt. of India. Gurgaon, pp. 5.

Bhargava, S.N. 1972. Aspergillus rot on Citrus aurentifolia fruits in the market. *Plant Dis. Reptr.* 56: 64.

Cheema, S.S., Jeyarajan, R. and Deol, I.S. 1974. Effect of stylar-end rot and stalk-end rot on sweet orange fruits. *Indian J. Hort.* 31: 117-120.

Choudhary, R. 2009. Management and factors affecting the post-harvest fruit rot of lime incited by Colletotrichum gloeosporioides (Penz.) Penz. and Sacc. M.Sc. Thesis, Rajasthan Agricultural

University, Bikaner.

Dris, R., Niskanen, R. and Jain, S.M. 2001. Crop management and post-harvest handling of horticultural products. Vol. 1- Quality management. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

Dubois, M., Gilles, K.A., Hamilton, J.K., Robers, P.A. and Smith, F. 1951. A colorimetric method for the determination of sugars. *Nature*. 168:167.

Dutta, S., Chettri, P., Paul, P., and Roy, S. 2009. Penicillium digitatum induced post infectional biochemical changes in mandarin orange. *Ann. Pl. Prot. Sci*. 17 (1): 167-171.

Frost, H.B. and Krug, C.A. 1942. Diploid tetraploid perielinal chimeras as bud variants in citrus. *Genetics*. 27: 619.

Godara, S.L. 1994. Studies on post-harvest diseases of orange fruits. Ph.D. Thesis, Rajasthan Agricultural University, Bikaner.

Kapur, S., Kapur, S.P. and Cheema, S.S. 1992. Some of the biochemical changes in stalk-end rot infected kinnow fruits. *Plant Dis. Res*. 7: 275-276.

Mckinney, H.H. 1923. Influence of soil temperature and moisture on infection of wheat by Helminthosporium sativum. *J. Agric. Res*. 26: 195-217.

Naqvi, S.A.M.H. 1993. Influence of pre- and post-harvest factors on export oriented production of Nagpur mandarin. In: Proc. of Vasantrao Naik Memorial National Seminar on Agricultural Science Export oriented horticultural production. pp. 181-185.

Pathak, V.N. 1980. Diseases of fruit crops. Oxford and I.B.H. Publishing Co., New Delhi, pp. 106-111.

Ramanjulu, V. and Reddy, M.R.S. 1989. Post-infection changes in Sathgudi sweet orange fruits caused by Gloeosporium limetticola. Indian Phytopath. 42: 191-192. Ranganna, S. 2000. Handbook of analysis and quality control for fruit and vegetable products. Tata McGraw Hill Publ. Co. Ltd., New Delhi.

Sharma, J.N., Chohan, G.S., Vij, V.K. and Monga, P.K. 1992. Effect of spacings on growth, yield and quality of kinnow mandarin. *Indian J. Hort*. 49: 158-164.

Sharma, N. and Alam, M.M. 1998. Post-harvest disease of Horticulture Perishables Chapter-2 International Book Distribution Company. pp. 28-41.

Sharma, R.N. 2007. Physico-chemical analysis and management of post-harvest fungal diseases of kinnow fruits (Citrus deliciosa Tan.). Ph.D. Thesis, Rajasthan Agricultural University, Bikaner.

Sharma, S. 2002. Incidence of post-harvest fruit rots of mandarin (Citrus reticulata var. kinnow) in Anupgarh Panchayat Samiti (Sriganganagar), pathogenicity and their management, M.Sc. Thesis, Rajasthan Agricultural University, Bikaner.

Singh, A. and Sinha, K.K. 1982. Biochemical changes in musambi fruits inoculated with species of aflatoxin producing aspergilli. *Curr. Sci*. 51: 841-842.

Singh, B.P., Gupta, A.K. and Chundawat, B.S. 1978. Effect of various treatments on storage of kinnow fruits. *Punjab Hort. J*. 18: 61-65.

Singh, D., Thakur, A.K. and Jain, R.K. 2002. Management of post-harvest diseases of kinnow (Citrus reticulata Blanco). Proceedings of National Workshop on Post-harvest Management of Horticultural Produce., held at National Productivity Council, Chandigarh (Feb. 7th-8th), pp. 117-123.

Somogyi, M. 1952. Aresenomolybdate reagent colour development method of reducing sugar determination. *J. Biol. Chem*. 200, 245.

Thind, S.K., Arora, P.K. and Josan, J.S. 2006. Kinnow cultivation- A "Gold Revolution" in Punjab. Seminar on cultivation of citrus with special emphasis on quality and export of kinnow, held at Regional Station (PAU), Abohar (Feb. 23rd). pp. 5-7.

Waller, J.M., Lenn'e, J.M. and Waller, S.J. 2002. Plant pathologist's pocket book. CABI Publishing Wallingford, UK. 3rd ed. pp. 447-449.

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# Studies on physicochemical characters of fruits of Date palm genotypes

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**Abstract**

In Kachchh region of Gujarat, variability with respect to berry colour, weight, pulp content, fruit size, taste, bunch size and yield potential were observed in date palm orchards. A survey was carried out to identify suitable genotypes of date palm (*Phoenix dactylifera* L.) based on the fruit quality and yield attributing characters. Fruits of ten elite types were collected and physicochemical characters were studied. The genotypes showed considerable variation in morphological and physicochemical characters of fruits. The colour of berry at *doka* stage was yellow, red to dark red. Variation in fruit weight from 7.71 to 17.4g, stone weight 0.81-1.50g., TSS 19.8 -36.2 °brix and acidity 0.18-0.40 % was recorded. The suckers of identified genotypes DP-01 and DP -03 would be procured for multiplication and evaluation under hot arid region and it can be further utilized for improvement programme.

(**Key words**: Date palm, *Phoenix dactylifera*, variability, genotypes, fruit quality

## Introduction

Date palm (*Phoenix dactylifera* L.; family-Palmaceae) is one of the most important fruit tree for semi arid and hot arid regions of the country. It is an ancient fruit and it is believed to be indigenous to countries around Persian Gulf. Date palm groves in coastal belt of Kachchh from Anjar to Mandvi have developed naturally through seeds, which were probably brought by Turk settlers, Traders, gardeners and Haj pilgrims. The seedlings are very old in Kachchh region and some new systematic plantations of date palm are being developed either through suckers or tissue culture plants of cv. Barhee. At present, about 500 acre area of tissue culture plantations has been covered. However, seedling populations are not found in other parts of country. The ripe fruits (*doka* or khalal) are used for fresh consumption and processing. Every part of the date palm plant is useful since its history of cultivation and utilization .Dried fruit pulp is used for flavoring the bakery products. Date palm leaves are used for making handicraft items *viz.* broom, hand-fan, mat, rope etc. Date is nutritious fruit having high calorific value in the form of sugar, mineral and vitamins (Zaid, 1999; Singh and Dhandar, 2007). It has high market potential since the production of soft dates (*Pind Khajoor*) and dry dates (*Chhuhara*) in our country is very less. Presently, India imports about 2, 30,926 MT dates every year from Gulf countries to meet out the domestic requirement.

At present, about 16,688ha area is under date palm cultivation in the coastal region of Kachchh with an estimated annual fruit production 1,23,490 tonnes. Variability in date palm exists through out Kachchh region because the date groves have originated from seeds. Date palm is a dioecious and monocotyledonous plant. The soil of the region is sandy loam and average annual rainfall is 425 mm. All the fruit from Kachchh palms are harvested during mid June to July at *doka* or khalal stage (hard ripe yellow, red or dark red colour) of maturity because of early rains. Intercrops viz. pearl millet, cluster bean, forage and small fruit plants are grown in association with date palm in Kachchh region (Muralidharan *et al*, 2008). Date palm plantations are economically important because it requires minimum care and it has tremendous potential in arid parts of western Rajasthan, Punjab and Haryana as well as in coastal belt of Gujarat. A very limited work has been conducted on post harvest management in India for proper utilization of date fruits. Therefore, major emphasis should be given on processing and value addition in date palm (Sharma *et al*, 2010).

Keeping in view, a survey was conducted to exploit genetic diversity of date palm to identify superior plus trees having better quality of fruits at *doka* stage, higher fruits yield, medium to heavy bearing types, suitability for processing, rain and *Graphiola* leaf spot disease tolerance, the details of survey, identification of elite type, fruiting and quality characters and production system have been discussed in this paper.

## Material and methods

A survey of date palm orchards was conducted during the year 2010 in Kachchh region of Gujarat to identify genotypes having better quality and productivity of fruits and also having rain tolerance characters. The orchards surveyed in villages near Mundra, Dhrub, Motipar, Gharsisa, Anjar, Naninagalpar and nearby Bhuj.

Kachchh region of Gujarat is spread over 45,652 sq. km. lies between 22° 5 to 24 ° 4 N latitude and 68° 9 to 71° 5 E longitudes. This area is highly suitable for date palm

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cultivation in our country. Palms having prolific bearing, attractive colour of fruit, sweet in taste and disease free were identified and marked. Plant population, fruiting behavior, number of bunch /palm and fruit characters along with status of uses, marketing etc. were recorded to analyze date palm production and utilization. Ten fruit samples were collected from identified elite tree. Data on important fruit characters were assessed for the extent of variability and compared with better palm for further multiplication and evaluation through clonally and raising seedling progenies.

**Results and discussion**

The data pertaining to physicochemical characters of date palm fruits are presented in Table-1. The date palm orchards were surveyed near by Mundra, Bhuj, Kachchh region to identify elite type. The maximum seedling population exists on field or farm boundary, road side, river belt and depressions. The seedling palms are natural and very old, which are estimated to be around 1.9 million. However, some seedlings have been planted at close spacing at farmer's field. The palm trees are having good potential in natural population which should be multiplied. Among dates groves some are high yielding while others are unproductive because of high palm height, improper pollination, small size fruits and poor management.

The plant characters basically depend upon genetic composition as well as soil and climatic features of the growing site. In general, 20-30 feet trees height was observed while some old date groves were about 50 feet in height. The palm had good foliage, vigorous growth and 5-10 offshoots per palm. However, some date groves are well managed by removing suckers for new plantations or better fruiting. But the maximum date groves are in natural state. Now tissue culture plantations of cv. Barhee have been done in which suckers has not been allowed to grow for early fruiting. Variability in fruiting in tissue culture plantation was also observed. All tissue culture plantations are under drip system and spaced at 8x8m. Branching in date palm is rare (Zaid, 1999) but from one place 3-4 palms were growing in groves. It has been observed that if aerial suckers are not removed from mother plants, the growth of aerial suckers also looks like branch in date palm.

The fruit yield in date palm directly depends upon size of bunch and berry, number of bunches/palm and number of fruits per bunch. Variation in number of bunches from 4 to 10 per tree was observed. Variation in number of bunches, size of bunches and berries might be due to genetic features of the type, soil types, plant density per unit area and management practices employed. The bunch weight also varies from 5 to 20 kg depending on size of berries and thinning practices. Fruit thinning improves the size of berry in date palm is known practice to growers. However, all the growers do not practice thinning of fruits. Variation in number of bunches per plant and fruit yield has also reported by Murlidharan *et al,* (2008).

Variability in date palm fruits was observed with respect to weight of berry (7.71 to 17.41 g), fruit size (3.00 x 4.22cm length and 1.54x2.58cm width) and pulp content (6.59 to 16.30 g) besides fruit shape and colour. Variation in size, berry colour, length of bunch, weight and yield have also been described by Muralidharan *et al.*(2008). As far as fruit weight is concerned DP-01 and DP-03 were found superior in size and quality characters in comparison to other germplasm lines (Table 1). Variation in pulp stone ratio was 5.5 to 16.6 in DP-01 collected from Mundra. The variations in colour of fruits from yellow to dark red were observed at doka stage, which is very useful to popularize date for fresh consumption. The data on biochemical parameters such as TSS and acidity also reveals a wide variation among the fruits. The minimum TSS was recorded in DP 08 with a value of 20.83° Brix whereas the highest TSS was recorded in DP03 with a magnitude of 34.50 ° Brix. Perusal of data in table 1 reveals that the difference between the genotypes in fruit size, pulp weight, pulp stone ratio and seed size were varied. Fruit characters vary greatly depending on variety, environmental conditions and technical care given like fertilization,

Table 1. Physico-chemical characters of date palm germplasm line fruits

| Genotypes | Source | Fruit colour | Fruit shape | Fruit characters | | | Fruit flesh weight (g) | Stone weight (g) | Pulp: stone ratio | Acidity (%) | T.S.S.(°Brix) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Weight (g) | Width (cm) | Length (cm) | | | | | |
| DP01 | Dhrub | yellow | oblong | 13.11 | 2.48 | 4.04 | 11.61 | 1.59 | 7.28 | 0.233 | 32.5 |
| DP02 | Mundra | yellow | oblong | 11.31 | 2.36 | 3.6 | 9.48 | 1.66 | 5.71 | 0.4 | 27 |
| DP03 | Radhanpur | yellowish brown | oblong | 11.03 | 1.94 | 4.09 | 9.66 | 1.28 | 7.53 | 0.267 | 34.5 |
| DP04 | Mundra | red | oblong | 8.37 | 1.82 | 3.92 | 7.27 | 1.3 | 5.59 | 0.283 | 27.83 |
| DP05 | Mundra | red | oblong | 8.1 | 1.92 | 3.44 | 6.82 | 1.23 | 5.53 | 0.233 | 28.5 |
| DP06 | Anjar | light red | oblong | 7.71 | 1.54 | 3.4 | 6.59 | 1.08 | 6.11 | 0.267 | 26.66 |
| DP07 | Nagalpar | yellow | oblong | 10.06 | 2.04 | 3 | 9.12 | 0.9 | 10.07 | 0.183 | 36.16 |
| DP08 | Mundra | greenish yellow | oblong | 8.96 | 1.9 | 3.1 | 7.59 | 1.17 | 6.48 | 0.35 | 19.83 |
| DP09 | Mundra | redish orange | oblong | 7.88 | 2 | 3.02 | 7.11 | 0.81 | 6.07 | 0.367 | 22.83 |
| DP10 | Mundra | yellowish orange | oblong | 17.41 | 2.58 | 4.22 | 16.29 | 0.97 | 16.69 | 0.233 | 20.5 |

pollination, etc. (Zaid, 1999).The palm bearing big size dark red or yellow colour sweet in taste fruits were considered promising. The fruit yield vary from 50 to 100 kg per tree which depends upon the age of tree, extents and pattern of rainfall, pollination, number of bunches / tree, number of berries / strand, management practices besides soil and climatic conditions. In general, 50-60 kg fruits/palm is harvested at *doka* stage by the farmers. The quality of *doka* fruits varied greatly because of genetic variability in seedling palms. The elite palms, which bear good quality, sweet fruits fetches good price in the market. In Mundra area, fruit bunches were harvested and packed with berry strand in carton for sale in local mandi. The wholesale price of *doka* fruits varies from Rs. 5 to 10 per kg in local mandi which depends upon quality of fruits, grading, packing, etc. Use of date fruits for processing and value addition is very less as narrated by the date growers.

**References:**


Muralidharan,C.M., Tikka, S.B.S. and Verma, Piyush. 2008. Date palm cultivation in Kachchh. Tech. Bulletin- 2, Date palm Research Station, SDAU, Mundra, p.36.

Sharma, S.K., Sharma, B.D., Singh, D., Shivalingam, P.N., Bhargava, R., Singh, R. S. and Meena, S. R. 2010. Souvenir of National Workshop on Date palm, CIAH, Bikaner, p188.

Singh, R.S. and Dhandar, D.G. 2007. *Khajoor ki Kheti* (in Hindi), Directorate of Extension. Ministry of Agriculture, Govt. of India, New Delhi. p.22.

Zaid, A. 1999. Date palm cultivation, F.A.O., Rome, p 238.

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# Response of different levels of zinc and farmyard manure on growth and yield of pea (*Pisum sativum* L.)

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**Abstract**

A field experiment was conducted to study the effect of zinc and farm yard manure (FYM) on growth and yield of pea (*Pisum sativum* L.) during *Rabi*, 2009-10. The results revealed that application of 40 kg zinc sulphate $ha^{-1}$ significantly increased vine length at harvest (77.12 cm), number of branches per plant at harvest (5.66), days taken for first flowering (47), number of nodules per plant at harvest (46.28), number of pods per plant (17.22), number of grains per pod, average pod length (cm), average weight of pod (g), weight of grains per green pod (g), shelling percentage (45.61), biomass content (45.86 q $ha^{-1}$) and green pod yield (78.95 q $ha^{-1}$) over control where no zinc was applied. Similarly, application of FYM at 350 q $ha^{-1}$ significantly increased vine length at harvest (80.06 cm), number of branches per at harvest (5.79 cm), days taken for first flowering (49), number of nodules per plant at harvest (48.59), number of pods per plant (18.20), number of grains per pod, average pod length (cm), average weight of pod (g), weight of grains per green pod (g), shelling percentage (48.50), biomass content (47.09 q $ha^{-1}$) and green pod yield (81.35 q $ha^{-1}$) over control where no FYM was applied. The combined effect of zinc (40 kg $ha^{-1}$) and FYM (350 q $ha^{-1}$) was found significant pertaining to number of branches per plant at harvest (6.15), days to first flowering (51) and green pod yield (80.03 q $ha^{-1}$) compared to control and in respect to green pod yield, it was found statistically at par with 0, 150 and 250 q of FYM coupled with 40 kg $ha^{-1}$ zinc application.

**Key words**: *Pea, zinc, FYM, growth, yield, interaction*

## Introduction

Pea (*Pisum sativum* L.) is an important vegetable crop grown throughout India as well as in Rajasthan. In India, it is grown mainly as winter vegetable in the plains of North India and as summer vegetable in the hills. It is highly nutritive and rich source of digestible proteins (7.2%) along with carbohydrates (15.9%) and mineral matter like calcium (20 mg/100g), while dried pea grain contains protein (19.7%), carbohydrate (56.5%), calcium (75 mg/100g) besides being a good sources of vitamins. Peas are utilized mainly as a vegetable and are also processed, dehydrated and canned for value addition (Aykroyd, 1963). The role of chemical fertilizers is important in order to meet out the nutrient requirement of the crop but continuous use of these on lands will have deleterious effects on physical, chemical and biological properties of soil, which in turn reflects on yield (Sarkar *et el.*, 1997) so that the most logical way to the management of long term fertility and productivity of the soil is the use of micronutrients with the combination of organic manures. Therefore, there is an urgent need to reduce the usage of chemical fertilizers and in turn increase the usage of organic manures with micronutrients which are known to improve physico-chemical properties of soil and supply the nutrients in available form to the plants. The role of micronutrients and their mechanism in plant metabolism are well known as the minor elements are known to act as catalysts in promoting organic reactions taking place in plants, the zinc deficiency is more frequently encountered in Indian soils, especially, in saline and sandy soils of Western Rajasthan than deficiency of other micronutrients, particularly when the soils are either highly alkaline or are weathered and coarse (Duarte *et al.*, 1961). Response to zinc fertilizers in zinc deficient soils is obvious as reported for several crops including pea (Reddy *et al.*, 1995).

Among the various factors responsible for higher yield potential, application of adequate quantities of FYM is considered as one of the most effective way for boosting the crop yield in soils of Western Rajasthan, which are very poor in organic matter and content. Organic manures especially FYM not only increase the yield but also improve physical, chemical and biological properties of the soil which in turn improve fertility, productivity and water holding capacity of soil. Besides this, Use of FYM increases soil organic matter content and had greater residual effects (Kumaran *et al.*, 1998). So far, the study on pea crop with reference to micronutrients and FYM was not carried out in this zone; hence, the present investigation was undertaken to study the effect of zinc and FYM on pea crop.

## Materials and methods

The experiment was conducted at College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner during *Rabi* season of 2009-10. The experiment consisted twelve treatments comprising of three levels of zinc (0, 20 and 40 kg $ha^{-1}$) and four levels of FYM (0, 150, 250 and 350 q $ha^{-1}$) in factorial randomized block design with three replications. The zinc was applied through zinc sulphate in soil before sowing. The soil of

experimental field was sandy loam with pH of 8.54, organic carbon 0.12 per cent, available $N_2$ 87.72 kg $ha^{-1}$ and available zinc 0.24 ppm. The test crop (Pea cv. Azad P-2) was sown at a spacing of 30 x 7 cm. The recommended basal dose of N:P:K @ 25:40:50 kg $ha^{-1}$ was applied uniformly in the plots. Inter cultural operations were followed according to package and practices. The pickings of green pods were done at three times *viz.* 86th, 100th and 113th DAS. The final harvesting of plants at half dry stage of plants was done at 123rd DAS subjected to record total biomass content on dry weight basis including dry weight of green pod yield. Observations on different growth parameters at given stage and on yield parameters at every picking of green pods were recorded on ten randomly selected plants from each treatment in every replication eliminating the border effect and analysed statistically as per the standard procedures to test the significance.

**Result and discussion**

***Effect of zinc and FYM on growth parameters***

The data presented in Table 1 showed significant increase in vine length at harvest (77.12 cm), number of branches per plant at harvest (5.66) per plant, days to first flowering (47) and number of nodules per plant at harvest (46.28) was observed under the application of zinc sulphate at 40 kg $ha^{-1}$ compared to control. The promotive effect of zinc on plant growth parameters obtained in the present study may be attributed to the involvement of zinc in various physiological and biochemical processes in pea plants. The application of zinc lead to an increase in plant growth attributes which might be due to active synthesis of tryptophane; a precursor of auxin, besides the synergistic effect of zinc which may serve as a source of energy for the synthesis of auxin, the same could be attributed as one of the factor for the growth of plant (Raghav and Singh, 2004). This could also be attributed to its role in metabolic activity mainly in protein synthesis in plant as well as nitrogen fixation (Nagaraju and Yadahalli, 1996). Raghav and Sharma (2003) reported that soil application of 40 kg ZnSO4 $ha^{-1}$ gave the highest plant height in tomato, okra and pea i.e. 69.3 cm, 69.5 cm and 48.7 cm, respectively. Kasturikrishna and Ahlawat (2000) recorded significantly more number of root nodules per plant in pea crop with the application of zinc at 5 kg $ha^{-1}$.

A data presented in Table 1 also showed significant increase in vine length at harvest (80.06 cm), number of branches per plant at harvest (5.79), days to first flowering (49) and number of nodules per plant at harvest (48.59) with the application of FYM at 350 q $ha^{-1}$ compared to control. This was due to the organic manures would have improved the soil physical conditions and increased nutrient availability resulting in a better vegetative growth and increased yield of pea crop (Rafi *et al.*, 2002). Further, the better growth and development of plants with application of FYM might be due to increased availability of nitrogen as well as other required nutrients to the plants throughout the season. The prolonged period for flower initiation may be due to more availability of nutrients through FYM resulting into more vegetative growth period; hence, delay in flowering. These results are in agreement with the findings of Rafi *et al.* (2002) in tomato, Subbarao and Sankar (2001) in brinjal and Arumugam and Anuburani (2008) in tomato. Ghuge *et al.* (2007) also observed better growth in cabbage with organic manure application. The interactive effect of zinc and FYM (Table 3) has been found significant in respect to number of branches and days taken to first flowering. The application of 40 kg zinc along with 350 q FYM $ha^{-1}$ significantly increased number of branches per plant at harvest (5.79) and days taken to first flowering (49) compared to control. This might be due to inadequate availability of nutrients through zinc and FYM resulting into more vegetative growth (Manolikar *et al.*, 2007).

***Effect of zinc and FYM on yield parameters***

The fertilization of pea with zinc sulphate at 40 kg $ha^{-1}$ significantly increased yield attributing character *viz.* number of pods per plant (17.22), number of grains per pod (7.30), average pod length (6.59 cm), average weight of pod (7.05 g), weight of grains per pod (3.23 g), shelling percentage (45.61), total biomass content (45.86 q $ha^{-1}$) and green pod yield (78.95 q $ha^{-1}$) over control (Table 2). This might be due to the main function of zinc in plant as a metal activator of several enzymes like dehydrogenase, proteinase and peptidases (Prasad and Kumar, 2010). The beneficial effect of zinc on the yield and yield parameters may be attributed to the fact that soil application of zinc resulted in increased supply of the available zinc to the plants which resulted in proper growth and development of the plants. The essential role of zinc has been established as a component of several enzymes concerned with carbohydrate and nitrogen metabolism, in addition to its involvement directly or indirectly in regulating the various physiological processes of plants (Marschner, 1995). Zinc application contributed in increase in yield probably owing to its influence on auxin synthesis, nodulation and nitrogen fixation which promotes plant growth and development, there by favourably influencing yield attributes and grain yield (Islam *et al.*, 1989). The present findings are in confirmity with the findings of Dube *et al.* (2003) in tomato cv. Pusa Ruby. Increase in fruit length of okra with application of zinc was reported by Kumar and Sen (2005). Further, the data (Table 2) indicated that FYM at 350 q $ha^{-1}$ significantly increased the number of pods per plant (18.20), number of grains per pod (7.59), average pod length (6.98 cm), average weight of pod (7.46 g), weight of grains per pod (3.62), shelling percentage (48.50), total biomass content (47.09 q $ha^{-1}$) and green pod yield (81.35 q $ha^{-1}$) over control. The beneficial effect of farm yard manure on yield attributes was probably due to enhanced supply of macro as well as micronutrients during entire growing season. It might have attributed to higher manufacture of food and it subsequent partitioning in sink. The reason for increased yield with the application of farm yard manure could be attributed to solubilization effect of plant nutrients by the addition of FYM leading to increased uptake of nutrients especially NPK as reported by Subbiah *et al.* (1982). The increase in number of pods per plant and seeds per pod in pea with organic manure application was reported by Bhattarai *et al.* (2003). Increase in the yield of

chilli by organic manures has also been reported by Sharu and Meeradai (2001).

The interactive effect of zinc and FYM (Table 3) has been found significant pertaining to green pod yield. The combined application of zinc at 40 kg $ha^{-1}$ along with 350 q FYM $ha^{-1}$ significantly increased green pod yield (80.03 q $ha^{-1}$) compared to control and being statistically at par to 0, 150 and 250 q $ha^{-1}$ FYM when each quantity applied with 40 kg $ha^{-1}$ zinc sulphate. This increase in green pod yield might be due to the better efficiency of zinc and farm yard manure and there translocations (Sharma and Abraham, 2010). Besides, the organic manures form organometallic complexes with zinc, which resulted in the increase of its efficiency which lead to better growth of plants and consequently higher yield (Gupta and Handore, 2009).

Table 1. Effect of zinc and FYM on growth parameters of pea

| Treatments | Vine length at harvest (cm) | Number of branches at harvest | Days to first flowering | Number of nodules per plant at harvest |
|---|---|---|---|---|
| Zinc levels ( $ZnSO_4$ kg $ha^{-1}$) | | | | |
| 0 | 66.45 | 4.99 | 45 | 40.78 |
| 20 | 73.13 | 5.39 | 46 | 43.67 |
| 40 | 77.12 | 5.66 | 47 | 46.28 |
| S.Em. ± | 1.29 | 0.08 | 0.2 | 0.8 |
| CD (5%) | 3.79 | 0.23 | 0.5 | 2.35 |
| FYM levels (q $ha^{-1}$) | | | | |
| 0 | 63.68 | 4.87 | 43 | 37.63 |
| 150 | 69.99 | 5.21 | 45 | 42.43 |
| 250 | 75.21 | 5.51 | 46 | 45.66 |
| 350 | 80.06 | 5.79 | 49 | 48.59 |
| S.Em. ± | 1.49 | 0.09 | 0.2 | 0.92 |
| CD (5%) | 4.38 | 0.26 | 0.6 | 2.71 |

Table 2. Effect of zinc and FYM on yield parameters of pea

| Treatments | Number of pods per plant | Number of grains per pod | Average pod length (cm) | Average wt. of pod (g) | Wt. of grains per pod (g) | Shelling (%) | Biomass content (q $ha^{-1}$) | Green pod yield (q $ha^{-1}$) |
|---|---|---|---|---|---|---|---|---|
| Zinc levels ( $ZnSO_4$ kg $ha^{-1}$) | | | | | | | | |
| 0 | 14.8 | 6.37 | 5.72 | 6.28 | 2.71 | 42.9 | 41.34 | 69.47 |
| 20 | 16.22 | 6.89 | 6.22 | 6.74 | 3.02 | 44.46 | 43.66 | 74.38 |
| 40 | 17.22 | 7.3 | 6.59 | 7.05 | 3.23 | 45.61 | 45.86 | 78.95 |
| S.Em. ± | 0.24 | 0.12 | 0.11 | 0.12 | 0.06 | 0.87 | 0.48 | 1.12 |
| CD (5%) | 0.71 | 0.34 | 0.31 | 0.36 | 0.19 | 2.55 | 1.48 | 3.29 |
| FYM levels (q $ha^{-1}$) | | | | | | | | |
| 0 | 13.30 | 5.99 | 5.19 | 5.83 | 2.31 | 39.59 | 39.90 | 66.61 |
| 150 | 15.70 | 6.66 | 5.96 | 6.47 | 2.80 | 43.19 | 42.58 | 72.15 |
| 250 | 17.12 | 7.17 | 6.57 | 6.98 | 3.21 | 46.01 | 44.90 | 76.96 |
| 350 | 18.20 | 7.59 | 6.98 | 7.46 | 3.62 | 48.50 | 47.09 | 81.35 |
| S.Em. ± | 0.28 | 0.13 | 0.12 | 0.14 | 0.07 | 1.00 | 0.56 | 1.29 |
| CD (5%) | 0.82 | 0.39 | 0.36 | 0.42 | 0.22 | 2.94 | 1.63 | 3.79 |

Table 3. Interactive effect of zinc and FYM on growth and yield of pea

| Number of branches per plant at harvest | | | | |
|---|---|---|---|---|
| Treatments | $F_0$ | $F_1$ | $F_2$ | $F_3$ |
| $Zn_0$ | 4.49 | 4.89 | 5.26 | 5.32 |
| $Zn_1$ | 4.94 | 5.41 | 5.31 | 5.90 |
| $Zn_2$ | 5.19 | 5.32 | 5.96 | 6.15 |
| S. Em± | 0.16 | | | |
| CD (5%) | 0.46 | | | |
| Days to first flowering | | | | |
| $Zn_0$ | 42.67 | 44.67 | 45.33 | 47.33 |
| $Zn_1$ | 43.33 | 45.00 | 46.33 | 48.67 |
| $Zn_2$ | 44.00 | 45.67 | 47.67 | 51.00 |
| S. Em± | 0.33 | | | |
| CD (5%) | 0.97 | | | |
| Green pod yield (q $ha^{-1}$) | | | | |
| $Zn_0$ | 51.62 | 71.07 | 73.01 | 82.19 |
| $Zn_1$ | 71.13 | 62.56 | 81.98 | 81.82 |
| $Zn_2$ | 77.08 | 82.81 | 75.89 | 80.03 |
| S. Em± | 3.85 | | | |
| CD (5%) | 11.28 | | | |

**References**


Arumugam, S. and Anburani, A. 2008. Effect of certain organics and pressmud on growth and yield characteristics of tomato. *The Asian Journal of Horticulture*. 3(2): 273-276.

Aykroyd, W.R. 1963. *ICMR Special Repblic series*. Number 42.

Bhattarai, R.K., Singh, L.N. and Singh, R.K. 2003. Effect of integrated nutrient management on yield attributes and economics of pea (*Pisum sativum* L.). *Indian Journal of Agricultural Sciences*. 73(4): 219-220.

Duarte, U.M.M.K.V., Lelly and N. Narayana. 1961. Micronutrient status of Bombay State. *Journal of Indian Society of Soil Science*. 9: 41-53.

Dube, B.K., Sinha, P. and Chatterjee, C. 2003. Effect of zinc on yield and quality of tomato. *Indian Journal of Horticulture*. 60(1): 59-63.

Ghuge, T.D., Gore, A.K. and Jadhav, S.B. 2007. Effect of organic and inorganic nutrient sources on growth, yield and quality of cabbage (*Brassica oleracea* var. *capitata*). *Journal of Soil and Crops*. 17: 89-92.

Gupta, S. and Handore, K. 2009. Direct and residual effect of zinc and zinc amended organic manures on the zinc nutrition of field crop. *International Journal of Agriculture Sciences*. 1(2): 26-29.

Kasturikrishna, S. and Ahlawat, I.P.S. 2000. Effect of moisture stress and phosphorus, sulphur and zinc fertilizers on growth and development of pea (*Pisum sativum* L.). *Indian Journal of Agronomy*. 45(2): 353-356.

Kumar, M. and Sen, N.L. 2005. Effect of zinc, born and gibberellic acid on yield of okra (*Abelmoschus esculentus* L. Moench). *Indian Journal of Agronomy*. 62(3): 308-309.

Kumaran, S., Natrajan, S. and Thamburaj, S. 1998. Effect of organic and inorganic fertilizers on growth, yield and quality of tomato. *South Indian Horticulture*. 46(3-4): 203-205.

Manolikar, R.R., Vitkar, M.N., Vasmate, S.D., Patil, R.F. and Kalalbandi, B.M. 2007. Effect of integrated nutrient management on growth and yield of tomato (*Lycopersicon esculentum* Mill.). *The Asian Journal of Horticulture*. 2(2): 178-180

Marschner, H. 1995. Mineral Nutrition of Higher Plants, Academic Press, New York. pp 347-64

Nagaraju, A.P. and Yadahalli, Y.H. 1996. Response of cowpea to source and levels of phosphorus and zinc. *Indian Journal of Agronomy*. 41(1): 88-90.

Panse, V.G. and Sukhatme, P.V. 1995. Statistical methods for Agricultural workers. ICAR, New Delhi.

Prasad, S. and Kumar, U. 2010. Principles of Horticulture. Agrobios Pub. (2): p., 211.

Rafi, Mohmad, Narwadkar, P.R., Prabu, T. and Sajindranath, A.K. 2002. Effect of organic and inorganic fertilizers on growth and yield of tomato (*Lycopersicon esculentum* Mill). *South Indian Horticulture*. 50(4-6): 522-526.

Raghav, M. and Sharma, R.D. 2003. Growth and yield of tomato, okra, vegetable pea cropping sequence as affected by levels and methods of zinc application. *Progressive Horticulture*.35(1): 96-99.

Raghav, M. and Singh, N.P. 2004. Effect to zinc application on growth and yield of potato. *Progressive Horticulture*. 36(1): 135-137.

Reddy, I.S., Reddy, M.G.R.K., Veeraraghavaiah, R., Subramanyam, K. and Reddy, D.S. 1995. Response of tomato to micronutrients. *South Indian Horticulture*. 33:1 23-25.

Sarkar, R.K., Karmakar, S. and Chakraborty, A. 1997.

Response of summer green gram (*Phaseolus radiatus*) to nitrogen, phosphorus application and bacterial inoculation. *Indian Journal of Agronomy*. 38(4): 578-581.

Sharma, V. and Abraham, T. 2010. Response of black gram (*Phaseolus mungo*) to nitrogen, zinc and farm yard manure. *Legume Research*. 33(4): 295-298.

Sharu, S.R. and Meeradai, M. 2001. Effect of integrated nutrient management on yield and quality in chilli (*Capsicum annum* L.). *Vegetable Science*. 28(2): 184-185.

Subbarao, T.S.S. and Sankar, C.R. 2001. Effect of organic manures on growth and yield of brinjal. *South Indian Horticulture*. 49: 288-291.

Subbiah, K., Helkiah, J., Ravikumar, V. and Rajgopal, C.K. 1982. Effect of combined application of organic and inorganic fertilizer on yield and nutrient uptake of chilli cv. MDU-1. *South Indian Horticulture*. 30: 45-47.

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# Effect of improved cultivation practices on incidence of jassid, *Amrasca biguttula biguttula* in okra [*Abelmoschus esculentus* (L.) Moench]

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**Abstract**

An experiment was conducted at College of Agriculture, Bikaner to find out the effect of improved cultivation practices *viz.,* irrigation methods, planting of different cultivars and uses of mulches on incidence of jassid (*Amrasca biguttula biguttula)* in okra. The results of the experiment revealed that in case of irrigation methods, the minimum number of jassid (1.73/3 leaves) was recorded in 0.6 volume of drip irrigation while maximum (5.45/ 3 leaves) was observed in 1.0 volume of surface irrigation. Planting of different cultivar was not significantly influence the incidence of jassid. In the treatments when mulches were used, this minimum number of jassid (2.69/ 3 leaves) was recorded in bui mulch while maximum number of jassid was recorded in those treatments when mulches were not used.

**key words:** *Cultivars, drip irrigation, jassid, mulches, okra*

## Introduction

Okra is one of the important hardy fruit vegetable grown throughout the country in warm climate. Its fruits are highly delicious and nutritionally rich in potassium, calcium, iron, thiamine and vitamin 'C 'and crude fibre and mainly used for preparation of stuff vegetables. It occupies an area of 0.40 million hectare with production of 4.19 million tonnes in the country (Anonymous, 2008). In Rajasthan, it is being cultivated in 3200 hectare area with production of 18000 tonnes (Anonymous, 2009). Many factors are responsible for low productivity and production of okra but insect pests have been reported to cause substantial damage to the okra crop.

Among these, jassid [*Amrasca biguttla biguttla*] (Ishida) (Homoptera: Cicadellidae) is most important in the tropics and subtropics because environmental conditions are often conducive year round for growth and development of host and pest (Singh *et al.*, 1993; Kakar and Dobra, 1988). Jassid are very serious pest in dry weather condition or whenever there is a spell of drought. Both nymphs and adults of this wedge shaped pale green leaf-hopper suck the sap from the lower surface of leaves and injecting some toxic material resulting in curling of leaves upward and plant growth is stunted. Severe infestation cause burnt leaves which fall down later. There is drastic decrease in yield (Singh, 1998). The maximum productivity of okra and minimum incidence of jassid were obtained by judicious use of irrigation water by drip irrigation and mulches. The concept of drip irrigation is to create a continuous wetted strip along the plant line. The even supply of water and nutrients directly to the root zone creates an optimal environment for the roots to efficiently absorb the soil nutrients for appropriate growth of the plants. The people are realizing that drip system is the only way to use this natural resource in judicious manner so that maximum yield can be obtained from a single drop of water with minimum jassid infestation over surface irrigation. One of the important aspect of improvement in yield, quality of okra and minimum jassid infestation was selection of suitable cultivars to a particular agro-climatic region. Use of mulches regulates soil moisture, stabilize soil temperature, suppress weed growth, minimize leaching losses of nutrients, check excessive evaporation, reduce soil erosion, minimum jassid population by maintaining optimum moisture at root zone. It is, therefore, needed to manage this pest more effectively by combined use of drip irrigation, suitable cultivars and mulches. Keeping this in view, the present studies were planned to observe the effect of drip irrigation, cultivars and mulches on incidence of jassid on okra.

## Material and methods

The studies were carried out at Research Farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner during the rainy seasons of 2008 and 2009. The experiment was laid out in Split-Split plot design and replicated three times with twenty four treatment combinations. The treatments included four levels of irrigation viz. 100 %, 80 % and 60 % ET through drip and 100 % recommended surface irrigation; two cultivars viz., Arka Anamika and Tulsi Hybrid; and Three treatments of mulches viz., control, Bui mulch (Organic mulch @ 10 tonnes /ha) and Black polyethylene (25 micron). The volume of water required under drip irrigation system was computed using following equation:

$V = Ep \times Kp \times Kc \times A \times Wp$

Where, V= Volume of water required in litre / day, Ep= Mean pan evaporation for the month in mm/day, Kp= Pan coefficient (0.7 for class A pan), Kc= Crop coefficient, A= Plant to plant x row to row spacing (0.40 m x 0.20 m), Wp= Wetting fraction (0.9)

The seeds were sown at 40 x 20 cm spacing between row to row and plant to plant in rainy season. FYM @ 200 q/ha was applied at the time of field preparation. A

uniform dose of 60 kg $P_2O_5$/ha through DAP, 50 kg $K_2O$/ha through muriate of potash and half dose of nitrogen (50 kg) through urea were applied in the soil at the time of sowing. The remaining dose (50 kg) of nitrogen through urea was applied through drip irrigation. After germination of seeds, *bui* was placed in the experimental plots @10 t/ha while black polyethylene was placed between the rows of okra. In drip irrigation, water was applied per day while in surface method water was applied at weekly interval.

The observations on number of jassid were counted by selecting five randomly plants and then tagged. Three leaves from top, middle and bottom of each plant were plucked and then counts of the jassid population from lower surface of leaves and finally calculated the average jassid population.

**Results and discussion**

Perusal of data in table 1 and fig. 1 showed that number of jassid per three leaves was influenced significantly by different irrigation volumes during both the years and in pooled analysis. Population of jassid was recorded maximum (5.45 /3 leaves) in surface irrigation followed by 1.0 volume of drip (4.70 /3 leaves) and minimum in 0.6 volume of drip (1.73 /3 leaves). There was progressive decrease in population of jassid from drip 1.0 volume to drip 0.6 volume. This treatment prevented excessive vegetative growth resulting unfavorable conditions of incidence of jassid. Frequent application of water maintains the soil moisture almost near to the field capacity, thereby crop did not suffer from moisture stress during growth period. Similar results were reported by Raina *et al.* (1999).

The data presented in table 1 and fig. 1 showed that during 2008, number of jassid was minimum (3.35 /3 leaves) in Tulsi hybrid as compared to Arka Anamika (3.94/ 3 leaves). Similar trend was observed during 2009, minimum number of jassid (3.74/ 3 leaves) was recorded in Tulsi hybrid whereas maximum under Arka Anamika (3.97/ 3 leaves). Pooled data indicated that minimum number of jassid (3.55/ 3 leaves) was recorded in Tulsi hybrid over Arka Anamika (3.96/ 3 leaves), however, both the cultivars were at par with each other in terms of incidence of jassid in both the years as well as in pooled data.

It is further evident that during 2008, number of jassid was minimum in bui mulch (2.64/3 leaves) followed by black polyethylene mulch (3.59/ 3 leaves) and control (4.71 / 3 leaves). Similar trend was observed during 2009. The pooled data of 2008 and 2009 exhibited that minimum number of jassid (2.69 / 3 leaves) was recorded in bui mulch whereas, maximum was under control (4.78/ 3 leaves). Low evaporation and more moisture conservation in soil which result in overall better performance of okra plant may be one of the reason of low and high number of jassid incidence on the plants. The present results are inconformity with those of Sterk and Span (1997) and Samaila (2011) who reported that straw mulch allow for better air circulation and resulted in better performance of tomato plants in field.

Table 1: Effect of irrigation volumes, cultivars and mulches on Jassid population in okra crop

| Treatment | Number of Jassid / three leaves | | |
|---|---|---|---|
| | 2008 | 2009 | Pooled |
| Irrigation levels | | | |
| Surface ( 1.0 V) | 5.23 | 5.675.45 | |
| Drip ( 1.0 V) | 4.35 | 5.054.70 | |
| Drip ( 0.8 V) | 3.05 | 3.203.13 | |
| Drip ( 0.6 V) | 1.95 | 1.511.73 | |
| SEm± | 0.242 | 0.477 | 0.267 |
| CD (P=0.05) | 0.84 | 1.650.82 | |
| Cultivars | | | |
| Arka Anamika | 3.94 | 3.973.96 | |
| Tulsi | 3.35 | 3.743.55 | |
| SEm± | 0.274 | 0.315 | 0.209 |
| CD (P=0.05) | NS | NS NS | |
| Mulching | | | |
| Control | 4.71 | 4.854.78 | |
| Bui | 2.64 | 2.732.69 | |
| Black polyethylene | 3.59 | 3.993.79 | |
| SEm± | 0.313 | 0.291 | 0.213 |
| CD (P=0.05) | 0.90 | 0.840.60 | |

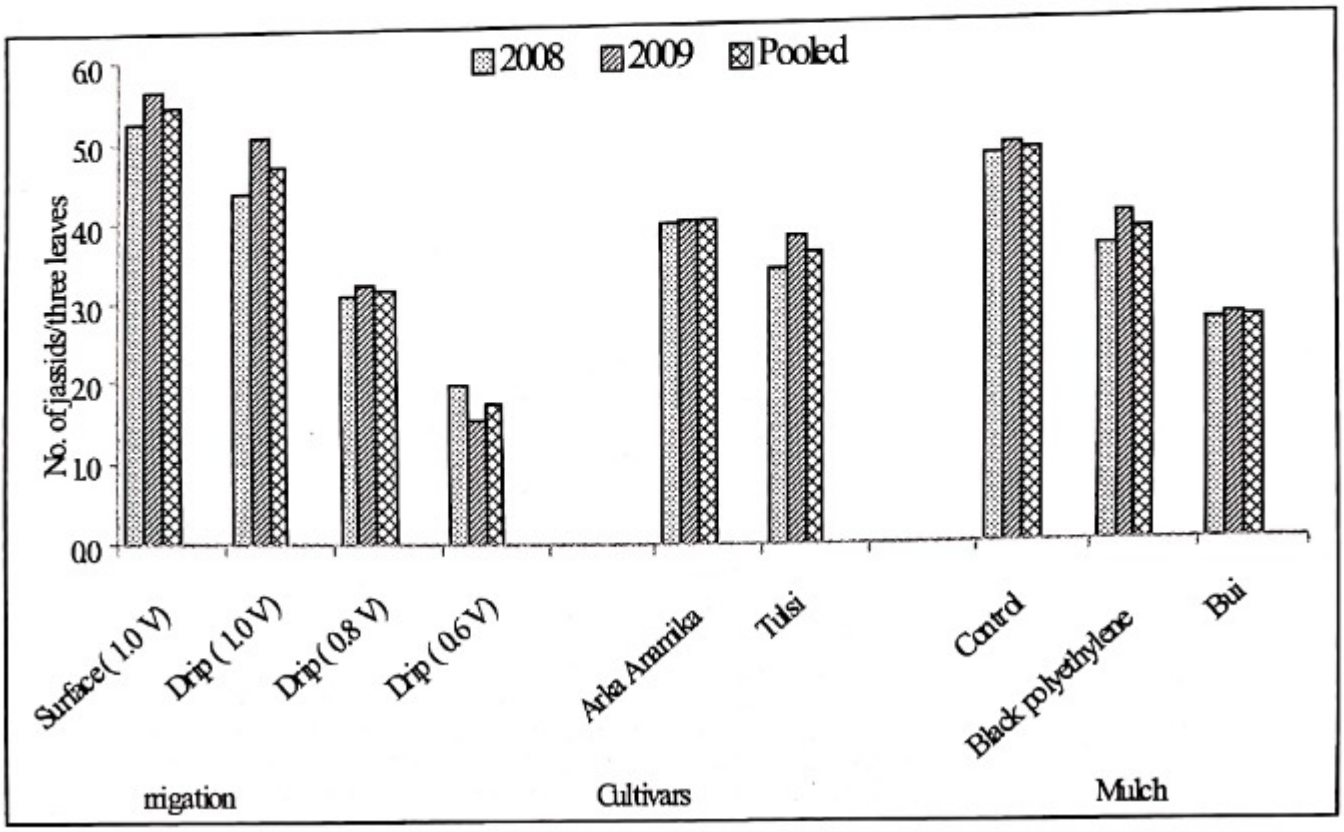


Figure 1. Effect of irrigation volumes, cultivars and mulches on Jassid population in okra crop

**References**


Anonymous. 2008. Database, National Horticulture Board, Gurgoun.

Anonymous. 2009. Area and Production of vegetables in India,

State/UTs.www.cropinfo.In/InfoBasc/excel/vegetable. htm

Kakar, K.L. and G.S. Dobra. 1988. Insect-pests of okra, *Abelmoschus esculentus* (Linn.) Monech. and their control under mid-hill conditions. J. Insect Sci. 1(2): 195-198.

Raina, J.N., Thakur, B.C. and Verma, M.L. 1999. Effect of drip irrigation and polyethylene mulch on yield, quality and water use efficiency of tomato. *Indian Journal of Agric. Sci.* 69(6) : 430-433.

Samaila, Aliyu. 2011. Nutritional quality of tomato (*Lycopersicon esculentum* Mill.) as influenced by mulching, nitrogen and irrigation interval. *Journal of Agricultural Science*. 3(1):266-269.

Singh, J., Sohi, A.S., Dhaliwal, Z.S. and Mann, H.S. 1993. Comparative incidence of *Helicoverpa armigera* Hb. and other pests on okra and sunflower intercrops in cotton under Punjab conditions. J. Insect Sci. 6: 137-138.

Sterk, G. and Spaan, W.P. 1997. Wind erosion control with crop residues in the Sahel. *Soil Science Society of American Journal*. 61: 911-16.

Singh, S.P. 1998. Production Technology of Vegetable Crops. Agricultural Research Communication Centre. Pp. 75.

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# Genetic variability studies and scope of improvement in sponge gourd under hot arid agro-climate

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**Abstract**

Fifteen landraces of sponge gourd were evaluated for 19 quantitative characters to study the genetic variability and association of the traits. The analysis of variance revealed considerable genetic variability in the evaluated germplasm. The GCV and PCV estimates were high for fruit yield/plant, number of fruits/plant and number of seeds/fruit indicating better scope for improvement through simple selection. These characters also depicted high estimates for heritability and genetic gain indicating additive type of gene action. Fruit yield/plant showed positive and significant association with number of fruits/plant and fruit weight. Among the genotypes tested for performance studies, AHSG-4 and AHSG-5 recorded the highest fruit yield potential under arid conditions. The genotype AHSG-4 exhibited earliness (53.84 days) for first marketable harvest.

**Key words**: *Sponge gourd, Luffa cylindrica, genetic variability and hot arid agro-climate.*

## Introduction

Out of 9 species of *Luffa*, *L. acutangula*, *L. cylindrica* and *L. hermaphrodita* are native to India and are consumed as vegetable (Chandra, 2). Sponge gourd (*Luffa cylindrica* L.) is an important cucurbitaceous vegetable grown throughout the country. Despite its commercial importance, not much attempt has been made on its genetic improvement particularly to identify and develop genotype under stressed environmental conditions of arid region (Samadia, 7). Information on the magnitude of genetic variability available in the germplasm and knowledge of association between yield and its contributing traits are required to utilize the material potentially in breeding programme. Therefore, the present study was undertaken to assess the extent of genetic variability in the evaluated germplasm of sponge gourd and to assess the scope for improvement under hot arid agro-climate.

## Materials and methods

The experimental material for the investigation comprised 15 land races collected from the tribal area of southern Rajasthan and northern Gujarat. The germplasm were evaluated at the experiment farm of Central Institute for Arid Horticulture, Bikaner (28° N latitude and 73° 18' E longitude and an altitude of 235 m above sea level) where the agro-climate is characterized by extremes of temperature (- 4° C in winter to 48° C in summer), low rainfall (150 - 300 mm in short spells from July - September), high vapour pressure deficit (30 mb in May-June), high solar radiation, high wind speed (12 - 16 km/hr) with dust storms, beside poor fertility and water holding capacity of the sandy soil. The experiment was laid during the rainy-winter season of 2003 and 2004 in a randomized block design with three replications. Seeds of each genotype were sown at 50 cm spacing on one side of the channel of 10 m length. The channels were spaced 2.5 m apart. Out of 15 - 18 plants maintained for each genotype, observations were recorded on five selected plants per replication for quantitative and qualitative characters. Recommended cultural practices were followed. Nineteen quantitative traits taken for presentation of results are days to appearance of first male flower (DFMF) days after sowing (DAS), days to appearance of first female flower, DAS (DFFF), node to first fruit set (NFS), days to first harvest, DAS (DFH), fruit length, cm (FL), fruit diameter, cm (FD), fruit weight, kg (FW), number of fruits/plant (NF/P), fruit yield/plant, kg (FY/P), vine length, m (VL), leaf length, cm (LL), leaf width, cm (LW), leaf size, $cm^2$ (LS), stamenned stalk length, cm (SSL), mature fruit length, cm (MFL), number of seeds/fruit (NS/F), seed length, cm (SL), seed width, cm (SW) and weight of 100 seeds, g (STW). The data were subjected to statistical analysis adopting standard procedures using computer based INDOSTAT packages.

## Results and discussion

The analysis of variance revealed highly significant mean square estimates for all the 19 characters indicating sufficient variability in the germplasm. Wide range of variation was observed for all the characters (Table 1 and 2). The period of appearance of male and female flower ranged from 31.95 - 64.77 and 43.23 - 74.18 days after sowing (DAS), respectively. The first marketable fruit harvesting ranged from 53.84 - 83.61 days. Among the genotype, the earliest first harvest was recorded in AHSG-4 (53.84 days) followed by AHSG-15. The number of marketable fruits per plant ranged from 4.55 - 12.34 with a population mean of 8.06. The genotype AHSG-5, AHSG-4, AHSG-13, AHSG-3 AHSG-10, and AHSG-15 recorded higher number of fruits than the mean of population. Among the genotype evaluated, total marketable fruit yield/plant ranged from 0.384 - 1.421 kg with a population

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mean of 0.876 kg. The maximum fruit yield/plant was obtained in AHSG-5 (1.42 kg) followed by AHSG-4 (1.30 kg). On the basis of fruit quality characters, earliness and fruit yield, the genotype AHSG-4 was found to be the most potential. The germplasm under evaluation were diverse and thus have potential for further improvement for fruit yield and quality characters under high temperature conditions of arid region.

Genotypic and phenotypic coefficient of variation (GCV and PCV) study indicated that there is an ample scope of improvement of this crop (Table 2). In general, the estimates of PCV were higher than GCV for all the characters. A close correspondence between PCV and GCV values in respect of all the characters indicated that environment had very little influence on the expression of the character. The GCV which gives a picture of the extent of genetic variability in the population ranged from 4.31 (seed length) to 34.88 (fruit yield/plant). The GCV and PCV estimates were considerably high (>25%) for economic traits such as fruit yield/plant, number of fruits/plant and number of seeds/fruits indicating better scope of improvement through selection. Since the difference between GCV and PCV was very low, phenotypic selection should be better for fruit yield.

High heritability estimates were recorded in respect of all the characters. Though heritability estimates give a useful indication of the relative value of selection based on phenotypic expression, but reliable conclusion, cannot be dawn unless genetic advance is not taken into consideration along with heritability (Johnson *et al.*, 3). Genetic advance as percentage of mean in the present study ranged from 7.21 - 71.84%. High heritability value accompanied with high genetic advance for number of fruits/plant, fruit yield/plant and number of seeds/fruit indicates additive type of gene action. Simple selection, therefore, could be effective for the improvement of these traits. High heritability accompanied with low to moderate genetic advance for maturity, fruit and seed characters seems to be due to non-additive type of gene action and therefore simple selection for these characters will be less effective (Panse and Sukhatme, 5). The present studies on genetic variability components are in agreement with the results of Krishna Prasad and Singh (4), Singh *et al.* (8) and Ram *et al.* (6) in ridge gourd. The high variability and heritability along with high genetic gain for number of fruits and fruit yield per plant indicate that either the selected genotypes could be tested under multi-location trial or selected as a donor for these characters to be used in breeding programme.

The magnitude of genotypic correlations coefficients, in general, indicated higher than the phenotypic ones for most of the characters studied (Table 3), thereby establishing an inherent relationship among the characters. These results are in agreement with those of Abusaleha and Dutta (1) in ridge gourd and Ram *et al.* (6) in *Luffa*. Fruit yield/plant showed significant positive correlation with number of fruits/plant and fruit weight. Vine length exhibited positive and significant relationship with number of fruits and fruit yield/plant. Days to anthesis of first male flower, days to anthesis of first female flower and days to first harvest showed negative and non-significant association with fruit yield/plant. Positive and significant association had been observed between days to anthesis of male and female flower with days to first harvesting indicating mutual association of these characters.

Table1. Genetic variability studies for various characters in sponge gourd

| Characters | Range | | Mean | ECV (%) | GCV (%) | PCV (%) | $h^2$ (broad sense) | Genetic Advance (GA) | GA as percentage of mean (5 %SI) |
|---|---|---|---|---|---|---|---|---|---|
| | Minimum | Maximum | | | | | | | |
| DFMF | 31.95 | 64.77 | 50.78 | 3.98 | 16.18 | 16.35 | 98.02 | 16.76 | 33.01 |
| DFFF | 43.23 | 74.18 | 60.24 | 4.11 | 12.95 | 13.17 | 96.74 | 15.81 | 26.24 |
| NFS | 17.27 | 29.23 | 24.99 | 5.84 | 13.45 | 13.87 | 94.07 | 6.61 | 26.88 |
| DFH | 53.84 | 83.61 | 69.88 | 3.07 | 10.90 | 11.05 | 97.42 | 15.49 | 22.16 |
| FL | 14.42 | 24.17 | 19.35 | 6.33 | 11.69 | 12.25 | 91.09 | 4.44 | 22.99 |
| FD | 3.18 | 4.25 | 3.62 | 2.22 | 10.58 | 10.68 | 98.55 | 0.78 | 21.65 |
| FW | 0.076 | 0.125 | 0.106 | 5.87 | 13.87 | 14.28 | 94.36 | 0.03 | 27.76 |
| NF/P | 4.55 | 12.34 | 8.06 | 7.89 | 28.00 | 28.37 | 97.42 | 4.59 | 56.93 |
| FY/P | 0.384 | 1.421 | 0.867 | 11.24 | 34.88 | 35.48 | 96.65 | 0.61 | 70.64 |
| VL | 2.71 | 3.54 | 3.17 | 6.36 | 9.72 | 10.39 | 87.51 | 0.59 | 18.73 |
| LL | 11.41 | 20.37 | 16.05 | 1.83 | 15.19 | 15.23 | 99.51 | 5.01 | 31.22 |
| LW | 13.83 | 28.28 | 20.79 | 1.38 | 21.08 | 21.09 | 99.86 | 9.02 | 43.35 |
| LS | 189.23 | 576.43 | 341.33 | 1.90 | 33.98 | 33.99 | 99.90 | 238.81 | 69.96 |
| SSL | 1.11 | 3.15 | 1.73 | 4.06 | 34.95 | 35.03 | 99.55 | 1.24 | 71.84 |
| MFL | 20.26 | 37.57 | 28.68 | 5.73 | 19.92 | 20.19 | 97.31 | 11.61 | 40.48 |
| NS/F | 123.49 | 405.25 | 246.94 | 3.53 | 32.59 | 32.66 | 99.61 | 165.51 | 67.02 |
| SL | 1.060 | 1.236 | 1.136 | 5.37 | 4.31 | 5.31 | 65.59 | 0.08 | 7.21 |
| SW | 0.530 | 0.913 | 0.765 | 7.05 | 13.91 | 14.50 | 92.12 | 0.21 | 27.51 |
| STW | 8.730 | 12.650 | 11.155 | 2.23 | 11.64 | 11.72 | 98.79 | 2.66 | 23.85 |

Table 2: Growth, flowering and fruit yield characters in evaluated sponge gourd germplasm

| Genotype | DFMF | DFFF | NFS | DFH | FL | FD | FW | NF/P | FY/P | VL |
|---|---|---|---|---|---|---|---|---|---|---|
| AHSG 001 | 64.77 | 74.18 | 28.93 | 83.61 | 14.42 | 3.18 | 0.07 | 7.57 | 0.57 | 3.26 |
| AHSG 002 | 52.11 | 61.04 | 26.69 | 73.47 | 21.49 | 4.15 | 0.08 | 4.69 | 0.38 | 2.82 |
| AHSG 003 | 52.32 | 61.47 | 26.36 | 68.29 | 17.34 | 3.83 | 0.10 | 9.45 | 0.97 | 2.89 |
| AHSG 004 | 31.95 | 43.23 | 26.59 | 53.84 | 21.49 | 4.15 | 0.12 | 10.44 | 1.30 | 3.51 |
| AHSG 005 | 57.68 | 66.54 | 29.23 | 75.04 | 19.26 | 3.53 | 0.11 | 12.34 | 1.42 | 3.54 |
| AHSG 006 | 52.75 | 63.26 | 25.57 | 73.60 | 18.26 | 3.77 | 0.10 | 7.82 | 0.85 | 3.54 |
| AHSG 007 | 54.95 | 67.47 | 26.36 | 77.24 | 22.23 | 3.55 | 0.11 | 7.96 | 0.94 | 3.54 |
| AHSG 008 | 48.36 | 55.92 | 26.03 | 64.92 | 24.17 | 4.25 | 0.12 | 7.96 | 0.98 | 3.45 |
| AHSG 009 | 53.67 | 63.02 | 21.45 | 71.48 | 19.27 | 2.82 | 0.09 | 4.55 | 0.42 | 2.75 |
| AHSG 010 | 51.21 | 55.01 | 19.54 | 66.54 | 19.26 | 3.54 | 0.11 | 9.37 | 1.08 | 2.81 |
| AHSG 011 | 54.12 | 64.54 | 25.50 | 72.21 | 18.37 | 3.48 | 0.11 | 4.61 | 0.51 | 2.71 |
| AHSG 012 | 53.67 | 62.46 | 25.46 | 74.72 | 18.27 | 3.50 | 0.10 | 6.25 | 0.67 | 3.25 |
| AHSG 013 | 51.83 | 60.58 | 22.30 | 69.80 | 17.36 | 3.53 | 0.09 | 10.34 | 0.99 | 3.46 |
| AHSG 014 | 49.05 | 59.34 | 21.57 | 67.94 | 18.47 | 3.26 | 0.09 | 8.40 | 0.77 | 2.85 |
| AHSG 015 | 33.34 | 45.53 | 17.27 | 55.47 | 20.60 | 3.87 | 0.12 | 9.13 | 1.10 | 3.17 |
| CD at 5 % | 3.30 | 4.14 | 2.40 | 3.89 | 2.04 | 0.15 | 0.01 | 1.04 | 0.16 | 0.33 |

Table 3: Genotypic (above) and phenotypic (below) diagonal correlation among various characters in sponge gourd

| CHR | DFMF | DFFF | NFS | DFH | FL | FD | FW | NF/P | FY/P | VL | MFL | NS/F | SL | SW | STW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DFMF | **1.000** | 0.998 | 0.504 | 0.986 | -0.552 | -0.548 | -0.589 | -0.248 | -0.437 | -0.123 | -0.438 | -0.429 | 0.382 | 0.001 | -0.090 |
| DFFF | 0.968 | **1.000** | 0.543 | 1.004 | -0.548 | -0.573 | -0.597 | -0.302 | -0.488 | -0.057 | -0.547 | -0.420 | 0.307 | -0.117 | -0.120 |
| NFS | 0.418 | 0.533 | **1.000** | 0.550 | -0.072 | 0.182 | -0.152 | 0.034 | -0.018 | 0.397 | -0.213 | -0.037 | -0.036 | -0.447 | 0.047 |
| DFH | 0.959 | 0.979 | 0.529 | **1.000** | -0.503 | -0.514 | -0.596 | -0.340 | -0.509 | 0.006 | -0.511 | -0.486 | 0.234 | -0.095 | -0.088 |
| FL | -0.511 | -0.509 | -0.076 | -0.475 | **1.000** | 0.636 | 0.661 | 0.005 | 0.295 | 0.264 | 0.330 | 0.007 | -0.376 | 0.108 | 0.651 |
| FD | -0.536 | -0.552 | 0.179 | -0.508 | 0.606 | **1.000** | 0.467 | 0.237 | 0.389 | 0.336 | 0.581 | 0.190 | -0.353 | -0.272 | 0.276 |
| FW | -0.566 | -0.565 | -0.139 | -0.583 | 0.586 | 0.455 | **1.000** | 0.408 | 0.689 | 0.384 | 0.209 | 0.539 | -0.036 | 0.050 | 0.384 |
| NF/P | -0.257 | -0.287 | 0.026 | -0.328 | -0.018 | 0.229 | 0.395 | **1.000** | 0.938 | 0.615 | 0.374 | 0.346 | 0.420 | 0.285 | 0.118 |
| FY/P | -0.438 | -0.464 | -0.019 | -0.496 | 0.247 | 0.378 | 0.687 | 0.933 | **1.000** | 0.627 | 0.390 | 0.471 | 0.309 | 0.244 | 0.279 |
| VL | -0.098 | -0.027 | 0.384 | -0.001 | 0.203 | 0.322 | 0.394 | 0.567 | 0.594 | **1.000** | -0.011 | 0.016 | -0.003 | 0.113 | 0.242 |
| MFL | -0.426 | -0.537 | -0.211 | -0.516 | 0.291 | 0.570 | 0.210 | 0.369 | 0.386 | -0.005 | **1.000** | 0.125 | 0.043 | -0.008 | -0.098 |
| NS/F | -0.425 | -0.413 | -0.036 | -0.475 | 0.002 | 0.186 | 0.522 | 0.344 | 0.464 | 0.011 | 0.123 | **1.000** | 0.012 | -0.097 | 0.137 |
| SL | 0.311 | 0.245 | -0.009 | 0.210 | -0.231 | -0.274 | -0.049 | 0.315 | 0.214 | -0.045 | 0.001 | 0.023 | **1.000** | 0.744 | 0.369 |
| SW | -0.004 | -0.124 | -0.427 | -0.091 | 0.093 | -0.264 | 0.041 | 0.282 | 0.238 | 0.077 | -0.005 | -0.089 | 0.558 | **1.000** | 0.450 |
| STW | -0.088 | -0.112 | 0.043 | -0.086 | 0.614 | 0.276 | 0.373 | 0.120 | 0.277 | 0.235 | -0.095 | 0.137 | 0.274 | 0.432 | **1.000** |

## References


Abusaleha and Dutta, O.P. 1990. Association of yield components in ridge gourd. *Haryana Journal Horticulture Science,* 19: 358-62.

Chandra, U. 1995. Distribution, domestication and genetic diversity of Luffa gourds in Indian sub-continent. *Indian Journal of Plant Genetic Resources,* 8: 189-96.

Johnson, H.W., Robinson, H.F. and Comstock, R.E. 1955. Estimates of genetic and environmental variability in soybean. *Agronony Journal,* 47: 314-18.

Krishna Prasad, V.S.R. and Singh, D.P. 1989. Studies on heritability, genetic advance and correlations in ridge gourd (*Luffa acutangula* Roxb.). *Indian Journal of Horticulture,* 46: 390-94

Panse, V.G. and Sukhatme, P. V. 1957. Genetics and quantitative characters in relation to plant breeding. *Indian Journal of Genetics,* 17: 312-28.

Ram, D., Rai, M., Verma, A. and Singh, Y. 2006. Genetic variability and association analysis in Luffa sp. *Indian Journal of Horticulture,* 63: 294-97.

Samadia, D. K. 2005. Collection and conservation of some gourd landraces of tribal areas of Rajasthan. *Indian Journal of Plant Genetic Resources,* 18 (3): 258-60.

Singh, R. P., Mohan, J., Singh, D. and Singh, D. 2002. Studies on genetic variability and heritability in ridge gourd [*Luffa acutangula* (Roxb.) L.]. *Agricultural Science Digest,* 22: 179-80.

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# *In vitro* micropropagation of guava (*Psidium guajava* L.) through nodal explant using different phytohormone combination

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**Abstract**

Guava is a popular fruit of subtropical area. Guava is one of the recalcitrant plant species for tissue culture. *In vitro* plant exudation and inborn contamination are two major bottle necks during *in vitro* culture of guava. Therefore the present study was undertaken to optimize the concentration of phytohormones for micropropagation of guava. Nodal explants were taken for the study and were excised from guava plants maintained in the germplasm block of the institute. Nodal buds (2.5cm length) were excised and brought in the lab in 50mg/l Ascorbic acid. For surface sterilization Bavestin (200mg/l) was used followed by 0.1% $HgCl_2$ for 5 minutes. Explants were inoculated vertically on MS medium supplemented with 50 mg/l PVP and BAP alone or in combination with Kinetin. The cultures were incubated at 25°C in the dark for two days then allowed to grow under a photoperiod of 16/8 hours light and dark period. Among the different combinations of BAP and Kinetin used, MS medium supplemented with 2 ppm BAP, 1 ppm Kinetin and 50 ppm PVP found best for shoot proliferation. MS medium supplemented with 1 ppm IAA found best for rhizogenesis.

**Key Words:** Guava, nodal explants, sterilization, micropropagation, phytohormones

## Introduction

Guava is a rich source of vitamins, minerals, organic acids, and pectins (Chan *et al.*, 1971; Rathore, 1976; and Loh and Roa, 1989). It belongs to the Mytraceae family with chromosome number 2n=22 and possesses 150 species. This is native to tropical America, but it is cultivated in every tropical and subtropical country of the world. In India, guava is well adopted in almost all the states. The major guava-growing states are Bihar, Uttar Pradesh, Karnataka, Gujarat and Andhra Pradesh. It is estimated that the area and production of guava in India is 150.9 thousand ha and 1710.6 M ton (Singh *et al.*, 2003). Guava is an important tropical fruit tree and is normally propagated by layering, cuttings, stooling, and budding or recently by wedge grafting but the rate of multiplication by this method is not very fast. Micropropagation methods could assist in rapid and mass production of clonal stock of newly released improves cultivars of guava. Many workers have reported the protocols for micropropagation of guava (Amin, 1986; Jaiswal and Amin, 1986; Amin and Jaiswal, 1988; Papadatou *et al.*, 1990; Prakash and Tiwari, 1996) using shoot buds. However, we reported here effects of different phytohormonal combinations on micropropagation in guava (*Psidium guajava L.*)

## Materials and methods

The study was conducted in Tissue Culture Laboratory at Allahabad Agricultural Institute- Deemed University Allahabad. The tree was grown inside shade net house and sprayed with carbendanzime (5%) regularly. The long shoots were excised from the tree and brought to the laboratory in 50 mg/l ascorbic acid. The defoliated shoots were cut in to 2.5 cm in size. The shoots were first washed under running tap water and then kept in a solution containing 0.1% Bavestin + 0.1% Indofil + 0.1% 8 Hydroxyquinoline (8HQC) for one and half hours. After thorough washing the explants were surface sterilized with 0.1% $HgCl_2$ for 5 minutes aseptically followed by 56 washing with sterile distilled water. The processed explants were inoculated vertically on MS medium (Murashige and Skoog, 1962) supplemented with different concentration of BAP (1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0 ppm) + 50 ppm Polyvinilpyrrolidon (PVP) + 1 ppm kinetin. The cultures were incubated at 25°C in the dark for two days then allowed to grow under a photoperiod of 16/8 hours light and dark period. The medium was gelled with 8 g/l agar and supplemented with 30 g/l sucrose. The pH was adjusted at 5.8 before autoclaving. The cultures were incubated at 3000 lux light illumination for 16 hours with 25±2°C temperature. Visual observations were taken away every 3 days and effect of different treatments was quantified on the basis of percentage of explants showing response for regeneration. Data were collected after 3 weeks including shoot and shoot length. For rooting individual shoots were separated from shoot cluster and transferred to culture tube containing 20 ml of MS medium having different concentrations of IAA (0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5 ppm) and maintained under identical conditions. Observations

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were noted after 3 weeks including no. of roots.

**Results and discussion**

The present study was designed to standardize a protocol for micro propagation of guava from nodal explants. Guava is an important tropical fruit tree and is normally propagated by layering, cuttings and budding or recently by wedge grafting but the rate of multiplication by this method is not very fast. So, micropropagation is only devising method for propagation. The stock of guava was maintained in shade net house and was sprayed regularly with fungicide. Shoots were sterilized with fungicide solution (bavestin + 0.1% Indofil + 0.1% 8HQC) followed by sterilization with $HgCl_2$ for 5 minutes aseptically. Data (Table 1) clearly revealed that around 2.0 cm long shoot explants inoculated on MS medium supplemented with 2 ppm BAP and 1 ppm Kinetin found to be best for quick bud induction (6 days) and *in vitro* proliferation (3.0 shoot/culture). Frequent subculturing was prerequisite for removal of phenol. *In vitro* shoot proliferative efficiency of guava was observed to be very low (1-2 microshoots/culture). Maximum proliferation was achieved with 2 ppm BAP, 1 ppm Kinetin and 50 mg/l PVP (910 microshoots/culture). The low multiplication rate may be due to low BAP concentration (0.5 1.0 %). *In vitro* rhizogenesis was achieved when micro shoots were transferred to MS medium fortified with IAA. Maximum roots (7 roots/shoot) within 20 days supplemented with 2 ppm IAA.

Many combinations and concentrations of growth regulators were tried for shoot and root regeneration. The MS medium supplemented with 2 ppm BAP, 1.0 ppm Kinetin and 50 ppm PVP proved to be the best medium for shoot multiplication. It shows that multiplication increases with increase in BAP concentration up to 2 ppm but further increase in BAP concentration reduces the shoot multiplication (Table 1). The nodal segments taken from *in vitro* proliferated shoots were of guava rise to 2-4 shoots by precocious axillary branching without an initial lagperiod (Amin and Jaiswal, 1988). By repeated sub culture, a large number of shoots were built up with a shoot multiplication rate of 3 to 4 fold per sub culture. The proliferated shoot cultures were established from shoot tips excised from seedlings grown in a growth chamber and culture on Rugini Olive medium (OM) supplemented with benzyladenine (Murashige and Skoog, 1962). For rooting from regenerated shoots different concentrations of IAA were tested (Table 2). Best rooting were observed on MS medium supplemented with IAA (2 ppm).

This report provides a simple protocol for *in vitro* micropropagation of guava by using nodal explants of field grown plant cultured on the MS medium supplemented with BAP (2 ppm), Kinetin (1.0 ppm) and 50 mg/l PVP after 5 to 6 week and maintained under identical conditions with frequent sub culturing. The regenerated shoots were rooted on different rooting media. Best rooting was observed on IAA (1 ppm) after 3-4 weeks.

**Acknowledgement**

Authors are grateful to Vice-Chancellor and Dean, College of Biotechnology and Allied Sciences, AAI-DU, Allahabad for providing necessary facilities.

Table 1. Effect of different concentration of growth hormones on development of guava shoots when supplemented to MS medium.

| BAP (ppm) | Kinetin (ppm) | PVP (ppm) | Percentage of shoot responded after 4 weeks | Number of shoots/explants |
|---|---|---|---|---|
| 0.5 | 1 | 50 | 10 | 1-2 |
| 1.0 | 1 | 50 | 35 | 4-5 |
| 1.5 | 1 | 50 | 50 | 5-7 |
| 2.0 | 1 | 50 | 75 | 9-10 |
| 2.5 | 1 | 50 | 60 | 8-7 |
| 3.0 | 1 | 50 | 55 | 6-5 |
| 3.5 | 1 | 50 | 30 | 3-4 |
| 4.0 | 1 | 50 | 15 | 2-3 |

Table 2. Effect of different concentrations of IAA on rooting of *in vitro* proliferated shoots of guava on MS medium.

| IAA (ppm) | % age of root induction | No. of roots/ regenerated shoot |
|---|---|---|
| 0.5 | 10 | 1 |
| 1.0 | 25 | 2 |
| 1.5 | 40 | 4 |
| 2.0 | 75 | 7 |
| 2.5 | 45 | 5 |
| 3.0 | 20 | 2 |
| 3.5 | 9 | 1 |

**References**


Amin, M. N. 1986. Micropropagation of a tropical fruit tree *Psidium guajava* L. *J. Indian Bot. Soc.* 65: 43 44.

Amin, M. N. and Jaiswal, V. S. 1986. Micropropagation as an aid to rapid cloning of guava cultivars. *Sci. Hort.* 36: 89 95.

Chan, H. T., Brekke, J. E. and Chan, T. 1971. Nonvolatile organic acid in guava. *Journal of Food Science.* 36: 237 239.

Jaiswal, V. S. and Amin M. N. 1986. *In vitro shoot proliferation and plant formation from somatic tissue of guava,* paper presented to the VI Intl. Congr. Plant Tissue Culture, University of Monnesota, Minneapolis. P-279.

Loh, C. S. and Rao, A. N. 1989. Clonal propagation of guava from seedlings and grafted plants and adventitious shoot formation in vitro. *Scientia Horticulturae.* 39: 31 39.

Murashige, T. and Skoog, F. A. 1962. Revised medium for rapid growth and bioassay with tobacco tissue culture. *Physiol Plant.* 15: 473 497.

Papadatou, P. and Pontikis, C. A. 1990. Ephtimiadox E and Uydaki M, Rapid Multiplication of guava seedling by in vitro shoot tip culture. *Sci Hort.* 45: 99 103.

Prakash, H. and Tiwari, J. P. 1996. *In vitro clonal propagation of Guava (Psidium guajava L.) cv. Sardar,* abstract in Natl. Symp. Horticulture Biotech, Bangalore, India, p. 28 -30.

Rathore, D. S. 1976. Effect of season on the growth and chemical composition of guava (*Psidium guajava* L.) fruits. *J. Hort Sci.* 51: 41 47.

Singh, G., Rajan, S. and Singh, A. K. 2003. Approaches and Strategies for precision farming in guava. In *Precision Farming In Guava,* edited by H. P. Singh, G. Singh, J. Samuel, and R. K. Pathak (NCPAH, DAC/PFDC, CISH, Lucknow, India) p. 92.

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# Biodiversity of vesicular arbuscular mycorrhizal (VAM) fungi in horticultural production system in northern Rajasthan

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**Abstract**

The diversity of vesicular arbuscular mycorrhizal (VAM) fungi in horticultural production systems of small farmer agro systems was analysis. Vesicular arbuscular mycorrhizal fungal symbioses are playing a key role for P uptake by horticultural crops grown there. The objective of this study was to determine AM fungal community's in cropping systems and to identify soil factors affecting their frequency and diversity. Totally 4 VAM fungal species were identified. It is concluded that it will be advisable for farmers to inoculate their horticultural crops with selected Mycorrhizal inoculants during the nursery stage, as it cannot be predicted from the soil conditions whether the native vesicular arbuscular mycorrhizal fungal community is sufficient to sustain a stable horticultural production in the region.

**Keywords:** Glomeromycetes, Vesicular Arbuscular Mycorrhiza, soil, arid region and agro-ecosystems.

## Introduction

Soil micro flora plays fundamental role for the productivity and stability of horticultural and agro ecosystems in the northern Rajasthan (Harley, 1983). Within this micro flora vesicular arbuscular mycorrhizal (VAM) fungi stand out because they are so important for the phosphate (P) nutrition of plants in this soil. They establish a mutualistic symbiosis with most of plants and this type of mycorrhiza is by far the most important worldwide. It is said that it occurs with more than 60-90% of the species of the plant kingdom (Trappe, 1987). Fungal species involved in the formation of VAM belong to the Glomeromycota (Schüssler *et. al.*, 2001).

### *Diversity of Vesicular arbuscular mycorrhizal fungi*

Among the factors influencing the vesicular arbuscular mycorrhizal fungal community dynamics and associations with plants, agricultural practices may be considered to be the most important (Bakshi *et. al.*, 1974). Tillage, crop rotation sequences, and crop management systems have been reported as critical factors affecting the development, activity and diversity of VAM fungi (Oehl *et. al.*, 2003; 2005). Mycorrhizal propagules can survive in the soil as spores which appear to be long-term structures of different ages, states of dormancy and germination periods and they constitute an inoculums source persisting for many years (Smithand Read, 2009). Hence, these fungal propagules represent the native mycorrhizal inoculums potential for locally grown crops. The fungal species naturally present in agro systems may be decisive for the productivity of crops. The main purpose of this study was to investigate the occurrence of AM fungi species in some horticultural ecosystems in soil of northern Rajasthan, and to determine whether there is any relation between their occurrence and soil factors. VAM fungi are present in almost every ecosystem from tropical rain forest and grasslands to extreme environments such as semi-arid (Veenendaal et al. 1992) and arid deserts (Allen and Allen 1992).

## Materials and Methods

The study site is situated in northern Rajasthan. The total human population of district is about 17.89 million and out of this nearly 72.6 percent in rural areas. The sampling was done in Sri Ganganagar district, which is under the influence of Great Thar desert. It is bounded on the north by Punjab state, on east by Hanumangarh district of Rajasthan, on the south by Bikaner district of Rajasthan, and on the west by Pakistan. The annual rainfall of this area is ranged between 250-300mm. The climate of this region is semi arid with extreme temperature condition in summer (up to 45 °c) and winter (up to 1°c) two agro ecosystems were selected for the study is northern part of Rajasthan: Horticultural systems habitually cropped by local farmers with vegetables, crops and fruit crops, based on cropping system. Soil samples were taken from Sri Ganga Nagar district where fruits crops are cultivated. Soil samples from the 0-10 cm horizon were taken from 10 $m^2$ plots from within the planting grows and between the rows. There were 4 replicated plots per location. Soil samples from each plot were bulked to give four replicates per ecosystem; soil samples were brought to the laboratory and stored in a freezer until analyses for separation of spores and the identification of VAM fungi species, and for soil analyses. Spores of VAM fungi were extracted and separated from the soil using the wet sieving and decanting procedure described by Sieverding (1991). For the taxonomic

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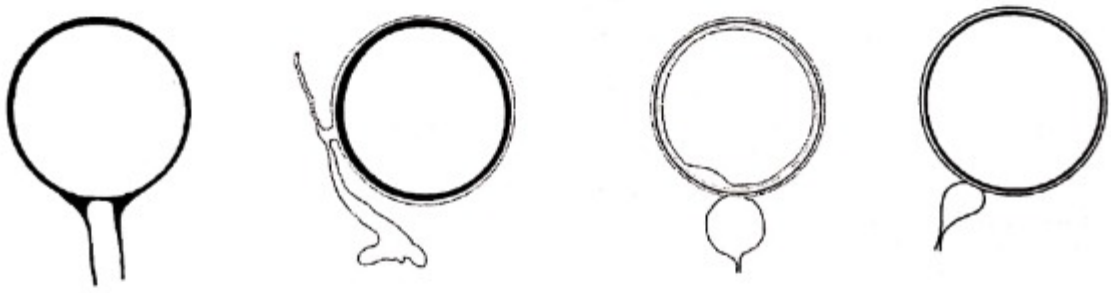
classification main morphological spore characteristics such as colour, size, type and number of spore walls, and the morphology of the subtending hyphae at the point of spore attachment were observed. The species identification was carried out using the keys and instructions given by Schenck and Pérez (1990) and INVAM (International Culture Collection of Arbuscular and Vesicular-Arbuscular Endomycorrhizal Fungi).

**Results and Discussion**

Periodical survey of Sriganganagar district, northern Rajasthan was undertaken to collect and identify different VAM spores associated with fruit plants. Rhizosphere soil sample collected from various localities revealed the presence of several species of different genera. The VAM genera were identified such as *Glomus, Gigaspora, Acaulospora and Scutellospora* (Figure 1). In the Present study, it was established that 80-90% VAM spores accounted in Sriganganagar region. The number of species was highly variable among the horticultural production sites ranges. This may indicate that these species are fit to survive and form spores under very diverse conditions. Therefore, these fungal species can be considered ecological generalists. In horticultural system soils presented relatively high diversity of VAM fungi. The function and importance of each of the different VAM fungal species in each ecosystem is known. In ecosystems, the horticultural and cropping systems, *Glomus* sp. represented each about 60% of all VAM fungal species found clearly the majority of the AMF community (Table 1). It is not surprising that most of VAM fungi spores owned to the *Glomus* genus because this is the prevailing genus in agricultural soils among the VAM species described so far (Jansa *et. al.*, 2003).

The results indicated that *Glomus* and *Gigaspora* were the dominant genera in Sriganganagar district, Northern Rajasthan. It has been found *Glomus* and *Gigaspora* usually produce more spores than *Acaulospora* and *Scutellospora.* Arid soil contain 7 -80 spores of VAM (*Glomus, Gigaspora, Acaulospora and Scutellospora.*) 100 per gram soil. Almost all plant growing in desert including Xerophyte do carry VAM fungi infection on their roots. (Kiran Bala *et. al.*, 1989) and the infection varied from plant to plant. VAM fungi also enhance nodulation and Nitrogenase activity in legumes (Tarafdar and Rao, 1997)



*Glomus* *Acaulospora* *Scutellospora* *Gigaspora*

Figure : 1 showing the various genera of VAM fungi

Table 1. Showing the distribution of plants and relationship with symbiotic plants of FAM fungi

| Sr. No. | VAM Fungi | Distribution of Plants | Symbiotic Plants |
|---|---|---|---|
| 1 | *Glomus sp.* | +++++ | All kinds of Plants |
| 2 | *Gigaspora* | ++++ | All kinds of Plants |
| 3 | *Acaulospora* | +++ | All kinds of Plants |
| 4 | *Scutelospora* | ++ | All kinds of Plants |

(+++++ maximum, ++++moderate, +++less moderate, ++minimum)

The diversity of VAM fungal species is highly variable in horticultural production systems of small farmers in the Northern Rajasthan. There is no relationship between the most common soil parameters with such diversity, and the occurrence or absence of VAM fungi species is likely to depend on the divers agronomic historic inputs, that farmer apply to horticultural crops. Thus, because most of the horticultural crops depend obligatorily for growth on mycorrhizae, in the soil of the region, it is advisable to inoculate the horticultural crops with selected highly effective mycorrhizal inoculants at the nursery stage especially in organic agriculture. This will likely give farmers a more secure and sustainable production than to depend in crop production on unknown natural VAM fungi communities.

**Reference**


Allen, M.F. and Allen, E.B. 1992. Development of mycorhizal patches in a successional arid ecosystem. In: Read, J.D., Lewis, D.H., Fitter, A.H. and Alexander, I.J. (eds.) *Mycorrhizas in Ecosystem*. pp. 164-169. C.A.B. International, Wallingford UK

Bakshi, B.K. 1974. Mycorrhiza and its role in Forestry. PL480 Project Report, F.R.I., Dehradun, India.

Harley, J.L. and Smith, S.E. 1983. Mycorrhizal Symbiosis. Academic Press, London. p 461.

Jansa, J., Mozafar, A., Khun, G., Anken, T., Ruh, R., Sanders, I.R. and Frossard, E. 2003. Soil tillage affects the community structure of mycorrhizal fungi in maize roots. *Ecol. Appl.* 13, 1164-1176.

Kiran Bala, Rao, A.V. and Tarafdar, J.C. 1989. Occurrence of VAM associations in different plant species of the Indian desert. *Arid Soil Research* and *Rehabilitation*. 3: 391-396

Oehl, F., Sieverding, E., Ineichen, K., Madar, P., Boller, T. and Wiemken, A. 2003. Impact of land use intensity on the species diversity of Arbuscular mycorrhizal fungi in agroecosystems of Central Europe. *Appl. Environ. Microbiol.* 69, 2816-2824

Oehl, F., Sieverding, E., Ineichen, K., Ris, E.A., Boller, T. and Wiemken, A. 2005. Community structure of arbuscular mycorrhizal fungi at different soil depths in extensively and intensively managed agroecosystems. *New Phytol.* 265, 273-283.

Schenck, N.C. and Pérez, Y. 1990. Manual for the identification of VA Mycorrhizal Fungi. 3rd edition, Synergistic, Gainesville, Florida, U.S.A. 241p.

Schüssler, A., Schwarzott, D. and Walker, C. 2001. A new fungal phylum, the Glomeromycota: phylogeny and evolution. *Mycol. Res.* 105, 1413-1421.

Sieverding, E. 1991. Vesicular-Arbuscular Mycorrhiza Management in Tropical Agrosystems. GTZ, Eschborn, Germany. 371p.

Smith, S.E. and Read, D.J. 2009. Mycorrhizal Symbiosis. Academic Press, London. 605p.

Tarafdar, J.C. and Rao, A.V. 1997. Mycorrhizal colonization and nutrient concentration of naturally grown plants on gypsum mine-spoils in India. *Agriculture Ecosystems* and *Environments*. 61: 13-18.

Trappe, J.M. 1987. Phylogenetic and ecologicaspects of mycotrophy in the angiosperms from an evolutionary standpoint. In: Safir, G.R. (Eds.). Ecophysiology of VA Mycorrhizal Plants. CRC Press, Boca Raton, Florida. pp. 5-25.

Veenendaal, E.M., Monnaapula, S.C., Gilika, T. and Magole, I.L. 1992. Vesicular arbuscular mycorrhizal infection of grass seedlings in a degraded semi-arid savanna in Botswana. *New Phytol.* 121: 477-485.

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# A microscopic analysis of role of conidia and chlamydospore during germination process in *Fusarium udum*

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**Abstract**

This study is the report of *Fusarium udum conidia*, which are produced behind the active hyphal growth zone during filamentous growth. Monokaryons of *F. udum* have for a long time been known to constitutively produce abundant uninucleate asexual spores (conidia). These spores are sickle shaped, and because of this shape, they are called conidia. Chlamydospores are large, thick-walled spores of variable forms and with condensed cytoplasm. Filaments of *F. udum* produce both intercalary and terminal chlamydospores. During germination of the chlamydospore, a single germ tube displaces the spore pore cap. Similarly, a single germ tube is formed by the conidium. Nuclei within the germ tubes divide, and septa may be formed between the daughter nuclei; alternatively, the germ tubes may stay aseptate through several cycles of nuclear division. Multinucleate side branches emerge, while septum formation occurs in the older portions of the germ tubes to yield cell segments with one or only a few nuclei. This side branches contained new conidia.

**Keywords:** *Fusarium udum*, Conidia, Chlamydospore, Germination, Wilt

## Introduction

*Fusarium udum* causes wilting in *Cajanus cajan*. It can persist in soil for several years in the form of resisting body known as chlamydospores in absence of the host. Biological functions ascribed to these chlamydospores differ between species. For example, desiccation-resistant chlamydospores of *P. cinnamomi* are produced within plant roots during drought and are transported in root fragments or soil, germinating to cause infections when warm, moist conditions are encountered. When chlamydospores of the nematode-trapping fungus *D. flagrans* are fed to domesticated animals, they can survive passage through the alimentary tract and reduce the number of parasitic nematode larvae that develop from eggs in the feces, thus preventing clinical disease (Ballario *et. al.*, 1998). In addition, the chlamydospore developmental phase of *Aspergillus parasiticus* has been associated with increased aflatoxin production, while chlamydospores of *Fusarium* species are the principal means of long-term survival during unfavorable periods in the soil and play an important role as the primary inocula infecting plants (Ahmed and Miles, 1970; Asgeirsdottir, *et. al.*, 1995). Chlamydospores have also been observed in human fungal pathogens such as *Candida albicans*, *Paracoccidioides brasiliensis*, *Histoplasma capsulatum*, and *Blastomyces dermatitidis* (Ballario and Macino, 1997)

The environmental indications for chlamydospore formation for various fungi are usually species specific and include nutrients (Anderson, 1971), osmolarity, light (Bieszke, *et.al.*, 1999), pH, temperature, air (Anderson, 1971), drug treatment, and plant stimulants. Thus, although chlamydospores are produced by a broad assortment of fungi, their mechanisms of formation, biological functions, and molecular regulation remain enigmatic.

Here we describe the identification of chlamydospores in the *F. udum*. It can be readily isolated from the soil or infected plant root of *Cajanus cajan*. While many soilborne fungi produce chlamydospores as long-lived survival structures under hostile environmental conditions. Here we describe the formation of a morphological structure associated with *F. udum* that is providing the documentation of such structures in this organism.

## Materials and methods

### Isolation of fungal pathogen

The cropping areas of Betul district in Madhya Pradesh, India were surveyed and wilt prone area were marked. Samples of diseased root parts and seeds were randomly collected and fungal pathogen *Fusarium udum was* isolated from infected roots of pigeon pea (*Cajanus cajan*) following the water agar technique. This technique was used for the isolation of external and internal mycoflora of the diseased seeds and infected roots showing reddish brown lesions on the hypocotyls. The external surface mycoflora was isolated by directly placing the seeds and infected plant material on the water agar medium containing 2% agar. For the isolation of internal mycoflora, seeds and diseased roots were surface sterilized by soaking them in 0.5% sodium hypochlorite solution for 3-5 min. Samples were then rinsed in several changes of sterile

water to remove the traces of sodium hypochlorite, and placed on the surface of pre-incubated water agar plates containing Penta-chloro-dinitrobenzene (PCNB). After incubation at 28°C for one week, plates were observed for the appearance of various fungi.

**Identification of Fungal Pathogens**

Different fungal isolates from infected seeds and plant materials were grown on the potato dextrose agar (PDA) medium. The fungal cultures were maintained on potato dextrose agar (PDA) medium and characterized following illustration and description of standard mycological literature and comparing with standard cultures obtained from the division of Plant Pathology, Indian Institute of Pulses Research (IIPR), Kanpur, India.

**Pathogencity test**

After identification *F. udum,* culture was tested for the establishment of pathogenecity on *C. cajan*. Healthy seeds of pigeon pea were surface sterilized by 0.5% sodium hypochlorite solution and wrapped in seed germination paper and incubated for one week at 28°C. After seedling emergence, these were artificially inoculated by spraying aqueous suspension of Chalmydospore and conidia of *F. udum*. Thereafter, seedlings were transferred in to the earthen pots containing 5 kg steam sterilized soil. The pots were covered with polythene bags to avoid the contamination. Control plants were treated with sterilized distilled water. Symptoms of fusarium wilt on the root parts of the plants were observed. Infected plant parts were again used for the re-isolation of *F. udum* and the culture was later compared with that of parental culture of *F. udum*. Isolated fungal cultures of *F. udum* was maintained on PDA medium at 4 °C.

**Microscopy**

Cells were grown on PDA medium on the top of slides and kept for incubation at 28 °C. These slides were observed after every 6 h of incubation till complete mat of fungus was not grown.

**Results and discussion**

A clearer understanding of the reproductive modes and survival structures of fungal pathogens in the environment is of great importance with regard to their ecology and epidemiology. Budding, conidiation, sporulation, fragmentation of hyphae, and conversion of hyphal elements into chlamydospores are common modes of reproduction. In some soilborne fungi, chlamydospores have been documented to have a role as survival structures. This study is the report of *F. udum* chlamydospores, which are produced behind the active hyphal growth zone during filamentous growth. Monokaryons of *F. udum* have for a long time been known to constitutively produce abundant uninucleate asexual spores (conidia). These spores are

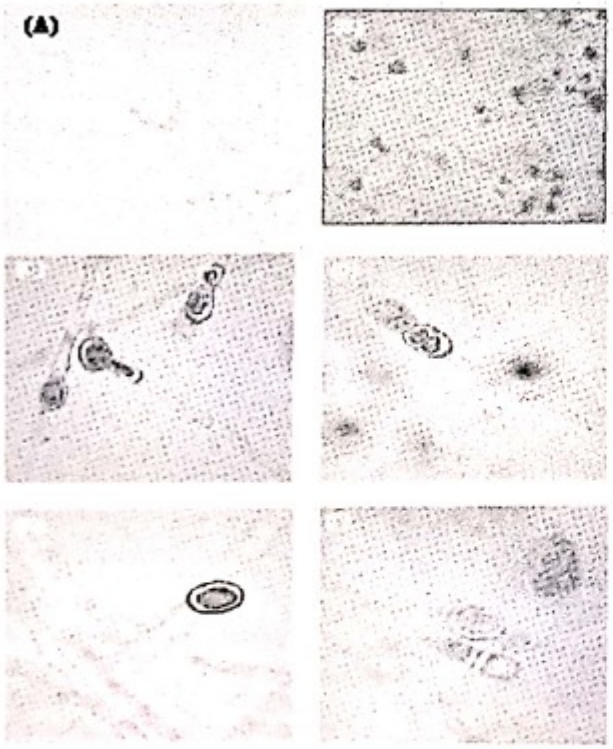


Fig 1: Macroconidia and microconidia of Fusarium udum (A), Different types of chlamydospores produced in Fusarium udum (B to F)

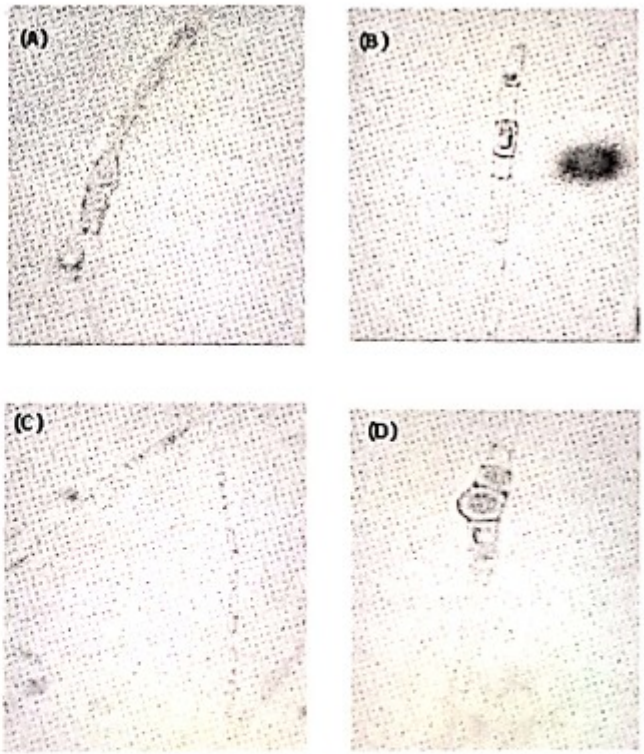


Fig 2: Different stages of chlamydospore formation by Fusarium udum from multinucleate hyphae (A to D). Young chlamydospores in the submerged mycelium of monokaryon

sickle shaped, and because of this shape, they are called conidia (Fig 1). Conidia are formed predominantly in the aerial mycelium and can regularly be detected in the submerged mycelium of agar culture (Fig 1a).

As we have found in our study, chlamydospores are large, thick-walled spores of variable forms and with condensed cytoplasm (Fig 1b). The generation mode of this type of spore in *F. udum* is not well documented. In general, chlamydospores may arise endogenously in cells of the vegetative hyphae following compression of the cytoplasm (chlamydospores in the strictest sense) or by transfer of the compressed cytoplasm from a hyphal cell into a bud (Connerton and Knes, 1994). Filaments of *F. udum* produce both intercalary and terminal chlamydospores (fig 2), which are potentially fully functional (independent from the mycelium) and physiologically active, as they are capable of generating new branches. Whether the energy stored in the chlamydospores is for their own survival and reproduction or to support proficient conidia production and/or maturation is an important unanswered question. Chlamydospore are proposed to be the propagules for *F. udum* dispersal and infection, and it is likely that chlamydospore are also long-term survival structures in nature.

Development starts with the protrusion of a young condia. Conidia germinate and give rise a complete met of fungus (Fig. 3a). Despite their poor cytological description, chlamydospores have been used to collect component monokaryons from dikaryotic mycelia. Chlamydospores from dikaryons generally contain one nucleus of each parental type. Dikaryotic chlamydospores germinate with either one germ tube or two germ tubes, one at each end. When two germ tubes are present, each will receive one nuclear type. Monokaryons arise from germination of the haploid binucleate chlamudospore or, alternatively, from germination of the uninucleate haploid conidia. During germination of the chlamydospore, a single germ tube displaces the spore pore cap (Fig. 3b). Similarly, a single germ tube is formed by the conidium (fig. 3c). Nuclei within the germ tubes divide, and septa may be formed between the daughter nuclei; alternatively, the germ tubes may stay aseptate through several cycles of nuclear division. Multinucleate side branches emerge (Fig 3d), while septum formation occurs in the older portions of the germ tubes to yield cell segments with one or only a few nuclei. This side branches contained new conidia (Fig. 3e). However, the description of this fungus is still not complete. There is need to carry out research work on developmental processes by physiological and genetic studies and to analyze the influences of the environment on development of this fungus.

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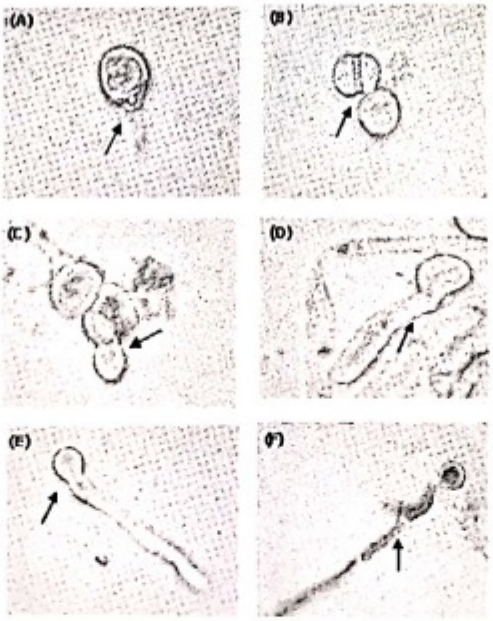
Fig 3I: Different strage of conidia



3 II: Chlamydospore germination of Fusarium udum during favorable

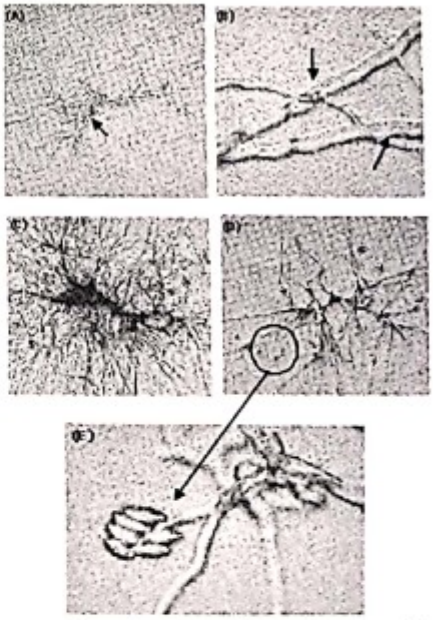


Fig 4: Formation fo mycelia after germination of conidia and chalmydospores of *Fusarium udum* (A), fusion of hyphae (B) resulting in formation of complete mat (C) and conidia produced at hyphal tips (D and E) of *Fusarium udum*.

References


Ahmad, S.S. and Miles, P.G. 1970. Hyphal fusions in the wood-rotting fungus *Schizophyllum commune*. I. The effects of incompatibility factors. *Genet. Res.* 15:19-28.

Anderson, G.E. 1971. The life history and genetics of *Coprinus lagopus*. Phillip Harris Biological Supplies, Weston-super-Mare, United Kingdom.

Ásgeirsdóttir, S.A., van Wetter, M.A. and Wessels, J.G.H. 1995. Differential expression of genes under control of the mating-type genes in the secondary mycelium of *Schizophyllum commune*. *Microbiol.* 141:1281-1288.

Ballario, P. and Macino, G. 1997. White collar proteins: PASsing the light signal in *Neurospora crassa*. *Trends Microbiol.* 5:458-462.

Ballario, P., Talora, C., Galli, D., Linden, H. and Macino, G. 1998. Roles in dimerization and blue light photoresponse of the PAS and LOV domains of *Neurospora crassa* white collar proteins. *Mol. Microbiol.* 29:719-729.

Bieszke, J.A., Braun, E.L., Bean, L.E., Kang, S., Natvig, D.O. and Borkovich, K.A. 1999. The *nop-1* gene of *Neurospora crassa* encodes a seven transmembrane helix retinal-binding protein homologous to archaeal rhodopsins. *Proc. Natl. Acad. Sci.* USA. 96:8034-8039.

Connerton, I. and Kües, U. 1994. Filamentous fungi: old mutants and new discoveries. *Trends Genet.* 10:1-2.

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# Population dynamics of lemon butterfly (*Papilio demoleus*) in *bael* (*egle marmelos*) as influenced by abiotic factors in arid region of Rajasthan

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**Abstract**

It was observed that population and infestation of *P. demoleus* appeared from August to February. The highest egg, larval population and plant infestation were observed 12.75, 6.15/ 10 branches and 65.0 %, respectively. The relationship between lemon butterfly egg, larval population and maximum temperature was (-0.53 & -0.55) negatively correlated whereas the maximum relative humidity was (0.44 & 0.53) positively correlated. Then, the egg and larval population gradually increased and reached to its peak, when the temperature decreased and humidity increased. The rainfall was also negatively correlated (-0.51) with egg population of lemon butter fly in arid region.

**Key words:** *Papilio demoleus*, *Aegle marmelos*, population dynamics, abiotic factors.

## Introduction

*Bael* (*Aegle marmelos* Correa) belongs to family Rutaceae is an important indigenous fruit crop to dry forest in hills, plains of central and southern parts as well as arid and semi arid regions of India. It also called as Bengal quince or Indian quince. Fruits are famous for its medicinal values as well as edible fruit quality. The *bael* is gaining popularity among the farmers of arid and semi arid areas for economic cultivation. However, the quality of fruits and productivity is not obtained up to the standard. One of the reasons for it is infestation of insect pests on the vegetative as well as developing fruits which ultimately leads to significant yield loss and quality attributes of the fruits. About 30 species of insect and mites have been reported feeding on *bael* in India (Lakra, 2004). Various types of insect-pests are found to be infesting bael in which *P. demoleus* is major one which defoliate the plant. Pathak and Rizvi (2002) reported that the *P. demoleus* is a serious citrus pest in India. Keeping in view its economic importance, the study has been carried out for population dynamics of lemon butterfly, *P. demoleus* on bael to develop a tool for ecofriendly management.

## Materials and methods

The population dynamics of *P. demoleus* on bael *(A. marmelos)* was recorded throughout the year at experimental farm of Central Institute for Arid Horticulture, Bikaner situated in western parts of Rajasthan. The observations of egg, larval population and plant infestation were recorded at fortnight intervals from appearance of lemon butterfly. The study was conducted in three replications, each having 10 branches per plant. Correlation coefficients among abiotic factors (temperature, relative humidity and rainfall) and egg, larval population and plant infestation of butter fly were also determined.

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## Results and discussion

The field experiments were conducted during 2009-10 and 2010-11 with bael (*Aegle marmelos*) to determine the population dynamics of lemon butter fly (*Papilio demoleus*) and influenced by abiotic factors. It revealed from the study that the damaging effect of lemon butterfly was recorded on bael from August to February months. The population of *P. demoleus* was observed between 0.75 to 6.15 larvae and 0.60 to 12.75 eggs per 10 branches of plant during the plant growth period. The plant infestation was observed from 3.30 to 65.00 per cent (Table 1). The first appearance of *P. demoleus* was observed 0.75 larvae, 0.60 eggs per 10 branches of plant and 3.30 per cent infestation on first fortnight of August when the maximum temperature was 37.33°C with maximum relative humidity 67.50 per cent. Narayanamma and Savithri (2002) studies on the seasonal abundance of citrus butterfly, *P. demoleus* were undertaken on 'Sathgudi' sweet orange and 'Tenali' acid lime. Pest incidence was first initiated from the second fortnight of August on sweet orange and from the first fortnight of September on acid lime. Then, the egg population gradually increased and reached to its peak 12.75 eggs per 10 branches of plant on first fortnight of November. The larval population (6.15/ 10 branches) and plant infestation (65.00 %) were maximum in second fortnight of November when the maximum temperature was 25.40 °C with maximum relative humidity 76.25 per cent. So, it observed that November was the most favorable period for *P. demoleus*. Sunita (2003) reported that the population dynamics of lemon butterfly was highest from November to February and peaked in August when the rainfall was 311.4 mm and the temperature was 32.8. The highest number of lemon butterfly larvae was highest in Kinnow lime during both years. Ram *et. al.* (2000) also reported that the incidence of *P. demoleus* was maximum in

the month of August-September on lime in Bundelkhand region of Uttar Pradesh.

Correlation coefficient between the egg, larval population and maximum and minimum relative humidity was found positively (0.44 & 0.53) and (0.26 & 0.39), respectively which showed that increase in relative humidity then increase the egg and larval population. Similar, correlation was found among per cent plant infestation and maximum and minimum relative humidity (0.43 & 0.34), respectively. The negative correlation was found between rainfall and egg, larval population and infestation (-0.51, -0.42 & -0.48), respectively which means increase in rainfall decreased the larval population. Narayanamma and Savithri (2002) correlation coefficient values were worked out in relation to weather factors and larval population of lemon butterfly. There was negative and significant relationship among pest population and maximum and minimum temperatures, while positive relationship with relative humidity. The plant infestation was positively correlated with egg and larval population (0.96 & 0.90). When the per cent plant infestation was increased then egg and larval population of lemon butterfly also increased (Figure.1). The finding was in agreement with Reddy and Kumar (2005).

Table 1. Population dynamic s of lemon butter fly, *Papilio demoleus* on bael in 2009-10 and 2010-11

| S No | Fortnight observations | Mean population/ 10 branches | | Plant infestation (%) | Temperature ($^0$C) | | Relative humidity (%) | | Rainfall (mm) |
|---|---|---|---|---|---|---|---|---|---|
| | | Egg | Larvae | | Max | Min | Max | Min | |
| 1. | August-I | 0.60 | 0.75 | 3.30 | 37.33 | 28.03 | 67.50 | 39.25 | 22.88 |
| 2. | August-II | 1.75 | 1.65 | 4.99 | 37.12 | 27.75 | 75.00 | 44.00 | 10.58 |
| 3. | September-I | 1.85 | 1.85 | 11.67 | 36.88 | 25.98 | 69.25 | 29.50 | 27.00 |
| 4. | September-II | 2.05 | 1.85 | 18.34 | 37.13 | 24.03 | 66.00 | 33.25 | 0.00 |
| 5. | October-I | 6.00 | 2.25 | 35.00 | 37.90 | 23.48 | 55.50 | 25.00 | 0.00 |
| 6. | October-II | 8.10 | 2.60 | 45.00 | 35.25 | 19.78 | 65.75 | 20.50 | 0.00 |
| 7. | November-I | 12.75 | 5.80 | 61.67 | 28.40 | 16.40 | 81.00 | 45.25 | 4.25 |
| 8. | November-II | 10.75 | 6.15 | 65.00 | 25.40 | 11.10 | 76.25 | 43.50 | 0.00 |
| 9. | December-I | 9.80 | 5.42 | 48.34 | 25.15 | 9.73 | 67.75 | 35.75 | 0.00 |
| 10. | December-II | 8.95 | 5.25 | 45.00 | 23.78 | 7.18 | 75.75 | 27.75 | 0.75 |
| 11. | January-I | 7.00 | 3.20 | 41.67 | 18.35 | 4.43 | 81.75 | 38.00 | 0.25 |
| 12. | January-II | 6.35 | 3.15 | 21.67 | 23.65 | 6.68 | 70.00 | 21.75 | 0.00 |
| 13. | February-I | 2.95 | 1.75 | 11.67 | 26.30 | 10.50 | 69.00 | 18.00 | 0.00 |
| 14 | February-II | 2.45 | 1.55 | 5.00 | 27.25 | 12.23 | 59.50 | 17.50 | 0.00 |

Egg

Larvae

Pupae

Adult

Plate: 1. Lemon butter fly (*Papilio demoleus*) on bael

Table 2. Correlation coefficient between egg, larval, plant infestation population of lemon butterfly and abiotic factors on bael in 2009-10 and 2010-11

| S. No. | Abiotic factors | Egg population | Larval population | Plant infestation |
|---|---|---|---|---|
| 1. | Maximum temperature $^0$C | -0.53 | -0.57 | -0.43 |
| 2. | Minimum temperature $^0$C | -0.55 | -0.56 | -0.45 |
| 3. | Relative humidity (Max %) | 0.44 | 0.53 | 0.43 |
| 4. | Relative humidity (Min %) | 0.26 | 0.39 | 0.34 |
| 5. | Rainfall (mm) | -0.51 | -0.42 | -0.48 |
| 6. | Between plant infestation and egg population | | 0.96 | |
| 7. | Between plant infestation and larval population | | 0.90 | |

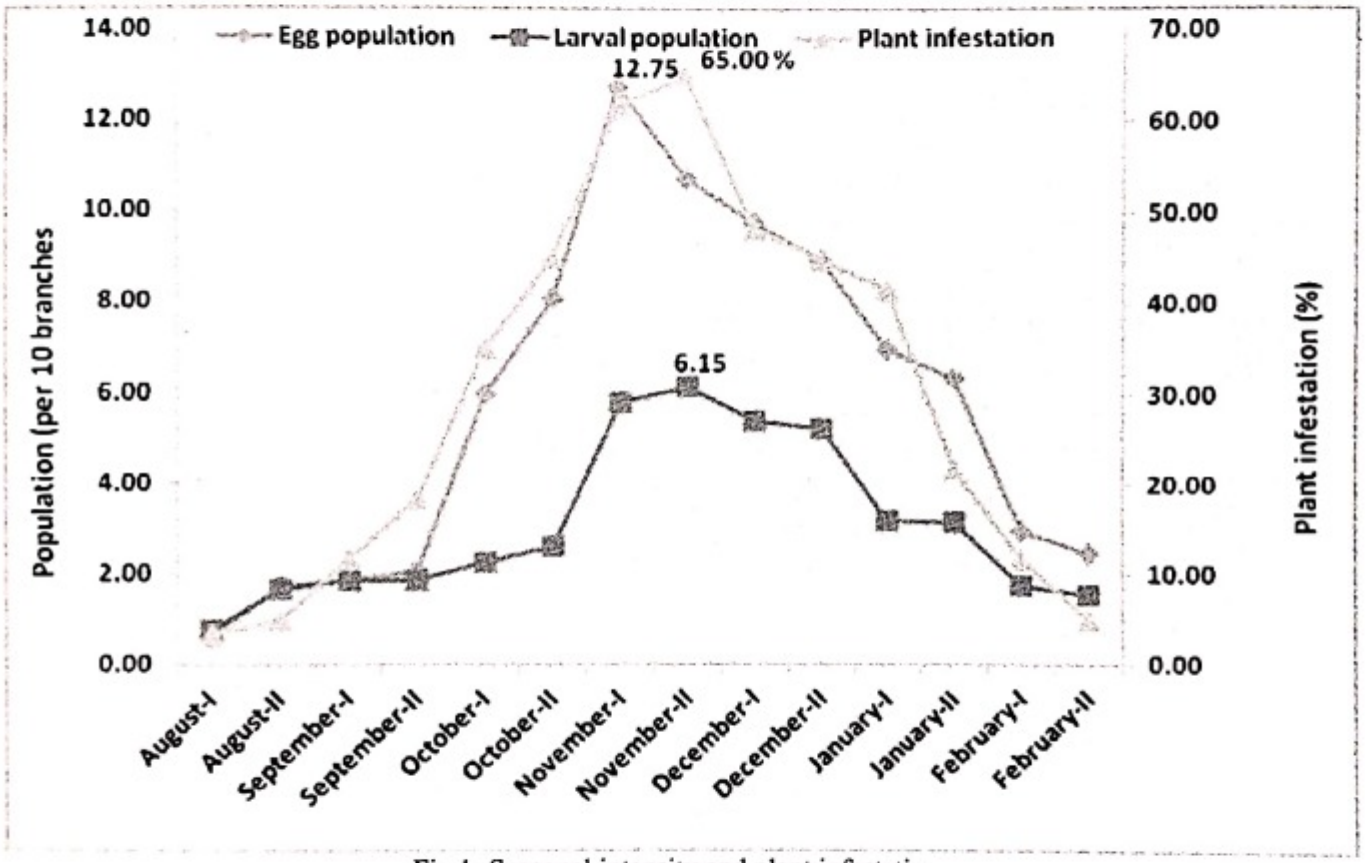


Fig 1: Seasonal intensity and plant infestatio.

**References**


Kumar, A. and Singh, C. P. 2008. Population dynamics of *Papilio demoleus* Linn. on *Psoralea corylifolia* in *tarai* Uttarakhand. *Annals of Plant Protection Sciences*. 16 (2): 370-372.

Lakra, R. A. 2004. Insect pests of fruits of arid and semi arid regions of India. In *pest management in horticultural crops* (ed. Verma, L. R., Verma, A.K. and Gaudam, D. C.). Vedams Books Pvt. Ltd., Delhi. Pp 544.

Narayanamma, V. L. and Savithri, P. 2002. Seasonal abundance of citrus butterfly, *Papilio demoleus* Linn. on Sathgudi sweet orange and Tenali acid lime. *Journal of Applied Zoological Researches*. 13(1): 54-56.

Pathak, K. N. and Rizvi, P. Q. 2002. Age specific life table of *Papilio demoleus* on different hosts. *Annals of Plant Protection Sciences*. 10: 375-376.

Ram, P., Pal, R. K. and Singh, J. 2000. Incidence of the lemon butterfly, *Papilio demoleus* on citrus. *Annals of Plant Protection Sciences*. 8(2): 245-246.

Reddy, N. A. and Kumar, C.T. A. 2005. Influence of weather factors on abundance and management of surpentine leaf miner on tomato. *Annals of Plant Protection Sciences*. 13: 315-318.

Sunita, A. 2003. Population dynamics of lemon butterfly in citrus crops. *Farm Science Journal*. 12(2): 159-160.

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# Effect of environmental factors on disease development of black rot of cauliflower incited by *Xanthomonas campestris pv. campestris* in Udaipur district of Rajasthan

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**ABSTRACT**

Major cauliflower growing area of Udaipur district was surveyed to know the severity of pathogens on development of black rot. An environmental factor essentially affects the intensity and spread of cauliflower black rot. Cauliflower plants inoculated at one week intervals, throughout the investigation during the rabi season (October 2003 to February -2004).The severe disease development was recorded during the month of January when the humidity between 82-89 per cent and temperature ranges between 23-30$^0$ prevailed. While the disease development was trace during October and November and low in the month of December. Disease progressed faster during the crop growth period in January and February under cage house condition. Regression and correlation coefficient important environment factors in relation to the progress of disease were noticed. The disease curve had three distinct phase (period) *viz*, initial inoculum build up or disease establishments, rapid disease progress and disease establishment. Regression showed positive picture and negative correlation was obtained for maximum and minimum temperature, which signified their role of the rapid disease progress period. However, maximum infection was noticed, when RH range between 82-89 per cent. It was observed that disease development gained momentum when the maximum temperature started lowering down from 33$^0$ C, minimum temperature below 23$^0$C adversely affect the disease development in cauliflower.

**Key words:** Severity, environmental factors, disease development, black rot, cabbage, *Xanthomonas campestris pv. Campestris*

## Introduction

Cauliflower (*Brassica oleracea* var.*botrytis* L) is one of the important vegetable crops of India. It is native of South Europe in the Mediterranean region (Thompson and Kelly, 1957). It was introduced in to India during Moghul period. Cauliflower is the most important member of the genus *Brassica*. In India, total area under cauliflower cultivation is 0.33 million ha and production 6.41 million tones during 2010 (NHB, Gurgaon 2010). It is cultivated for its shortened flower parts, which is used in many preparations like curries, soups and pickles. The edible portion of the plants is the "curd" made up of numerous divided hypertrophic branches, which terminate the main stem at the plant and is highly suppressed with number of parts of flower apparent there. Shah 1995 reported that a minimum inoculums level was necessary for pathogenensis in different host pathogen combination. Environmental condition *i.e* temperature, humidity and rain in particular decisively affect the intensity and spread of plant disease (Shekhawat and Patel 1977, Srivastava and Bais, 1985 and Santiranjan *et al*, 1986). Keeping in view, the present investigation was under taken with the objective to investigate the severity and effect of environmental factors on disease development of black rot of cauliflowers.

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## Material and methods

The periodical survey of four selected villages' namely Hawala, Bhujeda, Choti Nokha and Manva Khera of Udaipur district of Rajasthan were carried during rabi season (November to February 2003-2004) for collection of diseased samples of bacterial black rot of cauliflower. Disease severity in cauliflower was randomly recorded during survey and assessment. In the surveyed fields, incidence of black rot was recorded. To assess the incidence of disease , three fields were observed in each village and five plots from each fields was randomly selected for sampling and then per cent diseased incidence was calculated. In each fields disease and healthy plants were counted from each randomly selected five plots and per cent incidence of disease was calculated by using following formula given by (Wheeler, 1969)

$$PDI = \frac{\text{Numbers of Diseased Plants}}{\text{Total number of plants observed}} \times 100$$

For close observation disease, disease rating was made on twenty plants for each inoculation methods. To measure the quantum of disease, following disease rating key was devised based on disease development in which infected plants were categorized in six arbitrary classes (Scale 0-5).

0 = No infection
1 = Very slight bacterial infection covering 1-10 per cent leaf area.
2 = Slight bacterial infection covering 11-25 per cent leaf area.
3 = Moderate bacterial infection which covering 26-50 per cent leaf area.
4 = Severe bacterial infection which covering 51-75 per cent leaf area.
5 = Very severe bacterial infection which covering more then 75 per cent leaf area.

Per cent infection index was calculated by using following formula (Mc Kiny,1923;Chester 1959 and Wheeler,1969).

$$PDFC = \frac{\text{Sum of Individual rating}}{\text{No. of plants or leaves assessed x Maximum disease rating}} \times 100$$

**Effect of environmental factor on disease development of black rot of cauliflower**

Effect of weather parameters on black rot development of cauliflower was carried out at Rajasthan college of Agriculture, (MPUAT) Udaipur, during crop season of Rabi 2003-04. Cauliflower variety Pusi* seed were sown in seed bed at weekly intervals. After 35-40 days, the cauliflower seedlings were transplanted in 30 cm earthen pots at every weekly interval so as to provide the plants of same age for inoculation. In each pot two plants were accommodated and five pots were used for each inoculation. Plants were inoculated after 10-12 days of transplanting in pots from seed bed by carborundum abrasion technique with bacterial suspension (concentration $10^8$ cfu/ml) at 7 days intervals. The infection index was recorded 21 days after inoculation on each plant. The weather data *viz* .weekly tempertature, relative humidity and rainfall were obtained from farm metrology observatory, RCA, Udaipur.

Observation in respect of disease development under cage house condition was carried out at Department of Plant Pathology cage house at RCA Udaipur. In rabi season 2003-04 and were correlated with the meteorological data obtained from the farm weather observatory of RCA Udaipur. To recorded the observation, ten plants on which initial symptoms of the disease observed on 20th October 2003 were tagged and there after observation on disease development were recorded at the weekly intervals.

**Results and discussion**

The *X. c. pv. campestris* black rot of cauliflower severity was recorded in village of Udaipur district (Choti Nokha,Bhujeda, Hawala and Manva Khera) of Rajasthan. The disease appeared in most of the field wherever, the cauliflower (cv. Snowball) crop was grown. It was observed that PDI was more in the month of January and February.

Table 1 revealed that *X. c. pv. campestris* severity on black rot of cauliflower during rabi season 2003-04, ranged from trace to 40.30. The bacterial black rot disease was observed in all four villages, during the investigation. The maximum black rot (25.2 %) was recorded in Hawala village, followed by Bhujeda (23.92%), whereas the minimum disease incidence of bacterial black rot of cauliflower was recorded in Choti Nokha (18.85 %). The incidence of the disease was successively increased during the period but comparatively high during January and February. Similarly results were also observed by Santiranjan, 1986 and Singh, 2001.

The results presented in table 2 and fig 1 revealed that the disease could be produced artificially during the crop season although, its infection index was varied significant and affected by environmental conditions. The effect of various environmental factors on the progress and decline of the disease and regression and correlation coefficient was also obtained. In the crop season (October 2003 to February 2004) the disease was in trace to low on plants inoculated in month of October and November 2003. During this period a poor correlation existed between temperature and humidity conditions. The temperature was high (maximum temperature 30-33° C). The humidity was comparatively low, minimum humidity ranged between 31-34 and maximum humidity between 84-86 per cent. The precipitation was negligible. Disease development was better from second week of December onward and maximum disease was recorded on plant inoculated on 19th Jan .2004 followed by 26th Jan, 12th Jan and 2nd Feb, 2004, high humidity and temperature were favourable for disease development .The most favourable period of disease development was from last week of December 2003 to Second week of Feb., 2004, which decline there after. During favourable period the maximum humidity ranged between 82-89 per cent and maximum temperature range between 23-30° C. Shekhawat (1975) found high humidity and temperature between 22.34o C to be the most favourable for bacterial leaf spot of chilli (X. c. pv. vesicatoria).Similarly results were also found by Shekhawat and Patel (1977) in green leaf spot in mung bean. Choudhary and Chakraverti (1989), found that high relative humidity (above 70.75 per cent and maximum) temperature fluctuation around 30-35o C were congenial for spot and blight development of castor (*X.c.pv.ricini*). Gupta (1991) reported that black rot disease of cabbage in Manipur appeared in near the end of February. Oliveira *et al* (1996) found that major development of black rot (*X.c. pv.campestris)* on cole crops was registered during the warm and humid period.

Regression and correlation coefficient were calculated for important environmental factors in relation to the progress of the disease. These observations led to an important conclusion that the disease progress curve had had three distinct phase (periods) viz., initial inoculums

builds up or disease establishment, rapid disease progress and disease stabilization. This method had a given a very clear positive picture and negative correlation was obtained for maximum and minimum temperature, which signified their role of the rapid progress of the disease. Similar finding was also obtained by Singh, 2001.

Table 1. Per cent incidence of black rot of cauliflower incited by *X.c pv campestris*.

| Place/Time | PDI (Per cent Disease Incidence)* | | | | |
|---|---|---|---|---|---|
| | Nov. | Dec. | Jan | Feb. | Mean |
| Choti Nokha | Trace | 20.1 | 24.5 | 30.8 | 18.55 |
| Bhujeda | 1.3 | 25.5 | 30.3 | 38.6 | 23.92 |
| Hawala | 1.6 | 27.3 | 31.6 | 40.3 | 25.2 |
| Manva Khera | Trace | 22.6 | 26-8 | 37.4 | 21.92 |

*Average of five replication.

Table 2. Black rot development on cauliflower plants on weekly inoculati on made during October. 2003 to February 2004 (in pots)

| Date of inoculation | Per cent infection index | Temperature ($^0$ C) | | Relative humidity (%) | |
|---|---|---|---|---|---|
| | | Maximum | Minimum | Maximum | Minimum |
| 20 Oct.2003 | Trace | 32.2 | 14.9 | 73 | 33 |
| 27 Oct. 2003 | Trace | 32.8 | 14.7 | 73 | 34 |
| 03 Nov.2003 | Trace | 33.4 | 15.2 | 71 | 32 |
| 10 Nov.2003 | 1.8 | 32.2 | 13.9 | 70 | 31 |
| 17 Nov.2003 | 3.6 | 30.4 | 12.5 | 76 | 29 |
| 24 Nov.2003 | 4.2 | 29.1 | 12.7 | 72 | 32 |
| 01 Dec.2003 | 6.8 | 28.9 | 10.4 | 78 | 31 |
| 08 Dec.2003 | 14.3 | 30.8 | 10.3 | 84 | 25 |
| 15 Dec.2003 | 23.1 | 28.1 | 10.8 | 83 | 33 |
| 22 Dec.2003 | 30.4 | 26.8 | 6.4 | 82 | 34 |
| 29 Dec.2003 | 34.6 | 25.0 | 5.9 | 84 | 42 |
| 05 Jan. 2004 | 39.3 | 24.1 | 7.3 | 86 | 35 |
| 12 Jan. 2004 | 46.7 | 26.2 | 7.0 | 84 | 27 |
| 19 Jan. 2004 | 53.1 | 27.8 | 8.5 | 85 | 30 |
| 26 Jan. 2004 | 50.5 | 23.0 | 6.5 | 89 | 36 |
| 02 Feb. 2004 | 46.4 | 23.3 | 5.8 | 86 | 26 |
| 09 Feb. 2004 | 42.8 | 26.7 | 5.8 | 65 | 17 |
| 16 Feb. 2004 | 37.1 | 29.3 | 9.1 | 77 | 27 |
| 23 Feb. 2004 | 32.1 | 31.3 | 10.9 | 74 | 19 |

Table 3. Effect of different environmental factors on black rot development in cauliflower plant on weekly inoculation made during Oct.2003 to Feb. 2004 (in pots).

| Environmental factors | Regression equation (Y= a + bx) | Correlation coefficient (r) |
|---|---|---|
| Maximum temperature | Y= 161.07**-4.78 x ** | -0.807** |
| Minimum temperature | Y= 76.25**-5.20 x** | 0.885** |
| Maximum humidity | Y =107.94**+1.69x | 0.585* |
| Minimum humidity | Y =42.82**-0.060 | -0.180 |

Y= Estimated disease infection a= Intercept, b= Regression coefficient

*Significant at 5 % ** Significant at 1%.

**References**


Anonymous (2010) Horticulture data base 2010

Choudhary, S. L. and Chakravarti, B.P. 1989. Status of bacterial leaf spot and blight of castor in Rajasthan. India. *Proc. 7 th Int. Conf. Plant Pathol. Bact.* Budapest, Hungry. 2:583-588.

Gupta, D.K. 1991. Studies on black rot of cabbage in manipur. *Indian J. Mycol Pl. Pathol.* 21:203-204.

Ignatov, A., Hida, K. and Kuginuki, Y. 1999. Environmentally dependent changes of disease symptoms caused by X.c. pv. campestris on brassica. *Acta Phytopathologica et Entomologica Hungarica.* 34 (3) :183-186

Jain, J.P. 1982. Epidemiology and pathogenesis of bacterial blight of guar caused by X.c.pv .cyamopsidis *.Ph.D Thesis University of Udaipur* ,Udaipur.

Oliveira, C.A. 1996. Monitoring of occurrence of black rot of and Alternaria disease kale crop.(*Brassica Oleracea* var *accphaler*) in lavras, Brazil. *Sumna phyto pathologica.* 22 (3-4):209-211.

Ruissen, M. A., Vossen, R.T.M.,Vander and Kocks, C. G. 1993. Growth of *Xanthomonas campestris pv campestris* population at constants and variable temperature. *Netherlands Journal of Plant Pathology.* 99: 173-179.

Santiranjan, S., Chattopadhyay, B. and Bandyopadhyay, S. 1986. Study of incidence of black rot of cabbage and cauliflower under different month of planting following natural condition. *Indian J. Mycological Research.* 24 (2):125-137.

Shah, R., Bhatnagar, M .K. and Mali, B.L. 1989. Epidemiology of bacterial blight of cow pea. Proc. 7th Con. *Plant Pathol. Bact.* Budapest, Hungry. 323-328.

Shekhawat, G.S. and Patel, P. N. 1977. Seed transmission and spread of bacterial blight of cowpea and leaf spot of green gram in summer and mansoon season. *Pl. Dis. Rep.* 61:390

Shekhawat, P. S. 1975. Investigation on bacterial leaf spot of chillies caused by *X.vescatoria. Ph. D Thesis,* University of Udaipur, Udaipur

Singh, R.B. 1987.Survival, epidemiology pathogenesis and control of bacterial pustule of soybean. Ph. D. Thesis Rajasthan Agricultural University, Bikaner.

Singh, K.P. 2001. Pathogenesis, Epidemiology and Management of Black rot Disease of cabbage (*Brassica oleracea var.capitata*) caused by *X.c.pv.campestris*. M Sc. Thesis RCA, Rajasthan Agricultural University, Bikaner.

Srivastava, S.S.L. and Blaish, B.S. 1985. Epidemiology of bacterial leaf pustule of soybean caused by *X.c.pv. glycines.Indian Phytopath.* 38:520-521.

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# Changes in physico-chemical composition of pomegranate fruits during growth and development under arid ecosystem

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**Abstract**

The fruits of pomegranate variety "Mridula" showed double sigmoid pattern of growth and development. The length, diameter, volume and weight of fruit indicated two phases of growth: a rapid phase until 30-90 days after anthesis and there after a gradual phase until harvest. With the advancement of the fruit maturity, the percentage of the arils and aril rind ratio increases, whereas, percentage of rind and its thickness decreased continuously throughout the growth period of the fruit. Total soluble solids, TSS: acidity ratio, reducing and non reducing sugars and ascorbic acid content of the fruits increased with advancement of fruit maturity, whereas acidity after little increase in the beginning, gradually decreased with growth and development. For best dessert quality and profitable marketing fruits of pomegranate var. 'Mridula" under arid ecosystem can be harvested 120-150 days after anthesis.

**Key Words:** *pomegranate, fruit growth, development, composition, maturity*

## Introduction

Pomegranate (*Punica granatum* L.) belongs to family punicaceae and is thought to be indigenous to the region of Iran where it was first cultivated in 2999 BC, however, it spread to the Mediterranean countries at a very early dates (Hayes, 1957). The fruit is one of the favorites of tropical and sub tropical regions. Because of its versatile adaptability, hardy nature, low maintenance cost, steady and high yields, its cultivation has spread to semi arid and arid regions and there is still further scope for its expansion (Dhandhar and Singh 2002). Pomegranate requires a long hot summer for fruit to mature, however, it can withstand low temperatures in winter. It is drought and salt tolerant plant. Under arid and semi arid ecosystem pomegranate flowers from late April until mid May, whereas, maturity and ripening extends from mid September to November depending upon the cultivars (Patil and Karale, 1990). In the epidermis of pomegranate seeds, the cells are relatively very elongated in the radial direction and are rod shaped (Fahn, 1975) and form edible parts termed as aril. Fruit growth is typically described as a single or double sigmoid curve reflecting organ flesh weight and other measures of growth (e.g. dry weight, diameter, or length) and may give different growth curves (Commbe, 1976) which varies with different ecozones and *bahars* (flowering and fruiting period). In the recent times export of pomegranate from India for world market has increased. But every year cracking, bruising, sun scald and variation in fruit size at harvest time render reasonable quantity of fruits unmarketable. Therefore, some growers prefer to harvest larger fruits soon and allow others to grow more to obtain bigger size. In order to maximize yield and get uniform size of fruits, it is necessary to know the phases of growth that are susceptible to environmental and physiological manipulation. Except some data on physical and chemical attributes at maturity and ripening (Ben-Arie *et. al.*, 1984; Al-Maiman and Ahmad, 2002), there is little information on the physiology of growth and development of the pomegranate fruits. Moreover, significant physiological changes associated with growth and development of pomegranate fruits may occur earlier and different cultivars may behave differently in different ecosystems. In view of the tremendous scope and importance of pomegranate fruits, present investigation was conducted to study in detail its growth and development under arid ecosystem.

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## Materials and methods

For the present study pomegranate fruits of cultivar "Mridula" were obtained from mature trees (8 years old) from Central Institute of Post Harvest Engineering and Technology, Research orchard Abohar, Punjab during advanced *mrig bahar* (May-September) 2005-07.The trees were spaced 5 x 3 meters and received routine cultural care suitable for commercial fruit production including summer and winter pruning requirement of *bahar* (Singh and Kingsly, 2007). The flowers were tagged at anthesis stage for selecting fruits of uniform maturity to study the different stages of growth and development. Ten fruits were selected randomly at 30 days of interval and the observations were recorded accordingly. The observations on physical parameters like length , weight, and volume of fruit, color of rind and aril, percentage of rind and aril, aril rind ratio, percentage of juice and number of arils in 100 gram weight and rind thickness were recorded periodically. TSS was measured using hand refractometer and titrable acidity of juice was determined by titration method (AOAC, 2000). Ascorbic acid was determined according to methods given by Rangana 1986. Colour of arils at different stages was calculate using plants lab mini scan XP plus colorimeter indicating 'L' (Luminance ) and 'a' (red/green ).

**Results and discussion**

The data in respect of length, diameter, weight and volume of fruit indicated two phases of growth (Fig. 1 &2): a rapid phase until 30-90 days after anthesis and there after a gradual phase until harvest, thus giving a double sigmoid for fruit growth curve. These findings are in agreement to *Ben-Arie et. al., (1984)* and Mirdehgan and Rahemi (2006), Fond *et. al.*, (1979), Shulman (1984) who also reported sigmoid growth patterns in pomegranate fruits. Percentage of aril and aril rind ratio increased with growth; however, increase was rapid from 30-60 days and gradual there after till maturity, whereas, percentage of rind and its thickness decreased continuously with growth and the decrease in percentage of rind was recorded gradual there after (Fig. 3, 4, 5). Similar results have been reported by Khodade *et. al.*, (1990). Juice content of fruits during growth and development increased rapidly up to 120 days and after that there was gradual increased up to 150 days of anthesis (Fig. 6). Juice content of fruit increased while percentage of aril decreased with advancement of maturity of fruit. Malhotra *et. al.*, (1983) and Shulman (1984) also reported same trend. Similar results were also reported by Khodade (1990).

Number of arils per 100 gram fruit decreased rapidly from 30th day of anthesis to 150 days of anthesis (Fig. 7). The data showed that the juice content of the seeds increased with advancement of maturity of fruit. Malhotra (1983) and Shulman (1984) reported similar results in pomegranate.

Data on changes in chemical composition of the fruit during fruit growth which indicates total soluble solids, TSS: acidity ratio, reducing and non reducing sugars, ascorbic acid content of the fruit increased with advancement of maturity, while, the acidity increased slightly from 30-60 days and there after decreased rapidly continuously and rapidly and up to 150 days of anthesis (Fig 8,9,10,11).The increase in TSS:acid ratio in juice of pomegranate was with advancement of maturity was also given by Malhotra (1983) and Khodade (1990). The data on colour characteristics (Fig 12) of the arils indicates slight increase in "L" value from 30-60 days of anthesis and after that there was no significant change in increasing trend of this value, indicating no remarkable change in brightness of the arils. The "a" value indicating redness of the fruit which increased rapidly up to 120 days and there after the increasing trend was not significant. Hence it could be inferred for the study that under hot arid ecosystem during advanced mrig *bahar* the fruit of pomegranate var. 'Mridula" for best quality and profitability marketing may be harvested between 120 to 150 days after anathisis.

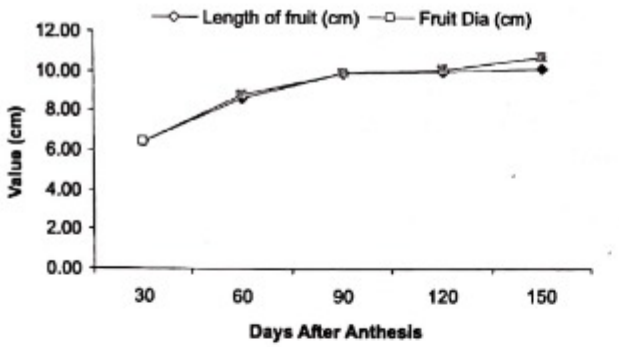


Fig. 1: Pomegranate fruit length and diameter during growth and development.

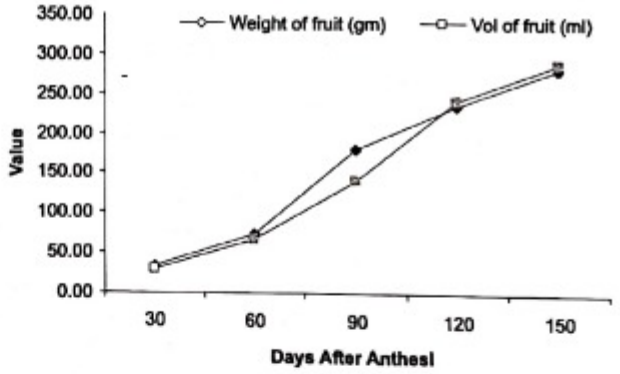


Fig. 2: Pomegranate fruit weight and volume during growth and development.

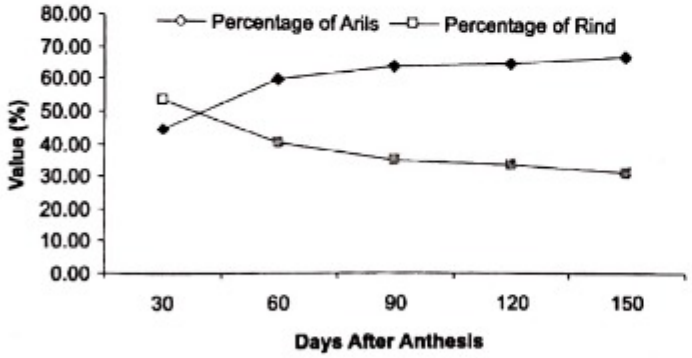


Fig. 3: Pomegranate fruit percentage of aril and rind during growth and development.

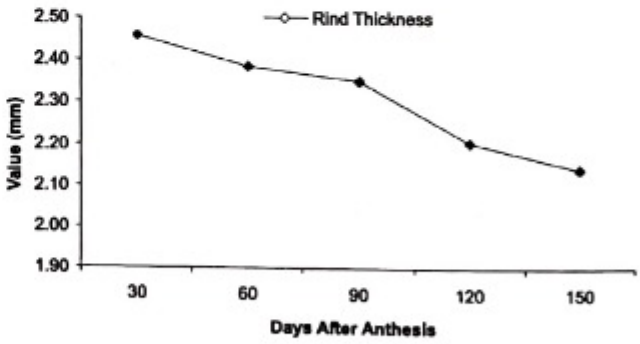


Fig. 4: Pomegranate fruit rind thickness during growth and development.

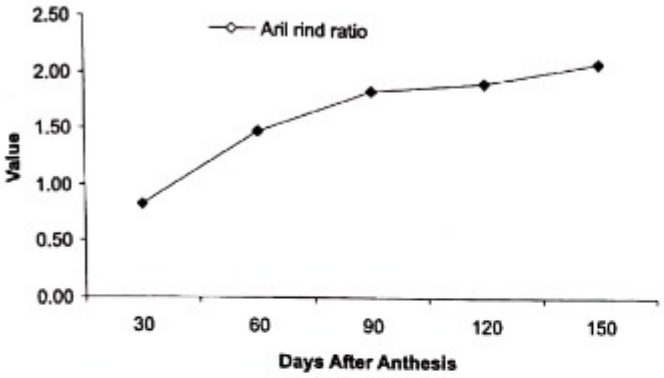


Fig. 5: Pomegranate fruit aril rind ratio during growth and development.

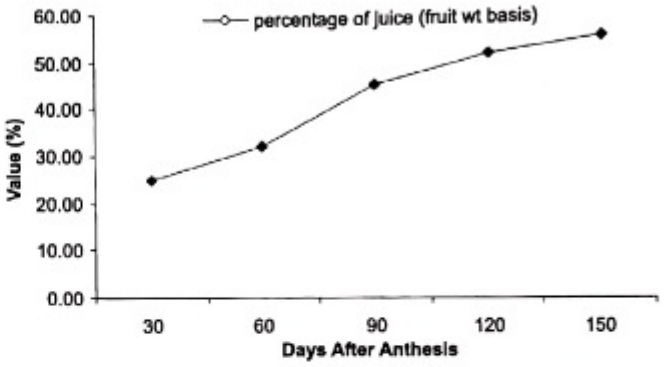


Fig. 6: Pomegranate fruit percentage of juice during growth and development.

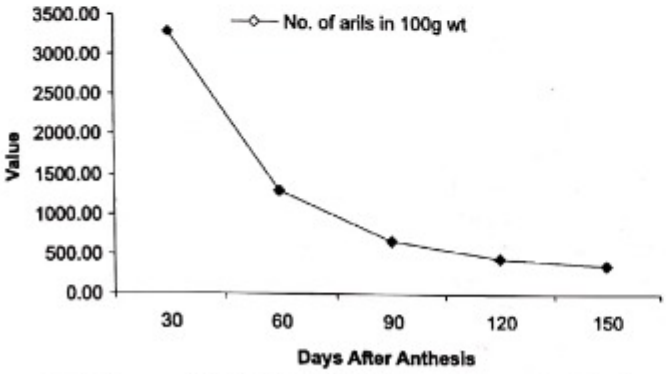


Fig. 7: Pomegranate fruit No of arils in 100g wt. during growth and development.

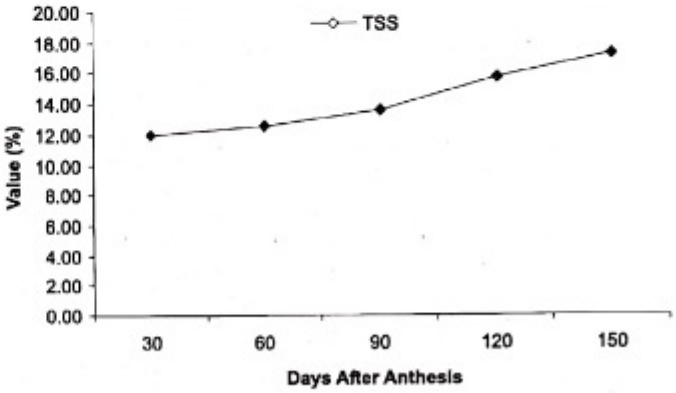


Fig. 8: Pomegranate fruit TSS (%) during growth and development.

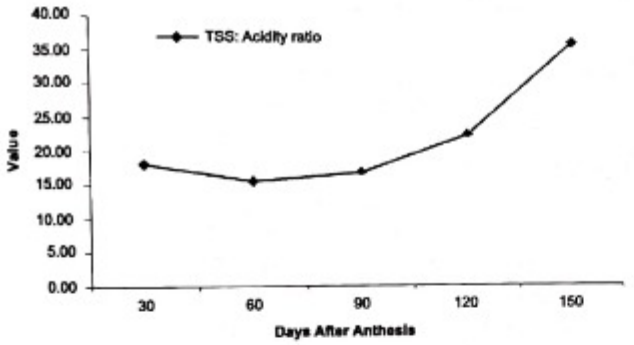


Fig. 9: Pomegranate fruit TSS: acid ratio during growth and development.

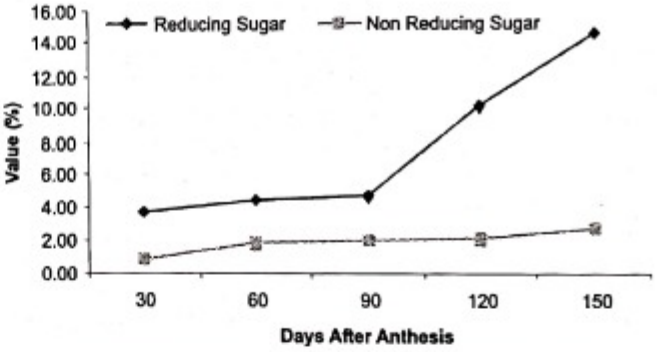


Fig. 10: Pomegranate fruit reducing sugar and non reducing sugar during growth and development.

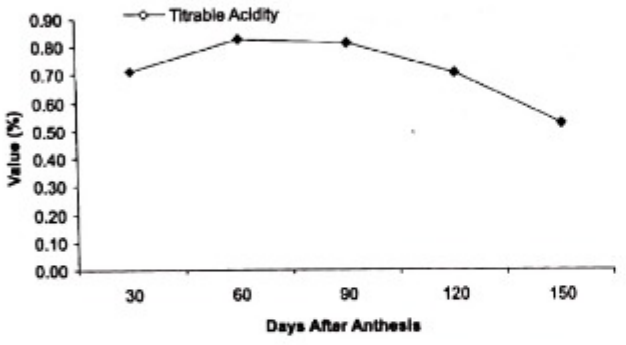


Fig. 11: Pomegranate fruit Titrable acidity during growth and development.

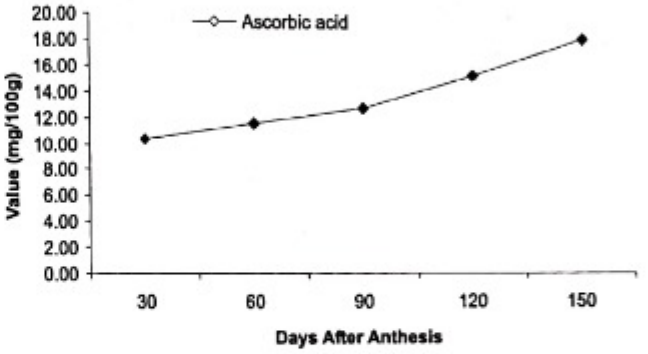


Fig. 12: Pomegranate fruit Vitamin C during growth and development.

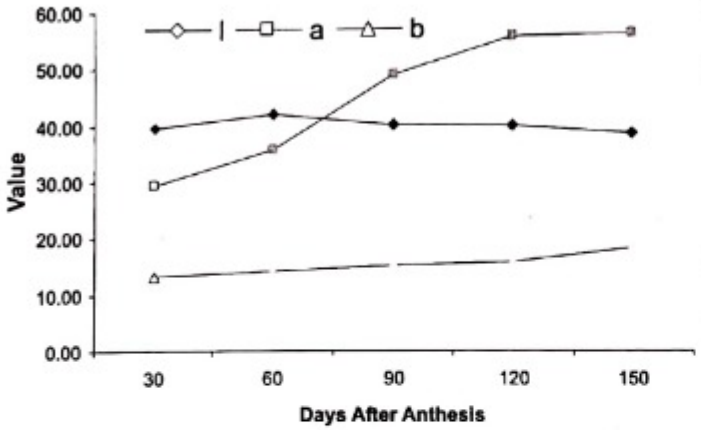


Fig. 13: Pomegranate aril colour during growth and development.

**References**


Al Maiman, S. A. and Ahmad, D. 2002. Changes in physical and chemical properties during pomegranate (*Punica granatum* L.) fruit maturation. *Food Cemistry*. 76:437-41.

AOAC. 2000. In Official methods of Analysis. *Assoc. of Official Analytical Chemists* (17th edn.) (Ed. Horwitz), Mayland. USA.

Ben Arie, R., Segal, N. and Guelfa Reich, S. 1984. The maturation and ripening of the 'Wonderful Pomegranate. *J. Amer. Soc. Hort. Sci.* 109:898-902.

Commbe, B. G. 1976. The development of fleshy fruits. *Ann. Rev. Plant Physiology*. 27:207-28.

Dhandhar, D. G. and Singh, D. B. 2002. Current status and future needs for the development of pomegranate. In: *Proceedings of National Horticulture Conference held during 18-19 October 2002* organized by Deptt. of Agric. and co operation, Min. of Agric. N. Delhi.

Fahn, A. 1974. Plant anatomy, *Pergamon Press. Inc.*, Oxford. UK. P611.

Fond, M. M., Barkat, M. R. and Elvazal, S. A. 1979. Bud burst activity, flowering and fruit set of dela Grenomillere and Manfoloti pomegranate cultivars under Giza conditions. *Research Bulletin. Faculty of Agricultural, Ain Shems University*, pp.17.

Hayes, W.B. 1957. Fruit Growing in India. Kitabistan, Allahabad, India. 502p.

Khodade, M. S., Warhat, K. N. and Kalo, P. N. 1990. Physico chemical changes during growth and development of pomegranate fruit. *Indian J. Hort.* 47(1):21-27.

Malhotra, V. K., Khajuria, H. N. and Jawanda, J. S. 1983. Studies on physico chemical characteristics of pomegranate cultivars . II. Chemical Characteristics. *Punjab Hort. Journal.* 23:158-161.

Mirdehghan, S. H. and Rahemi, M. 2006. Changes in physico-chemical attributes of pomegranate during fruit growth and development. *Indian J. Hort.* 63(2):122-125.

Patil, A. V. and Karale, A. R. 1990. Pomegranate. In Fruits: *Tropical and Sub Tropical* (Eds., Bose, T.K and Mitra, S. K) Naya Prakash Publications, Kolkata.

Rangana, G. S. 1986. Manual of analysis of fruit and vegetable Products. *Tata McGrow Hill Publishing Co.* Pvt., New Delhi.

Shulman, Y.L., Fainberstein and S. Lavee. 1984. Pomegranate fruit development and maturation. *J. Hort. Sciences*, 59(2):265-274.

Singh, D. B. and. Kingsly, A. R. P. 2007. Regulation of bahar in pomegranate (*Punica granatum*) to control fruit cracking and improve the quality. *Indian Journal of Agricultural Sciences*. 77(10):692-4.

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SHORT COMMUNICATION

# Distribution of micronutrient cataions in arid irrigated ber orchards in Sikar district of Rajasthan

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In Rajasthan, fruit cultivation is practised over an area 19795 ha and total production is 238475 tonnes (Anonymous 2005).The area of Sikar district forms a part of Thar desert which covers an area of 774244 square kilometres situated in the North Eastern Rajasthan. The district has moderate climate with seasonal temperature variation with scanty rainfall to the magnitude of 450-500 mm per annum during normal rainfall years. Increasing the production of fruits thus has sufficient scope in arid region of Rajasthan. In Sikar district, the area under fruit crops is 200 ha with production of 0.02 lakh metric tonnes (Anonymous 2005). There is a vast potential of increasing area under fruit cultivation in arid region of Rajasthan provided irrigation facilities are available. These areas are suitable for cultivation of fruit crops such as aonla, ber, beal citrus, pomegranate etc. Presently Sikar district has nearly 2,12,096 lac hectares irrigated area through tube wells/wells. Irrigation facilities has opened great avenues for cultivation of fruit crops likes ber, aonla, bael, lime, pomegranate, datepalm, guava, jamun, karonda, phalsa etc, besides traditionally grown fruits such as Ker (*Capparis decidua*), Gonda (*Cordia myxa*), Pilu (*Salvadora oleiodes*), Khejri (*Prosopis cineraria*) etc. Ber is an important fruit crop of arid and semi arid regions of north india. It can be successfully grown even on the marginal land where the most of the other fruit crops fail to give best economic returns. In Indian fruit industry, poor nutrition is the major cause of low orchard efficiency resulting poor productivity and poor fruit quality. Balanced nutrition of fruit crops is paramount importance particularly in arid areas having largely sandy soils of poor fertility status. For knowing the exact status of mineral nutrition in the fruit trees, survey of the orchards for their fertility status is done. Studies on nutritional survey of arid fruits in Rajasthan are meagre inspite of their great importance and relevance. With this aim, the present study was undertaken to evaluate the micronutrient fertility status of different orchards in Sikar district. A soil survey during the year 2007-2008 was conducted in Sikar district of Rajasthan. Eight orchards were selected covering different tehsils viz. Fatehpur, Danta Ramgarh, Piparali, Laxmangarh and Reengus.The details of locations and name of the fruit growers are given in table 1.

Soil samples were collected from eight fruit orchards, on the basis of variability and orchard performance at different locations of Sikar district. Thereafter, from each selected orchards, three soil profiles, based on soil fertility variation and plant performance were taken up. One hundred ninety two representative composite soil samples at different soil depths viz., 0-15, 15-30, 30-45, 45-60, 60-75, 75-90, 90-105 and 105-120 cm. were collected. The soil samples were analyzed for available Fe, Cu, Zn, and Mn were extracted with DTPA solution (Lindsay and Norvell, 1978) and were determined by atomic absorption spectrophotometry. As per the ratings given by Tandon (1992a), the soils having <4.5 mg $kg^{-1}$, < 0.6 mg $kg^{-1}$, < 0.2 mg $kg^{-1}$, < 2.0 mg $kg^{-1}$ of iron, zinc, copper and manganese, respectively falls under deficient category.

The distribution of DTPA extractable micronutrients as depth wise in 8 ber fruit orchards in Sikar district of Rajasthan was studied.

The extractable iron in soils ranged from 2.11 to 6.33 mg $kg^{-1}$ which showed a regular decreasing trend with increasing depths. It is evident that 30 per cent soil samples drawn from surface soil depth of ber orchards were deficient and 62 per cent were sufficient in DTPA

Table 1. Locations and name of fruit growers

| S.No. | Name of fruit grower | Village | Location |
|---|---|---|---|
| 1. | Shri Ummed Kumar | Raghunathpura | Raghunathpura |
| 2. | Shri Roopchand Peepaliwal | Pachar | Pachar-III |
| 3. | Shri Pokharmal | Purohit Ka Bas | Purohit Ka Bas-I |
| 4. | Govt. Nursery | Palsana | Palsana-II |
| 5. | Shri Iqbal Khan | Fatehpur | Fatehpur-I |
| 6. | Shri Kesha Ram | Pratappura | Pratappura |
| 7. | Shri Moolchand Meena | Lakhani | Lakhani |
| 8. | Shri Ishaq Yashin | Fatehpur | Fatehpur-II |

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extractable iron in the present study. The deficient to sufficient status of iron found in the soil might be due to calcareousness, low organic carbon content, light textured coarse sandy soils. Lal and Biswas (1973) observed that available iron content ranged from 0.3 to 5.6 ppm in Rajasthan soils and it was low i.e. 2 ppm in the desert soils, whereas, similar observations were reported by Bhatnagar and Chandra (2003) and Kumawat (2005).

The DTPA extractable zinc content in the soils ranged from 0.147 to 0.983 with the mean value of 0.574 of all the soil depths. Taking 0.60 mg $kg^{-1}$ as critical limit given by Tandon, 1992, 50 per cent soil samples drawn from surface soil depth of ber orchards were deficient and remaining 50 per cent were sufficient in with respect to available zinc content, and also showed a regular decreasing trend with increase in depth. The deficiency of zinc in soils might be due to the presence of quartz, feldspar or the exchange complex being such as to have sites saturated with Ca/ Mg under alkaline soil reaction. Calcareous nature and low organic matter are some of the other properties where low levels of zinc are anticipated. These results are in accordance with the findings of Bhatnagar and Chandra (2003) and Kumawat (2005).

From the data presented in the table, it is evident that the DTPA extractable copper content of soil depths ranged from 0.100 to 0.467 mg $kg^{-1}$ with their mean value 0.223 mg $kg^{-1}$. The copper content showed a regular decreasing trend with increase in depth. The 50 per cent soil samples drawn from surface soil depth of ber orchards were deficient and remaining 50 per cent were sufficient in with

Table 1. DTPA Extractable Iron (mg $kg^{-1}$) in Ber Orchards at Different Soil Depths in Sikar District

| Location of orchards | Soil depths (cm) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0-15 | 15-30 | 30-45 | 45-60 | 60-75 | 75-90 | 90-105 | 105-120 | Mean |
| Raghunathpura | 2.96 | 2.93 | 2.90 | 2.84 | 2.82 | 2.78 | 2.74 | 2.71 | 2.83 |
| Pachar-III | 4.92 | 4.89 | 4.86 | 4.80 | 4.77 | 4.74 | 4.69 | 4.63 | 4.79 |
| Purohit Ka Bas-I | 6.25 | 6.22 | 6.19 | 6.14 | 6.11 | 6.07 | 6.02 | 5.96 | 6.12 |
| Palsana-II | 6.33 | 6.31 | 6.24 | 6.21 | 6.16 | 6.13 | 6.08 | 5.80 | 6.16 |
| Fatehpur-I | 2.43 | 2.40 | 2.36 | 2.34 | 2.28 | 2.21 | 2.15 | 2.11 | 2.28 |
| Pratap Pura | 3.65 | 3.62 | 3.52 | 3.50 | 3.46 | 3.41 | 3.37 | 3.33 | 3.48 |
| Lakhani | 5.35 | 5.32 | 5.32 | 5.28 | 5.25 | 5.21 | 5.17 | 5.15 | 5.26 |
| Fatehpur-II | 4.91 | 4.89 | 4.85 | 4.79 | 4.75 | 4.72 | 4.67 | 4.63 | 4.78 |
| Mean | 4.60 | 4.57 | 4.53 | 4.49 | 4.45 | 4.41 | 4.36 | 4.29 | |

Deficient – 37%
Sufficient – 63%

Table 2. DTPA Extractable Zinc (mg $kg^{-1}$) in Ber Orchards at Different Soil Depths in Sikar District

| Location of orchards | Soil depths (cm) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0-15 | 15-30 | 30-45 | 45-60 | 60-75 | 75-90 | 90-105 | 105-120 | Mean |
| Raghunathpura | 0.297 | 0.273 | 0.253 | 0.230 | 0.203 | 0.190 | 0.170 | 0.147 | 0.220 |
| Pachar-III | 0.860 | 0.837 | 0.820 | 0.800 | 0.787 | 0.770 | 0.750 | 0.647 | 0.784 |
| Purohit Ka Bas-I | 0.670 | 0.647 | 0.627 | 0.600 | 0.580 | 0.567 | 0.543 | 0.407 | 0.580 |
| Palsana-II | 0.867 | 0.847 | 0.820 | 0.800 | 0.783 | 0.760 | 0.740 | 0.593 | 0.776 |
| Fatehpur-I | 0.463 | 0.443 | 0.427 | 0.407 | 0.387 | 0.367 | 0.343 | 0.353 | 0.399 |
| Pratap Pura | 0.567 | 0.547 | 0.527 | 0.507 | 0.480 | 0.450 | 0.430 | 0.403 | 0.489 |
| Lakhani | 0.983 | 0.953 | 0.927 | 0.900 | 0.873 | 0.853 | 0.823 | 0.650 | 0.870 |
| Fatehpur-II | 0.547 | 0.527 | 0.510 | 0.483 | 0.453 | 0.437 | 0.417 | 0.467 | 0.480 |
| Mean | 0.657 | 0.634 | 0.614 | 0.591 | 0.568 | 0.549 | 0.527 | 0.458 | |

Deficient 50%
Sufficient 50%

Table 3. DTPA Extractable Copper (mg $kg^{-1}$) in Ber Orchards at Different Soil Depths in Sikar District

| Location of orchards | Soil depths (cm) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0-15 | 15-30 | 30-45 | 45-60 | 60-75 | 75-90 | 90-105 | 105-120 | Mean |
| Raghunathpura | 0.147 | 0.140 | 0.133 | 0.130 | 0.123 | 0.117 | 0.120 | 0.110 | 0.128 |
| Pachar-III | 0.373 | 0.353 | 0.330 | 0.310 | 0.287 | 0.267 | 0.243 | 0.210 | 0.297 |
| Purohit Ka Bas-I | 0.467 | 0.440 | 0.410 | 0.390 | 0.373 | 0.347 | 0.317 | 0.283 | 0.378 |
| Palsana-II | 0.360 | 0.347 | 0.327 | 0.307 | 0.290 | 0.273 | 0.240 | 0.217 | 0.295 |
| Fatehpur-I | 0.160 | 0.147 | 0.127 | 0.127 | 0.120 | 0.117 | 0.107 | 0.100 | 0.125 |
| Pratap Pura | 0.370 | 0.343 | 0.320 | 0.293 | 0.277 | 0.257 | 0.227 | 0.207 | 0.287 |
| Lakhani | 0.193 | 0.167 | 0.163 | 0.153 | 0.140 | 0.130 | 0.127 | 0.117 | 0.149 |
| Fatehpur-II | 0.160 | 0.140 | 0.140 | 0.133 | 0.130 | 0.127 | 0.117 | 0.107 | 0.132 |
| Mean | 0.279 | 0.260 | 0.244 | 0.230 | 0.218 | 0.204 | 0.187 | 0.169 | |

Deficient 50%
Sufficient 50%

Table 4. DTPA Extractable Manganese (mg $kg^{-1}$) in Ber Orchards at Different Soil Depths in Sikar District

| Location of orchards | Soil depths (cm) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0-15 | 15-30 | 30-45 | 45-60 | 60-75 | 75-90 | 90-105 | 105-120 | Mean |
| Raghunathpura | 1.82 | 1.68 | 1.63 | 1.57 | 1.51 | 1.46 | 1.40 | 1.36 | 1.56 |
| Pachar-III | 3.87 | 3.80 | 3.73 | 3.66 | 3.62 | 3.55 | 3.51 | 3.47 | 3.65 |
| Purohit Ka Bas-I | 5.40 | 5.34 | 5.27 | 4.55 | 4.48 | 4.43 | 4.37 | 4.32 | 4.77 |
| Palsana-II | 3.45 | 3.37 | 3.30 | 3.26 | 3.21 | 3.14 | 3.08 | 3.03 | 3.23 |
| Fatehpur-I | 2.21 | 2.17 | 2.10 | 2.03 | 1.99 | 1.93 | 1.86 | 1.83 | 2.01 |
| Pratap Pura | 2.91 | 2.81 | 2.75 | 2.69 | 2.63 | 2.60 | 2.52 | 2.48 | 2.67 |
| Lakhani | 4.83 | 4.74 | 4.70 | 4.64 | 4.59 | 4.54 | 4.48 | 4.43 | 4.62 |
| Fatehpur-II | 1.91 | 1.81 | 1.76 | 1.70 | 1.66 | 1.62 | 1.57 | 1.52 | 1.69 |
| Mean | 3.30 | 3.22 | 3.15 | 3.01 | 2.96 | 2.91 | 2.85 | 2.80 | |

Deficient 25%
Sufficient 75%

respect to available copper content. The deficient to sufficient available copper status of orchard soil might be due to high pH, calcareousness, lower organic carbon and light textured coarse sandy soils. The present results are in accordance with those reported by Baser and Lodha (1971) who reported that available copper status in sandy soils of Rajasthan varied from 0.05 to 2.38 ppm. Similar types of results have also been reported by Bhatnagar and Chandra (2003) who reported available copper status in sandy soils of Rajasthan varied from 0.0.08 to 0.51 ppm.

The data presented on DTPA extractable manganese content of orchard soils showed a regular decreasing trend with increase in depths. The DTPA extractable manganese content in the soils ranged from 1.36 to 5.40 mg $kg^{-1}$ with their mean value of 3.02 of all the soil depths. Twenty five per cent soil samples of ber were found deficient and remaining 75 per cent were sufficient in respect to DTPA extractable manganese. Results of DTPA extractable manganese in all the orchards clearly indicate that deficiency of manganese in the ber orchards is now coming. The deficiency of DTPA extractable manganese might be due to the presence of high $CaCO_3$ content and low organic carbon content. These results are in accordance with those reported by Bhatnagar and Chandra (2003) and Kumawat (2005).

**References**


Anonymous. 2005. Horticultural Data Base. National Horticultural Board, Ministry of Agriculture, Govt. of India.

Baser, B.L. and Lodha, P.S. 1971. Available micronutrients in sandy soils of Rajasthan. *Annals Arid Zone.* 10 : 93-94.

Bhatnagar, P. and Chandra, A. 2003. Distribution of micronutrient cations in arid irrigated orchard soil profiles of western Rajasthan. *Journal of Eco-physiology.* 6(3-4): 93-100.

Kumawat, R. 2005. Nutrient status of soils of ber (*Zizphus mauratina* L.) orchard in Jaipur district of Rajasthan. M.Sc. Thesis, RAU, Bikaner.

Lindsay, W.L. and Norvell, W.A. 1978. Development of DTPA soil test for zinc, manganese and copper. *Soil Sci.Soc.Am. J.* 42 : 421-428.

Lal, F. and Biswas, T. D. 1973. Factors affecting the distribution and availability of micronutrient elements in major groups of Rajasthan surface soils. *Journal of Indian Society of Soil Science.* 21 (4): 455-466.

Tandon, H.L.S. 1992a. Fertilizer Development and Consultation Organization, , A Bhanot Corner, 1-2 Pompers Enclave, New Delhi. p 202-204.

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SHORT COMMUNICATION

# Performance of bottle gourd to saline water with drip irrigation method

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In the uncommand area of IGNP arid zones of Rajasthan, the ground water availability varies in quality and quantity both with time and space. Most of the ground water is saline or sodic in nature with different magnitudes. Development of technology for efficient and safer utilization of poor quality water for crop production is one of the thrust areas of research, as share of water allocation to agriculture is anticipated to reduce. It can be achieved through drip irrigation. Drip irrigation applies water directly to rhizosphere, thus maintaining high moisture within root zone without excess irrigation. These facts permit use of saline water through drip without risk of injury to crops and high salt concentration buildup near the plants. Use of poor quality water through a properly managed drip system provides advantage of reduced salinity level in the root zone. However, the degree of permissible water salinity for use in drip system depends on water quality, soil properties and salinity tolerance of particular crop. Several researchers have reported that through drip irrigation higher crop yields can be obtained along with considerable saving in irrigation water. Drip irrigation offers most uniform application water by restricting the water loss to minimum extent resulting into saving of irrigation water up to 50-60% and yield increases by 15-20% (Bangor, 1998). Singh and Singh (1978) reported that drip method resulted in increased yields in case of long gourd, round gourd and water melon by 41-47 % when same level of saline water is used. There is meagre information on use of saline water in sandy soils of western Rajasthan under drip method of irrigation in vegetables. Considering these in view an investigation was under taken on sandy soils with poor quality irrigation water, to study the efficiency of drip irrigation on bottle gourd.

A field experiment was conducted on sandy soils of Agricultural Research Station, Bikaner in kharif 2003 to 2004 to assess the tolerance of bottle gourd to different levels of irrigation water salinity through drip and flood methods. Treatment comprised of three salinity levels of irrigation water (EC 0.25, 3.0 and 6.0 $dSm^{-1}$) under two methods of irrigation i.e. drip and flood. The soils of experimental field was sandy in texture, alkaline in reaction (pH 8.4), low in organic carbon (0.10%) and medium in available phosphorous (24 Kg $P_2O_5$ /ha) and potash (200 Kg $K_2O$ /ha). The experiment was laid out in randomized block design with three replications in plot size of 3m X 3m. The drip lateral was installed in the centre of each plot with on line drippers (PC types) of 4.0 lph discharge. The healthy hybrid seeds of bottle gourd (var. Gutaka) were sown by dibbling method with plant to plant spacing 1.0 metre in the last week of June during both the years of experimentation. The standard recommended agronomic practices were followed. Recommended dose of fertilizer (120 kg Nitrogen, 80 kg $P_2O_5$ and 60 kg $K_2O$) and plant protection measures were under taken. Sintex tanks of 1000 litres capacity each were used to supply water of required salinity. The water available from the tube well was used as basic source of saline water having EC 4.1 $dSm^{-1}$. The required salinity was achieved by adding the pre calculated amount of salts. Final picking of fruits were done up to first week of December. The treatments were evaluated in terms of yield attributing parameters, yield and water use efficiency. For analysis of salinity build up in soil profile due to saline water irrigation under drip and flood methods, soil samples were also taken at three points which were located horizontally at 0, 15 and 30 cm apart from the either side of emitter. At each of these three locations soil samples were collected from four depths i.e. 0-15. 15-30, 30-45 and 45-60 cm. Similarly, in case of flood irrigation soil samples were taken from the same four depths but at only one location. Soil samples were collected at sowing and harvesting of crop and analyzed as per method outlined by Richards (1954). Rainfall received during the crop season was 230 and 102.8 mm during 2003 and 2004.

Yield of bottle gourd differ significantly with $EC_{iw}$ levels. Maximum yield was recorded with $EC_{iw}$ 3.0 $dSm^{-1}$ and it was at par as compared to best available IGNP canal water having EC 0.25 $dSm^{-1}$. Yield decreased significantly at $EC_{iw}$ 6.0 $dSm^{-1}$ in both the years. Maximum number of fruits per plant (8.3) and highest fruit weights (841g) were recorded in treatment $EC_{iw}$ 3.0 $dSm^{-1}$ (Table 1). About 23.75 % reduction in yield of bottle gourd was observed with water having $EC_{iw}$ 6.0 $dSm^{-1}$ as compared to $EC_{iw}$ 3.0 $dSm^{-1}$. Singh *et. al., (2004)* also reported 40% reduction in yield of tomato at EC 8.0 $dSm^{-1}$ in *rabi* season.

Maximum water use was observed in flood method of irrigation which was 32.35 % higher than drip method of irrigation. Whereas, highest mean water use efficiency of 443 kg / ha-cm was observed in treatment having ECiw 3.0 $dSm^{-1}$ under drip method of irrigation (Table 2). Singh *et al,*. (1978) also reported higher yields compared to surface method when same level of saline water is used. Kadam and Kartikeyan (2004) also advocated superiority of drip method over surface method.

The resulting ECe at harvest as affected by salinity levels of irrigation water in 0-45 cm soil profile at 0, 15 and 30 cm lateral distances from the emitter are shown

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in Table 3. In general, the soil salinity increased with increase in salinity of irrigation water at all depths and locations. Zone of minimum salt concentration existed below the emitter in studied soil profile. The trend clearly indicate that the salt concentration in soil profile increase with increase in lateral as well as vertical distance from the emitters. This is due to differences in moisture content of ponded, wetted and wetting zone of area irrigated by a particular emitter. The ponded zone have always higher moisture both laterally and vertically which starts decreasing as we move toward wetted zone with minimum at the end of wetting zone. This moisture variation causes movements of salts from the near vicinity of emitter, creating comparatively much less saline zone in which root perform there activity. In other words it can be inferred that the salts are leached away from the active root zone of plant providing better growing conditions. Salt concentration was highest at 30 cm distance from emitter. This may be due to fact that salts have moved with water away from active root zone.

Bottle gourd can be grown successfully with moderate saline water up to 3.0 $dSm^{-1}$ on sandy soils of western Rajasthan with drip irrigation method.

Table 1. Effect of different salinity levels of water and method of irrigation on yield and yield attributes of bottle gourd

| Treatments | Yield ( q $ha^{-1}$) | | | No of fruit/plant | | | Av. Fruit weight (g) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2003 | 2004 | Mean | 2003 | 2004 | Mean | 2003 | 2004 | Mean |
| Drip method ECiw ($dSm^{-1}$) | | | | | | | | | |
| 0.25 | 185 | 218 | 207 | 6.5 | 7.5 | 7.0 | 740 | 801 | 771 |
| 3.0 | 234 | 247 | 240 | 7.9 | 8.7 | 8.3 | 806 | 875 | 841 |
| 6.0 | 164 | 197 | 183 | 4.6 | 4.8 | 4.7 | 527 | 563 | 545 |
| Average | 194 | 221 | 210 | 6.3 | 7.0 | 6.7 | 697 | 746 | 719 |
| Flood method ECiw ($dSm^{-1}$) | | | | | | | | | |
| 0.25 | 181 | 198 | 190 | 6.9 | 7.1 | 7.0 | 675 | 730 | 703 |
| 3.0 | 172 | 183 | 178 | 6.5 | 6.9 | 6.7 | 622 | 660 | 641 |
| 6.0 | 147 | 163 | 155 | 3.1 | 3.7 | 3.4 | 492 | 528 | 510 |
| Average | 167 | 181 | 174 | 5.5 | 5.9 | 5.7 | 596 | 639 | 618 |
| LSD (p= 0.05%) | | | | | | | | | |
| EC | 9.3 | 1.3 | 4.6 | 0.2 | 0.2 | 0.2 | 15.7 | 14.6 | 13.0 |
| M | 6.2 | 0.8 | 3.1 | 0.1 | 0.1 | 0.1 | 10.5 | 9.7 | 8.7 |
| ECX M | 18.7 | 2.5 | 9.2 | 0.4 | 0.4 | 0.4 | 31.3 | 29.1 | 26.0 |

Table 2. Water Use (mm) and WUE (Kg/ ha /cm) through drip and flood method

| Treatments | Water Use (mm) | | | WUE (Kg/ ha-cm) | | |
|---|---|---|---|---|---|---|
| | 2003 | 2004 | Mean | 2003 | 2004 | Mean |
| Drip method ECiw ($dSm^{-1}$) | | | | | | |
| 0.25 | 518 | 547 | 533 | 357 | 398 | 378 |
| 3.0 | 523 | 562 | 542 | 447 | 439 | 443 |
| 6.0 | 556 | 574 | 565 | 264 | 284 | 274 |
| Average | 532 | 561 | 547 | 356 | 374 | 365 |
| Flood method ECiw ($dSm^{-1}$) | | | | | | |
| 0.25 | 703 | 734 | 720 | 257 | 270 | 264 |
| 3.0 | 712 | 746 | 729 | 242 | 245 | 244 |
| 6.0 | 737 | 712 | 725 | 199 | 229 | 214 |
| Average | 717 | 731 | 724 | 233 | 248 | 241 |

Table 3. Salinity (ECe) build up in soil profile with saline water irrigation through drip irrigation after bottle gourd

| Soil depth (cm) | Drip | | | Flood | | |
|---|---|---|---|---|---|---|
| | 0.25 | 3.0 | 6.0 | 0.25 | 3.0 | 6.0 |
| | Just Below emitter | | | | | |
| 0-15 | 0.40 | 1.33 | 1.96 | 0.62 | 1.21 | 1.63 |
| 15-30 | 0.48 | 1.07 | 1.83 | 0.58 | 1.59 | 2.17 |
| 30-45 | 0.56 | 1.53 | 2.24 | 0.55 | 1.66 | 2.55 |
| 45-60 | 0.52 | 1.74 | 2.21 | 0.51 | 1.80 | 2.90 |
| | 15 cm distance from emitter | | | | | |
| 0-15 | 0.56 | 1.79 | 2.2 | 0.62 | | |
| 15-30 | 0.48 | 1.98 | 2.14 | 0.58 | | |
| 30-45 | 0.42 | 1.97 | 2.48 | 0.55 | | |
| 45-60 | 0.56 | 2.1 | 2.73 | 0.51 | | |
| | 30 cm distance from emitter | | | | | |
| 0-15 | 0.7 | 2.01 | 2.61 | 0.62 | | |
| 15-30 | 0.62 | 2.39 | 2.92 | 0.58 | | |
| 30-45 | 0.78 | 2.13 | 3.1 | 0.55 | | |
| 45-60 | 0.85 | 2.47 | 3.75 | 0.51 | | |

**References**


Bangor, A.R. 1998. Results of research on Trickle Irrigation presented to Agresco- Sub committee, MPKV, Rahuri.

Kadam, J.R. and Kartikeyan, S. 2004. Yield and yield attributes of tomato as influenced by fertigation. National seminar on Development in Soil Science 2004 held on Oct 27-30, ANGRAU, Hyderabad. *J. Indian Soc. Soil Sci.* 172.

Richards, L.A. 1954. Diagnosis and improvement of saline alkali soils. U.S.D.A. Hand book No. 60

Singh, S.D., Gupta, J.P. and Singh, P. 1978. Water requirement and saline water use by drip irrigation. *Agron. J.* **70:** 948-51.

Singh, S.D. and Singh, P. 1978. Value of drip irrigation compared to conventional irrigation for vegetable production in hot arid climate. *Agron. J.* **70:** 945-47.

Singh, R.B., Chauhan, C.P.S. and Shishodia, P.K. 2004. Comparative study of summer and winter season tomato crop tolerance to saline irrigation with drip method. *Proceedings,* National seminar on Development in Soil Science. 170.

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SHORT COMMUNICATION

# Variation and character association studies in Isabgol

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Isabgol is a wonder plant with immense laxative utility. It is herb loaded with beneficial soluble fiber. The seed coat known as husk, has medicinal properties and is used as laxative in traditional system of medicine and has been proved beneficial in habitual constipation, chronic diarrhea and dysentery and irritation of digestive tract (Vigar Zaman etal.2002). The progress of any breeding programme depends upon the extent of genetic variability present in the population. The genetic variability along with the heritability gives a reliable picture of the genetic advance to be expected from selection (Burton,1952) while the heritability coupled with genetic advance aids in predicting the valuable conclusion for effective selection based on phenotypic performance. Correlation studies provide an opportunity to study the magnitude and direction of association of yield with its components and also among various components. To accumulate optimum combination of yield contributing characters in a single genotype, it is essential to know the implication of the interrelationships of various characters along with path coefficients. It was therefore proposed to study the Variation and character association of grain yield and its component characters in isabgol ( Plantago ovata L.)

Experimental material comprised of 36 genotypes of isabgol, were planted in randomized block design with three replications at Research Farm, College of Agriculture, Bikaner during rabi 2008-09. Each entry was spaced apart at 30 x 10 cm in a plot of 2 x 4m size. The observations were recorded on five randomly selected plants from each replication for characters viz ;days to 50 per cent flowering, days to maturity., plant height, number of effective tillers per plant, spike length, number of seeds per spike, 1000-seed weight, swelling percentage ,biological yield per plant ,harvest index and seed yield per plant on individual plant basis were recorded on plot basis. Genetic variability was calculated as per the formula suggested by Johanson et al. (1955). The correlation coefficients and path coefficient analysis were based on Dewey and Lu (1959).

Significant differences were observed among the genotypes for all the characters studied indicating presence of adequate variability. High estimates of PCV and GCV were observed in seed yield per plant, number of effective tillers per plant and biological yield per plant (Table1), indicating the scope of exploiting variability for further improvement of these traits. High GCV and PCV for one or more above mentioned traits have also been reported by Godawat and Sharma (1994). High estimates of heritability were observed for almost all the traits ranging from 68.20 for plant height to 98.00 for test weight indicating high merit value of these characters for any selection programme. Thus these characters will aid in a selection programme owing to their high heritability value. Genetic advance is also expressed as the shift in gene frequency towards superior side on exercising selection pressure. The expected genetic advance showed wide range from 1.25 for swelling percentage to 40.73 for number of effective tillers per plant. Heritability estimates along with genetic advance are normally more helpful in predicting the gain under selection than heritability estimates alone (Lush,1940). The high heritability coupled with high genetic advance per cent were recorded for 1000-seed weight, seed yield per plant and spike length indicated the major role of additive gene action in inheritance of these characters. These results are in agreement to the earlier findings of Bhagat (1980) and Godawat and Sharma )1994.

The phenotypic correlation between important yield attributing characters and seed yield per plant revealed that seed yield and biological yield showed highly significant positive correlation. Similarly seed yield with number of effective tillers per plant, spike length, number of seeds per spike, 1000-seed weight and harvest index also showed highly positive significant correlation (Table 2). Other character pairs which showed positive and significant association were number of effective tillers per plant with spike length, number of seeds per spike, 1000-seed weight, biological yield per plant and harvest index; spike length with number of seeds per spike, 1000-seed weight, biological yield per plant and harvest index; number of seeds per spike with 1000-seed weight, biological yield per plant and harvest index; 1000-seed weight with biological yield per plant and harvest index; biological yield per plant with harvest index. These findings suggest that selection for these characters is likely to contribute towards highly yield. It can be concluded that by making selection for grain yield, the maximum weight age should be given for number of effective tillers followed by spike length, number of seeds per spike and 1000-seed weight. These results were also suggested the findings of Bhagat (1980); Sharma and Kothari (1997)) and Sharma and Garg (2002).

Path analysis was carried out using phenotypic correlations to estimate the direct and indirect contribution of individual characters on grain yield. Harvest index had

Table 1. Estimates of mean, range, coefficient of variance, heritability and genetic advance of 11 characters in isabgol

| Characters | Mean±S.Em. | Range | Coefficient of variance | | Heritability (%) | Genetic Advance | G.A. as % of mean |
|---|---|---|---|---|---|---|---|
| | | | Phenotypic | Genotypic | | | |
| Days to 50% flowering | 71.14±0.57 | 58.00-61.67 | 9.80 | 9.50 | 93.90 | 13.48 | 5.16 |
| Days to maturity (No.) | 114.92 ± 1.03 | 100.00-132.67 | 9.14 | 8.73 | 91.40 | 19.76 | 3.87 |
| Plant height (cm) | 30.76 ±0.67 | 22.33-36.91 | 11.64 | 9.62 | 68.20 | 5.03 | 7.29 |
| Number of effective tillers per plant | 53.10 ± 1.33 | 18.33-101.67 | 38.7 | 37.96 | 96.20 | 40.73 | 12.02 |
| Spike length (cm) | 4.68 ±0.07 | 2.70-6.40 | 21.14 | 20.60 | 95.00 | 1.94 | 29.73 |
| Number of seeds per spike | 84.93 ± 1.80 | 57.33-107.67 | 16.20 | 14.90 | 84.60 | 23.98 | 5.77 |
| 1000-seed weight (g) | 1.58 ± 0.007 | 1.30-1.91 | 9.51 | 9.41 | 98.00 | 30.30 | 34.85 |
| Swelling percentage | 9.69 ± 0.17 | 8.26-11.22 | 9.23 | 7.65 | 68.70 | 1.27 | 11.61 |
| Biological yield per plant (g) | 22.14 ± 0.49 | 9.33-38.27 | 35.82 | 35.19 | 96.60 | 15.77 | 17.94 |
| Harvest index (%) | 24.89 ± 0.96 | 13.34-33.52 | 24.36 | 21.44 | 77.50 | 9.68 | 12.50 |
| Seed yield per plant (g) | 5.87 ±0.21 | 1.47-12.80 | 52.99 | 51.93 | 96.00 | 6.15 | 42.27 |

Table 2. Direct and indirect phenotypic and genotypic path coefficients effects of 11 characters on seed yield per plant in isabgol

| Character | | Days to 50% flowering | Days to maturity | Plant height (cm) | Number of effective tillers per plant | Spike length (cm) | Number of seeds per spike | 1000-seed weight (g) | Swelling percentage | Biological yield per plant (g) | Harvest index (%) | Correlation with Seed yield per plant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days to 50% flowering | G | -0.222 | 0.159 | 0.027 | -0.044 | -0.165 | -0.086 | -0.024 | 0.028 | 0.165 | 0.004 | -0.141 |
| Days to maturity (No.) | P | 0.002 | 0.015 | 0.000 | 0.004 | -0.001 | 0.007 | 0.001 | 0.001 | -0.007 | 0.039 | 0.061 |
| | G | -0.118 | 0.299 | 0.027 | 0.029 | -0.007 | -0.036 | 0.036 | -0.058 | -0.014 | -0.053 | 0.070 |
| Plant height (cm) | P | -0.001 | -0.001 | 0.005 | 0.010 | -0.012 | -0.006 | 0.002 | 0.000 | 0.098 | 0.007 | 0.099 |
| | G | 0.048 | -0.064 | -0.127 | 0.035 | 0.184 | 0.071 | 0.035 | -0.012 | -0.115 | 0.011 | 0.092 |
| Number of effective tillers per plant | P | -0.001 | 0.001 | 0.001 | 0.099 | -0.108 | -0.055 | 0.014 | 0.000 | 0.687 | 0.311 | 0.952** |
| | G | 0.027 | 0.024 | -0.012 | 0.356 | 1.171 | 0.502 | 0.237 | -0.006 | -0.752 | -0.610 | 0.973** |
| Spike length (cm) | P | -0.001 | 0.000 | 0.001 | 0.090 | -0.118 | -0.057 | 0.014 | 0.000 | 0.700 | 0.309 | 0.941** |
| | G | 0.030 | -0.002 | -0.019 | 0.339 | 1.229 | 0.520 | 0.233 | -0.007 | -0.785 | -0.597 | 0.977** |
| Number of seeds per spike | P | -0.001 | -0.002 | 0.001 | 0.086 | -0.105 | -0.063 | 0.013 | 0.001 | 0.652 | 0.294 | 0.876** |
| | G | 0.036 | -0.020 | -0.017 | 0.342 | 1.222 | 0.523 | 0.234 | -0.010 | -0.775 | -0.609 | 0.966** |
| 1000-seed weight (g) | P | -0.001 | 0.001 | 0.001 | 0.091 | -0.106 | -0.054 | 0.016 | 0.001 | 0.673 | 0.302 | 0.922** |
| | G | 0.022 | 0.043 | -0.018 | 0.338 | 1.147 | 0.491 | 0.249 | -0.015 | -0.744 | -0.595 | 0.951** |
| Swelling percentage | P | 0.001 | -0.002 | 0.000 | -0.003 | 0.004 | 0.004 | -0.001 | -0.010 | -0.029 | -0.018 | -0.053 |
| | G | -0.037 | -0.105 | 0.009 | -0.014 | -0.054 | -0.031 | -0.023 | 0.166 | 0.058 | -0.007 | -0.052 |
| Biological yield per plant (g) | P | 0.001 | -0.001 | 0.002 | 0.000 | -0.003 | 0.004 | -0.001 | -0.010 | -0.029 | -0.018 | 0.964** |
| | G | 0.046 | 0.005 | -0.018 | 0.338 | 1.218 | 0.511 | 0.234 | -0.012 | -0.792 | -0.580 | 0.989** |
| Harvest index (%) | P | 0.000 | 0.002 | 0.000 | 0.083 | -0.098 | -0.051 | 0.013 | 0.001 | 0.567 | 0.370 | 0.885** |
| | G | 0.002 | 0.025 | 0.002 | 0.343 | 1.159 | 0.504 | 0.235 | 0.002 | -0.727 | -0.632 | 0.941** |

*, ** Significant at 5% and 1% level of significance, respectively
Residual effect 0.0230 (genotypic), 0.0149 (phenotypic)

the highest positive direct effect on seed yield followed by number of tillers per plant, 1000-seed weight, days to maturity, days to 50 per cent flowering and plant height (Table2). This suggests that seed yield might increase if other variables remain constant. Similar results were also obtained for high direct effect on seed yield by Mittal et al. (1975) . Negative direct effect on seed yield was found with, spike length, number of seeds per spike, swelling percentage and biological yield per plant. Further indirect effect for spike length via biological yield followed by number of tillers per plant via biological yield, 1000-seed weight via biological yield, harvest index via biological yield were high and positive, hence these characters may be useful as selection criteria to isolate superior lines for higher seed yield in isabgol. The residual effect observed in path analysis was low indicating that the characters included in the present study were able to explain the most effects on seed yield in isabgol.

In conclusion, seed yield can be improved by direct selection of harvest index, number of effective tillers per plant and number of seeds per spike.

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## References

Bhagat, N. R. 1980. Studies on variation and association among seed yield and some component traits in Plantago ovata Forsk. *Crop Improv.* 7:60-63.

Burton, G. W. 1952. Quantitative inheritance in grasses. Proc. Int. Grassland congr. 6: 277-283

Dewey, D.R. and Lu, K.H. 1959. A correlation and path coefficient analysis of components of wheat grass seed production. *Agron. J.* 51: 515-518.

Comstock, R.E., Kellehr, T. and Morroue, E.B. 1958. Genetic variation in a sexual tree species, the garden strawberry. *Genetics*. 64: 634-46.

Godawat, S. L. and Sharma, A. K. 1994. Variability pattern in psyllium. *Indian PI. Genet. Res.* 7(1): 55-57.

Johnson, H. W., Robinson, H.F. and Comstock, R.E.

1955. Estimates of genetic and environmental variability in soybean. *Agron. J.* 47: 314-318.

Lal, R. K., Sharma, J. R. and Mishra, H. O. 1999. Induced variability and varietal selection in isabgol (Plantago ovata). *J. Medi. and Arom. Pt. Sci.* 21: 34-37.

Lush, J. L. 1940. Intra-sire correlation or regression offspring on dam as a method of estimating hereditability of characteristics. *Ann. Prod. Am. Animal Prod.* 33: 293-301.

Mital, S. Po', Bhagat, N. R. and Maheswari, M. L. 1975. Improvement of Plantago ovata (Forsk) through tetraploid and mutation breeding. Indian *J. Agric. Sci.* 45:426-429.

Sharma, A. K. and Garg, D. K. 2002. Correlation response and correlations in isabgol(Plantago ovata Forsk.). *Crop Improv.* 29:1, 110-112.

Sharma, A. K. and Kothari, P. R. 1997. Correlated response in Isabgol (Plantago ovata Forsk). Presented in third Agricultural Science Congress, held at P.A.U. Ludhiana Proceeding pp. 157.

Viqar, Zaman., Manzoor, S.M. Mehreen, Z. and Nauman, Aziz. 2002. The presence of antiamoebic constituents in psyllium husk. *Phytotherapy-Research.* 16: 78-79

**INDIAN JOURNAL OF ARID HORTICULTURE**
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SHORT COMMUNICATION

# Impact of bio-inoculants on seed germination and plant growth of guava (*Psidium guajava* Lamk.)

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Due to rising cost of chemical fertilizers and their adverse effects on soil health, the economically attractive and alternate potential sources of plant nutrients should be exploited. The excessive use of these chemical fertilizers adversely affects human health resulting in dreadful diseases like cancer, hypertension and other abnormalities. Further, to sustain the productivity, the bio-inoculants can supplement them to certain extent in various food crops. But it is not the common practice in various horticultural crops. The seed coat of most of the fruit crops is very hard. To break the seed dormancy, either some chemical treatment or long incubation period is required. These bio-inoculants can be helpful in breaking the seed dormancy by producing various plant growth substances. Hence the present investigations were undertaken to study the response of different bio-inoculants in combination with either FYM or vermicompost on seed germination and plant growth in guava (*Psidium guajava* Lamk.).

The experiment was conducted at the Experimental Farm, CCSHAU Regional Research Station, Bawal during the years 2007-08 and 2008-09. The experiment was laid out in randomized block design with six replications of each treatment both with vermicompost as well as farm yard manure. For filling up of polythene bags, the loamy sand soil and vermicompost/FYM were mixed together in 1:1 ratio. The different treatment combinations were- $T_1$: FYM alone; $T_2$: FYM+PGPR(*Pseudomonas maltophilia* PM4); $T_3$: FYM+VAM(vesicular arbuscular mycorrhizae); $T_4$: FYM+PSB(phosphate solubilizing bacteria); $T_5$: FYM+*Azotobacter chroococcum*; $T_6$:FYM+PSB +*Azotobacter*+PGPR; $T_7$: Vermicompost(VC) alone; $T_8$: VC+PGPR; $T_9$: VC+VAM; $T_{10}$: VC+PSB; $T_{11}$: VC+*Azotobacter*; $T_{12}$: VC+PSB+ *Azotobacter*+PGPR. In total there were twelve treatments; six each of vermicompost+soil and FYM+soil.

The seeds of guava were surface sterilized with 0.2% mercuric chloride solution for five minutes and then washed 2-3 times with sterilized distilled water, coated with charcoal based inoculants and then twenty seeds per replication for each treatment were impregnated into the polythene bags. The bio-inoculants used in the study were collected from Department of Microbiology, CCSHAU, Hisar and grown in their respective media under aseptic conditions.

*Glomus fasciculatum*, species of VAM fungi was used as VAM inoculants. The inoculums consisted of soil, spores and hyphae from chopped root fragments of pearl millet. Ten gram of the inoculums was mixed with the top soil in each polythene bag before sowing of guava seeds. The observations were recorded in terms of per cent seed germination at different time intervals up to 40 days of sowing. Then plant saplings were thinned down to one healthy sapling per bag and observed for plant height, number of leaves per plant and dry shoot weight at 150 days of sowing.

During the period 2007-08, maximum percent germination (34.2%) was observed in the treatment having FYM+ PSB+ *Azotobacter*+ PGPR; followed by FYM+VAM (29.2%). Per cent seed germination was slightly better in the treatments having FYM over their respective vermicompost treatments, however, the difference between them was non-significant. During 2008-09, the maximum germination (51.1%) was recorded in FYM + PGPR and FYM + *Azotobacter*; closely followed by FYM+ PSB+ *Azotobacter*+ PGPR and vermicompost+ *Azotobacter* (48.9 %) (Table 1). Plant height was also stimulated by different bio-inoculants in combination with farm yard manure as well as vermicompost during the period of investigation. However, PSB alone did not contribute much on different plant growth parameters.

VAM inoculation with FYM as well as with vermicompost positively affected number of leaves per plant during both the years (Table 2). The similar trends were followed when dry weight of shoot was recorded after 150 DAS. In general, VAM culture and co-inoculation of PSB, PGPR and *Azotobacter* stimulated plant growth parameters more positively as compared to single inoculation or untreated control. The response with FYM was slightly better over their respective vermicompost treatments.

Various reports in horticultural crops indicated that bio-inoculants either individually or in combination had synergistic effect on plant growth. The dual inoculation of *Azotobacter* and *Glomus fasciculatum* had more positive response in peach seedlings as compared to single inoculation or control (Godara *et al.*, 1998). Sharma and his associates (2002) reported that VAM fungi enhanced nutrient uptake and level of plant growth substances in apple seedlings. Subbiah (1990) also reported that when adequate amount of farmyard manure added to the soil with biofertilizers, it improved biofertilizer efficiency and ultimately nutrient status of the soil. Similar increase in growth of fruit plants with biofertilizers has also been reported by Sharma and Bhutani (1999). Increase in the

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growth of pecan seedlings could be attributed to the combined effect of biofertilizers on nutrient uptake and plant growth (Joolka *et al.*, 2004). The possible reason for better plant growth and germination can be attributed to maximum and early bacterization near root zone which induce germination by inducing root inducing substances (Wani *et al*; 1988). Similar reports have been made by Nath and Korla (2000) in ginger.

**References**


Godara, R.K., Awasthi, R.P. and Kaith, N.S. 1998. Interaction effect of VA-mycorrhizae and *Azotobacter* inoculation on growth and macronutrients of peach seedlings. *Haryana. J. Hortic. Sci.* 27: 235-40.

Joolka, N.K., Singh R.R. and Sharma, M.M. 2004. Influence of biofertilizers, GA, and their combinations on growth of pecan seedlings. *Ind. J. Hort.* 61: 226-228.

Nath, B. and Korla, B.N. 2000. Studies on effect of biofertilizers in ginger. *Ind. J. Hort.* 57: 168-71.

Sharma, S.D. and Bhutani, V.P. 1999. Influence of VA-mycorrhizae and P-fertilization on growth, leaf area and root colonization of apple seedlings. *Haryana. J. Hortic. Sci.* 28: 134-136.

Sharma, S.D., Bhutani, V.P. and Awasthi, R.P. 2002. Effect of vesicular-arbiscular mycorrhizae and phosphorus on leaf and soil mineral nutrient status of apple seedlings. *Ind. J. Hort.* 59: 140-144.

Subbiah, K. 1990. Nitrogen and *Azospirillum* interaction on fruit yield and nitrogen use efficiency in tomato. *South Ind. Hort.* 38: 342-44.

Wani, S.P., Chandrapalaiah, M.A., Zambre and Lee, K.K. 1988. Association between $N_2$ fixing bacteria and pearl millet plants - Response, mechanisms and resistance. *Plant and Soil.* 110: 284-302


Table 1. Effect of bio-inoculants on seed germination and plant height in guava

| Treatments | Seed germination (%) | | Plant height(cm) | |
|---|---|---|---|---|
| | 2007-08 | 2008-09 | 2007-08 | 2008-09 |
| $T_1$-FYM alone | 20.8 | 37.7 | 18.8 | 27.5 |
| $T_2$-FYM+PGPR | 25.8 | 51.1 | 29.7 | 28.7 |
| $T_3$-FYM+VAM | 29.2 | 45.5 | 28.0 | 29.2 |
| $T_4$-FYM+PSB | 20.0 | 44.4 | 18.3 | 27.9 |
| $T_5$-FYM+*Azotobacter* | 24.0 | 51.1 | 22.3 | 28.2 |
| $T_6$-FYM+PSB+ *Azotobacter*+PGPR | 34.2 | 48.9 | 19.2 | 31.5 |
| $T_7$- Vermicompost(VC) alone | 21.0 | 23.3 | 15.5 | 20.3 |
| $T_8$-VC+PGPR | 22.5 | 46.6 | 27.7 | 25.0 |
| $T_9$-VC+VAM | 21.7 | 37.5 | 26.3 | 26.7 |
| $T_{10}$-VC+PSB | 26.3 | 37.7 | 16.3 | 23.3 |
| $T_{11}$-VC+*Azotobacter* | 25.2 | 48.9 | 18.0 | 27.4 |
| $T_{12}$-VC+PSB+ *Azotobacter*+PGPR | 26.7 | 28.9 | 25.2 | 28.4 |
| Mean | 24.8 | 41.8 | 22.1 | 27.0 |
| CD at 5% | 2.04 | 3.41 | 1.87 | 2.17 |

Table 2. Effect of bio-inoculants on other plant growth parameters in guava.

| Treatments | No. of leaves/plant | | Dry shoot wt. (g) | |
|---|---|---|---|---|
| | 2007-08 | 2008-09 | 2007-08 | 2008-09 |
| $T_1$-FYM alone | 11.5 | 15.42 | 0.38 | 0.56 |
| $T_2$-FYM+PGPR | 21.8 | 17.17 | 1.17 | 0.77 |
| $T_3$-FYM+VAM | 22.5 | 18.80 | 0.95 | 0.83 |
| $T_4$-FYM+PSB | 15.5 | 15.75 | 0.53 | 0.79 |
| $T_5$-FYM+*Azotobacter* | 17.2 | 18.20 | 0.48 | 0.67 |
| $T_6$-FYM+PSB+ *Azotobacter*+PGPR | 14.8 | 17.75 | 0.95 | 0.92 |
| $T_7$- Vermicompost(VC) alone | 13.3 | 14.24 | 0.42 | 0.48 |
| $T_8$-VC+PGPR | 19.0 | 17.33 | 1.25 | 0.62 |
| $T_9$-VC+VAM | 20.5 | 15.67 | 1.08 | 0.68 |
| $T_{10}$-VC+PSB | 15.0 | 18.20 | 0.59 | 0.72 |
| $T_{11}$-VC+*Azotobacter* | 14.0 | 16.50 | 0.57 | 0.84 |
| $T_{12}$-VC+PSB+ *Azotobacter*+PGPR | 14.5 | 17.83 | 0.82 | 0.82 |
| Mean | 16.6 | 16.9 | 0.76 | 0.72 |
| CD at 5% | 1.49 | 1.35 | 0.12 | 0.17 |

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SHORT COMMUNICATION

# Studies on maturity indices of karonda (Carissa carandas L.) fruits

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Karonda (Carissa carandas L.) a member of family Apocynaceae is an indigenous fruit of Indian subcontinent. It is an underutilized evergreen thorny bush which thrives well through out Tropical and Subtropical climate (Singh and Singh, 1992) and is also found in Africa, Australia, Srilanka, Thailand, Indonesia and Malaysia mainly in wild form. In India its cultivation was initiated by the European in Kitchen garden to get fruit for jelly preparation. Karonda is known by several vernacular names such as karaunda, Karunda, garinga, krrona, timukhia and gotho in Hindi; Kurumia, Karamcha, Bainchi, Karenja and tair in Bingali; Karauanda and baronda in Marathi; Karamarda and Timbarran in Gujrati; Karamarda, Karamardaka, avinga and vrishnapakphula in Sanskrit; Kendakeri and Kerendokuli in Uriya; waaka and kalivikaya in Telgu and Kalaka and Kalapa in Tamil. It can flourish well on saline, alkaline and other waste lands on which other fruit crops do not thrives well. Karonda is best plant for live fencing that also produces fruits.

The fruit of karonda is good source of iron, calcium and pectin. Its vitamin 'C' and anthocyanin content enhances the antioxidant properties of the fruit. The fruit is used for preparation of jelly, pickle, beverages and preserve. The karonda candy is used in place of cherry in baking industries. The ripe fruit having antiascorbutic properties is reported to be cooling, acid and useful in bilious (Watt, 1972), cough, diabetes, Leprosy, anaemia and intestinal worming (Vasu, 1986). The fruit is not popular as desert because of its latex content and special astringent taste. Maturity is a stage of fruit development when fruits get its full growth (Singh *et. al.*, 1993). The stage of harvesting has significant effect on quality, shelf life and marketability of fruits. it is, therefore, need to decide maturity indices for harvesting of fruits at its right stage of maturity for different uses. Specific gravity, colour and T.S.S./ acid ratio are the criteria to determine the maturity of jamun (Ashraf, 1987) and aonla (Singh *et. al.*, 1993) fruits. Karonda is a non-climacteric underutilized fruits regarding that systematic information on harvest indices are not available so far. The present study therefore was done to formulate the maturity indices of karonda fruits.

The experiment was conducted at Department of Horticulture, N.D.University of Agriculture & Technology, Kumarganj, Faizabad, U.P. and the fruits were collected from experimental farm of the university. The study was done on Maroon and Pink with White Blush (PWB) genotypes of karonda. Four Plants of each genotype were selected randomly and one branch in each direction on each selected plants was tagged for taking the sample of the fruits. Samples were taken at 15 days intervals after fruit set. Fruit weight was recorded on physical balance and average fruit weight was calculated and expressed in g. Water displacement method was used in determination of volume and specific gravity was calculated dividing the weight of fruit by its volume.

Total Soluble Solids (T.S.S.) was estimated using Japan made ERMA hand refractometer of 0-32% range and calibrated at 20 °C. The acidity was determined by titrating a known volume of sample against 0.1 N NaOH solution using phenolphthalein as an indicator (Ranganna, 1978). The per cent T.S.S. was divided by per cent acidity to get T.S.S./Acidity ratio. The fruit colour was determined with the help of Horticultural Colour Chart (Wilson, 1938). The recorded data were statistically analysed using Complete Randomised Design.

The data recorded on the changes in fruit weight and volume during growth and development of both Maroon and PWB genotypes are presented in Table-1 which shows significant gradual increase in weight and volume of fruits up to 105 days after fruit set (DAFS) whereas changes were not significant between 105-120 DAFS. It indicates that fruit got maximum growth at 105 DAFS. Similarly significant increase in specific gravity was recorded up to 90 DAFS thereafter changes were not significant it was due to more qualitative changes in fruits after 90 DAFS. Continuous increase in T.S.S. / acid ratio was recorded in fruits of both genotypes that might be the conversion of organic acids into their salts which contribute to increase in T.S.S. and a simultaneous decrease in titrable acidity (Hawker, 1968). The colour of the fruits also changes from green to dark purple or red indicating degradation of chlorophyll and synthesis of anthocyanins when fruit proceeded to maturity and ripening. Maturity

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indices of various fruits such as mango (Singh *et al.*, 1976), jamun( Ashraf, 1987), ber (Pandey *et al.*, 1990), sapota (Paralkar *et al.*, 1987), papaya(Akamine and Goo,1971),grape (Daulta and Gupta, 1973), and Litchi (Singh and Abidi, 1986) were also determined by using the parameters of specific gravity, colour and T.S.S./ acid ratio.

The findings of present investigation indicate that maturity of karonda fruits can be considered after 105 DAFS which coincided with their natural maroon and pink with white blush colour, specific gravity of 1.02 and 1.02 and T.S.S./acidity ratio of 1.43 and 1.18 with maximum growth in Maroon and PWB genotypes, respectively. This was most appropriate stage to harvest Karonda for candy, jelly and pickles. The fruit ripened and become soft after 120 DAFS with dark purple and dark red colour having T.S.S. acid ratio of 1.74 and 1.42 in Maroon and PWB genotypes, respectively.This was the correct stage for harvesting of the fruits for squash, syrup and other beverages.

**References**


Akamine, E.K. and Goo, T. 1971. Relationship between surface colour development and soluble solids in papaya. *Hort.Sci.* 6 (6):567-568.

Ashraf, S.M. 1987. Studies on Post Harvest Technology of Jamun fruits.Ph.D.Thesis, N.D.University of Agriculture and Technology, Faizabad, U.P., India.

Daulta, B.S. and Gupta, U.S. 1973. Determination of maturity standards in some grape cvs. under Hissar conditions.*Haryana J.Hort.Sci.* 2 (3):23-24.

Hawker, J.S. 1968. Enzymes involved in sugar metabolism in the developing grape varieticis. *Proce.Aust.Biochem.Soc.*12th mtg.126:66.

Pandey, R.C., Pathak, R.A. and Pathak, R.K. 1990. Physico chemical changes associated with growth and development of fruit in ber (Zizyphus mauritiana Lamk.). *Indian J.Hort.* 47 (3):286-290.

Paralkar, P.S., Joshi, G.D. and Saivi, M.J. 1987. Studies on physico-chemical changes in sapota cv.Kalipatti fruits during growth and development. *Indian Fd. Packer.* 41 (4):11-18.

Ranganna, S. 1978. Manual of Analysis of Fruit & Vegetable Products. Tata Pub. Co. Ltd., New Delhi.

Singh, A. and Abidi, A.B. 1986. Studies on physico-chemical attributes of some promising Litchi cvs.during ripening.*Narendra Deva J.Agric.Res.* 1 : 70-73.

Singh, I.S., Pathak, R.K., Diwedi, R. and Singh, H.K. 1993. Aonla Production and Post harvest Technology. Bulletin, Department of Horticulture, N.D.University of Agriculture and Technology, Faizabad, U.P., India.

Singh, J.R. and Singh, A.K. 1992. *Indian Pomology*, Kaushilya Prakashan. Varanasi (India).

Singh, V.R., Pandey, I.C., Upadhyay, W.P. and Tripathi, B.M. 1976. Physiological and biochemical changes during maturity of mango variety Neelam. *Prog.Hort.* 8:13-18.

Vasu, N. 1986. B.R.Publication Corporation, Delhi. *Encyclopaedia Indica. Vol. IV.*

Watt, G. 1972. A dictionary of the economic product of India.Vol.II, Cosmo Publications, New Delhi.

Wilson, R.F. 1938. Horticultural Colour Chart. Wilson colour Ltd. (In collaboration with the Royal Horticultural Society and British Colour Council) Londan.

INDIAN JOURNAL OF ARID HORTICULTURE
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SHORT COMMUNICATION

# Status of *Alternaria* blight of watermelon under Rajasthan conditions

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Watermelon [*Citrullus lanatus* (Thunb) Mansf.] is one of the most widely cultivated crop in the world. China is the leading country in production of watermelon followed by Turkey, United States, Iran and Republic of Korea (Huh *et al.*, 2008). This crop is also known as *Tarbooj*, *Kalinda* and *Mateera* in India. It accounts for 6.8% of the world area devoted to vegetable production (Goreta *et al.*, 2005). Farrukhabadi, Moradabadi, Faizabadi of Uttar Pradesh and Mateera of Rajasthan are an important landraces of watermelon grown by farmers using their own saved seeds. It has sufficient variability for high productivity, quality, appearance traits such as shape, size, colour and is able to withstand damage from biotic and abiotic factors (Wehner *et al.*, 2001). It is subjected to attack of a number of fungal, bacterial and viral diseases, which inflict heavy damage on yield of the crop every year. Among the fungal diseases, *Alternaria* blight is an important disease in Rajasthan and other watermelon growing states of India. This disease needs regular monitoring for evolving effective control measures. Keeping the above facts in mind, a survey was conducted to record the status of *Alternaria* blight in four districts of Rajasthan at farmer's fields and the results are presented in Table 1 and Fig. 1.

A survey was conducted on watermelon fields in four districts of Rajasthan *viz.*, Bikaner, Hanumangarh, Jaipur and Sriganganagar during April- May 2010 and the incidence and severity of *Alternaria* blight were recorded. Observations were recorded from farmer's fields located at different places under natural conditions. Naturally infested watermelon plants showing characteristic symptoms of *Alternaria* blight caused by *Alternaria* spp. were examined from each field. For assessing disease incidence and severity, three fields from each village/locality were randomly selected. In each district, three villages/localities were surveyed. The diseased and healthy plants taken from 2 m x 2 m area of three random fields in every village were counted and disease incidence was calculated on the basis of per cent plant infected. Disease severity was also recorded on the basis of per cent leaf area affected (Singh *et al.* 2006).

The incidence and severity of *Alternaria* blight of watermelon recorded during survey programme is presented in Table 1. The data revealed that *Alternaria* blight of watermelon was present to the varying extents in watermelon fields of above four districts of Rajasthan in which two localities such as Pakka Saharana (Hanumangarh) and Piperan (Sriganganagar) were found free from the incidence of the disease. The disease incidence and disease severity ranged from 13.50- 26.50% and 3.0 to 18.50%, respectively. Highest disease incidence (26.50%) and disease severity (18.50%) were observed at Pathology Block (Beechwal, Bikaner) followed by Khejroli (Chomu, Jaipur), 25.50% and 12.0%, respectively. The disease incidence (13.50%) and disease severity (3.0%) were found lowest at locality Khara (Bikaner). The district wise average disease severity was observed highest (10.92%) in Bikaner district, while minimum disease severity (5.58%) was found in Hanumangarh followed by Sriganganagar (5.67%) (Fig. 1).

Variation in different disease parameters such as disease incidence and disease severity from location to location has been reported in case of many pathogen-host interactions (Chauhan *et al.*, 2002; Singh *et al.*, 2003). Basir (2005) also recorded variation in the status of angular leaf spot in french bean.

Other factors contributing to variation in disease incidence and disease severity in various villages/localities of Rajasthan may probably be attributed to differences in local atmospheric conditions. This include deviation in relative humidity, temperature and rainfall pattern among the abiotic factors and monoculturing, soil types and use of susceptible varieties among biotic and edaphic factors. The disease may attain an alarming proposition and may cause serious losses in watermelon growing areas if not taken care well in time. Therefore, it is imperative to evolve an effective management strategy to combat this disease, before the disease is blown out of proportion.

**References**

Basir, S. 2005. Studies on angular leaf spot (*Phaeoisariopsis griseola*) of french bean (*Phaseolus vulgaris* L.). Ph.D. Thesis submitted to Sher-E-Kashmir Univ. of Agricultural Sciences & Technology - Kashmir, Srinagar (J&K). 120 pp.

Chauhan, V. B., Singh, V. B. and Singh, A. K. 2002. Status of *Phytophthora* blight of pigeonpea in Eastern Uttar Pradesh. *Ann. Pl. Protec. Sci.* **10** : 402- 404.

Goreta, S., Perica, G., Dumicic, G., Bucan, L. and Zanic, K. 2005. Growth and yield of watermelon on polyethylene mulch with different spacings and

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Table 1. Disease incidence and severity of *Alternaria* blight of watermelon in Rajasthan during 2010.

| S. No. | Name of village/ locality | Name of district | Disease incidence (%) | Disease severity (%) |
|---|---|---|---|---|
| 1. | Khejroli (Chomu) | Jaipur | *25.50 | *12.0 |
| 2. | Sonarawali (Chomu) | Jaipur | 16.50 | 8.75 |
| 3. | Blaken (Chomu) | Jaipur | 17.5 | 3.6 |
| | | | Mean=19.83 | 8.11 |
| 4. | Khara | Bikaner | 13.50 | 3.0 |
| 5. | Beechwal (Pathology Block) | Bikaner | 26.5 | 18.50 |
| 6. | Jaisalsar, Dungargarh | Bikaner | 19.25 | 11.25 |
| | | | Mean=19.75 | 10.92 |
| 7. | Pakka Saharana | Hanumangarh | 0.0 | 0.0 |
| 8. | Lilawali | Hanumangarh | 18.50 | 7.75 |
| 9. | Pili Banga | Hanumangarh | 17.25 | 9.0 |
| | | | Mean=11.92 | 5.58 |
| 10. | Piperan | Sriganganagar | 0.0 | 0.0 |
| 11. | Morjhandakhari | Sriganganagar | 18.75 | 7.50 |
| 12. | Suratgarh | Sriganganagar | 16.33 | 9.5 |
| | | | Mean=11.69 | 5.67 |

*Data presented in average of the observations recorded in three fields at each village/locality.

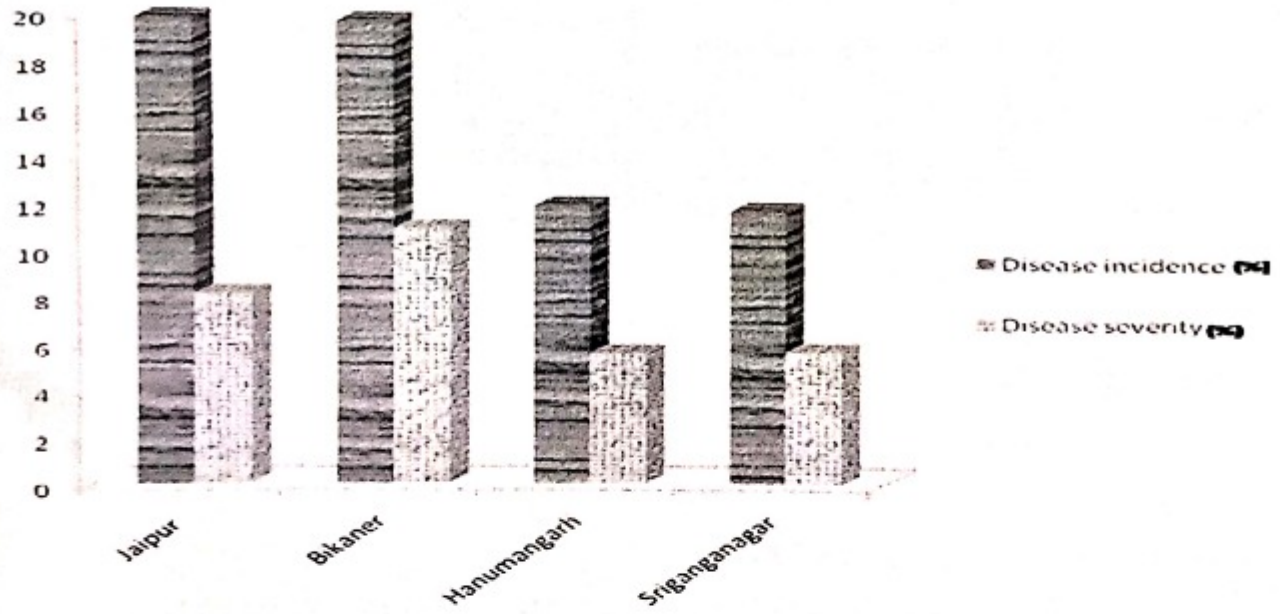


Fig.1 Status of disease incidence and severity of *Alternaria* blight

nitrogen rates. *Amer. J. Hort. Sci.* 40: 366-369.

Huh, Y.C., Solmaz, I. and Sari, N. 2008. Morphological characterization of Korean and Turkish watermelon germplasm. 1st Cucurbitaceae 2008, *Proceedings of the IX^th EUCARPIA meeting on genetics and breeding of Cucurbitaceae* (Pitrat, M. ed.), INRA, Avignon (France), May 21st-24th.

Singh, A. K., Tripathi, D. P. and Singh, S. B. 2006. Effect of different dates of transplanting on disease intensity and yield of tobacco caused by *Alternaria alternata*. *Ann. Pl. Protec. Sci.* **14** : 251-252.

Singh, J., Singh, R. B. and Singh, S. K. 2003. Status of web blight of mungbean in Eastern Uttar Pradesh. *Ann. Pl. Protec. Sci.* **11**: 173-175.

Wehner, T. C., Shetty, N. V. and Elmstrom, G. W. 2001. Breeding and seed production. In: D.N. Maynard (ed.). Watermelons: Characterization, production and marketing. ASHS Press, Alexandria, Va. pp. 27-73.

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SHORT COMMUNICATION

# Response of fenugreek to phosphorus, molybdenum and PSB

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Fenugreek is an annual herb, self pollinated, small seeded legume, which is grown as vegetable, fodder and seed crop. Its seeds contain protein, fatty oil, vitamins and minerals. Its seed has been found beneficial in many diseases. Disrupted free radical metabolism in diabetic may be normalized by fenugreek seed supplementation in the diet. So, the diabetic patients should be encouraged to include these medicinal plants in their daily diet to control blood sugar level (Kocchar *et al.* 2006). Fenugreek is a multipurpose crop whose every part is consumed in one or other form.

Productivity of fenugreek can be further enhanced by judicious package of fertilizers especially phosphorus, molybdenum and increasing the availability of phosphorus by seed inoculation with phosphate solubilizing bacteria. Adequate supply of phosphorus has been reported by various workers for vigorous growth, bumper yield, better quality and enormous nodule formation in legumes. Molybdenum either by soil application or through seed treatment significantly increased the grain yield of leguminous crop. Kumari *et al.* (2009) concluded that inoculation of phosphate solublising bacteria increased number of branches per plant, number of flowers per plant, number of pods per plant and dry weight/plant of urdbean.

A field experiment was conducted at College of Agriculture, Bikaner during *rabi* season, 2010-11. The soil of experiment site was loamy sand in texture containing 90.75, 21.80, and 201.15 kg $ha^{-1}$ available nitrogen, phosphorus and potassium, respectively in 0-15 cm soil depth with pH 8.41 and organic carbon 0.09 per cent. The soil was also low in molybdenum (0.04 mg $kg^{-1}$). The experiment was laid out in factorial randomized block design with three replications, assigning twenty four treatments consisting four levels of phosphorus (control, 20, 40 and 60 kg $P_2O_5$ $ha^{-1}$), three levels of molybdenum (control, 0.5 and 1.0 kg Mo $ha^{-1}$) and two levels of PSB inoculation (with and without seed inoculation). The uniform dose of N was maintained and phosphorus and molybdenum were drilled manually through di-ammonium phosphate and ammonium molybdate as per treatment at the time of sowing. Inoculation of seeds with phosphate solubilizing bacteria was done as per treatment. The fenugreek variety 'RMt 1' was sown in the first week of November.

An increase in P level significantly improved the yield attributing characters like branches per plant, chlorophyll content at flowering stage, nodules per plant, pods per plant, seeds per pod, seed and straw yield, protein and nitrogen content in seed, molybdenum and phosphorus content in seed and straw and their uptake of fenugreek up to 40 kg $P_2O_5$ $ha^{-1}$ whereas, nitrogen content in straw increased significantly only up to 20 kg $P_2O_5$ $ha^{-1}$ (Table 1, 2 & 3). Significantly higher values of yield attributes and seed yield of fenugreek were reported from different locations at 40 kg $P_2O_5$ $ha^{-1}$ [Dutta (2008) and Deo and Khandelwal (2009)].

Increase in Mo levels significantly improved the yield attributing characters like branches per plant, chlorophyll content at flowering stage, nodules per plant, pods per plant, seeds per pod, seed and straw yield, protein and nitrogen content in seed, molybdenum and phosphorus content in seed and straw and their uptake. Cvijanovic (2011) and Kumar and Sharma (2005) also reported similar results due to application of molybdenum in fenugreek.

The application of phosphate solubilizing bacteria recorded significantly higher branches per plant, chlorophyll content at flowering stage, nodules per plant, pods per plant, seed and straw yield, protein and nitrogen and phosphorus content in seed and straw and their uptake. These results get support from the findings of Vikram and Hamzehzarghani (2008) and Gaind and Gaur (1991). It is obvious that phosphate solubilizing bacteria produced higher quantity of organic acids which dissolved mineral phosphate and made it available to plants. These acids associate with metals and increase the concentration of soluble phosphate. They also synthesize growth promoting substances and produce vitamins which augment the plant growth (Gaind and Gaur, 1991). Thus, the beneficial effect of PSB in rendering the roots and branches helped in better nodulation and nitrogen fixation. These results are in agreement with those of Sarawagi and Rajput (2005) and Gupta and Sharma (2006).

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Table 1. Effect of phosphorus, molybdenum and PSB on Yield and yield attributes of Fenugreek

| Treatments | Seed yield (q/ha) | Straw yield (q/ha) | Branches / plant | Pods / plant | Seeds / pod | Nodules /plant | Chlorophyll content (mg/g) |
|---|---|---|---|---|---|---|---|
| P(kg/ha) | | | | | | | |
| 0 | 988 | 3121 | 7.81 | 29.81 | 12.12 | 4.87 | 1.63 |
| 20 | 1314 | 3418 | 9.42 | 34.26 | 13.13 | 5.28 | 2.18 |
| 40 | 1454 | 3614 | 10.44 | 37.26 | 13.92 | 5.59 | 2.37 |
| 60 | 1486 | 3668 | 10.67 | 37.48 | 14.28 | 5.71 | 2.41 |
| C.D at 5% | 71 | 159 | 0.60 | 1.56 | 0.73 | 0.24 | 0.09 |
| Mo (kg/ha) | | | | | | | |
| 0 | 1146 | 3222 | 32.68 | 12.77 | 12.77 | 5.13 | 2.03 |
| 0.5 | 1376 | 3561 | 35.72 | 13.44 | 13.44 | 5.40 | 2.20 |
| 1.0 | 1410 | 3584 | 35.70 | 13.88 | 13.88 | 5.55 | 2.21 |
| C.D at 5% | 61 | 138 | 1.35 | 0.63 | 0.63 | 0.21 | 0.08 |
| PSB | | | | | | | |
| Without Inoculation | 1219 | 3179 | 8.89 | 31.56 | 13.19 | 5.27 | 2.10 |
| With inoculation | 1402 | 3732 | 10.29 | 37.84 | 13.54 | 5.46 | 2.20 |
| C.D at 5% | 50 | 112 | 0.43 | 1.10 | NS | 0.17 | 0.07 |

Table 2. Effect of phosphorus, molybdenum and PSB on Nitrogen, Phosphorus, Molybdenum and protein content of fenugreek

| Treatments | Nitrogen content (%) | | Phosphorus content (%) | | Molybdenum content (mg $kg^{-1}$) | | Protein content (%) |
|---|---|---|---|---|---|---|---|
| | Seed | Straw | Seed | Straw | Seed | Straw | Seed |
| P(kg/ha) | | | | | | | |
| 0 | 2.60 | 0.77 | 0.410 | 0.133 | 4.03 | 1.13 | 16.27 |
| 20 | 2.85 | 0.81 | 0.434 | 0.153 | 4.23 | 1.24 | 17.81 |
| 40 | 2.99 | 0.83 | 0.452 | 0.165 | 4.29 | 1.27 | 18.71 |
| 60 | 3.06 | 0.84 | 0.461 | 0.168 | 4.31 | 1.28 | 19.14 |
| C.D at 5% | 0.13 | 0.04 | 0.015 | 0.008 | 0.12 | 0.06 | 0.83 |
| Mo (kg/ha) | | | | | | | |
| 0 | 2.69 | 0.78 | 0.411 | 0.143 | 3.94 | 1.18 | 16.82 |
| 0.5 | 2.96 | 0.83 | 0.452 | 0.159 | 4.31 | 1.25 | 18.50 |
| 1.0 | 2.98 | 0.83 | 0.455 | 0.162 | 4.39 | 1.27 | 18.63 |
| C.D at 5% | 0.12 | 0.03 | 0.013 | 0.007 | 0.11 | 0.05 | 0.72 |
| PSB | | | | | | | |
| Without Inoculation | 2.80 | 0.78 | 0.413 | 0.145 | 4.19 | 1.22 | 17.51 |
| With inoculation | 2.95 | 0.85 | 0.465 | 0.165 | 4.23 | 1.24 | 18.45 |
| C.D at 5% | 0.09 | 0.03 | 0.011 | 0.005 | NS | NS | 0.59 |

Table 3 . Effect of phosphorus, molybdenum and PSB on total nitrogen, phosphorus and molybdenum uptake and available P & Mo in soil after harvest of fenugreek

| Treatments | Total nitrogen uptake (kg $ha^{-1}$) | Total Phosphorus Uptake (kg $ha^{-1}$) | Total Molybdenum Uptake (g $ha^{-1}$) | Available Phosphorus in Soil after harvest (kg $ha^{-1}$) | Available Molybdenum in soil after harvest (mg $kg^{-1}$) |
|---|---|---|---|---|---|
| P(kg/ha) | | | | | |
| 0 | 50.03 | 8.24 | 7.52 | 15.57 | 0.0489 |
| 20 | 65.50 | 11.03 | 9.85 | 17.35 | 0.0524 |
| 40 | 74.02 | 12.65 | 10.85 | 18.75 | 0.0567 |
| 60 | 76.70 | 13.13 | 11.14 | 19.98 | 0.0591 |
| C.D at 5% | 3.60 | 0.59 | 0.48 | 1.15 | 0.0026 |
| Mo (kg/ha) | | | | | |
| 0 | 56.24 | 9.40 | 8.33 | 16.92 | 0.0510 |
| 0.5 | 70.85 | 12.06 | 10.42 | 18.29 | 0.0558 |
| 1.0 | 72.60 | 12.33 | 10.77 | 18.53 | 0.0560 |
| C.D at 5% | 3.12 | 0.51 | 0.42 | 1.00 | 0.0023 |
| PSB | | | | | |
| Without Inoculation | 59.45 | 9.71 | 9.04 | 16.72 | 0.0519 |
| With inoculation | 73.68 | 12.81 | 10.64 | 19.10 | 0.0566 |
| C.D at 5% | 2.54 | 0.41 | 0.34 | 0.82 | 0.0019 |

## References


Cvijanovic, G., Dozet G. D., Dukic V., Subic, J., Cvijanovic, D. and Dukic, V. 2011. Effects of Nitrogen fertilizing on the preceding crop and the application of Co and Mo on *Azotobacter* abundance in soya bean. *Romanian Biotechnological Letters. 16: 1.*

Deo, C. and Khandelwal, R. B. 2009. Effect of P and S nutrition on yield and quality of chickpea (*Cicer arietinum*). *Journal of Indian Society of Soil Science.* 57 (3): 352-36.

Dutta, D., Bandyopadhyay, P. and Maiti, D. 2008. Effect of P fertilization and growth regulators on yield, nutrient uptake and economics of fenugreek (*Trigonella foeum graecum*). *Research on Crops.* 9 (3): 599 601.

Gaind, S. and Gaur, A.C. 1991.Thermotolerant phosphate solubilising micro-organisms and their interaction with mungbean. *Plant and Soil.* 133: 141-149.

Gupta, A. and Sharma, V. K. 2006. Study on the effect of biofertilizer and phosphorus levels on yield and economics of urdbean (*Vigna mungo* L. Hepper). *Legume Research.* 29 (4).

Kochhar, A., Nagi, M. and Sachdeva, R. 2006. Proximate composition, available carbohydrates, dietary fibre and anti nutritional factors of selected traditional medicinal plants. *Journal of Human Ecology.* 19 (3): 195-199.

Kumar, J. and Sharma, M. 2005. Effect of phosphorus and molybdenum on yield and nutrient uptake by chickpea (*Cicer arietinum* L.) *Advances in Plant Sciences.* 18 (11): 869-873.

Kumari, M., Vasu, D., Hasan, Z. U. and Dhurwe, U. K. 2009. Effects of PSB (Phosphate Solubilizing Bacteria) on morphological characters of lentil (*Lens culinaris*). *Medicinal Biological Forum-An International Journal.* 1(2): 5-7

Sarawagi, S. K. and Rajput, R. S. 2005. Effect of phosphorus, zinc and PSB on growth and yield of soybean (*Glycine max* L. Merril) in vertisol of Chhattisgarh plains. *Annals of Agriulture Research.* 26 (2): 302 305.

Vikram, A. and Hamzehzarghani, H. 2008. Effect of PSB on nodulation and growth parameters of greengram (*Vigna radiate* L. Wilczek). *Research Journal of Microbiology.* 3 (2): 62-72.

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SHORT COMMUNICATION

# Responses of IBA to induce rooting in stem cuttings of cucurbits

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The main role of vegetative propagation of cucurbits through stem cuttings is to maintain gynoecious and male sterile line (Pandey and Rai, 2006). Seed propagation of cucurbits requires new planting materials every year due to the loss of hybrid vigour and delayed flowering and fruiting. The availability of true to true type hybrid seed in local market is also difficult. However, rapid multiplication of cucurbits by stem cuttings has been the answer to such problem in cucurbits. Some perennial cucurbits like pointed gourd and kundru etc. as well as pumpkin (Singh, 1997), bottle gourd and bitter gourd (Singh, 2004) has been successfully propagated by stem cuttings.

The application of plant growth regulators increased the rooting and fruiting in tomato, pumpkin, bottle gourd and bitter gourd (Singh, 1999, Singh, 1997 and Singh, 2004). The present experiment was taken to examine the efficacy of different doses of IBA on vegetative propagation of different cucurbits commonly grown in Baran district of Rajasthan.

The investigation was carried out on cucurbits stem cuttings at Krishi Vigyan Kendra, Anta during the year 2008-2009.The site experiences subtropical climate having three distinct seasons, i.e. rainy (mid-June to September), winter (October to February) and summer (March to mid-June).Average annual rainfall during the study period was 1552 mm, of which 85% was received during monsoon months within 56 hours. The mean maximum temperature was 38°C (April to June) and minimum was about 8°C (January).The soil of the experimental site is a black cotton-alluvial in reaction pH 8.5, EC 0.854 $dSm^{-1}$, high in free CaCO3(35%), highly deficient in organic carbon (0.32%), poor in available N (166.3 kg $ha^{-1}$), $P_2O_5$ (28.5 kg $ha^{-1}$) and $K_2O$ (148.2 kg $ha^{-1}$) with the soil texture sandy clay (sand, silt and clay: 54, 35 and 9% respectively).

The experimental material which consisted of 15-20 cm long cuttings (1.0 to 1.25 cm thick with 4-5 nodes) were harvested with the help of sharp knife from the tip portion of two month old available mother plants of cucumber (*Cucumis sativus* L.), sponge gourd (*Luffa cylindrica* Roem) and *tinda* (*Praecitrullus fistulosus* Pang.) varieties (Pusa Sanyog F1 hybrid), Pusa Chikni, Arka Tinda respectively on 10 August, 2008 and 10 March 2009. The 4 to 5 cm basal portions of 25 cuttings were treated with the solution of either 250 or 500 ppm indole butyric acid for 10 minutes and these cutting were compared with control constituted water treatment only. The treated cuttings were subsequently planted in 30X30X30 cm pits filled with 1/3 part of sand, 1/3 part of FYM and 1/3 part of upper soil at a distance of 2.5m X1.0 m on the eastern side of ridges. These treatments were replicated thrice in factorial randomized block design. Uniform cultural operations were adopted during the course of investigation. The observations on survival of cuttings were recorded after one month of planting and presented as per cent of total cutting planted. Subsequently, 5 cuttings were randomly tagged in each treated plots. All shoots emerging from these cuttings were counted and these cuttings were then uprooted after 35 days after transplanting for the counting of number of roots and its length. The number of days taken to flowering was counted at the time of first female flower emergence. Yield was recorded at the time of harvesting which was done at green tender stage. The data were statistically analysed as per procedure laid down by Panse and Shukhatme (1985).

Data revealed a profuse rooting and survival of cutting treated with IBA (Table 1). The total number of roots and its length was higher in 500 ppm IBA treated stem cuttings than 250 ppm IBA in all the cucurbits and required 2 to 3 day lesser time to induce rooting. Maximum rooting was recorded in rainy season sponge gourd followed by cucumber and *tinda*. The survival percentage of 500 ppm IBA treated stem cuttings was higher in sponge gourd (78.73- 94.15), cucumber (78.22-93.75) and *tinda* (35.93-49.87) in both the season than 250 ppm IBA. Probably maximum survival percentage was recorded due to increase of roots in plant growth regulator treated cutting (Singh, 2004). Maximum survival of cuttings was also due to the presence of differential level of endogenous rooting cofactors (Pandey *et.al.*, 1983) and carbohydrates and C: N ratio implicated in rooting of plant species.

The number of branches and yield were better (Table 2) in IBA treated stem cuttings of cucurbits. The cuttings treated with highest dose of IBA (500 ppm) produced maximum branching and takes one week lesser time to induce flowering. Flower induction was slightly earlier in summer season than rainy season in all cucurbits. The mature vines of cucumber, sponge gourd and *tinda* take minimum time to induce flowering. The response of 500 ppm IBA was more effective to significantly increase the

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yield of cucumber, sponge gourd and *tinda* i,e. 252.45-254.01, 227.48-228.35 and 219.51-220.14 q/ha respectively and harvested one week earlier than other treatment. The response of IBA and cucurbits are significantly increased the number of branch, number of days required for flowering, fruiting and yield but its interaction was non-significant. The increase in yield was due to the induction of early flowering, fruiting and number of branch per plant. Similar increase in yield was reported in pumpkin, bottle gourd, bitter gourd and tomato (Singh, 1997; Singh, 1999) stem cuttings.

## References


Pandey, A.K. and Rai, M. 2006. Use of growth regulators for quality vegetables. *Indian Horticulture.* 51(3): 28-29.

Pandey, D., Tripathi, S.P., Upadhyay, S.H. and Tewari, J.P. 1983. Biochemical basis of walnut rooting through stooling II. Effect of carbohydrate, nitrogen fraction, rooting cofactor and inhibitors. *Punjab Horticulture Journal.* 23: 203-208.

Panse, V.G. and Sukhatme, P.V. 1985. Statistical Methods for Agricultural Workers, ICAR, New Delhi.

Singh, D. K. 1997. A note on effect of paclobutrazole and IBA on stem cutting of pumpkin. *Vegetable Science.* 24: 176-178.

Singh, D. K. 1999. Response of hybrid tomato (*Lycopersicon esculentum*) to growth regulators. *Indian Journal of Agricultural Sciences.* 69: 51-53.

Singh, D. K. 2004. Performances of different cucurbits stem cuttings to IBA. *The Horticulture Journal.* 17(1): 83-87.


Table 1. Effect of IBA on rooting and survival of stem cuttings of different cucurbits.

| Treatment IBA (ppm) | No. of root/plant | | Length of root (cm) | | Days required for rooting | | Survival % | |
|---|---|---|---|---|---|---|---|---|
| | Rainy | Summer | Rainy | Summer | Rainy | Summer | Rainy | Summer |
| Cucumber | | | | | | | | |
| Control | 31.24 | 23.28 | 08.82 | 08.14 | 13.44 | 15.72 | 85.32 (21.33) | 72.35 (18.08) |
| 250 | 37.88 | 32.49 | 10.41 | 09.22 | 10.32 | 14.23 | 91.81 (22.95) | 76.82 (19.20) |
| 500 | 42.98 | 36.38 | 11.84 | 11.23 | 10.12 | 13.74 | 93.75 (23.43) | 78.22 (19.55) |
| Sponge gourd | | | | | | | | |
| Control | 31.51 | 23.53 | 08.93 | 08.97 | 12.93 | 15.48 | 89.22 (22.30) | 72.47 (18.11) |
| 250 | 38.34 | 32.77 | 10.35 | 09.34 | 10.32 | 14.05 | 92.25 (23.06) | 76.48 (19.12) |
| 500 | 43.8 | 36.13 | 11.89 | 11.35 | 10.05 | 13.35 | 94.15 (23.56) | 78.73 (19.68) |
| *Tinda* | | | | | | | | |
| Control | 22.35 | 15.74 | 06.37 | 05.87 | 16.12 | 18.39 | 41.18 (10.29) | 33.47 (08.36) |
| 250 | 28.25 | 21.01 | 07.94 | 06.14 | 14.37 | 16.47 | 46.52 (11.63) | 35.54 (08.88) |
| 500 | 29.41 | 22.49 | 08.01 | 06.58 | 13.68 | 15.89 | 49.87 (12.46) | 35.93 (08.98) |
| CD(0.05) | | | | | | | | |
| Treatment | 2.14 | 2.16 | 0.98 | 0.88 | 1.22 | NS | 3.47 | 3.10 |
| Cucurbits | 2.46 | 2.21 | 0.99 | 0.94 | NS | NS | NS | NS |
| Interaction | NS | NS | NS | NS | NS | NS | NS | NS |
| C.V. | 30.48 | 30.12 | 28.47 | 28.23 | 47.99 | 58.57 | 35.34 | 33.26 |

Table 2. Growth and yield traits of cucurbits raised through stem cuttings treated with IBA.

| Treatment IBA (ppm) | No. branch/plants | | Days required for female flowering | | No. of days taken to harvest | | Yield (Q/ha) | |
|---|---|---|---|---|---|---|---|---|
| | Rainy | Summer | Rainy | Summer | Rainy | Summer | Rainy | Summer |
| Cucumber | | | | | | | | |
| Control | 9.53 | 6.31 | 44.46 | 44.21 | 54.19 | 52.16 | 201.41 | 200.12 |
| 250 | 11.14 | 8.53 | 39.27 | 38.71 | 49.01 | 47.58 | 244.85 | 244.11 |
| 500 | 11.90 | 9.32 | 37.12 | 35.12 | 47.59 | 45.13 | 254.01 | 252.45 |
| Sponge gourd | | | | | | | | |
| Control | 9.59 | 6.55 | 44.54 | 42.31 | 50.84 | 48.47 | 208.52 | 207.15 |
| 250 | 11.54 | 8.63 | 39.48 | 37.11 | 44.12 | 41.68 | 214.28 | 214.07 |
| 500 | 11.95 | 9.38 | 37.58 | 36.26 | 42.15 | 41.18 | 228.35 | 227.48 |
| *Tinda* | | | | | | | | |
| Control | 6.05 | 4.33 | 44.31 | 43.41 | 50.09 | 48.47 | 191.48 | 190.98 |
| 250 | 7.53 | 4.99 | 40.12 | 38.98 | 44.75 | 43.08 | 201.47 | 200.96 |
| 500 | 7.97 | 5.64 | 39.10 | 38. 09 | 42.07 | 41.86 | 220.14 | 219.51 |
| C.D(0.05) | | | | | | | | |
| Treatment | 0.48 | 0.69 | 2.15 | 2.14 | 2.04 | 2.18 | 1.01 | 0.98 |
| Cucurbits | 0.61 | 0.71 | 2.34 | 2.87 | 2.27 | 2.68 | 2.41 | 1.86 |
| Interaction | NS | NS | 2.14 | 2.21 | NS | NS | NS | NS |
| C.V. | 27.25 | 27.46 | 11.13 | 11.11 | 21.12 | 22.61 | 68.32 | 62.01 |

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SHORT COMMUNICATION

# Marketing of *aonla* fruits

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*Aonla* (*Emblica officinalis* Gaertn.), also known as Indian gooseberry, is the emerging fruit crop with lot of scope for commercial cultivation with its wider adoptability across India. It comes up well in black saline soil, dry lands, with less pest incidence, prolonged storability, high medicinal value and thereby greater demand in pharmaceutical, cosmetic and food industry. Recently role of extension has been stretched beyond production and market information has been brought under its purview to facilitate the farmer in fetching good price for his produce. Marketing of aonla fruits has become important aspect in view of its greater demand from various sectors. Keeping this in view, a study was conducted to assess the method of marketing of aonla fruits by the farmers.

The study was conducted in Panchmahals and Vadodara districts of Gujarat. The list of *aonla* farmers was prepared and thirty farmers were randomly selected. A structured interview schedule was prepared to assess the marketing of *aonla* fruits by the *aonla* farmers. Data were collected during January March 2001, by interviewing the farmers at their farm. The statistical tools used were frequency and per cent.

Table 1 revealed that the majority (43 per cent) of the farmers sold the aonla fruits to pre-harvest contractor. This might be due to saving the expenditure on watch and ward of the fruit trees when the fruit was in bearing condition, harvest, packing, and transportation. Further, the farmer got the income well in advance of harvest of the fruits. However, the price offered by pre-harvest contractor was usually less remunerative than the direct auctioning at wholesale market. Sadaphal *et.al.* (2003) observed that the white onion growers sold their produce through wholesaler in other village. Custard apple growers expressed that commission agents deduct more commission, fluctuations in the market prices, difficulty in getting the documents for export purpose, prices are not according to the quality of fruits, and damage of fruits during transportation were the major marketing constraints (Yelpanekar *et.al.*, 2000). Onion growers expressed that open auction sale fetches low price for onion produce, low prices and fluctuation in market price, commission agents charge heavy commission, without involvement of middleman/ commission agents, it is very difficult to sell the onion produce in market, and malpractices adopted in market were the major problems in marketing of onion produce (Waman and Patil, 2000).

**Mode of transport of *aonla* fruits**

It was evident from table 2 that all the farmers used truck for transporting the *aonla* fruits to the market. It might be due to fast, and huge space. White onion growers had transported their produce from the storage place to the marketing place by bullock cart (Sadaphal *et.al.*, 2003).

**Type of packing of aonla fruits**

Table 3 indicated that the majority (47 per cent) of the farmers used wooden boxes for packing *aonla* fruits. Forty per cent of the farmers packed *aonla* fruits in gunny bags. It might be due to cheap, easy and local availability of wooden boxes and gunny bags. These packing materials caused bruising of fruits, leading to brown discoloration on the skin of the fruits within two hours. Even though the Corrugated Fibre Boxes (CFBs) were the best packing material, none of the farmers used it. It might be due to high cost, non-availability at local place.

**Source of information**

Table 4 revealed that the majority (40 per cent) of the farmers got the information regarding the price of aonla fruits from *mandi* agent. This might be due to cosmopoliteness of the farmers and they might be regularly visiting the *mandies* and contacted the *mandi* agent and got the first hand information on the prevailing price of aonla fruits.

Farmers sold the aonla fruits to pre-harvest contractor. Truck was used for transporting the *aonla* fruits to the market. Wooden boxes were used for packing *aonla* fruits. Farmers consulted *mandi* agent for market price of aonla fruits. The market of aonla had to be strengthened and the competition among different sectors that needed aonla as essential raw material of their products had to be manoeuvred in favour of the farmers. The electronic media like television channels, Internet and modern communication devices like cellular phones might be effectively used for delivering latest information about prevailing market prices at various markets. Farmers should be persuaded to pack the *aonla* fruits in the Corrugated Fibre Boxes (CFBs) which are best packing material with no bruising and no browning of fruits; easy for packing, handling, transport; attractive and preferred by the end users. CFBs should be made easily, locally available and at low cost affordable by the farmers.

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Cooperatives might be established to eliminate the middlemen. The farmers might be provided training about value addition of aonla fruits like preparation of pickles, *murraba*, mouth freshner, etc.

Table 1. Method of *aonla* marketing

| S.No. | Method | Farmers | |
|---|---|---|---|
| | | No. | Per cent |
| 1 | Self marketing through commission agent | 7 | 23.4 |
| 2 | Sale to pre-harvest contractor | 13 | 43.4 |
| 3 | Direct auctioning in the wholesale market/mandies | 10 | 33.4 |
| 4 | Sale to cooperative society | 0 | 0 |

Table 2. Mode of transport of *aonla* fruits

| S.No. | Mode | Farmers | |
|---|---|---|---|
| | | No. | Per cent |
| 1 | Truck | 30 | 100 |
| 2 | Cartload | 0 | 0 |
| 3 | Others | 0 | 0 |

Table 3. Type of packing of aonla fruits

| S.No. | Method | Farmers | |
|---|---|---|---|
| | | No. | Per cent |
| 1 | Basket | 0 | 0 |
| 2 | Wooden box | 14 | 46.7 |
| 3 | Wooden crate | 4 | 13.4 |
| 4 | Gunny bag | 12 | 40 |
| 5 | Loose loading in truck | 0 | 0 |
| 6 | CFB box | 0 | 0 |

Table 4. Source of information

| S.No. | Method | Farmers | |
|---|---|---|---|
| | | No. | Per cent |
| 1 | Mandi agent | 12 | 40 |
| 2 | Newspaper | 7 | 23.4 |
| 3 | Television | 4 | 13.4 |
| 4 | Market | 7 | 23.4 |

**References**


Sadaphal, S.S., Sawant, P.A. and Nirban, A.J. 2003. Storage and marketing practices of white onion followed by the white onion growers. *Maharashtra Journal of Extension Education*. 22(1):75-77.

Waman, G.K. and Patil, P.S. 2000. Production, storage and marketing constraints faced by onion growers. *Maharashtra Journal of Extension Education*. 19:104-108.

Yelpanekar, P. H., Sawant, G.K. and Rade, V.M. 2000. Factors associated with production and marketing of custard apple. *Maharashtra Journal of Extension Education*. 19:100-103.

Cooperatives might be established to eliminate the middlemen. The farmers might be provided training about value addition of aonla fruits like preparation of pickles, *murraba*, mouth freshner, etc.

Table 1. Method of *aonla* marketing

| S.No. | Method | Farmers | |
|---|---|---|---|
| | | No. | Per cent |
| 1 | Self marketing through commission agent | 7 | 23.4 |
| 2 | Sale to pre-harvest contractor | 13 | 43.4 |
| 3 | Direct auctioning in the wholesale market/mandies | 10 | 33.4 |
| 4 | Sale to cooperative society | 0 | 0 |

Table 2. Mode of transport of *aonla* fruits

| S.No. | Mode | Farmers | |
|---|---|---|---|
| | | No. | Per cent |
| 1 | Truck | 30 | 100 |
| 2 | Cartload | 0 | 0 |
| 3 | Others | 0 | 0 |

Table 3. Type of packing of aonla fruits

| S.No. | Method | Farmers | |
|---|---|---|---|
| | | No. | Per cent |
| 1 | Basket | 0 | 0 |
| 2 | Wooden box | 14 | 46.7 |
| 3 | Wooden crate | 4 | 13.4 |
| 4 | Gunny bag | 12 | 40 |
| 5 | Loose loading in truck | 0 | 0 |
| 6 | CFB box | 0 | 0 |

Table 4. Source of information

| S.No. | Method | Farmers | |
|---|---|---|---|
| | | No. | Per cent |
| 1 | Mandi agent | 12 | 40 |
| 2 | Newspaper | 7 | 23.4 |
| 3 | Television | 4 | 13.4 |
| 4 | Market | 7 | 23.4 |

**References**


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Waman, G.K. and Patil, P.S. 2000. Production, storage and marketing constraints faced by onion growers. *Maharashtra Journal of Extension Education.* 19:104-108.

Yelpanekar, P. H., Sawant, G.K. and Rade, V.M. 2000. Factors associated with production and marketing of custard apple. *Maharashtra Journal of Extension Education.* 19:100-103.