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NANDYAL GRAM 452 (NBEG 452), A HIGH YIELDING *DESI* CHICKPEA VARIETY FOR ANDHRA PRADESH

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ABSTRACT

Nandyal Gram 452 (NBeG 452), a high yielding *desi* chickpea cultivar developed by Regional Agricultural Research Station, ANGRAU, Nandyal was notified during October, 2020 for commercial cultivation in Andhra Pradesh state. The variety has a yield potential of 2500 kg ha^{-1} with a duration of 90 – 105 days. It is semi -spreading type with attractive pods and bold seeds having a test weight of 24-26 g and protein content of 20.5 %. This variety has gained attention of the farmers and it has potential to replace the old variety 'JG -11' and is expected to contribute for increase in chickpea productivity and net returns in farmers holdings.

Key words : Nandyal Gram 452, Seed yield, *Desi* chickpea

INTRODUCTION

Chickpea is the world's second most important food legumes; rich in protein (18%-22%) and also possesses fibre, vitamin B and minerals. India is the principal producer and consumer of chickpeas in the globe with cultivable area of 9.68 mha and 11.08 million tons of production and 1142 kg ha^{-1} productivity (AICRP on Chickpea, 2021). The crop is grown in almost all parts of the country, mostly as a rainfed crop. Madhya Pradesh is the sole largest maker with 40% of total production. Rajasthan, Maharashtra, Karnataka, Uttar Pradesh and Andhra Pradesh contribute to 13%, 12%, 11%, 5% and 6%, respectively. In southern states, Andhra Pradesh has witnessed chickpea revolution during the past decade. The chickpea area has increased from 1,46,000 ha in 1998-99 to 4,59,000 ha in 2019–2020. The major chickpea growing districts in Andhra Pradesh are Kurnool, Prakasam, Anantapur and Kadapa. Nearly 80% of the chickpea growing area of the state is in these four districts. Regional Agricultural Research Station, Nandyal, Kurnool district is the lead centre responsible for location specific research in scarce rain fall zone of Andhra Pradesh. The southern states of India are characterized by short and warm winters. Unlike traditional chickpea growing areas in the northern India, in case of southern states the duration of chickpea crop is short (90–120 days) and often suffers due to moisture stress. Crop

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improvement programmes at Regional Agricultural Research Station, Nandyal since 2004 have lead to the development of high yielding chickpea varieties with traits suitable for cultivation in Andhra Pradesh. Nandyal Gram - 452, the recently released cultivar is a high yielding wilt resistant variety notified for cultivation in Andhra Pradesh during 2020. A brief note on the development of the variety and its performance in yield trials and in farmers fields is discussed in this paper.

MATERIALS AND METHODS

NBeG-452 cultivar is a selection from a cross of ICCV 37 x ICC 12451 varieties. The cross was made at ICRISAT and advance breeding line was supplied to RARS, Nandyal. Advance breeding line obtained from this cross was evaluated at research station as per the standard protocol of Acharya N.G. Ranga Agricultural University. The female parent of the cross, ICCV 37 is the high yielding variety known as 'Kranti' released during 1989. It has a test weight of 18 g. The male parent 'ICC 12451' is a semi erect plant type with a yield potential of 20 q ha^{-1} and a test weight of 22 g. After its successful performance in station yield trials (2010-–12) and AICRP trials (2013–15) and also in Andhra Pradesh state multi-location trials (2014–16), it was also tested for three years in farmer's fields as minikits (2016–19).

RESULTS AND DISCUSSION

The first step in the evaluation of promising lines in research station are initial and advanced varietal trials. In these trials, NBeG 452 recorded 1539 kg ha^{-1} with a yield advantage of 19.0 % over the local check, JG - 11 (Table 1). Subsequently it was also tested in AICRP system during 2013–14. In AICRP trials of South Zone conducted at four locations, NBeG 452 recorded 1946 kg ha^{-1} of seed yield with yield advantage of 17.7 % over the check, JG 11 (1653 kg ha^{-1}). In AICRP trials of West Central Zone conducted at eight locations, the yield advantage (2127 kg ha^{-1}) recorded was almost same (17.2 %). In multi -location trials conducted in different districts of Andhra Pradesh during 2014-15 & 2015-16, this entry recorded yield superiority of 11.8 % and 18.5 %, respectively over the check JG 11. Furthermore, in AVT I (2014-15) of West Central Zone conducted at eight locations, NBeG 452 recorded 1694 kg ha^{-1} with a yield increase of 15.2 % over the check, JG 315 (1471 kg ha^{-1}). Verma *et al*. (2019) reported that NBeG 452 was the most stable genotype over environments and suitable for breeding medium bold genotypes.

Agronomy trials of AICRP on chickpea tested at 6 centers under normal dates of sowing with recommended fertilizer doses (20 kg N + 50 kg P_2O_5), NBeG 452 recorded (1344 kg ha^{-1}) 15.6% yield advantage against the check JG 315 (1163 kg ha^{-1}). This culture's response to nitrogen application (Table 2) @ 20 kg ha^{-1} (2205 kg ha^{-1}) and 40 kg/ha (2295 kg ha^{-1}) was on par

Table 2. Response of NBeG 452 to nitrogen application at RARS, Nandyal (2019-20)

Treatments	Seed yield (kg ha^{-1})	% increase over the check
N-level-3 (kg ha^{-1})		
N_0: 0	1844	—
N_1: 20	2205	19.6
N_2: 40	2299	24.7
S.Em+	63	
C.D. @ 5%	186	

Table 1. Performance of NBeG 452 in yield trials in research stations

Year	Centre	Seed yield (kg ha^{-1})		% increase over check
		NBeG 452	JG 11 (Ch) / JG 315 (Ch)	
2010 – 2011 (Station trial)	RARS, Nandyal	1292	1085	
2011 – 2012 (Station trial)	RARS, Nandyal	1785	1501	
	Mean	**1539**	**1293**	**19.0**
2013 – 2014 (AICRP trial- IVT-South Zone)	Gulbarga	1595	1325	
	Nandyal	1973	1513	
	Bijapur	1652	1979	
	Lam	2562	1798	
	Mean	**1946**	**1653**	**17.7**
2013 – 2014 (AICRP trial- IVT-West Central Zone)	Badnapur	2420	1626	
	Junagadh	1934	1356	
	Rahuri	2048	1930	
	Sehore	2741	1821	
	Kota	2222	1979	
	Indore	3099	2942	
	Akola	918	1277	
	Banswara	1635	1586	
	Mean	**2127**	**1815**	**17.2**
2014 – 2015 (Multi-location trials in Andhra Pradesh)	ARS, Tandur	2535	2474	
	ARS, Podalakur	1805	1515	
	ARS, Madhira	1581	1440	
	RARS, Nandyal	1957	1772	
	RARS, Lam	1890	1530	
	Mean	**1953**	**1746**	**11.8**
2015 – 2016 (Multi-location trials in Andhra Pradesh)	RARS, Nandyal	2066	2123	
	RARS, Lam	1974	1561	
	Mean	**2095**	**1768**	**18.5**
2014-15	Badnapur	1975	1392	
	Junagadh	1651	1367	

Table-1 Contd..

Table-1 Contd..

Year	Centre	Seed yield (kg ha^{-1})		% increase over check
		NBeG 452	JG 11 (Ch) / JG 315 (Ch)	
(AICRP trial-AVT I– West Central Zone)	Rahuri	2497	1969	
	Sehore	1380	1916	
	Kota	**1500**	**1151**	
	Indore	1914	1719	
	Akola	963	864	
	Banswara	1671	1390	
	Mean	**1694**	**1471**	**15.2**
2015 – 2016 AICRP Agronomy trial- Normal date of sowing with recommended N and P levels (20 kg N +50 kg P_2O_5)	Junagadh	1022	1023	
	Rahuri	1694	1416	
	Akola	1087	1300	
	Badnapur	782	849	
	Kota	1740	1361	
	Sehore	1740	1027	
	Mean	**1344**	**1163**	**15.6**

Table 3. Performance of NBeG 452 in farmer's holdings (Minikits and On-farm trials)

S.No.	Year	Testing Centre	Seed yield (kg ha^{-1})		%increase over check
			NBeG 452	Localcheck	
1	2016 – 2017 Minikit – Ist year	Kurnool, Prakasam and Kadapa districts	1446 + 226	1203 + 235	20.0
2	2017– 2018 Minikit – Ist year	Kurnool, Ananthapuram and Kadapa districts	1473 + 75	1300 + 66	13.3
3	2018 – 2019 Minikit – Ist year	Kurnool, Prakasam, Ananthapuramu, Kadapa and Guntur districts	1237 + 210	1075 + 164	15.1
4	2017 – 2018 On Farm trial	Kurnool and Ananthapuramu districts	1433 + 49	1245 + 46	15.1
5	2018 – 2019 On Farm trial	Kurnool, Prakasam, Ananthapuramu, Kadapa and Guntur districts	1358 + 91	1178 + 77	15.3

Table 4. Ancillary and Nutritional parameters of NBeG - 452

Ancillary traits	NBeG 452	JG 11	Nutritional traits	NBeG 452	JG 11
Days to 50 % flowering	46	45	Dal recovery (g $kg^{-1)}$	740	748
Days to maturity	95	98	Broken dal (g kg^{-1})	81	52
100 seed weight (g)	26.1	22.0	Broken dal with seed coat (g kg^{-1})	79	43
No.of pods/plant	50.6	45.0	Husk (g kg^{-1})	100	157
			Dal recovery (%)	74	74.8
			Protein content (%)	20.5	20.0

Table 5. Reaction of NBeG-452 to major pests and diseases

Entry	Dry Root Rot (%)			*Fusarium* wilt (%)	*Helicoverpa* pod damage (%)	
	2013–14	2014–15	2015–16	2013–14	2014–15	2015–16
NBeG 452	2.38	22.9	1.30	10.2	19.1	5.80
Susceptible check	19.75 (L 550)	92.9 (L 550)	26.60 (L 550)	85.3 (JG 62)	33.0 (ICCV 3137)	28.4 (ICCV 3137)
Resistant / Tolerant check	2.19 (JG 315)	78.0 (JG 315)	15.20 (JG 315)	3.70 (JG 315)	16.6 (ICCL 86111)	6.0 (ICCL 86111)

Table 6. DNA fingerprinting of NBeG-452 and other popular varieties of chickpea

Marker	Parents of NBeG 452		Proposed variety	Popular varieties				
	ICC12451	ICCC37	NBeG 452	JAKI9218	JG 11	NBeG3	NBeG 47	NBeG 49
ICCM0249	160	160	160	160	160	191	160	191
CASTMS11	229	229	229	229	229	229	231	229
NCPGR127	222	218	218	218	218	216	218	216
NCPGR21	164	143	147	147	147	149	149	149
GA24	200	200	200	200	200	200	202	200
TAA170	275	272	281	265	281	259	259	259
TR11	183	183	183	183	-	213	183	213

and significantly superior to no nitrogen application (1844 kg ha^{-1}). After its consistent superior performance in all the yield trials over the popular checks, it was proposed for minikit testing in different chickpea growing areas of Andhra Pradesh. Minikit testing of NBeG 452 in farmer's holdings recorded 20.0%, 13.3% and 15.1% superiority over the popular check, JG 11 during 2016-17, 2017-18 and to 2018-19, respectively. In large-scale demonstrations conducted during 2017-19 in farmer's holdings, its superiority was clearly evident as this entry recorded 1433 kg ha^{-1} and 1358 kg ha^{-1} seed yield which is 15.1% and 15.3% higher than the popular varieties grown by the farmers (Table 3).

Data on its ancillary characters (Table 4) over locations revealed that it has a test weight of 26 g and matures in 95 days with an average of 50 pods per plant. It nutritional traits are also encouraging with low husk (100 g), good dal recovery (74%) on par with check variety (74.8%) and got attractive bold seeds with 20.5 % protein content. NBeG 452 is moderately resistant to *Fusarium* wilt (Table 5) and recorded significantly less dry root rot incidence and comparable in its performance with resistant check. It is also on par with tolerant check in its reaction to pod borer (*Helicoverpa armigera*).

DNA fingerprinting data (Table 6) for NBeG -452 genotype was generated at ICRISAT using seven SSR markers along with its parents (ICC12451 and ICCCV 37) and five popular cultivars (JG 11, JAKI 9218, NBeG 3, NBeG 47 and NBeG 49) grown in Southern India. Three markers (NCPGR127, NCPGR21 and TAA170) were found polymorphic between the parents and two markers (ICCM0249 and NCPGR127) could differentiate NBeG 452 from other popular cultivars, NBeG- 3 and NBeG- 49. At least one marker was found polymorphic between NBeG 452 and the other popular varieties evaluated.

The line NBeG- 452 has been assigned with national identity, IC633789 by ICAR-NBPGR, New Delhi. The Central Sub Committee on Crop Standards, Notification and Release of Varieties has also notified this variety on 10 th July, 2020 and the gazette notification of the Govt.of India published on 7 th October, 2020 as S.O 3482 (E). Regional Agricultural Research Station, Nandyal centre has also sufficient stock seed and will be scaled up in the seed chain system in near future to fulfill the huge demand from farmers.

CONCLUSION

In Andhra Pradesh, more than 80 % of the chickpea cultivation is saturated with age-old short duration *desi* varieties JG 11 and JAKI 9218 and the development of Nandyal Gram - 452 (NBeG - 452) is a landmark in chickpea cultivation which is recommended as a better alternative to JG 11 and other *desi* varieties grown by farmers of Andhra Pradesh. It is a semi spreading type with medium plant height with a yield potential of 2500 kg ha^{-1} recommended for cultivation as a rainfed crop and can also be grown with one or two irrigations in all the chickpea growing districts of Andhra Pradesh.

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YIELD PERFORMANCE AND ECONOMICS OF CLUSTER BEAN AS INFLUENCED BY WEED CONTROL MEASURES UNDER RAINFED CONDITIONS

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ABSTRACT

The field experiment was conducted to find out the effect of weed management practices on yield performance and economy of clusterbean (*Cyamopsis tetragonoloba*) under rainfed conditions during rainy season of *Kharif,* 2015-16.The results revealed that weed density, dry weight and weed control efficiency were not significantly ($p > 0.05$) influenced by different weed management practices. The lowest weed density, dry weight and highest weed control efficiency were recorded with hand weeding twice at 20 DAS and 40 days after sowing (DAS) (weed-free check) although the result is not significant. However,seed yield varied significantly due to different weed management practices. The highest seed yield (477 kg ha^{-1}) was obtained with hand weeding twice at 20 DAS and 40 DAS which was on par with post-emergence (POST) of imazethapyrat 40 g a.i ha^{-1} at 20 DAS (465 kg ha^{-1}), pre-emergence (PRE) application of pendimethalin at 0.75 kg a.i ha^{-1}+ imazethapyrPOST at 40 g a.i ha^{-1} at 20 DAS (437 kg ha^{-1}) and pendimethalin PRE @ 0.75 kg a.i ha^{-1}+ quizalofopethyl POST @ 37.5 g a.iha^{-1} at 20 DAS (411 kg ha^{-1}). The higher gross (Rs. 14296 ha^{-1}) and net returns (Rs. 9196 ha^{-1}) were obtained with hand weeding twice at 20 DAS and 40 DAS followed by imazethapyr POST @ 40 g a.i ha^{-1} at 20 DAS. The highest benefit-cost ratio was registered with hand weeding at 20 DAS (0.69) followed by weedy check (0.62) and hand weeding twice at 20 DASand 40 DAS (0.60).

INTRODUCTION

Ananthapuramu is the second most drought - affected district of India (NRAA, 2020), it receives an annual rainfall of 500 mm. The location is been considered as a rain shadow region of south-west or north-east monsoon. After seeing great revenues with clusterbean during previous years by Rajasthan farmers, farmers in Ananthapuram, Guntur, Kurnool, Karimnagar, Nellore, Prakasam and Ranga Reddy districts of undivided Andhra Pradesh state have also started the cultivation of clusterbean for seed in more than 1000 ha(Annual Report, 2013). Being a rainfed crop, severe weed infestation leading to competition for water and nutrients was one of the major constraints for sustained higher productivity of cluster bean. Among the different weed management practices,

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handweeding is a traditional and effective option but labour scarcity at a critical time for weed competition and higher labour costs impose major limitations on the economic feasibility of manual weeding. The only recommended herbicide for clusterbean in this region is pendimethalin PRE, however, PRE herbicide is being skipped due to one or the other reasons and there is no recommendation for post emergent herbicide. As the information on suitable POST and combination of PRE and POST herbicides for clusterbean is meagre for higher yield and economics. Therefore, a study was initiated to find out suitable pre and post emergence herbicide for clusterbean crop.

MATERIAL AND METHODS

The field experiment was conducted during rainy season (*kharif*), 2015-16 at Agricultural Research Station, Ananthapuramu, Andhra Pradesh. The experiment was laid out in a randomized block design and replicated thrice. The treatments consisted of weedy check (No weeding, T1), hand weeding at 20 days after sowing (T2), hand weeding twice at 20 DAS and 40 DAS (weed-free check, T3), pendimethalin (pre-emergence, PRE) at 0.75 kg a.i ha^{-1} (T4), Imazethapyr (post emergence,POST) at 40 kg a.i ha^{-1} at 20 DAS (T5), quizalofopethyl POST at 37.5 g a.i ha^{-1} at 20 DAS (T6), imazethapyr + imazamox POST at 40 g a.i ha^{-1} at 20 DAS (T7), pendimethalin at 0.75 kg a.i ha^{-1} as pre emergence followed by hand weeding at 20 DAS (T8), pendimethalin PRE at 0.75 kg a.i ha^{-1} folowed by Imazethapyr POST at 40 g a.i ha^{-1} at 20 DAS (T9), pendimethalin PRE at 0.75 kg a.i ha^{-1} followed by quizalofop ethyl POST at 37.5 g a.i ha^{-1} at 20 DAS (T10), pendimethalin PRE at 0.75 kg a.i ha^{-1} followed by Imazethapyr + Imazamox POST at 40 g a.i ha^{-1} at 20 DAS (T11). As per the treatments, herbicides were applied by using foot sprayer. The field was prepared by passing a tractor drawn disc plough twice followed by tractor- drawn cultivator twice to get the fine seed bed. Clusterbean seed (var. RGC 1025) with 95% germination was used for sowing. The fertilizers (N, P_2O_5 and K_2O) were applied at the time of sowing through urea, single super phosphate and muriate of potash, respectively. At harvest, five plants were randomly selected for recording growth parameters such as plant height, number of pods per plant, number of seeds per pod and test weight. The grain and haulm yield from the net plot (5 m x 5 m) area of each treatment was recorded and expressed in kg ha^{-1}. Weed biomass was sampled at 30 DAS and 60 DAS using a random quadrant of 0.5 x0.5 m.Plantmaterialwasdried at 65^{o}Cf or 72h before determining dry weight.

RESULTS AND DISCUSSION

Weed density, dry weight and weed control efficiency were not significantly influenced by different weed management practices (Table 1). The lowest weed density, dry weight and highest weed control efficiency were recorded with hand weeding twice at 20 DAS and 40 DAS (weed-free check) compared to all other treatments.These results were in agreement with Godara and Ravindra Singh (2015) findings who reported that weed-free check recorded significantly higher reduction in weed dry weight at 30 DAS and at harvest than other treatments but statistically at par with the application of imazethapyr POST (20 DAS) at 40 g or 60 g and pendimethal in PRE 1 kg ha^{-1} + one manual weeding at 30 DAS.

Table 1. Weed density, weed dry weight and WCE in clusterbean as influenced by weed management practices

Treatments	Weed density (no./m2)		Weed dry weight (g/m2)		WCE (%)	
	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
T1: Weedy check (No weeding)	25.0	41.7	9.8	16.1	0.0	0.0
T2: HW at 20 DAS	13.6	21.8	4.4	7.7	55.1	52.2
T3: HW at 20 DAS and 40 DAS (Weed free check)	7.1	12.3	1.2	3.6	87.7	77.6
T4: Pendimethalin @ 0.75 kg a.i ha^{-1} as pre	21.5	31.4	7.7	8.6	21.4	46.6
T5: Imazethapyr @ 40 g a.i ha^{-1} as post at 20 DAS	10.7	17.7	3.8	6.3	61.2	61.1
T6: Quizalofopethyl @ 37.5 g a.i ha^{-1} as post at 20 DAS	17.8	32.8	5.8	8.5	40.8	47.2
T7: Imazethapyr + Imazamox @ 40 g a.i ha^{-1} as post at 20 DAS	17.3	27.8	5.7	7.7	41.8	52.2
T8: T4 + HW at 20 DAS	12.7	22.3	4.8	6.7	51.0	58.3
T9: T4 + T5	11.6	16.4	2.7	4.1	72.4	74.3
T10: T4 + T6	24.5	32.8	5.1	9.2	47.9	42.8
T11: T4 + T7	11.9	15.3	2.4	3.8	75.5	76.4
CV	61.9	40.5	74.7	42.1	-	-
S.Em+	6.15	6.18	2.42	1.69	-	-
CD at 5%	NS	NS	NS	NS	-	-

WCE: Weed Control Efficiency

Plant height of clusterbean measured at harvest was not significantly influenced by different weed management practices though the highest plant height was noticed with hand weeding at 20 DAS and hand weeding twice at 20 DAS and 40 DAS (weed-free check).These results were in contradictory with the findings of Singh *et al.* (2016) who reported that application of imazethapyr + imazamox POST (at 20 DAS, 3-4 leaf stage) 40 g ha^{-1} and imazethapyr POST at 40 g ha^{-1} and pendimethalin PRE 0.75 kg ha^{-1} significantly increased the plant height in clusterbean.

Number of pods per plant varied significantly for different weed management practices. The highest number of pods per plant was obtained

Table 2. Growth, yield attributes and yield of clusterbean as influenced by weed management practices

Treatments	Plant height (cm)	Number of pods per plant	Number of seeds per pod	Test weight (g)	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})
T1: Weedy check (No weeding)	20.5	9.1	5.7	32.8	294	601
T2: HW at 20 DAS	25.3	10.1	6.6	33.9	385	684
T3: HW at 20 & 40 DAS (Weed-free check)	25.3	15.7	7.0	37.3	477	988
T4: Pendimethalin @ 0.75 kg a.i ha^{-1}as pre	21.9	9.9	5.9	34.8	350	555
T5: Imazethapyr @ 40 g a.i ha^{-1}as post at 20 DAS	24.7	14.7	6.7	35.2	465	867
T6: Quizalofopethyl @	22.3	10.4	6.2	33.1	328	603
37.5 g a.i ha^{-1} as post at 20 DAS						
T7: Imazethapyr + Imazamox @ 40 g a.i ha^{-1} as post at 20 DAS	25.1	11.2	5.8	31.7	331	810
T8: T4 + HW at 20 DAS	22.7	11.3	6.0	31.3	386	758
T9: T4 + T5	24.4	13.3	6.7	34.9	437	854
T10: T4 + T6	20.7	10.1	6.5	32.6	382	685
T11: T4 + T7	25.0	13.9	6.6	34.8	411	841
CV	16.9	16.5	9.1	16.2	14.8	35.4
S.Em+	2.24	1.15	0.33	2.7	32.9	153.3
CD at 5%	NS	3.43	NS	NS	97.8	NS

with hand weeding at 20 DAS which was on par with imazethapyr POST at 40 g a.i ha^{-1} at 20 DAS, pendimethalin PRE at 0.75 kg a.i ha^{-1}, imazethapyr + imazamox POST at 40 g a.i ha^{-1} at 20 DAS, pendimethalin PRE at 0.75 kg a.i ha^{-1}+ imazethapyr POST at 40 g a.i ha^{-1} at 20 DAS. Number of seeds per pod and test weight did not vary significantly due to adopted weed management practices.However, the highest number of seeds per pod and test weight were recorded withhand weeding twice at 20 DAS and 40 DAS (weed-free check).These results were in conformity with Godara and Ravindra Singh (2015) who noticed that the highest yield attributes, *viz.,* pods/plant, number of seeds/ pod, and test weight were recorded in weed-free check but statistically at par with other tested herbicide treatments.The results

Table 3. Gross, net returns and B:C ratio of clusterbean as influenced by weed management practices

Treatments	Cost of cultivation (Rs.ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B:C ratio
T1: Weedy check (No weeding)	9300	8832	5732	0.62
T2: HW at 20 DAS	11300	11540	7774	0.69
T3: HW at 20 & 40 DAS (Weed free check)	15300	14296	9196	0.60
T4: Pendimethalin @ 0.75 kg a.i ha^{-1} as pre	16462	10490	5003	0.30
T5: Imazethapyr @ 40 g a.i ha^{-1} as post at 20 DAS	17038	13955	8276	0.49
T6: Quizalofopethyl @ 37.5 g a.i ha^{-1} as post at 20 DAS	18352	9831	3714	0.20
T7: Imazethapyr + Imazamox @ 40 g a.i ha^{-1} as post at 20 DAS	19410	9925	3455	0.18
T8: T4 + HW at 20 DAS	22572	11572	4048	0.18
T9: T4 + T5	24310	13097	4993	0.21
T10: T4 + T6	26786	11454	2526	0.09
T11: T4 + T7	29006	12344	2675	0.09
S.Em+	-	-	-	-
CD at 5%	-	-	-	-

corroborated with the findings of Hemraj Dhaker *et al*. (2009) and Singh *et al*. (2006).

Seed yield varied significantly due to adopted weed management practices. The highest seed yield was obtained with hand weeding twice at 20 DAS and 40 DAS (T3) which was on par with imazethapyr POST at 40 g a.i ha^{-1} at 20 DAS (T5), pendimethalin PRE at 0.75 kg a.i ha^{-1}+ imazethapyr POST at 40 g a.i ha^{-1} at 20 DAS (T9), pendimethalin pre at 0.75 kg a.i ha^{-1}+ quizalofopethyl POST at 37.5 g a.i ha^{-1} at 20 DAS (T10) (Table 2).The haulm yield was not significantly varied due to weed management practices. However, highest haulm yield was recorded with hand weeding twice at 20 DAS and 40 DAS (weed-free check). These results were in agreement with Godara and Ravindra Singh (2015) who reported that weed-free check recorded the highest seed and haulm yield but these were statistically at par with imazethapyr 40 g ha^{-1} or 60 g ha^{-1} at 20 DAS and pendimethalin PRE kg ha^{-1} + one hand weeding, revealing that these weed control options were equally effective for higher productivity of clusterbean.

Higher gross and net returns were obtained with hand weeding twice at 20 DAS and 40 DAS followed by imazethapyr POST at 40 g a.i ha^{-1} at 20 DAS (Table 3). The highest benefit-cost ratio was registered with hand weeding at 20 DAS followed by weedy check. This might be due to higher weed control efficiency and higher seed and haulm yield under weed-free check.

CONCLUSION

Hand weeding twice at 20 DAS and 40 DAS or imazethapyrPOST 40 g $a.iha^{-1}$ at 20 DAS is recommended for better weed control and to obtain higher net returns in clusterbean in rainfed areas of Andhra Pradesh.

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STABILITY ANALYSIS FOR YIELD AND RELATED TRAITS IN PEARL MILLET (*Pennisetum glaucum* (L.) R. Br.) HYBRIDS

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ABSTRACT

Stability analysis for thirty-three pearl millet genotypes and two checks was carried out in three different environments during 2018-2019. G × E interaction was estimated using Eberhart and Russell model and genotype-grouping method. The ANOVA revealed significant effect of environments on the performance of hybrids for the three traits taken. Among the hybrids, AUBH-15 showed stable performance for grain yield per plant as it had high mean, non-significant deviation from regression (S^2di), regression around unity and low co-efficient of variation, hence, this hybrid can be recommended for commercial cultivation. The hybrids which were identified as stable for other attributing traits by regression model could not be confirmed by the grouping technique. Thus, the recommendation was given based on the grain yield per plant, the most important economic trait. The study must be extended to more diverse testing sites to obtain more robust information on the environment effect.

Keywords: G × E interaction, Eberhart and Russell, Genotype-grouping

INTRODUCTION

Pearl millet (*Pennisetum glaucum* L. R. Br.) also known as bajra, is a diploid (2n= 2x= 14) belongs to the family Poaceae (Gramineae) and genus Pennisetum. It is a C4 annual cereal crop with wide adaptability, high photosynthetic efficiency and dry matter production. It is a cross pollinated crop and endowed with a rich reservoir of genetic variability for various yield components, adaptation and quality traits (Berwal and Khairwal, 1997).

In India, pearl millet is grown in 7.38 million ha with an average production of 9.13 million tonnes and productivity of 1237 kg ha^{-1} during 2017-2018 (Source: Directorate of Millets Development, 2019; Project Coordinator Review, 2019). In India, Rajasthan occupies first place with an area of 4.24 million ha and 3.75 million tonnes of production; while, Madhya Pradesh ranks second in yield with 2435 kg ha^{-1} of productivity.

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A desirable cultivar is one that does not only yield well in its area of initial selection, but also maintains the high yielding ability over a wide range of environments within its intended area of production. G × E interaction is done for the difference in genotype to the changes in the additive environment. Genotype × Environment (GE) interaction is extremely important in the development and evaluation of plant varieties, because they reduce the genotypic stability. values under diverse environments (Herbert *et al.,* 1995). Interaction between G × E has an important impact on the improvement of varieties (Allard and Bradshaw, 1964). Eberhart and Russell (1966) considered a stable genotype to have a slope equal to unity and deviation from regression equal to zero. This approach has been extensively used by several breeders (Virk *et al.,* 1985) emphasizing that linear regression should be regarded as a measure of the response of a particular genotype, whereas, deviation from regression should be considered as a measure of stability of genotype with the lowest deviation being the most stable. Therefore, the objective of the study is to evaluate stability among the hybrids for yield and its attributing characters in varying environments.

MATERIALS AND METHODS

The experimental material consisted of 33 pearl millet hybrids (G_1 to G_{33}) obtained from the Plant Breeding Farm, Department of Genetics and Plant Breeding, Annamalai University. Two commercial hybrids (86M89 and MBH 160) were used as checks. Those genotypes were raised in three different environments *viz.,* Sathyamangalam (E1) (11.4548°N; 77.4365°E); Gobichetti-palayam (E2) (11.3028°N; 76.9383°E) and Mettupalayam (E3) (11.5034°N; 77.2444°E) in October, 2018. The soil was red sandy with pH of 6.92, 6.85, 6.73 and EC of 1.08, 0.85 and 1.02 for the three locations, respectively. The NPK content varied from medium to high for the locations. The average temperatures recorded were 27.02°C, 27.6°C, 26.9°C and rainfall was 824 mm, 720 mm and 751 mm, respectively for the three locations. Thirty-three hybrids with two checks were sown at the rate of one seed per hole in a single row of 5 meter length with intra row spacing of 15 cm x 60 cm. The experiments were laid out in Randomized Block Design (RBD) and replicated thrice. For each hybrid, a total of 15 plants per replication were maintained.

Standard agronomic practices were followed for raising and maintenance of plants. Five plants were randomly selected from each replication for observation of three quantitative traits *viz.,* number of tillers, panicle length (cm) and grain yield per plant (g). Eberhart and Russell (1966) model was used to study the stability of genotypes under varying environments.

RESULTS AND DISCUSSION

The analysis of variance for Eberhart and Russell model revealed significant differences for the characters, which indicated the presence of genetic variability for all the parameters (Table 1). Mean squares for genotype × environment (G × E) were found significant for the traits indicating that the hybrids showed differential response in varying environments. Significant G × E interactions were also mentioned by Shinde *et al*. (2002), Chikurte *et al*. (2003), Yahaya *et al*. (2006) and Dadarwal *et al*. (2018) in pearl millet.

The variance due to E + (G × E) which was highly significant for all the traits against pooled

error showed distinct nature of locations and G × E interactions in the phenotypic expression of hybrids. The environment (linear) variance was significant for all the characters indicating that the linear responses of genotypes to environment differed significantly for the said characters. This could be due to variations in weather and soil conditions of different locations as also reported by Dhuppe *et al*. (2017). As the genotype × environment interaction was found significant as it was partitioned into linear and non-linear components (Eberhart and Russell, 1966). The linear component of G × E interaction was significant for all the characters, which revealed linear response of genotype to environmental variations. Similar results were given by Patil *et al*. (2014), Pabale and Pandya (2010), Ezeaku *et al*. (2014) and Ishaq and Meseka (2014). However, relative magnitude of linear component of G × E interaction was higher than non-linear component except for panicle length. The findings are in line with those of Anarase *et al*. (2002). Pooled deviation was found significant for all the characters, which revealed non-predictable performance of hybrids across the environments. Similar results were reported by Pabale and Pandya (2010), Ezeaku *et al*. (2014) and Chikurte *et al*. (2003).

In case of number of tillers, the hybrids G4, G9, G10, G11 and G12 showed higher mean than the general mean with non-significant deviation from deviation (S2di) with regression coefficient value greater than one indicating below average stability of hybrids in favourable conditions. The hybrids G2, G5, G14 and G20 exhibited above average stability in poor environments as they had higher mean value than the general mean with non-significant deviation from regression (S^2di) and regression coefficient less than one. The hybrid G27 showed wider adaptability over environments as they had high mean value with non-significant deviation from regression (S^2di) and regression coefficient close to unity (Table 2). Similar results were reported by Karale *et al.* (1997) in pearl millet.

In case of panicle length, the hybrids G5, G8, G9 and G33 showed below average stability in favourable environments as they had high mean with non-significant deviation from regression and regression coefficient more than unity. G6, G7 and G25 showed above average stability in poor environments as they had higher mean value than the general mean with non-significant deviation from regression and regression coefficient less than one. The hybrid G23 had higher mean than grand mean with non-significant deviation from regression and regression coefficient as around unity indicating its average stability across the environments for this character (Table 2).

Hybrids G5, G16 and G33 showed below average stability for grain yield in favourable environments as they had higher mean value with non-significant deviation from regression and more than unity regression coefficient value. The hybrids G4, G26 and G31 had higher mean with non-significant deviation from regression and regression coefficient less than unity indicating above average stability in poor environments. The hybrid G15 recorded average stability across the environments as it had higher mean value than general mean and non-significant deviation from regression and regression coefficient around unity (Table 2). Earlier studies of Yahaya *et al.* (2006), Munawwar *et al.* (2007), Patil *et al.* (2014) and

Table 1. Analysis of variance for Ebernart and Russel model

Source	df	MSS		
		No. of tillers per plant	Panicle length (cm)	Grain yield per plant (g)
Genotypes	34	5.37**	18.48**	1430.26**
Environment	2	32.6**	227.46**	1134.22**
G × E	68	4.18**	6.35**	461.28**
E+ G × E	70	6.27**	12.66**	451.94**
Environment	1	6.52**	454.92**	1268.44**
(Linear) Genotype	34	5.18**	4.98**	495.24**
Environment Pooled	35	3.17*	7.49**	415.11**
(Linear) Deviation Pooled error	204	2.12	0.93	97.33

* Significant at 5% level; ** Significant at 1% level; MSS- mean sum of squares; df- degrees of freedom; G ×E : genotype × environment

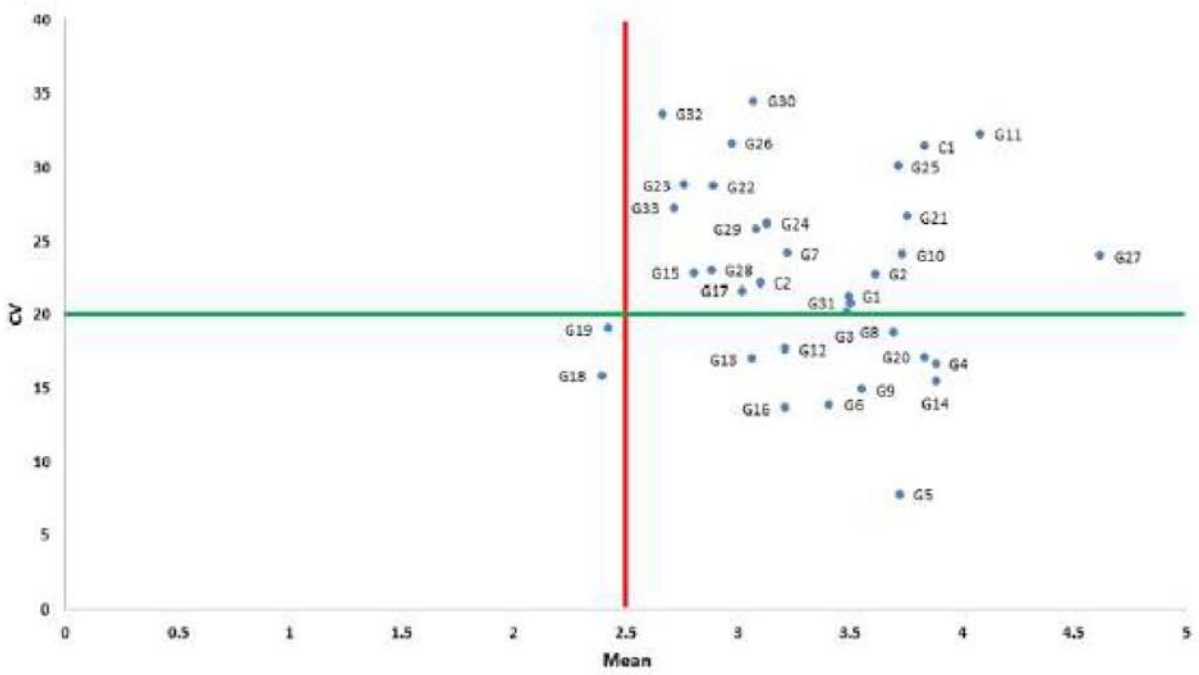

Fig. 1. Genotype grouping technique for number of tillers

Table 2. Stability parameters for number of tillers, panicle length (cm) and grain yield per plant (g)

Genotypes	No. of tillers/plant			Panicle length			Grain yield per plant		
	Mean	bi	2Sdi	Mean	b_i	S^2di	Mean	b_i	S^2di
G_1	3.49	1.83	-0.10	28.37	0.92	-0.67	112.33	8.14	27.45
G_2	3.61	0.72	0.03	28.32	1.51	0.99	119.33	10.44	**660.86****
G_3	3.48	-0.86	**0.56***	27.75	0.92	-0.34	126.33	0.77	**989.59****
G_4	**3.88****	1.28	-0.10	29.12	2.52	2.10	**147.33***	-1.48	105.40
G_5	**3.72***	0.23	-0.11	**31.23***	1.24	-0.56	**146.78***	12.23	90.85
G_6	3.41	0.09	-0.09	**30.86***	0.60	2.32	138.67	2.96	105.46
G_7	3.22	2.34	0.12	30.65	0.84	-0.52	90.22	-7.82	25.10
G_8	**3.69***	**1.89***	-0.12	**31.03***	1.57	-0.53	**184.55****	-10.84	**1045.88****
G_9	3.55	1.41	-0.01	**34.34****	1.56	-0.65	112.22	5.31	-20.52
G_{10}	3.73	1.46	-0.12	26.35	**1.82***	-0.92	143.11	1.45	-50.16
G_{11}	**4.08****	2.78	0.02	24.18	1.39	-0.91	107.33	-8.81	157.47
G_{12}	3.21	1.53	-0.08	26.17	0.91	-0.89	130.89	0.80	2.47
G_{13}	3.06	-0.13	-0.11	28.94	1.24	-0.84	144.78	4.63	56.34
G_{14}	**3.88****	0.26	-0.01	28.27	1.32	-0.86	**150.22***	4.62	**895.42****
G_{15}	2.80	**-0.43***	-0.12	29.81	1.81	-0.64	**148.00***	0.97	274.90
G_{16}	3.21	0.34	0.04	25.31	1.25	**5.97****	**164.44****	8.79	180.67
G_{17}	3.02	0.76	0.09	28.44	**0.27***	-0.92	121.67	-4.62	-79.23
G_{18}	2.39	-0.09	-0.11	25.11	0.68	-0.52	142.00	8.35	**779.83****
G_{19}	2.42	0.01	-0.07	26.99	0.71	0.09	**174.56****	20.15	**637.87****
G_{20}	**3.83***	0.87	0.11	26.66	0.08	**104.62****	128.00	**-3.37***	-96.45
G_{21}	**3.75***	**1.55***	-0.12	28.95	-0.24	**15.64****	**146.89***	-1.29	**355.99***
G_{22}	2.89	**2.23***	-0.12	**31.19***	0.95	**6.65****	115.66	4.92	-80.05
G_{23}	2.76	2.37	-0.11	**32.42****	0.97	-0.66	143.89	3.49	-57.12
G_{24}	3.13	0.59	**0.63***	29.20	0.77	-0.34	117.44	6.44	131.22
G_{25}	**3.71***	**-0.76***	-0.12	**31.56****	0.87	-0.53	114.67	-0.31	-81.85
G_{26}	2.97	2.26	-0.04	30.69	0.67	**8.06****	**150.22***	-4.35	-28.68
G_{27}	**4.61****	1.05	0.14	**32.92****	2.15	**33.39****	107.67	-12.28	**2715.95****
G_{28}	2.88	-0.67	-0.06	30.52	1.66	**34.92****	122.78	-6.83	68.61
G_{29}	3.08	1.06	-0.06	26.46	0.52	0.92	115.55	-4.79	**314.98***
G_{30}	3.07	2.88	0.12	25.06	0.79	**3.78***	120.22	22.12	210.61
G_{31}	3.50	1.25	-0.08	**30.84***	**0.78***	-0.93	**160.00****	-9.01	34.19
G_{32}	2.66	1.04	**0.84****	29.76	0.32	**20.73****	87.78	-3.24	287.33
G_{33}	2.71	0.71	0.32	**33.09****	1.36	0.53	**169.00****	1.83	-92.26
C_1	**3.83***	1.66	**0.56***	29.22	0.46	0.30	139.89	-7.53	**1201.93****
C_2	3.10	1.46	-0.00	29.66	-0.27	1.03	126.11	-4.19	**352.46***
Population	3.08			29.13			129.16		
Mean ± SE	0.21			0.58			5.92		

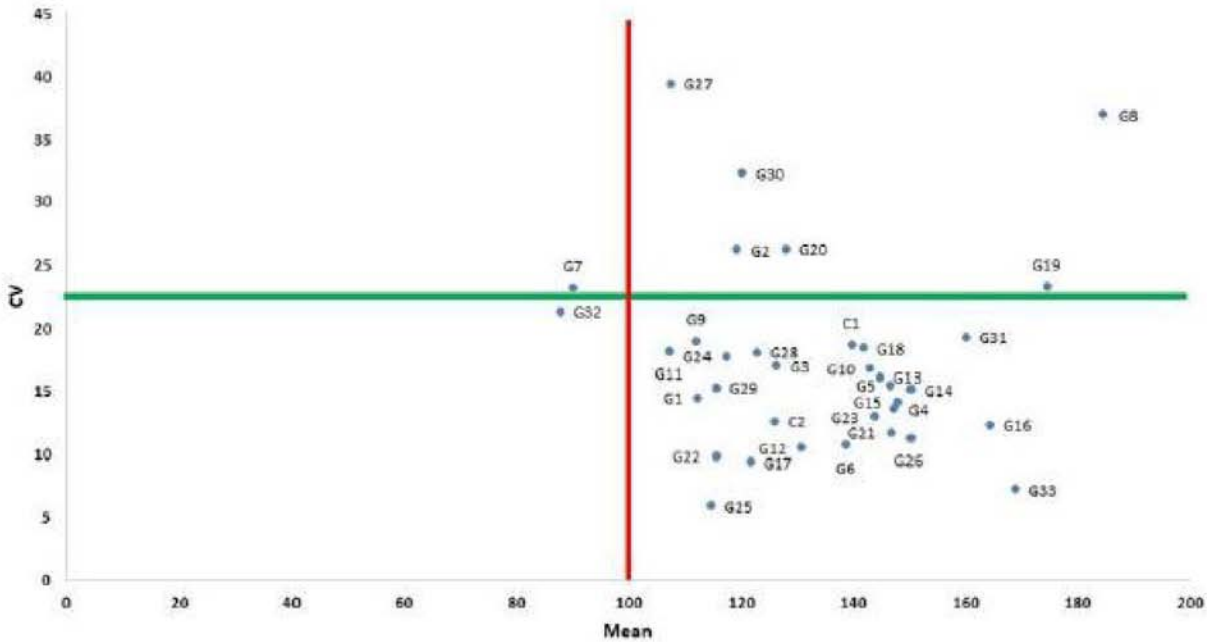

Fig. 2. Genotype grouping technique for panicle length

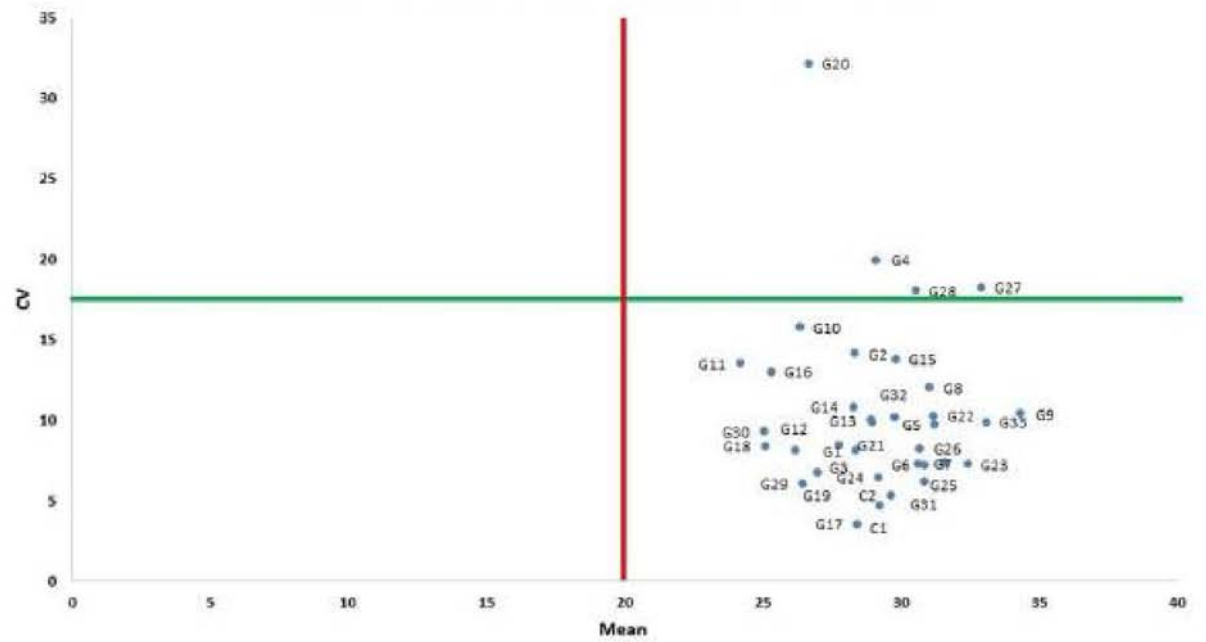

Fig. 3. Genotype grouping technique for grain yield per plant

Ezeaku *et al.* (2014) also reported findings which are in agreement with this study for grain yield per plant in pearl millet.

Thirty- five genotypes were categorized into four groups using genotype grouping technique (Fig. 1 to Fig. 3). Based on grain yield per plant, the hybrids G9 and G15 were considered as stable hybrids. The hybrids G1, G15 and G33 were placed in group I for panicle length and number of tillers. The hybrids falling under group II, III and IV are not discussed in this paper as they indicated differential and unpredictable response in various environments (Nirmal Raj, 2018).

CONCLUSION

According to Eberhart and Russell model, the hybrid AUBH-15 (G15) is the most stable hybrid across environments for grain yield per plant, which was also labeled as a stable hybrid in grouping technique. Though this hybrid was not stable for other two attributing traits, it can be recommended for commercial cultivation. The hybrid AUBH-33 (G33) was found to be stable under favourable conditions, whereas, the hybrid AUBH-31 could perform better in unfavourable condition. The preferential response of these hybrids could not be confirmed in genotype-grouping technique. Based on these results the future breeding strategy must be focused on more multi-location trials for identifying robust stable hybrids.

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PREVALENCE OF BACTERIAL LOADS ON SOME FRESH VEGETABLES SOLD IN LOCAL MARKET OF BHOPAL

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ABSTRACT

Vegetables are nutritious, sources of vitamins, minerals, fibres and these are part of our daily diet. However, main problem is quality of fresh vegetables available in the markets. It is important to detect and identify the microbial flora especially enteropathogens associated with fresh vegetables. Microbial analysis was performed on five different types of vegetable samples *viz.,* egg plant (brinjal) (*Solanum melongena*), bottle gourd (*Lagenaria siceraria***)**, capsicum (*Capsicum annuum*), carrot (*Daucus carota*), spinach (*Spinacia oleracea*) which were randomly collected from the local markets of Bhopal city. Vegetables showed the presence of more than four predominating pathogenic bacteria. Common bacteria found were identified as *Serratia entomophila, Proteus vulgaris, Yersinia aldovae, Enterobacter aerogenes* with Enterobacter genera being more dominating. Characteristic growth on selective cum differential media confirmed the presence of mixed *Enterobacteriaceae* population and the members were identified based on their biochemical properties. The presence of heavy load of Gram negative bacteria in fresh vegetables showed poor quality which puts a question mark on its wholesomeness. The presence of *Enterobacteriaceae* reflects the existence of favourable conditions in respective vegetables for the growth of microorganisms.

Keywords: Enteropathogens, Vegetables, Microbial analysis, Food borne, Pathogens

INTRODUCTION

Fresh vegetables are important for growth and overall well-being as they aid in prevention of many diseases due to their high nutritive values. However, fresh fruits and vegetables have recently become increasingly recognized as potential vehicles of foodborne diseases (Weldezgina and Muleta, 2016) due to unhygienic handling in the consumption value chain. Fresh vegetables normally carry natural non-pathogenicepiphytic microorganisms (Falomir *et al.,* 2010). However, many studies showed that unfortunately, raw vegetables are considerably contaminated microbiologically (Gimba and Madueke, 2015; Al-Kharousi *et al.,* 2016; Kaur and Bhowate, 2017; Ehimemen *et al.,* 2019). This may create a health risk for consumers due to the possibility of occurrence

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of pathogenic microflora. Since early 1990s, awareness about the potential of fresh product to cause food borne diseases has increased, and reported outbreaks associated with the consumption of fresh vegetables have grown steadily. Most of the reported outbreaks of gastrointestinal diseases are linked to the fresh product usage and have been associated with bacterial contamination,particularly with members of the Enterobacteriaceae family (Nagarjun and Rao, 2015; K³apeæ *et al.,* 2016; Toe *et al.,* 2017; Adeyemi *et al.,* 2019). The frequency of food borne outbreaks caused by contaminated fresh fruit and vegetables has increased in current years (Chauhan *et al.,* 2017; Mritunjay and Kumar, 2017; Mathur *et al.,* 2014). Kasture (2017) analysed 60 randomly collected samples from market and street vendors of Jafrabad town and confirmed the contamination of fresh vegetables, fruits with pathogens such as *Escherichia coli, Pseudomonas, Staphylococcus, Salmonella, Proteus*. Furthermore, Kaur and Rai (2015) study concluded the presence of six bacterial isolates *i.e. Bacillus, Enterobacter, Micrococcus, Listeria monocytogenes, Proteus vulgaris and Serratia* from the fresh vegetables. Furthermore, Shrivastava (2014) detected *E.coli, E. aerogenes, Pseudomonas, Staphylococcus, Salmonella, Klebsealla aerogens, Proteus* spp. and *Shigella* sp in 75 samples of vegetables and fruits, procured from different places of Bhopal city.

There is a worldwide concern about the increased prevalence of antimicrobial resistance in bacteria. Many of these bacteria found in fresh produce carry resistance factors to multiple antimicrobials, and thereby pose additional safety concerns for consumers (Said *et al.,* 2015; Tope *et al.,* 2016; Zekar *et al.,* 2017). The nonselective and widespread use of antimicrobial agents to treat humans and animals origin agriculture remains to be the main cause for increased resistance in pathogenic bacteria (Durso and Cook, 2014). To prevent the consequences on humans it is very important to detect and identify these pathogenic microorganisms from fresh vegetables. Hence, the study was carried out to examine the microorganisms present over the fresh vegetable surfaces which can help in observing the presence of any pathogenic microbe associated with human diseases and also determining the resistance phenotype of these isolates.

MATERIAL AND METHODS

Collection of samples

Bacteriological studies were carried out on five types of fresh vegetables from local markets of Bhopal. The fresh vegetables *viz.,* brinjal, bottle gourd, capsicum, carrot, spinach were collected between January and March, 2017. Samples were purchased from local markets in Bhopal and they were selected depending on their availability in the market during the period of sampling. The samples collected aseptically were refrigerated and analysed within 24h (Kaur and Rai, 2015).

Sample preparation and Isolation

A 25 g of sub sample of each vegetable was aseptically weighed and vigorously shaken in 225 ml of sterile saline for 3 minutes separately to homogenize the samples. Serial dilutions were prepared from the original homogenate in saline. A volume of 0.1mL aliquot of appropriate dilution

was spread-plated in duplicate on nutrient agar media and were incubated at 37°C for 24 h. The number of microorganisms was expressed as the number of colony forming units CFU/ml and was calculated using formula (Prescott, 2002) to determine the microbial load in each vegetable sample CFU/ml = [(No. of colonies X Dilution factor) / Volume of sample]

Characterization and Identification of Bacteria

Morphological identification of Bacteria: The isolated bacteria were identified on the basis of Gram's staining and morphological characteristics (Prescott, 2002).

Selective-cum-differential agar media-based identification: Gram-negative isolates belong to the family Enterobacteriaceae. The count of Enterobacteriaceae was performed on MacConkey agar and EMB agar media by streak plate method and incubation at 35^0C for 24 hrs. The pure isolated colonies were identified on the basis of distinguishing growth appearance. For each selective medium, one bacterial isolate that showed typical morphology was selected from each sample for identification.

Biochemical Tests: The isolated Enterobacteriaceae bacterial colonies were confirmed by Biochemical kit (Hi25™ Enterobacteriaceae Identification Kit KB003) and the results of biochemical tests were interpreted to determine the presumptive nomenclature of the potential pathogenic enteric bacteria isolates through ABIS online (Advanced Bacterial Identification Software version 12.8).

RESULTS AND DISCUSSION

Total plate count

Different types of colonies were seen on Nutrient Agar Medium (NAM), isolated colonies were picked for further study.

Table 1. Total viable count of vegetable samples

S.No.	Vegetable Sample	Sample Code	CFU/ml of sample
1	Carrot (*Daucus carota*)	A	7.0 X 10^9
2	Spinach (*Spinacia oleracea*)	B	5.8 X 10^9
3	Brinjal (*Solanum melongena*)	C	5.0 X 10^9
4	Capsicum (*Capsicum annuum*)	D	4.2 X 10^9
5	Bottle gourd (*Lagenaria siceraria)*	E	3.8 X 10^9

CFU= Colony forming unit

Microscopic and Morphological Identification

Microscopic identification of each bacterial isolate by Gram's Staining revealed both Gram -ve and Gram +ve forms.

Biochemical identification

Gram-negative strains were considered to belong to the family Enterobacteriaceae, and only these were included in further testing. Bacterial genera were confirmed on the basis of 25 biochemical tests/ parameters using Himedia Biochemical test kit (Hi25™Enterobacteriaceae Identification Kit KB003). The most prevailed genera confirmed in different isolates were *Proteus myxofaciens*>*Serratia entomophila*> *Yersinia aldovae.*

Table 2. Colonial and morphological characteristics and Gram Staining Observations

S.No.	Sample Code	Isolate Code	Morphological Characteristics	Gram's Staining
1	A	A1	Abundant, opaque, golden growth	+
		A2	Yellow glistering convex colonies	-
		A3	Opaque, round, translucent growth	+
		A4	Small flat pale-yellow colonies	-
		A5	White moist & glistening growth	+
		A6	Yellowish pin headed (Umbonate) colonies	-
		A7	Abundant, round, opaque growth	+
		A8	Opaque, white, waxy growth, abundant	+
2	B	B1	Colonies are brown in colour with an undulate margin	-
		B2	Abundant, opaque, golden growth	+
		B3	Opaque, white, waxy abundant growth	+
		B4	Large flat pale brownish coloured colonies	-
		B5	White moist & glistening growth	+
		B6	Colonies are off white in colour and small in size and flat in elevation	-
		B7	Opaque, round, translucent growth	+
3	C	C1	Yellow irregular glistering surfaced colonies	-
		C2	Abundant, Round, opaque growth	+
		C3	Pale Yellow irregular colonies	-
		C4	Abundant, Opaque, Golden growth	+
		C5	White moist & glistening growth	+
		C6	Whitish flat smooth entire edges colonies	-
4	D	D1	Large rough white colonies	-
		D2	White moist & glistening growth	+
		D3	Pale yellow flat irregular colonies	-
		D4	Abundant, Round, opaque growth	+
		D5	Small off-white coloured colonies	-
5	E	E1	Pale brown flat colonies	-
		E2	Abundant, Opaque, Golden growth	+
		E3	Small orange colour convex colonies	-
		E4	Small glistening orange colonies with entire smooth edges	-

Table 3. Characteristic growth on selective-cum-differential media

S. No.	Bacteria Identified	Selective Media Used
1	*Serratia entomophila*	Growth of pink colour colony on Mac Conkey Agar
2	*Proteus myxofaciens*	Growth of colorless colony on Mac Conkey Agar
3	*Yersenia aldovae*	Growth of colourless colony on Mac Conkey Agar
4	*Proteus vulgaris*	Growth of colorless colony on EMB Agar.
5	*Enterobacter aerogenes*	Pink-colored colony without sheen on EMB Agar

Selective-cum-differential media based identification results

Characteristic growth on selective cum differential media confirmed the presence of mixed *Enterobacteriaceae* populations and the members were identified based on their biochemical properties.

* V= variable, + = Positive, - = negative; **1- ONPG; 2- Lysine; 3- Ornithine; 4- Urease; 5- Phenylalanine deamination; 6- Nitrate reduction; 7- H_2S production; 8- Citrate utilization; 9- Voges-Proskauer's; 10- Methyl Red; 11- Indole; 12- Malonate utilization; 13- Esculine Hydrolysis; 14- Arabinose; 15- Xylose; 16- Adonitol; 17- Rhamnose; 18- Cellobiose; 19- Melibiose; 20- Saccharose; 21- Raffinose; 22- Trehalose; 23- Glucose; 24- Lactose; 25- Oxidase

The research was carried out to study the micro flora associated with fresh raw vegetables. Five fresh vegetable samples were collected from local market and bacterial population was isolated from them. The bacterial strains were characterized on the basis of various morphological and biochemical tests (Table 3 and Fig. 1 to Fig. 5). The strains were screened for antibiotic sensitivity against various antibiotics. Data presented in Table 1 show that among vegetable samples, the highest CFU (colony forming units) count was obtained of carrot *i.e.* $7X10^9$cfu for mL of sample on NAM. Similar finding were observed by Weldezgina and Muleta (2016). Ehimemen *et al*. (2019) observed high contamination and high number of pathogens on the surface of fresh vegetables and fruits in case of local market samples. A total of thirty bacterial strains were isolated in the study (Table 2). It was not set out to investigate the total epiphytic flora. The organisms considered to be of potential importance were those capable of surviving in the human intestine, *i.e.* enterobacteria. Gram-negative strains were considered to belong to the family Enterobacteriaceae and only these were included in further testing. On the basis of morphological and biochemical tests six isolates namely A4, B4, C1, D3,D5 and E4 isolated were identified as *Enterobacter aerogenes* Al-Kharousi *et al*. (2016) and K³apeæ *et al*. (2016) also detected the prevalence of the members of family Enterobacteriaceae among the bacterial population isolated from fruits and vegetables. While, A2, B6, C3, D1 and E3 were identified as *Serratia entomophila* and B1 and C6 were characterized as *Proteus vulgaries* (Table 4). Kaur and Rai (2015) also reported the presence of *Serratia entomophila* and *Proteus vulgaries* in vegetables and fruits. Several other workers

Table 4. Identification of bacteria by biochemical tests

Isolate No	Tests Performed*																									Organism Identified
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
A2	+	V	V	+	-	+	-	+	+	+	-	-	+	-	-	-	-	-	-	-	-	+	-	-	+	*Serratia entomophila*
A4	+	+	+	-	-	+	-	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	*Enterobacter aerogenes*
A6	-	-	-	+	-	+	-	-	-	-	-	-	V	-	-	-	-	-	-	-	-	+	+	-	+	*Yersinia aldovae*
B1	-	-	-	+	-	+	+	+	-	+	+	-	+	-	+	-	-	-	-	+	-	+	+	-	+	*Proteus vulgaris*
B4	-	V	V	+	-	+	-	+	-	-	-	-	V	-	+	-	-	-	-	+	-	+	+	-	+	*Enterobacter aerogenes*
B6	+	V	V	+	-	+	-	+	+	+	-	-	+	-	-	-	-	-	-	-	-	+	-	-	+	*Serratia entomophila*
C1	+	+	+	-	-	+	-	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	*Enterobacter aerogenes*
C3	+	V	V	+	-	+	-	+	+	+	-	-	+	-	-	-	-	-	-	-	-	+	-	-	+	*Serratia entomophila*
C6	-	-	-	+	-	+	+	+	-	+	+	-	+	-	+	-	-	-	-	+	-	+	+	-	+	*Proteus vulgaris*
D1	+	V	V	+	-	+	-	+	+	+	-	-	+	-	-	-	-	-	-	-	-	+	-	-	+	*Serratia entomophila*
D3	-	-	V	+	+	-	-	+	-	+	-	+	V	-	-	-	-	-	-	-	-	-	+	-	+	*Enterobacter aerogenes*
D5	+	V	V	+	-	+	-	+	+	+	-	-	+	-	-	-	-	-	-	-	-	+	-	-	+	*Enterobacter aerogenes*
E1	-	V	V	+	-	-	+	+	-	+	-	+	+	-	-	-	-	-	-	-	-	-	+	-	+	*Yersinia aldovae*
E3	-	V	V	+	-	+	-	+	-	-	-	-	V	-	+	-	-	-	-	+	-	+	+	-	+	*Serratia entomophila*
E4	+	+	+	-	-	+	-	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	*Enterobacter aerogenes*

have also detected *Serratia entomophila* and *Proteus vulgaries* from fresh fruits and vegetables and ready-to-eat vegetable salads (Shrivastava, 2014; Nitin Kasture, 2017; Adeyemi *et al.,* 2019). A6 and E1 were identified as *Yersinia aldovae*. Mac Donald *et al.* (2012) observed the presence of *Yersinia aldovae* while working with ready to eat salad mix. It was notable that we did not isolate *Escherichia coli* or enterococci were not isolated from any specimen, indicating a lack of contamination with human or animal faeces.

Many members of the family of Enter obacteriaceae are among the most potent and prevalent pathogens (Tope *et al*., 2016; Ehimemen *et al*., 2019; Adeyemi *et al*., 2019), common in fresh fruits and vegetables that are most often eaten raw. Many bacteria isolated in this study, such as *Enterobacter aerogenes, Serratia entomophila and Proteus vulgaries* are considered opportunistic pathogens; if they cause infection, their resistance to antibiotics can complicate treatment outcomes. Therefore, it is essential to study antibiotic resistance in bacteria isolated from food and fresh fruits and vegetables.

CONCLUSION

Four bacterial isolates *i.e. Enterobacter aerogenes, Serretia entomophila, Proteus vulgaries* and *Yersinia aldovae* were isolated and identified from the fresh raw vegetables. Among the four isolates, *Enterobacter aerogenes* were the dominant species. It was concluded that most of the fresh vegetables sold in local markets is contaminated with potential opportunistic enteropathogens. Thus, not fit for consumption as such and indicated the necessity for following hygienic practices while eating raw or culinary purposes. Studies should be conducted to investigate at which stages or critical points contamination of fresh produce is most likely to occur and to determine the sources of contamination so as to establish a better control system that assures safer fresh vegetables from farm to fork. It is important to thoroughly wash vegetables and dip them in food grade anti-bacterial chemicals for a decent time to eliminate pathogens and significantly reduce the microbial load.

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EFFECT OF MEDIA AND HORMONES ON ROOTING OF AFRICAN MARIGOLD STEM CUTTINGS IN MIST CHAMBER

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ABSTRACT

Experiments conducted from 2017 to 2019 (to find out suitable media and hormones for better rooting and establishment of marigold terminal cuttings for summer cultivation) revealed that cocopeat among media and IBA @ 3000 ppm as powder among hormonal treatments are the best which recorded highest percentage of rooted cuttings (75.00%, 95.10%), highest number of roots per cutting (122.68, 174.90), maximum survival percentage of rooted cuttings (77.96%, 96.62%), root length (4.64 cm, 5.62 cm) and percentage establishment of rooted cuttings in main field (76.03%, 95.58%), respectively. Among the interaction effects, cocopeat and IBA @ 3000 ppm as powder recorded the maximum values for percentage of rooted cuttings (98.00%), number of roots per cutting (174.90), primary roots per cutting (11.58), secondary roots per cutting (114.6), longest root (5.62 cm), fresh weight of roots (1.68 g), dry weight of roots (0.60 g), root to shoot ratio (1.25), survival percentage of rooted cuttings (96.62%) and percentage establishment of rooted cuttings in main field (95.58 %). Whereas, cocopeat, NAA 200 ppm and their combination recorded the maximum shoot length (16.07 cm, 22.86 cm and 23.49 cm) and highest number of leaves per rooted cutting (153.73, 184.80 and 197.55), respectively. The lowest values for all the parameters were recorded in sand medium alone without any hormonal treatments.

Key Words : Harmones, Marigold, Media, Mist chamber, Rooting, Terminal stem cuttings

INTRODUCTION

African marigold (*Tagetes erecta* L.) represents the top most flower among various loose flowers grown in urban and rural areas of India. Large quantities of marigold flowers are used in making garlands for various social, cultural and religious functions, decorations in weddings and festivals. Commercial cultivation of marigold on a large scale is gaining importance due to ease of cultivation, yield potential and adaptability to varied environmental conditions apart from its industrial usages *viz.,* dye extraction, feed purpose and extraction of chemicals. The area under marigold cultivation in Andhra Pradesh for the year 2019 was 7707 ha with a production of 89,828 MT of loose

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flowers. Marigold is widely cultivated in Ananthapur, Kurnool, Guntur, Chittoor, East and West Godavari districts of Andhra Pradesh.

Marigold is commercially propagated mainly through seed. Uniform sized commercial grade flower production in marigold is possible only when the plants are propagated through vegetative means as plants propagated through seed may not be uniform in their morphological and floral characters, due to segregation and recombination of different characters. Moreover, the plants propagated through seeds are not true-to-type compared to those propagated through vegetative means. True-to-type planting material is a basic need to ensure both quality and quantity of marigold flowers. At this juncture, rapid method of propagation becomes very important when planting material availability is limited due to scarcity of a clone or varieties or due to rapid expansion in area under marigold cultivation. The scientific knowledge on utilization of cuttings in propagation of marigold is very scanty. In marigold, treatment of stem cuttings with NAA/IBA recorded to maximize the production of number of roots per cutting. Hence, this experiment was taken up to standardize a suitable, easy, quick and best method for establishment of marigold terminal shoot cuttings to provide uniform and quality planting material.

MATERIAL AND METHODS

The experiment was conducted at Horticultural Research Station, Venkataramannagudem, West Godavari district of Andhra Pradesh. The location falls under ''Agro-climatic Zone-10 of East Coastal Plains and Hills'' (Krishna-Godavari Zone). The experimental site is geographically situated at 16°83' N latitude and 81°5' E longitude with an altitude of 34 m (112 feet) above the mean sea level. This zone experiences hot and humid summer, mild winter and an average annual rainfall of 900 mm. The research experiment was carried out during the summer months in 2017 and 2018.

The orange coloured early to medium duration spreading type Bidhan Marigold-2a selection from cultivar 'Siracole' was selected for the experiment. The terminal stem cuttings were collected from plants just before flowering *i.e.* 50 days after transplanting of the main crop. Uniform size cuttings of 15 cm length were taken as propagation material by vegetative means for initiation of roots on stem cuttings. Well sieved sand, vermiculite and cocopeat were used separately as growing media by filling the cells of portrays. A slant cut was given at the basal end of the terminal cutting to expose maximum absorbing surface area for induction of effective rooting. The basal part of (1-2 cm in length) the terminal cuttings was dipped in the hormonal solutions as per the treatment *viz.,* 200 ppm or 400 ppm of Indole Butyric Acid (IBA) solution; 200 ppm or 400 ppm of Napthalene Acetic Acid (NAA) solution for 5 minutes and subsequently the cuttings were air dried for 5 minutes. In another treatment the basal part of the terminal cutting was dipped for 5 seconds in IBA powder formulation at a concentration of 1500 ppm and 3000 ppm and the cuttings were just tapped to remove the excess powder adhered to the cutting. The treated cuttings were planted up to one node depth in portrays containing respective rooting media. Portrays were kept in mist-chamber for better rooting.

The experiment was conducted in a Completely Randomized Design (CRD) with factorial concept and replicated twice. There

were twenty-one treatment combinations comprising of three rooting media *viz.,* vermiculite, sand and cocopeat as factor I and seven hormonal treatments *viz.,* IBA 200 ppm (Solution), IBA 400 ppm (Solution), IBA 1500 ppm (Powder), IBA 3000 ppm (Powder), NAA 200 ppm (Solution), NAA 400 ppm (Solution) and control as factor II.

Observations on root and shoot parameters were recorded after 10 days of planting of the terminal cuttings. Total number of cuttings survived in each treatment was recorded after seven days of transplanting the cuttings in pro-trays. Percentage establishment of rooted cuttings was calculated based on number of cuttings survived after 30 days of planting of rooted cuttings in the main field.

RESULTS AND DISCUSSION

Effect of media on root parameters

Among the various media used for inducing rooting in terminal shoot cuttings of Bidhan Marigold – 2, cocopeat followed by vermiculite and sand were found to be best in terms of all root parameters (Table 1). Cocopeat medium produced significantly maximum percentage of rooted cuttings (61.53 %), the highest number of total roots per cutting (122.68), primary (7.94) and secondary (84.99) roots per cutting, longest root per cutting (4.64 cm) with maximum fresh (1.09 g) and dry weight of roots (0.40 g).

Phenolic compounds present in cocopeat protect the naturally occurring endogenous auxin *viz.,* indole-3-acetic acid (IAA) from its destruction by the enzyme IAA oxidase (Fadl *et al.,* 1979), thus, acting as a precursor in the formation of lignin for structural support. Beneficial physical characteristics of coir pith medium such as improved aeration and higher water retention capacity might have produced the highest percentage of rooted cuttings. Similar kind of results were earlier reported by Lokesha *et al.* (1988) in African marigold. Cytokinins in cocopeat might have encouraged the induction of adventitious roots along with auxin mediated cell division resulting in a greater number of roots per cutting. Cytokinins are also involved in regulating the direction of development *i.e*. by blocking root meristemoid development by enhancing unorganized cell divisions that would otherwise form root meristemoids. Rubasinghe *et al.* (2009) reported that high water holding capacity of cocopeat helps in absorption of more water and nutrients from the medium thereby increasing the number of primary, secondary and total roots produced per cutting. Cocopeat might have protected endogenous IAA from its destination helping in differentiation of meristematic cells into more root primordia thereby increasing the number of roots (Rubasinghe *et al.,* 2009). The longest root length in cocopeat medium might be attributed to its course texture and high porosity enabling the downward movement of water and nutrients (Singh *et al.,* 2002) for better development of newly formed roots on the cutting which led to the better penetration of roots easily (Siddagangaiah *et al.,* 1996) in the cocopeat medium. It has provided proper drainage facility and aeration to the developing roots thus enabled the roots to grow longer (Singh *et al.,* 2002). Jain *et al*. (1999) suggested that presence of higher quantity of food reserves in the cutting might have contributed for the cell elongation and development of longest roots formed in the terminal cuttings of African marigold. Coir pith has lower particle density and contributed to an

increase in specific surface area and water holding capacity of the medium which led to the better absorption of higher quantities of water and nutrients by roots (Rubasinghe *et al.,* 2009) which resulted in more root length and it was earlier reported by Renuka *et al*. (2014) in carnation. Highest root fresh and dry weight in cocopeat might be due to production of more number of primary and secondary roots.

Effect of media on shoot parameters

Cocopeat as rooting medium also showed significant impact on shoot parameters which recorded maximum shoot length (16.07 cm), root to shoot ratio on dry weight basis (0.66%), survival percentage of rooted cuttings (63.56%), percentage establishment of rooted cuttings (62.28%) and highest number of leaves per rooted cutting(153.73) followed by vermiculite and sand (Table 1).

Ample supply of oxygen, water and nutrients for proper functioning of the root system in cocopeat medium might have resulted in maximum shoot length (Jeyaseeli and Paul Raj, 2010). The better absorption of water and nutrients from the soil by the root system resulted in cell elongation to the highest degree in the shoot. Auxin mediated shoot growth might have resulted from the fundamental elongation of stems and leaves through cell division and cell elongation accounting for more number of leaves and longer shoot cells in huge numbers. Nagarajan *et al.* (1985) stated that increased porosity and nutrient status of cocopeat might also have contributed to an increase in number of leaves per rooted cutting in marigold. Cocopeat maintained higher levels of endogenous auxins in terminal cuttings that helped in initiation of more number of leaf primordia in rooted terminal cuttings. The highest root to shoot ratio recorded in terminal cuttings of marigold placed in cocopeat might be due to improved physical and physiological conditions provided by the medium for vigorous development of root system relative to the shoot system (Ratna Kumari, 2014). Better aeration in cocopeat is essential for gaseous exchange between soil and atmosphere to remove CO_2 released by roots and microorganisms in the soil to the external atmosphere and supply of O_2 from the external atmosphere to the growing roots might have improved respiration rate and survival of rooted cuttings (Jeyaseeli and Paul Raj, 2010). Continuous supply of nutrients and moisture apart from improved porosity and drainage facility in cocopeat medium might be the reason for better percentage establishment of rooted cuttings. The above conditions might have helped the rooted terminal cuttings of marigold to develop better root system resulting in higher chances for rapid establishment of terminal cuttings in main field. Similar results were reported by Barreto and Nookaraju (2007) in grape.

Effect of hormones on root parameters

Among IBA and NAA treatments, IBA showed more impact than NAA for all the root parameters as IBA @ 3000 ppm in powder form recorded maximum percentage of rooted cuttings (77.76%), the highest number of roots per cutting (174.90), primary (11.58) and secondary (114.60) roots per cutting, longest root per cutting (5.62 cm), maximum fresh (1.68 g) and dry weight of roots (0.60 g) per cutting followed by IBA @ 1500 ppm, 200 ppm, 400 ppm, NAA @ 200 ppm and 400 ppm while lowest values for the above root parameters were recorded in

control without any hormonal treatment (Table 2).

IBA might have increased the rooting efficiency of stem cuttings due to an increase in the level of auxin content in the internal tissue of stem cuttings or synergistically acted by modifying the action of IAA due to synthesis of endogenous IAA. External treatment of terminal cuttings with increased concentration of IBA might have coupled with endogenous auxins already present in the cuttings thus improving the percentage of rooting in terminal cuttings due to differentiation of more cambial cells into roots. Similar results were recorded earlier by Grewal *et al.* (2005) in chrysanthemum. Increased rooting in IBA at higher concentrations could be attributed to IBA effect on cell wall plasticity accelerating cell division thereby stimulating callus development and root growth (Weaver, 1972). Auxins also promote adventitious roots formation by their ability to induce initiation of lateral roots and also enhance transportation of carbohydrates to basal portion of the cutting. Formation of higher number of roots per cutting may be due to more cambial activity. Similar kind of results was earlier reported by Ullah *et al.* (2013) and Sharma (2014) in marigold.

Increased primary roots in cuttings treated with IBA in powder form @ 3000 ppm might be attributed to the optimum level of hormonal effect that could promote the rapid hydrolysis of carbohydrate substances and facilitated their downward movement for rapid cell division activity. Similar results were recorrded by Bharmal *et al.* (2005) in chrysanthemum. Presence of more quantity of auxins in IBA promoted the adventitious root formation by their ability to promote initiation of lateral roots (as secondary roots) and also enhanced the transportation of carbohydrates to the basal portion of cuttings. Similar kind of results was earlier reported by Singh (2012) in bougainvillea. Longest root length with IBA @ 3000 ppm might be due to early initiation of the roots resulting in increased rapid utilization of nutrients which might have contributed to the endosmosis of water as well as cell expansion in roots was earlier in comparison to other plant hormones (Ajaykumar, 2007). Further, IBA might have hydrolyzed the carbohydrates as well as nitrogenous compounds and the hydrolyzed compounds might have been translocated to the base of the cutting which has resulted in acceleration of cell division and cell elongation (Singh *et al.,* 2003). Similar kind of observations were earlier reported by Neetam *et al*. (2018) in jasmine. Production of more number of primary and secondary roots through an increased cell division activity with IBA @ 3000 ppm resulted in maximum root fresh and dry weights. Exogenous application of auxin could have triggered the initiation of more root primordia in a better way (Ratna Kumari, 2014). Such well-developed root primordia could have paved the way for better establishment of vascular connectivity within the conductive tissue of rooted cuttings as a result of which better root development might have occurred. Formation of roots in the terminal cutting was intensified by IBA application through polysaccharides hydrolysis providing energy for the meristematic tissue thereby encouraging formation of more root primordia. Similar kind of observation was earlier reported by Singh *et al.* (2013) in night queen and Renuka *et al*. (2014) in carnation.

Effect of hormones on shoot parameters

Regarding shoot parameters, the effect of NAA was more when compared to IBA. NAA @ 200 ppm recorded maximum shoot length (22.86 cm) and highest number of leaves per rooted cutting (184.80) followed by IBA @ 200 ppm, 400 ppm, NAA 400 ppm, IBA 1500 and 3000 ppm. In terms of other parameters, IBA @ 3000ppm recorded maximum root to shoot ratio (1.25%), survival percentage (79.64%) and percentage establishment (78.14%) of rooted cuttings followed by IBA @ 1500 ppm, 200 ppm and 400 ppm, NAA @ 200 ppm and 400 ppm, whereas, the lowest values for the above shoot characters were recorded in control without any hormonal treatment (Table 2).

Maximum shoot length with NAA 200 ppm might be attributed to early sprouting of vegetative buds. Auxin application as NAA enhanced cell division and elongation apart from promotion of protein synthesis resulting in enhanced vegetative growth (Evans, 1973). In marigold similar results were reported earlier by Ullah *et al.* (2013). The increased number of leaves might be attributed to the activation of shoot growth leading to the increased number of nodes and leaves. According to Wahab *et al.* (2001), increase in number of leaves might be due to diversion of maximum quantity of photo assimilates to the developing leaf buds, as leaves are one of the major production sites of natural auxins in the plant system besides being very important for vital processes like photosynthesis and respiration. Similar kind of results were reported by Bharthy *et al*. (2004) in carnation.

The highest root to shoot ratio with IBA 3000 ppm could be attributed to rapid hydrolysis of carbohydrates stored in the terminal cuttings and transport of sugars to the base of the cuttings helping in rapid respiration releasing more energy which is responsible for initiation of more root primordia, primary and secondary roots. In hibiscus also similar results were reported by Bhandari (2014). Increase in survival percentage of rooted cuttings with IBA 3000 ppm could be attributed to the development of effective root system in terms of number and length of roots which helped in uptake of nutrients and water from the soil as reported in case of hibiscus by Nanda and Mishra (2010). Highest percentage establishment of rooted cuttings with IBA 3000 ppm is due to promotive effect of auxins which resulted in better root and shoot development as reported by Nanda and Mishra (2010) in hibiscus.

Interaction effect of media and hormones on root parameters

An additive interaction effect of cocopeat and IBA 3000 ppm was noticed and found best which recorded maximum percentage of rooted cuttings (98.00%), higher number of number of roots (186.25), primary roots (12.65), secondary roots (123.05), longest root (5.59cm), maximum fresh and dry weight of roots (1.87 g and 0.62 g), respectively followed by vermiculite + IBA 3000 ppm and sand + IBA 3000 ppm. From the pooled data it is evident that the impact of IBA 3000 ppm on root parameters is more than the rooting media used (Table 3).

IBA application might have generated an indirect influence by enhancing the transformation rate of rooting primordia at the base of cuttings. Rapid hydrolysis of carbohydrates stored in the internal tissue and movement of sugars to the base of cuttings consequently led to the formation of young and

Table 1. Effect of media on root and shoot parameters in African marigold cv. Bidhan marigold -2 (Pooled data of two years)

Parameters	Media			SE m±	CD at 5%
	Vermiculite	Sand	Cocopeat		
Root parameters					
Percentage of rooted cuttings (%)	71.93 (59.25)	68.29 (56.61)	75.00 (61.53)	0.24	0.72
Number of roots per cutting	116.48	110.36	122.68	0.35	1.03
Number of primary roots per cutting	7.44	7.01	7.94	0.04	0.13
Number of secondary roots per cutting	80.59	77.67	84.99	0.04	0.13
Length of longest root per cutting (cm)	4.49	4.35	4.64	0.01	0.03
Fresh weight of roots per cutting (g)	1.00	0.91	1.09	0.01	0.03
Dry weight of roots per cutting (g)	0.38	0.35	0.40	0.002	0.005
Shoot parameters					
Shoot length (cm)	15.56	14.87	16.07	0.05	0.13
Number of leaves per rooted cutting	148.10	143.97	153.73	0.55	1.63
Root to shoot ratio (%) (on dry weight basis)	0.59	0.55	0.66	0.01	0.03
Survival percentage of rooted cuttings (%)	76.51 (62.40)	72.67 (59.66)	77.96 (63.56)	0.24	0.72
Percentage establishment of rooted cuttings (%)	72.15 (59.35)	68.55 (56.82)	76.03 (62.28)	0.28	0.82

* Figures in parenthesis indicate arcsine transformed values

active root tissue at a faster rate in the cuttings. Similar high percentage of rooted cuttings was earlier reported in hibiscus by Shadparvar *et al.* (2011). More number of roots per cutting (primary, secondary and total roots) was due to high cambial activity by IBA treatment coupled with the beneficial effects of cocopeat. External application of IBA might have generated an indirect influence by enhancing the transformation movement of sugars to base of the cuttings consequently leading to the formation of young and active root tissue at a faster rate. Results in line with this study were reported by Khewale *et al.* (2005) in carnation. Auxins in IBA stimulated cell elongation in roots, initiated the synthesis of structural enzyme of proteins in the formation of adventitious roots thus increasing the root length through the

Table 2. Effect of hormones on root and shoot parameters in African marigold cv. bidhan marigold - 2 (Pooled data of two years)

Parameters	Hormones						Control	SE m±	CD at 5%
	IBA (Solution)		IBA (Powder)		NAA (Solution)				
	200 ppm	400 ppm	1500 ppm	3000 ppm	200 ppm	400 ppm			
Root parameters									
Percentage of rooted cuttings (%)	80.17 (63.54)	73.50 (59.01)	87.80 (69.64)	95.10 (77.76)	65.50 (54.02)	56.50 (48.71)	43.50 (41.21)	0.37	1.10
Number of roots per cutting	129.52	112.13	147.75	174.90	97.23	82.87	71.17	0.53	1.58
Number of primary roots per cutting	8.52	7.10	9.67	11.58	6.05	5.20	4.13	0.07	0.20
Number of secondary roots per cutting	90.42	78.12	99.90	114.60	70.63	60.57	53.33	0.07	0.20
Length of longest root per cutting (cm)	4.75	4.47	5.04	5.62	4.17	3.89	3.52	0.02	0.05
Fresh weight of roots per cutting (g)	1.15	0.93	1.46	1.68	0.74	0.59	0.44	0.01	0.04
Dry weight of roots per cutting (g)	0.45	0.38	0.53	0.60	0.29	0.22	0.17	0.003	0.007
Shoot parameters									
Shoot length (cm)	20.15	17.36	12.18	11.14	22.86	14.68	10.15	0.07	0.20
Number of leaves per rooted cutting	162.45	156.23	138.75	131.85	184.80	147.93	118.18	0.84	2.49
Root to shoot ratio (%) (on dry weight basis)	0.63	0.52	0.73	1.25	0.42	0.39	0.25	0.02	0.05
Survival percentage of rooted cuttings (%)	84.59 (66.89)	76.08 (60.73)	90.68 (72.25)	96.62 (79.64)	68.13 (55.61)	62.50 (52.23)	51.36 (45.76)	0.37	1.10
Percentage establishment of rooted cuttings (%)	81.02 (64.20)	73.01 (58.70)	88.20 (69.98)	95.58 (40.09)	67.04 (78.14)	59.27 (54.96)	41.62 (50.33)	0.42	1.25

*** Figures in parentheses indicate arcsine transformed values**

Table 3. Interaction effect of media and hormones on root and shoot parameters in African marigold cv. bidhan marigold – 2 (Pooled data of two years)

Treatments	Root parameters							Shoot parameters				
	Percentage of rooted cuttings (%)	Number of roots per cutting	Number of primary roots per cutting	Number of secondary roots per cutting	Length of longest root per cutting (cm)	Fresh weight of roots per cutting (g)	Dry weight of roots per cutting (g)	Shoot length (cm)	Number of leaves per rooted cutting	Root to shoot ratio (%) (on dry weight basis)	Percentage establishment of rooted cuttings (%)	Survival percentage of rooted cuttings (%)
Vermiculite+IBA 200 ppm	80.50 (63.77)	130.50	8.55	90.55	4.79	1.08	0.46	20.38	163.30	0.63	84.48 (66.78)	80.90 (64.06)
Vermiculite+IBA 400 ppm	73.50 (58.67)	112.05	7.10	76.30	4.53	0.98	0.38	17.44	155.80	0.49	76.05 (60.68)	72.98 (58.66)
Vermiculite+IBA 1500 ppm	88.50 (70.18)	147.95	9.65	99.00	4.98	1.46	0.53	12.04	139.80	0.67	90.43 (72.01)	87.50 (69.26)
Vermiculite+IBA 3000 ppm	95.50 (77.89)	173.95	11.30	113.35	5.59	1.61	0.59	11.15	131.65	1.27	97.38 (80.71)	95.70 (78.00)
Vermiculite+NAA 200 ppm	65.50 (54.00)	97.25	6.05	71.25	4.19	0.78	0.29	23.33	180.65	0.42	68.68 (55.95)	67.87 (55.46)
Vermiculite+NAA 400 ppm	56.50 (48.71)	82.20	5.30	60.75	3.84	0.62	0.22	14.60	147.80	0.40	63.77 (52.97)	58.27 (49.74)
Vermiculite alone	44.30 (41.53)	71.45	4.15	52.90	3.51	0.48	0.17	10.02	117.70	0.24	54.76 (47.72)	41.81 (40.27)
Sand+IBA 200 ppm	78.50 (62.35)	122.75	8.20	86.40	4.63	1.06	0.42	19.36	160.55	0.62	82.79 (65.46)	77.75 (61.83)

*** Figures in parentheses indicate arcsine transformed values**

Table 3 Contd.

Table 3 Contd.

Treatments	Root parameters							Shoot parameters				
	Percentage of rooted cuttings (%)	Number of roots per cutting	Number of primary roots per cutting	Number of secondary roots per cutting	Length of longest root per cutting (cm)	Fresh weight of roots per cutting (g)	Dry weight of roots per cutting (g)	Shoot length (cm)	Number of leaves per rooted cutting	Root to shoot ratio (%) (on dry weight basis)	Percentage establishment of rooted cuttings (%)	Survival percentage of rooted cuttings (%)
Sand+IBA 400 ppm	71.00 (57.39)	105.95	6.60	74.50	4.28	0.79	0.34	16.73	154.90	0.48	73.25 (58.83)	70.19 (57.00)
Sand+IBA 1500 ppm	85.00 (67.19)	140.70	9.20	96.70	4.88	1.39	0.51	11.81	134.60	0.67	89.41 (70.98)	85.54 (67.62)
Sand+IBA 3000 ppm	92.00 (73.57)	164.50	10.80	107.40	5.50	1.57	0.58	10.99	130.70	1.16	94.54 (76.46)	93.09 (74.74)
Sand+NAA 200 ppm	62.00 (51.92)	92.40	5.80	68.35	4.09	0.68	0.27	21.77	176.20	0.41	66.1 3 (54.39)	63.45 (52.78)
Sand+NAA 400 ppm	54.00 (47.27)	78.15	4.80	58.45	3.77	0.54	0.21	13.89	143.10	0.39	60.16 (50.85)	56.81 (48.90)
Sand alone	35.50 (36.55)	68.10	3.70	51.90	3.34	0.34	0.15	9.56	107.75	0.15	42.44 (40.63)	33.04 (35.02)
Cocopeat+IBA 200 ppm	81.50 (64.50)	135.30	8.80	94.30	4.82	1.32	0.48	20.71	163.50	0.65	86.51 (68.42)	84.40 (66.71)
Cocopeat+IBA 400 ppm	76.50 (60.97)	118.40	7.60	83.55	4.60	1.03	0.41	17.93	158.00	0.59	78.96 (62.68)	75.85 (60.53)

*** Figures in parentheses indicate arcsine transformed values**

Table 3 Contd.

Treatments	Root parameters							Shoot parameters				
	Percentage of rooted cuttings (%)	Number of roots per cutting	Number of primary roots per cutting	Number of secondary roots per cutting	Length of longest root per cutting (cm)	Fresh weight of roots per cutting (g)	Dry weight of roots per cutting (g)	Shoot length (cm)	Number of leaves per rooted cutting	Root to shoot ratio (%) (on dry weight basis)	Percentage establishment of rooted cuttings (%)	Survival percentage of rooted cuttings (%)
Cocopeat+IBA 1500 ppm	90.00 (71.53)	154.60	10.15	104.00	5.27	1.52	0.56	12.70	141.85	0.87	92.22 (73.77)	91.55 (73.07)
Cocopeat+IBA 3000 ppm	98.00 (81.83)	186.25	12.65	123.05	5.78	1.87	0.62	11.29	133.20	1.34	97.96 (81.76)	97.92 (81.68)
Cocopeat+NAA 200 ppm	69.00 (56.14)	102.05	6.30	72.30	4.22	0.76	0.32	23.49	197.55	0.43	69.58 (56.5)	69.79 (56.63)
Cocopeat+NAA 400 ppm	59.00 (50.16)	88.25	5.50	62.50	4.05	0.62	0.25	15.54	152.90	0.40	63.59 (52.87)	62.72 (52.36)
Cocopeat alone	51.00 (45.55)	73.95	4.55	55.20	3.71	0.51	0.18	10.87	129.10	0.36	56.88 (48.94)	50.00 (44.98)
SEm±	0.65	0.92	0.12	0.12	0.03	0.02	0.004	0.12	1.46	0.03	0.65	0.73
CD at 5%	1.91	2.73	0.34	0.35	0.09	0.07	0.013	0.35	4.31	0.08	1.91	2.16

*** Figures in parentheses indicate arcsine transformed values**

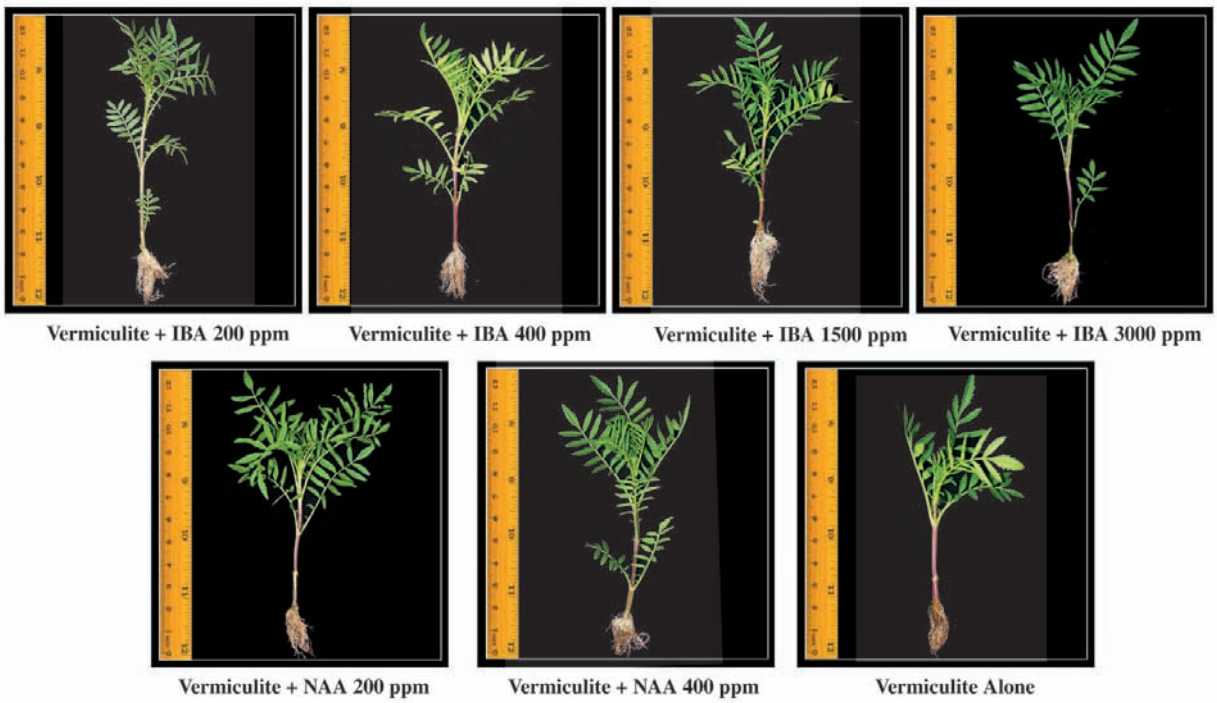

Fig. 1. Effect of vermiculite and hormonal treatments on propagation of african marigold CV. 'Bidhan Marigold-2'

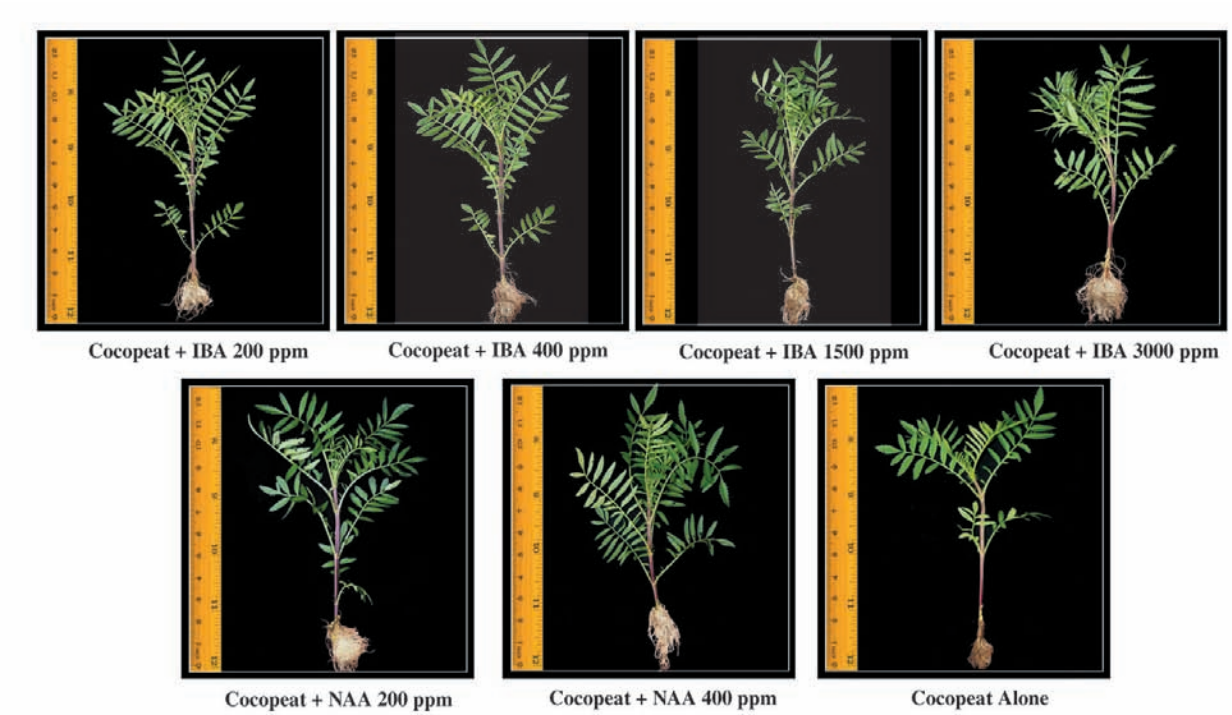

Fig. 2. Effect of cocopeat and hormonal treatments on propagation of african marigold CV. 'Bidhan Marigold-2'

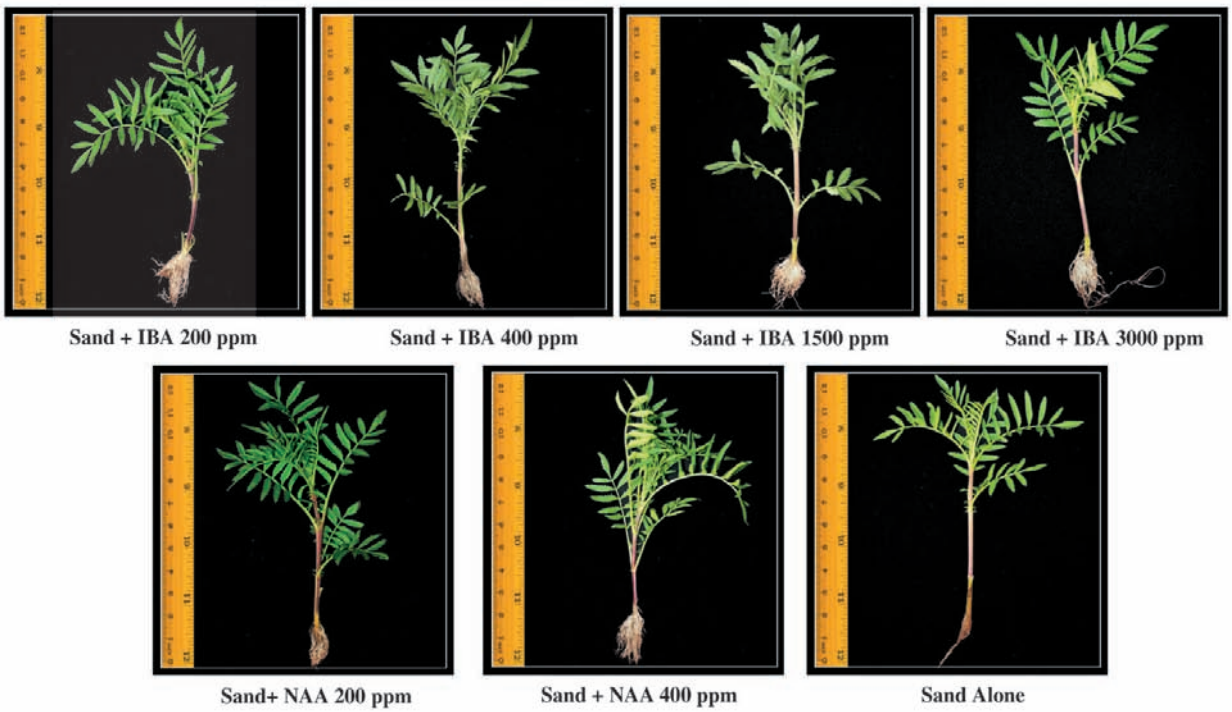

Fig. 3. Effect of sand and hormonal treatments on propagation of african marigold CV. 'Bidhan Marigold-2'

process of acidification. Similar kind of observations was earlier reported in hibiscus cuttings (Shadparvar *et al.,* 2011). Presence of favourable environmental conditions *viz.,* better aeration and water holding capacity in addition to cytokinins in cocopeat medium encouraged the induction of adventitious roots resulting in production of more number of roots. Furthermore, effect of IBA on cell wall plasticity might have accelerated the cell division, thus, stimulating more callus development thereby increased the root growth in terms of fresh and dry weight (Ganjure *et al*., 2012).

Interaction effect of media and hormones on shoot parameters

Pooled mean revealed that significantly longer shoot length (23.49 cm) and more leaves per rooted cutting (197.55) was recorded with cocopeat in combination with NAA 200 ppm followed by vermiculite + NAA 200 ppm and sand + NAA 200 ppm. NAA increased the shoot length and number of leaves per rooted cutting individually as well as in combination with different rooting media. In terms of other parameters, cocopeat and IBA @ 3000 ppm combination recorded maximum root to shoot ratio (1.34%), survival percentage (97.96%) and percentage establishment (97.92%) of rooted cuttings followed by vermiculite + IBA 3000 ppm, and sand + IBA 3000ppm, whereas, the lowest values for all shoot parameters were recorded in sand alone (Table 3).These results are in confirmation with the findings in pomegranate for root to shoot ratio and percentage establishment of rooted cuttings by Ratna Kumari (2014) and by Khewale *et al.* (2005) for survival percentage of rooted cuttings in carnation.

CONCLUSION

Cocopeat medium and IBA 3000 ppm treatment either alone or in combination are the best for obtaining better rooting percentage with more number of primary, secondary and total roots per cutting, longer roots with higher survival percentage and establishment in main field followed by IBA 1500 ppm, whereas, coco peat and NAA 200 ppm were the best in terms of shoot growth and number of leaves.

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ASSESSMENT OF NUTRITIONAL STATUS BASED ON BMI OF LODHA TRIBAL WOMEN IN MAYURBHANJ DISTRICT OF ODISHA

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ABSTRACT

Mayurbhanj is a tribal dominated district and Lodha is a primitive vulnerable tribe of this district. Very scanty information about their nutritional, dietary pattern and dietary habits was reported. Hence, this study was conducted in 2019-20 and 2020-21 to assess the nutritional status of the Lodha tribal women, so that it will be helpful for planning and monitoring programmes for the betterment of Lodha Tribal women.The respondents were selected randomly from ten villages of Moroda, Suliapada, Baripada and Shamakhunta. The study revealed that the average height of the Lodha tribal women was 146.6± 5.4 cm, body weight was 37.8 ± 6.31 kg, waist circumference was 78.3± 7.87 cm, hip circumference was 77.3 ±8.83 cm, mid arm circumference was 20.6 ± 2.21 cm, BMI was 17.6± 2.8 kg/m^2, waist hip ratio was 20.7± 2.21 cm. At the aggregate level 27.3 percentage of tribal women showed normal range of BMI value (18.5-22.9 kg/m^2) but 68.7% of the Lodha tribal women come under underweight ($\leq$ 18.5 kg/m^2) category of BMI classification.Only 2% of Lodha tribal women represented both over weight (23.0-24.9 kg/m^2) and obese ($\geq$ 25.0kg/m^2) category of Chronic Energy Deficiency (CED), this showed the tribal society was also stepping towards dual burden of malnourishment and overweight among Lodha tribal women. The research also revealed that there was statistically significant association between income with BMI and education with BMI, however, statistically non-significant association between age with BMI and types of family with BMI.

INTRODUCTION

There are more than 370 million indigenous people residing in 90 countries world-wide (United Nations, 2009). The indigenous people in India are known as Scheduled Tribes (STs), which is basically an administrative term. In India, the total tribal people constitute 104.3 million out of the total population of 1.21 billion people. India is the country which contains the highest tribal population in the world and the tribal people constitute 8.6% of the total population of India. There are nearly 705 schedule tribes and 75 vulnerable tribal groups in our country with different social and cultural living patterns (Government of India, 2011). There are 533 tribal communities living in India, out of which 62 communities live in Odisha (Deborah Thomas *et al*., 2015). Out of the 62 notified Scheduled Tribes, only 13 Scheduled Tribes were declared as Primitive Tribal Groups by the Government of India.

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Odisha state belongs to eastern India previously known as Orissa and has a total population of 42.0 million that covers a large portion of scheduled tribes (23%) and scheduled caste (17%) people (Government of India, 2011). Both categories maintain to be the most backward and socio-economically disadvantaged groups in India and have the minimum health outcomes in our country (Balrajan *et al.,* 2011). Odisha has an estimated poverty rate of 32.6% (Planning Commission of India, 2013) and the distribution of poverty reflects the social, economical, nutritional and finally health status of inequalities.

Various studies were conducted on tribal people, their living pattern, health and nutritional status. Kushwaha *et al.*(2020) reported that 24.16% tribal women such as Santals, Koyas, Paraja and Bhumija of Malkangiri were under weight and 87.08% women were anaemic. Studies conducted on Bathudis tribals of Keonjhar district by Bose and Chakraborty (2005) revealed that the prevalence of under nutrition (BMI< 18.5 kg/m^2) among them was very high (57.9%) and there was a significant difference undernutrition between men (52.5%) and women (64.5%). Nanda and Dhar(2017) found that the most (81%) of the Dongria Kandh tribe adolescent girls were from nuclear family and all of them belonged to low socio economic status and besides low adequacy of (35%) energy intake of studied subjects. The protein intake was adequate in only 38% of the respondents.Tribals constituting 8.2% of India's population are now attracting the attention of administrators and planners and are given priority in developmental programmes.

Mayurbhanj is a tribal population dominated district (58.7%) and was declared as the fully scheduled district of Odisha. Three types of PVTGs hill khariar, Birhor (Makirdia) and Lodha are seen in this district and needed special attention from social, financial and nutritional statuses. Lodha community is mainly seen in the hilly tracts of Mayurbhanj district of Odisha. Most of them were found in Suliapada and Moroda block of Mayurbhanj district. They were popular as a criminal tribe (Ota and Sahoo, 2010). There was chronic energy deficiency noticed among the men of lodha community as revealed by Goswami (2014). Lodha community is socially and economically backward and the total literacy rate of lodha tribe is 43.1%, whereas, female literacy rate is 35.1% (Government of India, 2011). Assessment of nutritional status is considered as a measure of health and is essential for planners to understand the food and nutritional condition among tribal population for betterment of these vulnerable groups.

There is dearth of studies conducted on lodha tribal women of Mayurbhanj district. Along with this there is very little information regarding dietary intake and nutritional status of lodha tribes. Hence, the study was carried out to assess the health and nutritional status of the lodha tribal groups which would be helpful in the formulation of required development programmes for the food and nutritional security of lodha tribal people in Mayurbhanj district of Odisha.

MATERIALS AND METHODS

The study was carried out in 10 villages of Morada, Baripada, Shamakhunta and Suliapada block of Mayurbhanj district during 2019-20 and

2020-21, as lodha tribal people were concentrated in these villages. A total of 300 Lodha tribal women were selected randomly.The age range for all groups was 18-45 years and they belonged to non-pregnant and non-lactating category. Anthropometric measurements of Lodha tribal women were taken and were interviewed for their socio-economic and other related information.

Data collection

Data was collected in the whole village from all the selected tribal women from 2019 to 2020. The information on socio- demographic profile was collected from each of the house hold through the pre-designed and pre-tested questionnaire. The medical officer had clinically examined all the individuals. Anthropometric measurements such as weight, height, waist circumference, hip circumference and mid-arm circumference were measured by using standard equipment and procedures. Lever accurate weighing scale was used and calibrated before and after each session. Weight was taken with only minimum clothing and was measured to the nearest 0.01 kg. Height was taken on height board and all the measures were taken ensuring that the respondents were standing upright with feet flat and firm against the wall and was measured to the nearest 0.1cm. Waist circumference, hip circumference and mid arm circumference were measured by the non-stretchable fibre tape. BMI was calculated using the following standard equation of Asian Indian-specific guidelines for defining and managing overweight and obesity(2009).

Chi-square test was used for assessing the association between age, income, type of family and education with BMI. The data were analysed using statistical software package SPSS 21.0 version and MS Excel 2019 version. Mean and standard deviation of the anthropometric data were calculated for each age group. Data analysis using Chi-square test and Karl Pearson coefficient of correlation was done to evaluate statistical significance.

BMI=weight (kg)/height (m^2)

Table 1. Cut-off points of BMI

S.No.	Nutritional status	BMI (kg/m^2)
1	Underweight	< 18.5
2	Normal Range	18.5-22.9
3	Overweight	23.0-24.9
4	Obese	≥ 25

Asian Indian- Specific Guidelines for Defining and Managing Overweight and Obesity (2009)

The data presented in the Table 2 depicts that only eight percent of the samples were living in joint families and 11.3% in extended families in comparision to 80.7% living in nuclear families, which showed the decreasing joint family trend among tribal areas. Similar results were reported by Rao *et al.* (2006) on changing pattern of family structure in villages. It was shifted from joint to nuclear family and found that 82% of the families were nuclear. Nanda and Dhar (2017) also reported the same that most (81%) of the adolescent girls of Dongria and Kondh tribes were from nuclear family. Kushwaha *et al.* (2020) stated that 76.25% women belonged to joint family.

Majority of the samples (68.3%) had total family members consisting of 4-8 family

RESULTS AND DISCUSSION

Table 2.Socio-economic and demographic data of Lodha tribal women (n= 300)

S.No.	Personal variables	Numberof the respondents(n= 300)	Percentage (%)
1	Type of family		
	Joint	24	8
	Nuclear	242	80.7
	Extended	34	11.3
2	Number of children		
	1	12	4
	2	23	7.7
	3	19	6.3
	>3	246	82
3	Total family members		
	1-4	54	18
	4-7	205	68.3
	>7	41	13.7
4	Educational status		
	Illiterate	258	86
	Primary (up-to class V)	22	7.3
	Secondary (VI - X)	8	2.7
	$10^{th\ class}$	7	2.3
	10+2	5	1.7
	Graduate	—	—
	Post graduate	—	—
5	Self-occupation		
	Agriculture	34	11.3
	Agriculture labour	89	29.7
	MGNREGS	31	10.4
	AWW	1	0.3
	Angawadi Helper	12	4
	Agriculture labour+ Leaf	105	35
	House wife	28	9.3
6	Continuous earnings for the family throughout the year		
	Continuous earnings present	121	40.3
	Continuous earnings Absent	179	59.7

(Table.2 Contd..)

(Table.2 Contd..)

S.No.	Personal variables	Numberof the respondents(n= 300)	Percentage (%)
7	Activity pattern of subjects		
	Sedentary	10	3.3
	Moderate	23	7.7
	Heavy	267	89
8	Source of Income		
	Agriculture	34	11.3
	Agriculture and others	266	88.7
9	Monthly Income (Rs.)		
	< 2000/-	51	17
	2000/- -3000/-	175	58.4
	3000/- - 5000/-	70	23.3
	5000/- -10,000/-	-	-
	10,000/- 15,000/-	4	1.3
10	Earning members		
	1	91	30.3
	2	197	65.7
	>2	12	4
11	Debts condition		
	Present	56	18.7
	Absent	244	81.3
12	Economics status of the families		
	Above poverty line	8	2.7
	Below poverty line (BPL)	292	97.3

members, 18% had 1-4 family members and nearly 13.7% had more than eight family members. Nanda and Dhar (2017) reported similar findings that 70.96% had total family members ranging from 7-9 family members. Kushwaha *et al.* (2020) revealed 76.25% respondents have five family members. The family size and pattern depicted that most of them were living in nuclear families and the family size consisted of 4-8 members and majority of them had more than 3-4 children. Due to ignorance, lack of knowledge, illiteracy and for social securityreasons, they preferred to give birth to more children.

Educational status showed that only 12% were literate, out of which 7% were with primary education qualifications, 3% have secondary education qualification and 1% each with 10^{th}class and 10 + 2 qualifications. This indicated that literacy rate among Lodha tribal women was

very low as compared to the literacy rate of women (42.01%) of this district (https://entranceindia.com/year-book/mayurbhanj-district-of-odisha-at-a-glance/).The findings of Kushwaha *et al*. (2020) on Santals, Koyas, poraja and Bhumija tribals of Malkanagiri district revealed that only 2.92% were illiterates, 50.4% had completed up to 7 year of schooling, 27.5% had completed higher secondary and 19.1% had achieved any professional course from ITI. Kanrar and Goswami (2020) also opined the same in their studies on juangs of Keonjhaardistrict. Kapoor *et al.* (2009) revealed that 3.5% respondents studied up to primary level and 4.9 % had studied up to higher secondary among Sahara Tribe women.

The main reason behind their poor educational status was lack of awareness and poor socio-economic status of their families. As majority of their financial resources they were also unable to provide their children with proper education.

The study depicted that the tribal women were engaged in various type of occupations to support their livelihood. Majority of the Lodha tribal women (35%) worked as agriculture labour. Collection of sal leaves was their main occupation followed by agriculture labour as 29.7%, 11.3% involved in agriculture work in their field, 10.4% were engaged in MGNREGs work, 9.3% were house wives, 4% of them were Anganwadi helpers and 0.3% were Anganwadi workers. This indicates that Lodha tribal people come to the main stream of society slowly and trying to create their own identity. Bose and Chakraborty (2005) opined majority of the respondents were low wage earning manual labourers on Bathudis. Kanrarand Goswami (2020) in their studies on Juangs stated that most of the female respondents were unemployed. Kapoor *et al.* (2009) reported more than 87% were earning lowest in Saharia primitive tribe.

From the data it was also revealed that 89% of the activity pattern of Lodha tribal women was heavy, followed by 7.7% belonging to moderate and only 3.3% come under sedentary pattern of activity. This indicates that the Lodha tribal women were very laborious and did strenuous work to support their livelihood. The main source of income for (88.7%) of Lodha tribal women was agriculture and other sources were sal leaf collection, MGNREGs works, etc and the

Table 3. Anthropometric measurements of tribal women in comparision to NCHS standards for different categories (n= 300)

Sl No	Variables	Standard NCHS	Mean	SD	Percent (%)
1	Height (cm)	154.7	146.6	5.4	94.7
2	Weight (kg)	56.6	37.8	6.31	66.7
3	Waist Circumference (cm)	78.3	64.2	7.87	64.2
4	Hip circumference (cm)	88	77.3	8.83	0.87
5	Mid Arm circumference (cm)	26.6	20.6	2.21	0.77

remaining 11.3% had only agriculture as the main source of income.

More than half of the tribal women (58.4%) had monthly income of Rs. 2000/- to Rs.3000/- followed by 23.3% and 17% Lodha tribal women with a monthly income of Rs.3000/- to Rs.5000 and Rs. 2000/- to Rs.3000/- respectively. Only 1.3% of the women earn Rs. 10000/- to Rs.15000/- per month. Vatsala*et al.* (2017) reported average household income of 95.8% subjects was Rs. <1000/- while a very few segment (0.4%) of the subjects were seen to earn Rs.>5000/- per month among females. Lenka (2016) noticed that the income of the tribal women of Jashipur blocks ranged from Rs. 80,000 to Rs.1,00,000 per annum due to their active involvement in SHGs which helped them to raise their income along with enhancement of social status and self confidence level of tribal women.

The study also revealed that 65.7 % of Lodha tribal family had two earning members *i.e.* both husband and 30.3 % of the family had only one earning member *i.e.* either husband or wife. However, 4% of the family had more than two earning members which indicated to their children doing some works. Further, 18.7% of the tribal Lodha family were in debt from different sources and remaining 81.3% people were not under any debt. Vatsala *et al.* (2017) observed that in critical situation of financial problem 53.6% females borrowed money from others. Again, only 2.7% of Lodha tribal family were above poverty line indicating very low economic status and were leading a miserable life.

Anthropometric standards measurements and difference of BMI values of tribal women (Table 3 and 4) of different age groups (18-45) were taken within each of the stratum and different grades of BMI were calculated.

The mean height of the tribal women was 146.6 ± 5.5cm and was 94.7% of the standard value. Bhardwaj and Kapoor (2007) noticed that the mean height of the respondents was 152.3±4.4 cm in their studies on Dhanka tribes. Bose and Chakraborty (2005) reported the mean height of Bathudis tribal women was 149.2±6.7 cm. The mean weight of the Lodha tribal women was 37.8 ± 6.31 Kg and is 66.7% of the standard value as per NCHS. Bisai*et al.* (2009) remarked the mean weight of the middle aged women of Savar tribes was 43± 5.5 Kg. Bose and Chakraborty (2005) observed that the mean age of the Bathudis tribal women was 39± 6.2 kg.The mean waist circumference of the Lodha tribal women was 64.2 ± 7.87 cm and 64.2% of the

Table 4. Body Mass Index of tribal women (n=300)

Sl No.	Grading of BMI	BMI (kg/m^2)	Frequency (n=300)	Percentage (%)
1	Underweight	<18.5	205	68.7
2	Normal Range	18.5-22.9	83	27.3
3	Over Weight	23-24.9	6	2
4	Obese	≥ 25	6	2

Source : Asian Indian- specific guidelines for defining and managing overweight and obesity, 2009

Table 5. WHR (Waist Hip Ratio) of tribal women among different categories (n=300)

Anthropometry variables (WHR)	Health risk based on WHR	Frequency
<0.8	Low Risk	122 (40.6)
0.81-0.85	Moderate Risk	59(19.6)
>0.85	High Risk	119 (39.6)

standard value as per NCHS. Bose and Chakraborty (2005) noticed that the mean WC of Baathudis tribal women were 63.9±6.8 cm. The mean hip circumference of the Lodha tribal women was 77.3 ± 8.83 cm (87% of the standard value as per NCHS). Bose and Chakraborty (2005) found out that the mean hip circumference of Bathudis tribal women was 78±5.7 cm. The mean mid arm circumference of the Lodha tribal women was 20.6 ± 2.21 cm (77% of the standard value as per NCHS). Sachdev *et al.* (2005) reported that the mean mid arm circumference was 26.8 ± 4.2 cm of young adult women. Bharadwaj and Kapoor (2007) reported a mid arm circumference of Dhankatribals as 20.7±1.5 cm. Similar findings were reported by Bose *et al.* (2007 and 2009).

BMI calculation is a simple and accurate assessment of the degree of thinness or obesity, according to the recommendations of WHO. Prevalence of under nutrition among tribal women in all the 10 villages was high. Most vitally, nutritional intervention programmes are required to be implemented for tribal populations immediately. With reference to the prevalence of Chronic Energy Deficiency (CED), the maximum (68.7%) of the Lodha tribal women were coming under underweight categories of CED and 27.3% of the Lodha tribal women were coming under Normal range (18.5-22.9 kg/m2) of CED. Only 2% indicated both for overweight (23.0-24.9 kg/m^2) and obese (≥25.0) categories of BMI classifications. Singh *et al.* (2013) remarked that the mean body mass index of the respondents was in the range of optimum health and value 5th percentile was resulted in the range of the severe chronic energy deficiency grade III (29.3%), obese 24.7% and overweight 8.7%. Ghosh (2016) reported that no Munda or Santal women were obese (≥30), 4.3% were pre-obese, 19.49% were underweight (≤18.5) among them 6.8% were severely underweight (< 18.00) and come under CED grade-III.

WHR: WHR is the ratio of circumference of the waist to that of hips. It was determined with a measuring tape to measure the circumference of the hips at the maximum wide part of buttocks and waist at the smaller circumference of natural waist usually just above the belly button. The ratio was calculated and the health risk was determined (Table 5).

As per WHR,40.6% of samples having normal WHR (*i.e.* < 0.8) were in low risk coming under high risk *i.e.* > 0.85 category indicating increased health risk for tribal women due to more fat deposition at the abdominal region and only 19.6% fell under moderate risk category *i.e.* 0.81-0.85.Vatsala *et al.* (2017) reported that 160 subjects had normal WHR values in the range of 0.7-0.8.

Table 6. Association of different socio-economic variables with BMI (n= 300)

Category	BMI					Chi-square	p
	Under weight No. (%)	Normal No. (%)	Over weight No. (%)	Obese No. (%)	Total		
	17-18.5	18.5-22.9	23-24.9	≥ 25			
Age (years)						6.47744	0.371925
18-25	119 (39.7)	42 (14)	4 (1.3)	3 (1)	168		
25-35	63 (21)	23 (7.7)	2 (0.7)	2 (0.7)	90		
35-45	23 (7.7)	18 (6)	0 (0)	1 (0.3)	42		
Income						123.008*	0
(Rs./ month)							
<2000	62 (20.7)	11 (3.7)	2 (0.7)	0 (0)	75		
2000-3000	95 (31.7)	41 (13.7)	3 (1)	1 (0.3)	140		
3000-5000	48 (16)	30 (10)	1 (0.3)	2 (0.7)	81		
>5000	0 (0)	1 (0.3)	0 (0)	3 (1)	4		
Education						141.967*	0
Illiterate	192 (64)	66 (22)	0 (0)	0 (0)	258		
Primary	6 (2)	12 (4)	1 (0.3)	3 (1)	22		
Secondary	5 (1.7)	2 (0.7)	1 (0.3)	0 (0)	8		
10^{th} pass	1 (0.3)	2 (0.7)	2 (0.7)	2 (0.7)	7		
Higher secondary	1 (0.3)	1 (0.3)	2 (0.7)	1 (0.3)	5		
Family type						8.08678	0.23088
Joint	17 (5.7)	4 (1.3)	1 (0.3)	2 (0.7)	24		
Nuclear	165 (55)	69 (23)	5 (1.7)	3 (1)	242		
Extended	23 (7.7)	10 (3.3)	0 (0)	1 (0.3)	34		

*Significant at 5% level of significance; Numbers in parenthesis is expressed as %

The study showed 39.7% (119) of the Lodha tribal women belonged to 18-25 years of age group, coming under CED category of underweight, 14% (42) were under normal range, whereas, only 1.3% and 1% belonged to overweight and obese category of malnourishment respectively. Twenty-one percentage (63) of the Lodha tribal women in the age group of 26-35 were in under underweight category of BMI, 7.7% of them belonged to normal BMI category and only 0.7% were overweight and obese category of CED. According to age groups (36-45 years age) categories,7.7% fell under underweight category of BMI classification, 6% belonged to normal category only 0.3% (1) represented the obese category of malnourishment (Table 6).This shows that there was no influence of age group on BMI of the Lodha tribal women (at 5% level of significance) but were positively correlated (rxy = 0.01212) with each other. Barbhuiya and Das (2013) reported a slight positive association (rxy=0.056) between age and BMI of adult Meiteis. Gopinath *et al.* (2018) observed that age had statistically significant ($p<0.05$) with malnutrition.

There was also relationship between income level and BMI of the Lodha tribal women. The tribal women (20.7%) belonged to the income groupof <Rs. 2000/- were coming under underweight category of BMI, 3.7% belonged to normal BMI category and only 0.7% belonged to overweight category of BMI, whereas, none of the tribal women belonged to obese category. Most of the lodha tribal women *i.e.* 31.7% of income groupRs. 2000-3000 were underweight, 13.6% were having normal BMI, but, only 1% and 0.7% belonged to overweight and obese category of malnourishment respectively. Both the malnutrition *i.e.* underweight (16%)and over weight (0.3%) and obese (0.7%) were seen among Rs.3000/- to 5000/- level of income range.However 10% of Lodha tribal women come in normal category of BMI. The statistical analysis correlation between income level of family and BMI of the Lodha tribal women showed a positive relationship between them. The Lodha tribe fell under normal category of BMI.The results indicated that there was relationship between income and BMI of the respondents and was statistically significant at 5% level of significance ($p=0$) and also positively correlated (rxy = 0.257413) with each other. Barbhuiya and Das (2013) found a significant positive association (rxy=0.215) between family income and BMI. Gopinath *et al.* (2018) reported a non significant relation between income and malnutrition.

Most of the Lodha tribal women were illiterate (86%) (Table 6). Among them, 64% belonged to underweight category of BMI and only 22% belonged to normal BMI category. Two percent of educated Lodha tribal women fell under over weight and obese category of BMI each and nearly 5.7% educated respondents belonged to normal category of BMI. Ghosh (2016) found association between literacy rate and undernutrition and reported that 93.22% subjects were illiterate. However, among them chances of being undernourished were 2.047 times more than literate one and it is concluded that maternal education played a major role in shaping nutritional status of the family members.

There was also association between type of family and BMI of the respondents. Majority (80.7%) were nuclear family and among them 23% belonged to normal category of BMI, whereas, 55% of the respondents were

underweight of BMI category and type of family and BMI were not related (non-significant relation). Gopinath *et al.* (2018) noticed statistically significant relation between family types with malnutrition.

CONCLUSION

The nutritional status among Lodha tribal women of reproductive age (18-45) category was found to be very low. Maximum of 68.7% of the tribal women come under underweight category of CED and 22.7% of the respondents were under normal category of CED. Only 2% of the respondents come under both overweight and obese category of CED indicating that the malnourishment was more in Lodha tribal women. Simultaneously, there was also an emerging trend of over nutrition and obesity on their society which cannot be over looked. Looking to this serious issues of under nourishment among the Lodha tribal women, required steps must be taken with target oriented efforts to suit to their culture easily acceptable to them. Frequent trainings, exposure visit and awareness programmes need to be arranged for them. The strategies must be properly planned from the bottom level approach considering sustainable food and adequate nutrition for health and nutritional development of Lodha tribal women.

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PREVALENCE OF ATTENTION DEFICIT HYPERACTIVITY DISORDER (ADHD) AMONG PRESCHOOLERS IN KOTTAYAM DISTRICT OF KERALA

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ABSTRACT

The study aims to determine the prevalence and gender differences of attention deficit hyperactivity disorder (ADHD) among preschoolers residing in the Kottayam district of Kerala. A total of 380 children aged between 4 and 5 years were selected through purposive sampling method from government and private schools during the year 2020-21. Fifteen preschools were selected after taking the consent of concerned authorities. Data was collected using the Vanderbilt ADHD rating scale IV preschool version (McGoey *et al*., 2007). The result of the study showed that 6% (23) of children had ADHD out of 380 children selected and this disorder was higher among boys with 3.4% (13) and 2.6% (10) among girls. However, the hyperactivity-impulsive type was more prevalent in boys and inattentive type in girls. Among the positive cases (23), children having hyperactivity type were 4.2% (16), inattention was 1.3% (5) and combined type was 0.5% (2).

Key Words: ADHD, Prevalence, pre-school children, Kottayam, Kerala

INTRODUCTION

ADHD is a common, chronic, and widespread childhood condition marked by developmentally inappropriate activity levels, impulsivity, and an inability to maintain attention and concentration. According to the Diagnostic and Statistical Manual of Mental Diseases, attention deficit hyperactivity disorder (ADHD) is characterized by widespread and debilitating symptoms of inattention, hyperactivity, and impulsivity (APA, 2013). The symptoms of ADHD must be evident before the age of seven years to meet the diagnostic criteria. ADHD has a high proportion of co-morbidity and has a substantial impact on school performance and family health even in the early stages of development (Josefa, 2016).The objective of the study was to find the gender difference and prevalence of attention deficit hyperactivity disorder among preschoolers in the Kottayam district of Kerala.

MATERIAL AND METHODS

The study was carried out in government and private schools located in the Kottayam district in the state of Kerala. Fifteen (15)

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preschool institutes were selected randomly after the consent of concerned authorities. The sample consisted of 380 children aged between 3-5 years selected through purposive sampling. The study was conducted in the academic year 2020-2021.An online survey using a structured questionnaire was used as the method of collecting data from the respondents. Parents of children were asked to complete the Vanderbilt ADHD rating scale. The scale consisted of 18 items with a three-point rating scale. Data obtained were analysed through the SPSS 20.0 version for windows. The qualities of the data collected from the sample were described and summarised using descriptive statistics. The chi-square test was used for estimating any difference in the sets that arose by chance.

RESULTS AND DISCUSSION

Demographic profile of the children

Table 1 lists the general information about the students who were chosen, such as their age, gender, and grade level.

Table 1 reveals that 234 children were 5 years old and which was the highest percentage (61.6%). Gender category consisted of 197 boys (51.8%) and 183 girls (48.2%). A majority of the 200 children were studying in the LKG class (52.6%).

Table 1. Demographic profile of the children (n=380)

S. No.	Category	Demographic variable	Frequency	Percentage
1	Age	4 years	146	38.4
		5 years	234	61.6
2	Gender	Boy	197	51.8
		Girl	183	48.2
3	Grade	L.K.G	200	52.6
		U.K.G	180	47.4

A total of 140 (95.8%) number of four-year old children had no symptoms of ADHD. Five (3.4%) children had hyperactive symptoms and only 1 (0.7%) child had both inattention and hyperactive symptoms. However, out of 234 five-year old children, 217 (92.7%) were normal, 5 (2.1%) had inattention, 11 (4.7%) were hyperactive and only 1 (0.4%) child had both inattention and hyperactivity symptoms. The test shows no significant difference based on age as the p-value is greater than 0.05 (Table 2).

Out of the 198 boys, 185 (94.4 %) were normal, one boy had inattention symptoms, 12 (6 %) were hyperactive and no child fell under combined type. Out of the 182 girls, 94 percent were normal, 4 (2.2 %) have inattention, 4 (2.7 %) were hyperactive and 2 (1.1 %) of the children belonged to the combined type. The Pearson Chi-Square test shows no significant difference based on age as the p-value is greater than 0.05 (Table 3).

Out of the 380 children, 6 (3.2%) girls and one (0.5%) boy were inattentive type. No

Classification of children based on age and gender

Table 2. Classification of children based on age (n=380)

S. No.	Age (in years)	Classification								Total children
		Normal		Inattention		Hyperactivity		Combined		
		Frequency	%	Frequency	%	Frequency	%	Frequency	%	
1	4	140	95.8	0	0.0	5	3.4	1	0.7	146
2	5	217	92.7	5	2.1	11	4.7	1	0.4	234
	Total	357	93.9	5	1.3	16	4.2	2	0.5	380
					Value		df		P-value	
Pearson Chi-Square					1.778		1		0.182	

Table 3. Classification of children based on gender

S. No.	Gender	Classification (n=380)							
		Normal		Inattention		Hyperactivity		Combined	
		Count	%	Count	%	Count	%	Count	%
1	Boy	185	94.4	1	0.5	12	6.0	0	0.0
2	Girl	172	94.0	4	2.2	4	2.7	2	1.1
	Total	357	94.2	5	1.3	16	4.2	2	0.5
					Value		df		P-value
Pearson Chi-Square					0.00173		1		0.967

symptoms of inattention were found in 196 (99.5%) boys and 178 (97.3%) girls. However, the p-value is less than 0.05 and hence significant (Table 4).

Hyperactivity symptoms were found in 10 (5.1 %) boys and 7 (3.8 %) girls. A total of 17 (4.5 %) children belonged to the hyperactive-impulsive type and the results are significant (Table 5).

The overall prevalence of ADHD was 6% out of 380 children selected for the study. These findings emphasize the importance of diagnosing ADHD in children at a young age in order to develop treatment strategies. (Joshi and Angolkar, 2018). One of the first studies to look at the incidence of ADHD in rural India highlighted the critical need for more study into the condition. (Anshuman, 2016). Ashraf and Razieh (2011) found informants regularly reported

Attention Deficit Hyperactivity Disorder (ADHD): Types and Gender Difference

Table 4. Inattentive type and gender difference (n=380)

Sl No	Gender	Inattentive type				Total
		No		Yes		
		Frequency	%	Frequency	%	
1	Boy	196	99.5	1	0.5	197
2	Girl	178	97.3	6	3.2	183
	Total	374	98.4	7	1.6	380
		Value		df		P-value
Pearson Chi-Square						0.010

Table 5. Hyperactive-Impulsive type and gender difference

Sl No	Gender	Hyperactive-Impulsive type				Total
		No		Yes		
		Count	%	Count	%	
1	Boy	187	94.9	10	5.1	197
2	Girl	176	96.2	7	3.8	183
	Total	363	95.5	17	4.5	380
		Value		df		P-value
Pearson Chi-Square						0.031

ADHD symptoms, possibly more by teachers than by parents, and teacher-parent agreement may be low. The findings may help to highlight the prevalence of ADHD in the population and the need to improve the quality of public health mental health services for the prevention and treatment of ADHD. (RioBianchini *et al*., 2013). The majority of ADHD children from a joint household and belonged to the lower middle class.(Pawan *et al*., 2020).

Hyperactive-impulsive symptom rate was higher than inattention symptom and the prevalence rate of ADHD was high among boys than girls. This is consistent with Visser *et al.* (2014) who found during the study period of 2003 to 2011, males had a continuously greater prevalence of ADHD than girls. According to Jyothsna and Anuja (2013) there is a significant prevalence of ADHD among elementary school students, with boys having a higher frequency than girls.

Results showed hyperactivity-impulsive type had a male predominance which agrees with the study of Jaisoorya *et al*. (2020) who reported that

4.3% self-reported symptoms for ADHD combined type, 1.8% for ADHD hyperactive-impulsive type and 1.4% for ADHD inattentive type with a male predominance in children attending school in India. They also claimed that clinically significant self-reported ADHD symptoms can be just as incapacitating as ADHD. Among the 23 children with ADHD, inattention was more prevalent in girls than boys. Sam *et al.* (2012) concluded that ADHD was significantly prevalent in boys than in girls. The prevalence of ADHD in school-going children aged between 5-12 years in Bengaluru was found to be 1.3%. Among the positive cases, children belonging to the hyperactivity type were 34.1%, inattention was 9.8% and combined type was 56.1% (Ramya, 2017). In comparision to western studies, the prevalence of ADHD and co-morbidity of bipolar disorder was lower in India. (Kuppili *et al.*, 2017).

CONCLUSION

The overall prevalence rate of ADHD was found to be 6% (23) with 3.4% (13) among the boys and 2.6% (10) among the girls in preschoolers out of the 380 children selected for the study. The prevalence rate of attention deficit hyperactivity disorder (ADHD) was high among boys than girls. The results also recommend the need for screening, early diagnosis and treatment of attention deficit hyperactivity disorder (ADHD) in preschool-age children.

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UTILISATION OF PASSION FRUIT AND MANGO FOR THE DEVELOPMENT OF A PROBIOTIC DRINK

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ABSTRACT

Probiotics are increasingly being added to food products in order to develop functional foods with health promoting effects. Hence, an attempt was made to develop a probiotic drink containing passion fruit and mango involving *L. acidophilus*.In the study, five treatments (along with one control) with three replications were standardized. The most acceptable combination (50% Passion fruit + 50 % Mango) of the drink was pasteurised at 80^0C for 20 minutes and allowed to cool. The pasteurised drink was then inoculated with 4il *L.acidophilus* and incubated for a period of one hour at 37^0C which had availability of 13. 35 log cfu g^{-1}.The probiotic passion fruit based drink along with its control(non-probiotic drink) had TSS content of 12.50 and 13.20 ^{0}Brix, titratable acidity of 1.98 % and 1.60 % , total sugar 16.66 and 17.10 g 100 g^{-1}, reducing sugar 4.08 and 4.40 g 100 g^{-1}, protein 0.70 and 0.36 g 100 g^{-1}, carbohydrate 13.32 and 14.72 100 g^{-1}, energy of 56.08 and 60.32 Kcal, ascorbic acid of 10 mg 100 g^{-1} and 13.7 mg 100 $g^{-1}$and total ash 1.60 % and 1.52 %, respectively.

Keywords: Passion fruit, *Lactobacillus acidophilus*, Mango, Viability, Sensory evaluation

INTRODUCTION

Probiotics are live microorganisms when administered in adequate amounts confer a health benefit on the host (WHO, 2001). Probiotic foods are those foods which contain a live microbiological culture either as a result of fermentation or as an intentional addition to benefit the host by improving the intestinal microbial balance. Addition of probiotics to food provides several health benefits such as decreasing the number of pathogenic gastrointestinal microorganisms, reducing the serum cholesterol level, improving the gastrointestinal function, strengthening immune system, protection of proteins and lipids from oxidative damage and has anticarcinogenic and antimutagenic effects.

The incorporation of probiotics to underutilised fruits can improve their acceptability and market potential. Such products may also have better profile of nutrients and therapeutic value. Yellow passion fruit (*Passiflora edulis*

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flavicarpa), which is native to the tropical Americas, is considered as an underutilized fruit crop but can be a good source of vitamins, like A and Cand minerals.

Passion fruit is not only nutritious but also has a variety of health care functions, such as refreshing, solve thirst, help digestion, improve renal function, eliminate fatigue and other effects (Liu *et al*., 2017). Passion fruit contains anti-inflammatory, anticonvulsant, antimicrobial, anticancer, antidiabetic, antihypertensive, antisedative, antioxidant properties and is used in treating conditions such as osteoarthritis, asthma and also act as colon cleanser. The different parts of the plants have also been used for treatment of ulcers, haemorrhoids, as sedatives, remedy for insomnia, digestive stimulant and remedy for gastric carcinoma (Thokchom and Mandal, 2017).The fiber and carbohydrate content of mango have been identified as beneficial to probiotic microorganisms during cold storage. A major challenge of adding probiotic microorganisms to fruit beverages is the impact on sensory attributes as a result of bacterial metabolism.The exotic components and sweetness of mango, and the acid balance help to lower the impact of bacterial metabolites and mask off flavors produced and attribute to the acceptance of mango based probiotic drinks (Acevedo-Martinez *et* al., 2018). Considering these factors, passion fruit and mango were selected for the incorporation of probiotics. If a probiotic product is developed from these fruit, it would definitely attract consumer attention and improve its economic value.

MATERIAL AND METHODS

The study was carried out from 2018 to 2020 at College of Agriculture, Kerala Agricultural University, Thrissur,Kerala. For the study, ripe passion fruit (yellow variety) and mango were collected from Cashew Research Station and Pineapple Research Stations of Kerala Agricultural University. Pure cultures of the probiotic strain *L. acidophilus* MTCC 10307 needed for the study was obtained from Institute of Microbial Technology (IMTECH), Chandigarh. All other ingredients needed for the study were purchased from the local market.

Standardisation of passion fruit drink

For the preparation of passion fruit based drink, the standard procedure of the FSSAI (2010) was followed.The quantity of ingredients used for preparation of drink was taken by calculating the acidity and TSS of the sample and then adding other ingredients in accurate quantity to maintain the FSSAI limits. Juices were strained and measured. Sugar syrup was prepared by heating appropriate amount of sugar in required amount of water. After cooling, measured quantity of juice was mixed with sugar syrup. It was then pasteurized at 80^0C for 20 minutes.

Organoleptic evaluation

Organoleptic evaluation of the drinks were conducted using a score card (9 point hedonic scale) by a panel of 15 judges. A series of acceptability trials were carried out using simple triangle test at the laboratory level to select the panel of judges between the age group of 18-35 years as suggested by Jellinek(1985). Based on the organoleptic qualities the best combination of the drink was selected.

Development of passion fruit based probiotic drink

The selected fruit drink (25 ml) was pasteurised at 80^0C for 20 minutes and allowed to cool. The pasteurised drink was then inoculated with 4ìl *L. acidophilus* and incubated for a period of one hour at 37^0 C. The probiotic passion fruit based drinks along with their control (non-probiotic drink) were then packed in food grade plastic bottles and stored under refrigerated conditions (Fig.1.).

Viability of *L. acidophilus* in passion fruit based probiotic drink

The viable count of *L. acidophilus* present in the passion fruit based probiotic drink was enumerated by serial dilution and plate count method as detailed by Agarwal and Hasija (1986). The microbial enumeration was completed by pour plate method using MRS agar and the results are expressed as 10^9 $cfug^{-1}$.

Physicochemical qualities of the drinks

The developed probiotic drink along with its control (non-probiotic sample) was assessed for TSS, titratable acidity, reducing sugar and total sugar according to the method of Ranganna (1986). Protein, carbohydrate, energy and ascorbic acid of the drinks were determined according to the standard procedure of Sadasivan and Manickam (1992). Total ash was analysed by the procedure of AOAC (1994).

Statistical analysis

The observations were analysed statistically in completely randomised design (CRD). The scores of organoleptic evaluations were assessed by Kendall's coefficient of concordance and the differences among treatments in nutritional qualities were assessed using Duncan's multiple range test (DMRT).

RESULTS AND DISCUSSION

Standardisation of combination of ingredients in the drink

In passion fruit based drink, different combinations of passion fruit juice and mango juice were tried(Table 1), in which, the percentage of passion fruit juice varied from 50 to 90 and percentage of mango juice varied from 10 to 50. Blending of two or more juices enable to produce beverages of superior quality with sensory,nutritional and medicinal properties (Bhagwan and Awadhesh, 2014). The mean scores for the organoleptic evaluation of passion fruit based mango drinks(Table 2), revealed that the treatment which contained 50 percent passion fruit juice and 50 percent mango juice (T_5) scored maximum for the organoleptic attributes except for texture. This combination secured a mean score of 8.84, 8.71, 8.48, 8.02, 7.84 and 8.37 for appearance, colour, flavour, texture, taste and overall acceptability, respectively and thetotal score of this treatment was 50.26. The scores of organoleptic evaluations were assessed by Kendall's coefficient of concordance and it was found that there was agreement between the judges. A passion fruit nectar developed by Charan (2016) had total score of 52.1, 50.9 and 47.3, respectively for first, second and third months of storage under ambient conditions. Mango and passion fruit (80:20) smoothie beverage prepared by Gallina *et al.* (2019) revealed that the overall acceptability of the product was 7.40 with good aroma and flavour.

Viability of *L. acidophilus* in passion fruit based probiotic drink

L. acidophilus present in the drinks was enumerated (Table 3). The viable count of *L. acidophilus* was 13.35 log cfu g^{-1} as against the desired level of 8 log cfu g^{-1} in probiotic foods.

Recently, Monteiro *et al*. (2020)reported that passion fruit pulp act as a good medium for probiotic culture, when fermented at a temperature of 30^{0}C. The researchers also concluded that presence of phenolic compounds and other acidic molecules can be the reason for probiotic production. This can provide health benefits because of the combination of probiotic properties and also properties of bioactive compounds.Ranjitha *et al.* (2018) developed a probiotic mango RTS using *Lactobacillus rhamnosus* and reported that the cell count was 8.25± 0.21, 9.07± 0.5 and 9.1±0.32 log cfu ml^{-1} during second, fourth and sixth days of incubation period, respectively. Mango RTS beverage inoculated with *Lactobacillus helveticus* MTCC 5463 has the potential for development of probiotic mango beverage as they showed good sensory attributes and also higher concentration of phenolic compounds and flavonoids after fermentation.

Physico- chemical qualities of the drinks

The physico-chemical qualities such asTSS, titrable acidity, total sugar, reducing sugar, protein, carbohydrate, energy, ascorbic acid and total ash in the probiotic and non-probiotic drinks were analysed (Table 4).There was significant reduction in the TSS content of probiotic drink (12.50^o Brix) compared to non-probiotic drinks (13.20^o Brix). During fermentation, the probiotic organism produces lactic acid by hydrolysing starch. This metabolic activity convert starch to fermentable simple sugars which is used by probiotic organisms (Adams *et al*., 2008).

It was observed that there was significant increase in titratable acidity of probiotic drinks (1.98) compared to non-probiotic drink (1.60).Titratable acidity increased significantly (Pd”0.05) with increasing fermentation time irrespective of the medium. Similar findings were observed by Shukla (2013), in which, whey-pineapple juice blend gave higher titratable acidity for five and 10 hours of fermentation.

The probiotic drinks showed a significantly lower content of total sugar and reducing sugar compared to non-probiotic drink. Fernandes *et al*. (2011) also opined that there was a difference in total sugar and reducing sugar on pasteurising passion fruit juice. The pasteurized juice had 9.63 % total sugar and 8.33 % reducing sugar content.

A higher value of protein content was observed in the probiotic drink (0.70 g 100 g^{-1}) than non-probiotic control (0.36 g 100 g^{-1}). The carbohydrate content was higher in non-probioticjuice compared to probiotic samples. Total energy content was 60.32Kcal and 56.08 Kcal in non-probiotic and probiotic drinks, respectively. Stanton*et al*. (2005) reported that both genera *Lactobacillus* and *Bifidobacterium* were reported to have high requirements of free aminoacids, peptides, vitamins and fermentable carbohydrates for their growth and development. The reduction in energy content of probiotic drink compared to non-probiotic drink was due to higher carbohydrate and fat content in fresh juice than probiotic juice (Rafiq *et al*., 2016).

Table 1. Proportion of ingredients in the prepared passion fruit-mango drinks

Treatments	Combinations
T_0(Passion fruit) - Control	100%
T_1 (Passion fruit + Mango)	90% + 10 %
T_2 (Passion fruit + Mango)	80% + 20 %
T_3 (Passion fruit + Mango)	70% + 30 %
T_4 (Passion fruit + Mango)	60% + 40 %
T_5 (Passion fruit + Mango)	50% + 50 %

Table 2. Mean score and mean rank scores for the organoleptic qualities of prepared passion fruit-mango drinks

Treatments	Mean score						
	Appea -rance	Colour	Flavour	Texture	Taste	Overall Accep -tability	Total Score
T_{0-} Control (100% Passion fruit)	8.57 (3.93)	8.48 (4.30)	7.88 (3.07)	8.04 (4.47)	7.82 (4.47)	8.10 (4.13)	48.89
T_1 (90% Passion fruit +10% Mango)	8.35 (2.80)	8.00 (2.00)	7.82 (2.93)	7.26 (2.53)	6.77 (2.80)	7.64 (4.03)	45.84
T_2 (80% Passion fruit + 20% Mango)	8.33 (2.97)	8.02 (2.37)	7.88 (3.00)	7.64 (3.07)	7.17 (2.77)	7.80 (3.60)	46.84
T_3(70% Passion fruit + 30% Mango)	8.55 (3.47)	8.17 (3.07)	7.95 (3.27)	7.91 (3.70)	7.46 (3.40)	8.00 (3.00)	48.04
T_4 (60% Passion fruit + 40% Mango)	8.57 (3.53)	8.24 (3.47)	7.97 (3.23)	7.82 (3.73)	7.56 (3.77)	8.03 (2.93)	48.19
T_5(50% Passion fruit + 50% Mango)	8.84 (4.30)	8.71 (4.43)	8.48 (4.50)	8.02 (4.43)	7.84 (4.80)	8.37 (4.30)	50.26
Kendall's W value	0.12	0.37	0.31	0.38	0.37	0.23	

Values in parenthesis are mean rank score based on Kendall's W

Table 3. Viable cell count of *L. acidophilus* in the prepared drinks

Fruit juice drink	Viable count (log cfu g^{-1})
Non-probiotic drink	Nil
Probiotic drink	13.35

Table 4. Physico-chemical qualities of the prepared drinks

Treatments	TSS (°Brix)	Titrable acidity (%)	Total Sugars ($g100g^{-1}$)	Reducing sugars ($g\ 100g^{-1}$)	Protein ($g100g^{-1}$)	Carbohydrate ($g100g^{-1}$)	Energy (Kcal)	Ascorbic acid ($mg100g^{-1}$)	Total ash (%)
Non Probiotic (control)	13.20^{a}	1.60^{b}	17.10^{a}	4.40^{a}	0.36^{b}	14.72^{a}	60.32^{a}	13.70^{a}	1.52^{b}
Probiotic	12.50^{b}	1.98^{a}	16.66^{b}	4.08^{b}	0.70^{a}	13.32^{b}	56.08^{b}	10.00^{b}	1.60^{a}
CD Value@ 5 %	0.220	0.023	0.161	0.023	0.023	0.023	0.023	1.610	3.044
Significance	S	S	S	S	S	S	S	S	NS

S- Significant; NS- Non Significant; Values with different superscript differ significantly at 5% DMRT Column wise comparision

Fig.1. Passion fruit and mango based probiotic drink

Non-probiotic passion fruit and mango combination drink showed comparatively higher ascorbic content of 13.7 mg $100g^{-1}$ than the probiotic drink 10 mg $100g^{-1}$. Shukla *et al*. (2013) reported that reduction in ascorbic acid content of probiotic drinks may be due to pasteurisation of juice and exposure to light. The ascorbic acid content in RTS drink prepared by blending juices of passion fruit and cashew apple in different ratios such as 25:75, 50:50, 25:75 + ginger drops and 50:50 + ginger drops was 80.26 mg 100 g^{-1}, 79.73 mg 100 g^{-1}, 76.39 mg 100 g^{-1} and 79.29 mg 100 g^{-1}, respectively (Sobhana *et al*., 2011).The study reported non-significant changes in the total ash of probiotic and non-probioticdrinks. As stated by Jood and Khetarpaul (2005) bacterial culture might increase the bioavailability of various minerals but there need not be any change in the total mineral content in the probiotic foods.

CONCLUSION

The study revealed that good quality probiotic drink can be prepared by using 50 % passion fruit juice and 50 % mango juice with good acceptability, nutritional qualities and with a viable count of 13.35 log cfu/ ml. The probiotic passion fruit based drink had a TSS content of 12.50 ^{0}Brix, 1.98 percent titratable acidity, 16.66 g $100g^{-1}$ total sugar, 4.08 g 100 g^{-1} reducing sugar, 0.70 g $100g^{-1}$ protein,13.32 100 g^{-1} carbohydrate, 56.08 Kcal energy, 10 mg 100 g^{-1} ascorbic acid and a total ash 1.60 percent. It can be concluded that passion fruit can be a suitable substrate for the development of probiotic drinks.

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NUTRITIONAL STATUS ASSESSMENT OF FEMALE CANCER PATIENTS IN COCHIN, KERALA

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ABSTRACT

The study envisaged the assessment of nutritional, functional status and, Quality of Life (QoL) among selected female cancer patients undergoing cancer therapy. The findings suggested that breast cancer was the leading type of cancer and the majority of the patients were in the terminal stages of cancer. The Subjective Global Assessment (SGA) revealed that the majority of subjects belonged to the mildly-moderately nourished category. All the study subjects had an inadequate nutrient intake concerning energy, protein, fat, calcium, iron, and ascorbic acid. A statistically significant difference was evident between the actual and suggested nutrient intake. The mean values of physical, social/family, emotional and functional well-being using the FACT-G scale were computed to be 16.6, 18.8, 11.2, and 10.8, respectively showing that QoL was poor among study subjects, thus, impacting cancer therapy. The nutrient intake of the patients was compared with SGA grading and it was found that there was a statistically significant difference in the nutrient intake among the patients belonging to different nutritional status categories with the lowest intake in the severely malnourished.

INTRODUCTION

Cancer is a disease with multifactorial etiology that can result in death if not treated appropriately. Cancer is caused both by external factors, such as tobacco use, infectious organisms, and unhealthy diets as well as internal factors, such as inherited genetic mutations, hormones, and immune conditions respectively (American Cancer Society, 2016). According to Sung *et al.* (2021) there were estimated 19.3 million new cases and 10 million cancer deaths worldwide in 2020. In India, non-communicable diseases (NCDs) were estimated to account for 63 percent of all deaths, and cancer was one of the leading causes (9%) (Mathur *et al.,* 2020).

Breast cancer is the most frequently diagnosed cancer in women. Jemal *et al.* (2011) indicated a high prevalence of breast cancer among total new cancer cases and total deaths globally. It has been indicated by Sadi and Avvaru (2014) that breast cancer is set to overtake cervical cancer, which is the most common type of cancer among women in India. The study by Chaves *et al.* (2010) assessing the diversity of nutritional status suggested a likely relation between nutritional status, disease

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aggressiveness, and consequent association with prognosis. Malnutrition is common and globally impacts all cancer patients by increasing the risk of infection, delaying wound healing, increasing treatment toxicity, prolonging hospital stay, increasing health-related costs, thus, can result in shortened survival (Zamiri *et al.,* 2015 and Vergara *et al.,* 2013).

The SGA is a validated method of assessing nutritional status and predicting complications in many different patient groups, including patients with cancer (Bauer *et al.,* 2002).QoL encompasses the patient's view and perspective of their global health, physical, social, financial, psychosocial performances, as well as symptoms such as pain, fatigue, anorexia, nausea, sleep, sexual dysfunction, and depression (Vergara *et al.*, 2013). According to Heydarnejad *et al.* (2011), several illness-related factors exist that can affect QoLand it is of prime significance to evaluate QoL in cancer patients. Nutrition plays an important role in maintaining better QoL among cancer patients (Vergara *et al.*, 2013).The study evaluates the nutritional, functional, and QoL of selected female cancer patients in the Ernakulam district of Kerala. The primary objectives included nutritional assessment of the selected patients using Modified SGA (Detsky *et al*., 1987) and evaluating the QoL of cancer patients using the Functional Assessment of Cancer Therapy-General (FACT-G) scale (Cella *et al.,* 1993).

MATERIAL AND METHODS

Cancer patients were purposively selected from the female oncology ward of the hospital in Ernakulam, Kerala during the period August 2016 to January 2017. The study population comprised fifty Non-pregnant Non-Lactating (NPNL) women belonging to the age group of twenty years and above**.** Since we need to analyse the nutritional status based on the subjects' oral food intake and tolerance, those who were fed exclusively through enteral or parenteral feeding methods were excluded from the study. An interview schedule was formulated and pretested for data collection. Data regarding medical history, diagnosis, symptoms, and ongoing treatment were elicited using the interview schedule. The SGA evaluates nutritional status based on the patient's history and physical examination (Detsky *et al*., 1987 and Read *et al.,* 2006).In this study, dietary patterns before and after the diagnosis of cancer were evaluated. Twenty-four-hour dietary recall was conducted for two consecutive days, and the average nutrient intake among subjects was computed (Longvah *et al.,* 2017) and compared with the Recommended Dietary Allowances of ICMR (2010). The nutrient Adequacy Ratio (NAR) of the diets consumed was also computed (Hatloy *et al.,* 1998). To evaluate different outcomes of cancer treatment in clinical practice (Raoof *et al.,* 2015), QoL was measured using the FACT-G scale (Cella *et al.,* 1993). The latest version, FACT-G Spanish Version 4, was used in this study, which assesses the physical, social/ family, emotional and functional well-being of the subjects (Dapueto *et al.,* 2003). Data wasrecorded, validated, and stored using the Statistical Package for the Social Sciences (SPSS) Windows Software, version 20.0. Appropriate interpretation and analysis of the obtained data were carried out.

RESULTS AND DISCUSSION

Breast cancer was the most frequently occurring cancer, prevalent among 44 percent

of the patients and gynecological cancer (26 percent) was the second most common type. Lung cancer was the least prevalent cancer found in just two percent of study subjects. Nearly half of the subjects were in terminal stages of cancer (44%). It was found that 34 and 18 percent of subjects were in stage III and stage II of cancer, respectively. The cancer was localized in 62 percent of the patients and metastasis was evident among 38 percent (Table 1).

Only a few subjects were identified to have a family history of cancer and none reported a history of tobacco, alcohol, and cigarette usage. Risk factors associated with the incidence of breast cancer among subjects in the study included the history of overweight and obesity among 36.4 percent of the subjects. Only one among the breast cancer patients had a family history of breast cancer (Table 2).

On analyzing the dietary habits among subjects, a vast majority (74 percent) followed a four meal pattern before the diagnosis and after diagnosis. Only 22 percent reported the same meal pattern. There was a reduction to two meals per day due to reasons such as decreased appetite, nausea, taste changes, and difficulty in food consumption, respectively (Table 3).

Table 1. Details pertaining to cancer diagnosis among the patients

Variables	Frequency (Percentage)
Type of Cancer	
Breast cancer	22 (44)
Colorectal cancer	4 (8)
Head and Neck cancer	4 (8)
Gynecological cancer	13 (26)
Stomach cancer	3 (6)
Lung cancer	1 (2)
Non-Hodgkin's Lymphoma	3 (6)
Stage of cancer	
Stage I	2 (4)
Stage II	9 (18)
Stage III	17 (34)
Stage IV	22 (44)
Cancer localized or Metastasis	
Localized	31 (62)
Metastasis	19 (38)

Table 2. Risk factors associated with the incidence of breast cancer

n=9

Variables	Frequency (Percentage)
History of overweight and obesity	8 (36.4)
Family history of breast cancer	1 (4.5)

Table 3. Frequency of meal consumption among the patients

n=50

Frequency of meal consumption	Frequency(Percentage)	
	Before diagnosis	After diagnosis
Two meals per day	0 (0)	20 (40)
Three meals per day	13 (26)	19 (38)
Four meals per day	37 (74)	11(22)

Modifications were made in the diet of the study subjects after cancer diagnosis based on the dietary and treatment requirements as well as the acceptability of foods. Time lag since modifications were made were different among the subjects. The majority of subjects (82%) included high protein foods in their diet. More than half of the subjects restricted the number of meals (58%) and changed the consistency of the meal (52%). Fifty percent of the patients restricted the consumption of high fat foods (Table 4).

From the results pertaining to the daily nutrient intake, the mean values of nutrient intake among subjects were statistically significantly lower than the recommended levels (Table 5). The intake of energy (t= -29.622, p=0.0001), protein (t = -21.05, p=0.0001) and iron (t = -39.23, p=0.0001) were very low.

Table 4. Modifications made in the diet of subjects after cancer diagnosis

n=50

Variables	Frequency (Percentage)
Restricting the number of meals	29 (58)
Change in consistency of meals	26 (52)
Inclusion of high protein foods	41 (82)
Restricting the consumption of high fat foods	25 (50)
Inclusion of specific foods for the treatment of cancer	6 (12)

Table 5. Mean nutrient intake by the patients

Nutrients	Actual Intake(Mean±SD)	RDA	t value	P-value
Energy (kcal)	641.05 ± 300.53	1900	-29.62	0.0001*
Protein(g)	22.24 ± 11.00	55	-21.05	0.0001*
Fat(g)	13.87 ± 6.47	20	-6.70	0.0001*
Calcium(mg)	399.34 ± 191.37	600	-7.41	0.0001*
Iron (mg)	4.11 ± 3.04	21	-39.23	0.0001*
Ascorbic acid (mg)	19.97 ± 18.51	40	-7.65	0.0001*

*Significant at 5% level; 't' values showing a comparision of daily mean nutrient intake and Recommended Dietary Allowances (RDA)

Table 6. Nutrient Adequacy Ratio (NAR) of diets consumed by the patients

Nutrients	Frequency (Percentage)			
	I	II	III	IV
Energy (kcal)	0 (0)	1 (2)	7 (14)	42 (84)
Protein(g)	1 (2)	4 (8)	11 (22)	34 (68)
Fat(g)	8 (16)	17 (34)	4 (8)	21 (42)
Calcium(mg)	9 (18)	14 (28)	6 (12)	21 (42)
Iron (mg)	0(0)	1 (2)	0 (0)	49 (98)
Ascorbic acid (mg)	6 (12)	5 (10)	6 (12)	33 (66)

I = 100% and above RDA ('adequate' for all other nutrients except 'excessive' for energy)

II = 75 to 99% of RDA (marginally adequate); III = 50 to 74% of RDA (marginally inadequate)

IV = Below 50% of RDA ('grossly inadequate' for all nutrients where inadequate for energy intake)

The Nutrient Adequacy Ratios (NAR) was computed and the subjects were grouped into four categories viz., intake adequate, marginally adequate, marginally inadequate, and grossly inadequate. The daily intake of all nutrients was found to be grossly inadequate among a vast majority of the subjects (Table 6).

Details pertaining to the Modified Subjective Global Assessment (SGA) classification of study subjects are indicated in Figure 1. The relation between nutritional status and nutrient intake was studied further (Table 7). There were statistically significant differences in the nutrient intake with respect to energy, protein, fat, calcium, iron (p = 0.0001), and ascorbic acid (p=0.023) between the three SGA categories that are well-nourished, mildly moderately nourished, and severely malnourished.

On assessing the QoL and functional status of subjects it was found that mean values of a

Table 7. SGA scores versus daily nutrient intake among the patients

n= 50

Nutrients	SGA	N	Mean	Standard Deviation	P-value
Energy (kcal)	Well Nourished	11	989.30	287.20	
	Mildly- Moderately Nourished	22	652.26	209.95	0.0001*
	Severely Malnourished	17	401.22	150.09	
Protein (g)	Well Nourished	11	34.07	10.90	0.0001*
	Mildly-Moderately Nourished	22	22.50	8.26	
	Severely Malnourished	17	14.27	6.57	
Fat (g)	Well Nourished	11	19.46	6.87	
	Mildly-Moderately Nourished	22	14.58	5.06	0.0001*
	Severely Malnourished	17	9.34	4.58	
Calcium (mg)	Well Nourished	11	545.81	187.42	
	Mildly-Moderately Nourished	22	421.40	157.88	0.0001*
	Severely Malnourished	17	276.02	160.98	
Iron (mg)	Well Nourished	11	7.38	4.34	
	Mildly-Moderately Nourished	22	3.88	1.74	0.0001*
	Severely Malnourished	17	2.30	1.31	
Ascorbic Acid (mg)	Well Nourished	11	33.01	25.48	
	Mildly-Moderately Nourished	22	17.59	13.12	0.023*
	Severely Malnourished	17	14.60	16.20	

*Significant at 5% level.

majority of domains are half of the maximum score (Table 8).

The study results indicated that breast cancer was the most frequent type among the patients followed by gynecological cancer. The majority of subjects were in the terminal stages of cancer and under palliative treatment. The risk factors among breast cancer subjects were early menarche and overweight/ obesity. Only a few patients under study had a family history of cancer. Modifications were made in the diet consumed by the patients based on the

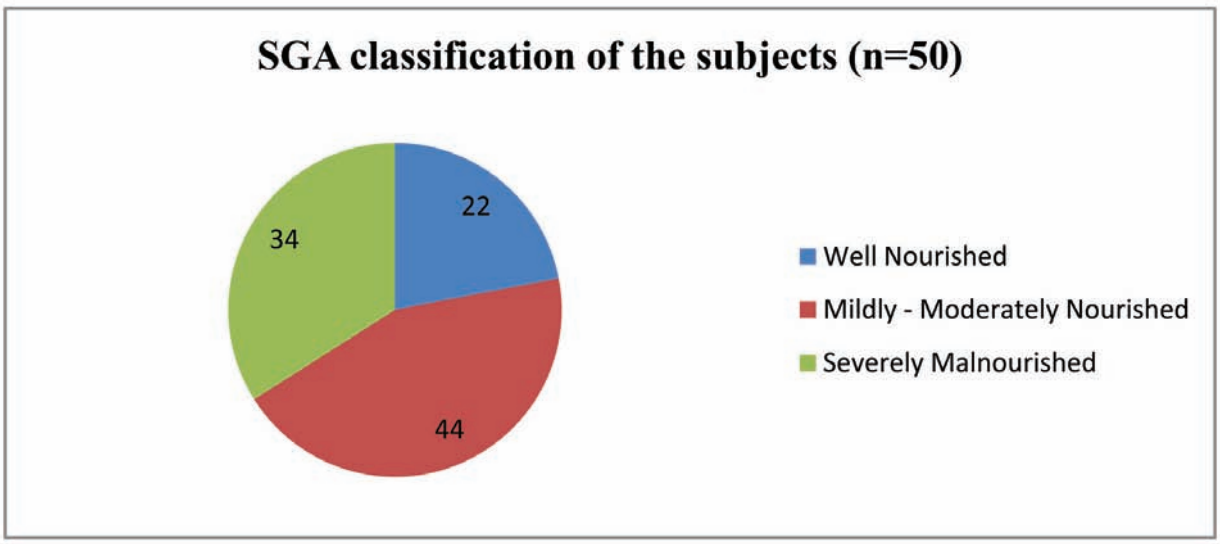

Fig. 1. Modified Subjective Global Assessment (SGA) classification of subjects (n=50)

Table 8. Quality of Life (QoL) and Functional Status of study subjects using FACT-G scale

n= 50

Domains of QoL	Mean± SD	Minimum	Maximum
Physical well-being (n=7)	16.6±7.06	5	28
Social/family well-being (n=7)	18.8±4.4	10	28
Emotional well-being (n=6)	11.2±5.5	2	22
Functional well-being (n=7)	10.8±4.4	4	22
FACT-G Total	57.5±8.6	44	75

requirements and acceptability of food. The frequency of meal consumption was low due to various reasons indicated viz., reduced appetite, nausea, taste changes, and difficulty in food consumption. As a result, the nutrient intake was grossly inadequate and subjectswere close to being malnourished as classified by SGA. Statistically significant differences were observed between QoL as measured by the FACT-G scores and the nutritional status as per SGA.

CONCLUSION

Breast cancer was the most common type of cancer among study subjects. All subjects had an inadequate nutrient intake with respect to energy, protein, fat, calcium, iron, and ascorbic acid. A statistically significant difference was evident between the actual and suggested nutrient intake. On studying the Nutrient Adequacy Ratio (NAR) gross inadequacy was observed in a vast majority of the subjects. On studying the nutritional status of subjects by Subjective Global Assessment more than three fourth of the subjects did not belong to the well-nourished category and approximately one-third were severely malnourished. The nutrient intake of subjects was compared with SGA grading and

it was found that there was a statistically significant difference in the nutrient intake among subjects belonging to different nutritional status categories with the lowest intake in the severely malnourished. The mean values of physical, social/family, emotional and functional well-being indicated that QoL was poor among the study subjects, thus, impacting cancer therapy. The existing poor nutritional status and inadequate nutrient intake contribute to the vicious cycle of malnutrition in cancer. Nutritional status assessment in cancer patients facilitates early detection of malnourished patients and allows for prompt nutritional intervention aiming to prevent nutritional deterioration and muscle wasting.

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BARRIERS FACED BY THE AGRI- ENTREPRENEURS OF KOTTAYAM DISTRICT DURING COVID-19 PANDEMIC

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ABSTRACT

The aim of the study conducted during the year 2020 was to identify the barriers faced by the agri-entrepreneurs of Kottayam district in the state of Kerala during the COVID-19 pandemic. Agri-entrepreneurs who were running enterprises in various agri-allied sectors such as value addition, fisheries, animal husbandry, and other enterprises such as mushroom, floriculture, and apiculture in the district were selected as sample. Confirmatory Factor Analysis (CFA) was used to determine the significance and impact of barriers on entrepreneurial activity. The results revealed a reversal of barriers normally faced by the entrepreneur. Barriers that were psychological in nature like gender role conflict and uncertainty had come to the fore replacing more enterprise-related like labour, finance and raw materials and social barriers like family and background.

Key Words: Agri entrepreneurs, Barriers, Confirmatory Factor Analysis, Entrepreneurship, Entrepreneurial activity.

INTRODUCTION

The COVID-19 pandemic has thrown open an opportunity to bring about a focus on the entrepreneur as an integral part of the community. Most studies on entrepreneurship have been based on economic, technical, financial, and management standpoints. The disruption caused by the pandemic has caused a reversal in outlook. The lockdown, stay-at-home orders, and work-at-home have caused issues such as uncertainty, gender role conflict, and community problems to come to the forefront.

Agri-entrepreneur is defined as, "An entrepreneur whose main business is agriculture or agriculture-related". India's economy is principally agriculture with approximately 60% of the population depending on it. Agriculture accounts for about 18% of the Gross Domestic Product (GDP) of the country. Thus agri-entrepreneurs have an important role in the Indian economy. Agriculture provides income to more than one billion people across the globe and is the backbone of many developing nations.

The pandemic affected India in the early months of 2020 and the government began a series of preventive measures to control the pandemic. These measures, considered to be one of the strictest in the world, caused significant hindrances to the production and distribution of agricultural products. Agri entrepreneurs, like

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every other part of the society, had been significantly affected by these measures, which brought about drastic changes to their economic situation, social behaviour and mental attitude. The changes were direct, indirect, short-term and long-term and have had a disruptive influence on the lives and livelihoods of agri-entrepreneurs. Earlier studies concentrated on the barriers faced by the entrepreneurs that were pre-pandemic, but now this study focuses on barriers faced by the entrepreneurs during the pandemic period. The objective of this article is to investigate the barriers that the agri-entrepreneurs faced during the pandemic crisis with an emphasis on psychological, social and enterprise level.

MATERIALS AND METHODS

The area selected for the study was Kottayam district of Kerala state and the samples

RESULT AND DISCUSSION

Demographic Profile of the Agri - entrepreneurs

Table 1. Demographic profile of the agri-entrepreneurs (n = 400)

Demographic Profile of the Agri Entrepreneur		Frequency	Percentage
1. Age	20-30 years	4	1.0
	30-40 years	48	12.0
	40-50 years	136	34.0
	50 and above	212	53.0
	Total	**400**	**100.0**
2. Gender	Male	288	72
	Female	112	28
	Total	**400**	**100**
3. Educational qualification	High school	100	25.0
	Intermediate	158	39.5
	Graduation	106	26.5
	Post-Graduation	36	9.0
	Total	**400**	**100.0**
4.Annual income (in Rs)	Up to 50000	36	9.0
	50001-100000	48	12.0
	100001-500000	216	54.0
	500000-1000000	68	17.0
	Above 10 lakhs	32	8.0
	Total	**400**	**100.0**

were agri-entrepreneurs running enterprises in various agri-allied sectors for a minimum of three years. Purposive sampling method was adopted to draw the sample from 48 villages covering 5 taluks of the district. The various allied sectors were classified into four sectors such as value addition, fisheries, animal husbandry and other enterprises (which included mushroom, floriculture and apiculture). A total number of 100 agri- entrepreneurs engaged in these sectors were selected. Thus, a total of 400 agri-entrepreneurs were identified as the sample of the study. The study was conducted during the year 2020. Primary data used for this study was gathered from a pre-structured questionnaire, as well as informal discussion with the agri-entrepreneurs during the survey. The demographic profile, classification of agri-entrepreneurs was described by using simple descriptive statistics such as frequency and percentages. Confirmatory Factor Analysis (CFA) was used to determine the significance and impact of barriers on entrepreneurial activity. (Fig.1)

Agri-entrepreneurs were aged from 20 to 50 and above with the majority being 50 and above, with 72 percent being male. A majority had an intermediate educational level with 54 percent having an annual income in the range of Rs.100001- Rs.500000. (Table 1)

Table 2. Classification of Agri-Entrepreneurs into various Agri-Allied Sectors (n=400)

Sector	Enterprise	Frequency	Percentage
Value addition(n=100)	Milk and milk products	04	4
	Fruit and Vegetable products	96	96
Fisheries(n=100)	Fisheries	100	100
Animal Husbandry(n=100)	Dairy management	48	48
	Poultry	28	28
	Duck rearing	08	8
	Goat rearing	16	16
Others(n=100)	Floriculture	28	28
	Apiculture	40	40
	Mushroom	32	32

The model fit indices for CFA, Barriers on Entrepreneurial activity

Table 3. The model fit indices for CFA-Barriers on Entrepreneurial activity

	÷2	DF	P	Normed ÷2	GFI	AGFI	NFI	TLI	CFI	RMR	RMSEA
Barriers	237.391	108	.000	2.198	.946	.895	.939	.939	.965	.061	.055

All the attributes loaded significantly on the latent constructs. The value of the fit indices indicates a reasonable fit of the measurement model with data (Table 3).

Table 4. The Regression Coefficients - Barriers on Entrepreneurial activity

Factors/ Latent Variables (Dependent Variable)	Construct (Independent Variable)	Regression Coefficient	C.R.	P	Variance explained (%)	Rank
	Availability of Finance (B1)	0.263	5.366	<0.001	6.9	20
	Availability of Labour (B2)	0.472	10.214	<0.001	22.3	13
	Availability of raw materials (B3)	0.566	12.784	<0.001	3.2	8
	External negative experiences (B4)	0.292	5.992	<0.001	8.5	18
	Personal negative experiences (B5)	0.704	17.438	<0.001	49.6	4
	Caste (B6)	0.288	5.905	<0.001	8.3	19
	Corruption(B7)	0.477	10.343	<0.001	22.7	12
	Lack of Training(B8)	0.518	11.429	<0.001	26.8	11
	Environmental conditions (B9)	0.430	9.163	<0.001	18.5	15
	Family (B10)	0.461	9.934	<0.001	21.3	14
Barriers	Risk bearing ability (B11)	0.647	15.345	<0.001	41.9	7
	Lack of support from friends (B12)	0.563	12.696	<0.001	31.7	9
	Government policies (B13)	0.652	15.517	<0.001	42.5	6
	Gender Role conflict (B14)	0.807	22.283	<0.001	65.2	1
	Routine problems (B15)	0.709	17.637	<0.001	50.2	3
	Background (B16)	0.534	11.870	<0.001	28.5	10
	Uncertainty (B17)	0.795	21.616	<0.001	63.3	2
	Social Status (B18)	0.363	7.578	<0.001	13.2	16
	Society based (B19)	0.299	6.145	<0.001	8.9	17
	Conventional methods (B20)	0.662	15.867	<0.001	43.9	5

Classification of agri-entrepreneurs into various agri-allied sectors

Agri-entrepreneurs were classified into various agri-allied sectors and presented in Table 2

Different types of agri-allied sectors practiced in Kottayam district and the classification of identified agri-entrepreneurs based on value addition, fisheries, animal husbandry, and other enterprises including floriculture, apiculture, and mushroom was shown. Ninety six percent value addition was noticed in fruits and vegetable products.

The Regression Coefficients-Barriers on Entrepreneurial activity

The Regression Coefficients - Barriers on Entrepreneurial activity is discussed in Table 4.

For the study, twenty independent variables (B1 to B20) were identified. Considering these independent variables, twenty corresponding hypotheses numbered H1 to H20 were also formulated by stating that these variables are barriers to entrepreneurial activity.

The results exhibited in Table 4 reveal that out of the twenty independent variables, fifteen variables were identified as barriers to entrepreneurial activity as the standardized direct effect of these constructs on barriers is more than the recommended value of 0.4 (p-value significant). Therefore, the hypotheses formulated, corresponding to these fifteen variables, were accepted. The remaining five independent variables were not identified as barriers to entrepreneurial activity as the standardized direct effect of these constructs on barriers was found to be less than the recommended value of 0.4 (p-value significant). Therefore, the hypotheses formulated corresponding to the remaining five variables *i.e.,* (social status, society based, external negative experiences, caste, and availability of finance) were rejected.

The variables identified as barriers were categorized into psychological, social, and enterprise-based. They are discussed below.

Psychological barriers

'Gender role conflict' was the most encountered psychological barrier with the maximum value of regression coefficient of 0.807 and ranked 1. This was due to the change in duties at home, job losses, work-at-home arrangements, working hours, and closure of businesses along with the school closures as well as the non-availability of various services. All these together brought changes to the division of labour in the household and exacerbated the gender role conflict. These findings were in agreement with Zamarro *et al.* (2021) who found that such changes drastically magnified gender differences. Alon *et al.* (2020) and Brodeur*, et al.* (2020) reported similar results of negative impacts on working women and gender roles. Béland *et al*. (2020) stated that it was the financial obligation due to COVID-19 that contributed to the gender role conflict. On the contrary, Sevilla and Smith (2020) found a small change towards equal allocation of childcare when men were working from home. Gender role conflict is a barrier to entrepreneurial performance. This is in line with De Simone *et al.* (2021) who stated that a high work-family conflict is not conducive to entrepreneurial performances.

The psychological barrier, 'uncertainty', with a regression coefficient value of 0.795 was

ranked second. The length of the lockdown, the economic downturn, the supply-side disruptions, consumer spending changes, and the bankruptcy of enterprises along with worries about health had increased uncertainty. This was supported by Zavras (2020) who noted that both economic and health-related factors influenced the rise of uncertainty during COVID-19. Altig *et al.* (2020) concluded that the massive spike in economic uncertainty was caused by "suddenness and enormity of the massive job losses and the severity of the economic contraction relative to the size of the mortality shock." Godinic *et al.* (2020) focused on the aspect of uncertainty as a long-term state of general panic, worry, anxiety. Kuckertz and Brändle (2021) pointed out that uncertainty caused by the pandemic went beyond levels that entrepreneurs normally faced.

The next psychological barrier was 'routine problems' *i.e.,* lack of structure, with a regression coefficient of 0.709 ranked 3rd. The routine of daily direct social interaction was an immediate casualty of the lockdown and stay at home. Other than the direct loss of income, there was a loss in the structure and custom of daily work, which further increased psychological and emotional problems resulting in the loss of motivation, meaning, and self-worth. This was corroborated by Williams *et al.* (2020) who described that the "loss of income and loss of structure and routine led to psychological and emotional 'losses' such as loss of motivation, loss of meaning and loss of self-worth". However, conversely, Tull *et al.* (2020) found that COVID-19 impact on daily life was associated with increased social support. Brooks *et al*. (2020) opined that frustration was exacerbated by not being able to take part in usual day-to-day activities.

The other psychological barriers were 'personal negative experiences' with a regression coefficient of 0.704, ranked 4th and followed by 'risk bearing ability' with a regression coefficient of 0.647 and ranked seven. Psychological distress ranging across anxiety, depression, adjustment disorder and insomnia, due to the enforced lockdown and stay-at-home orders were personal negative experiences that turned into barriers for entrepreneurial activity. Zarceño *et al.* (2021) reported that around 30% of the general population have suffered from such psychological problems based on various COVID-19 confinement studies.

Risk aversion became a factor due to the overarching fear amongst the populace. Debt aversion too is a form of risk aversion in entrepreneurs and Mikael *et al.* (2021) finds that debt-averse entrepreneurs show reluctance to take either debt or debt-based COVID-19 rescue packages. It was also found that such aversion leads to canceling of investments, laying off workers, or wages remaining unpaid.

Social barriers

The social barriers recognized were 'lack of support from friends', 'background' and 'family', with a value of regression coefficient of 0.563, 0.534, and 0.461 and ranked 9, 10, and 14, respectively. Family harmony was an indirect casualty of the pandemic.The stay-at-home orders, home quarantines, and online classes compounded the existing family problems. Along with this job losses and financial difficulties increased the frequency of domestic violence. A similar pattern was seen in the results by Afifah (2021) and the study further showed that lack of family harmony had a significant impact on stress.

The effect of the pandemic friendships was similar to the one seen in families. The period was not conducive to friendships either. Brooks *et al.* (2020) points out that there is a greater risk for psychological disorders and anxiety because of the loss of social interaction like friendship.The background environment was also seen as a barrier, and these findings are in accordance with Hitt *et al.* (2020) who reported that the background environment was one with barriers of short term discontinuities and significant uncertainties and that the easing of the pandemic may result in an environment with longer-term changes in the technology, society, and institutions.

Enterprise-based barriers

The enterprise-based barriers were 'conventional methods', 'government policies', 'availability of raw materials', 'lack of training', 'corruption', 'availability of labour', and 'environmental conditions'. 'Conventional methods' were seen as a barrier with the value of regression coefficient of 0.662 and ranked 5$^{th.}$. Conventional methods were the traditional methods used by the entrepreneur in their activities, however, these became barriers with the onset of the pandemic. These findings were consistent with the research by Bărbulescu *et al*. (2021) where it was shown that the pandemic had affected almost every aspect of life and successful methods used historically had become unfeasible and this forced a review of all existing conventional practices.

'Government policies' were also encountered as a barrier with the regression coefficient of 0.652 and ranked 6. Even though there were many schemes by the government, these were not found to be very supportive by the entrepreneurs. This is inconsistent with what has been found by Kumar *et al* (2021) who reported that the relief packages and other initiatives launched by the government and local administrations aimed at sustaining farming systems have enjoyed some success.

Another enterprise-based barrier was 'availability of raw material' with the value of regression coefficient 0.566 and ranked eight. Enterprises had to cease operations due to the lack of raw material as transportation was shut down throughout the country. Similarly, Agrawal *et al.* (2020) also concluded that the pandemic had affected manufacturing firms and supply chain across the world resulting in shortages of raw materials for all sectors including agriculture.

'Lack of training' was recognized as a barrier, with the regression coefficient value of 0.518 and ranked 11. The pandemic brought about a change in the way normal business was done. And the entrepreneurs felt that they lacked the training to use these new systems efficiently. These findings are consistent with research by Junusi (2020) who reported that online systems for communication, marketing, and payment became predominant and a lack of training in the use of these systems became a barrier.

'Corruption' was felt as a barrier and with a regression coefficient of 0.477 was ranked 12. The entrepreneurs felt that lockdown restrictions were disproportionately applied across different sectors and classes of people. Steingrüber *et al.* (2020) had come with a similar conclusion and stated that the pandemic increased corruption-related incidents and this emphasizes the importance of transparency and accountability efforts.

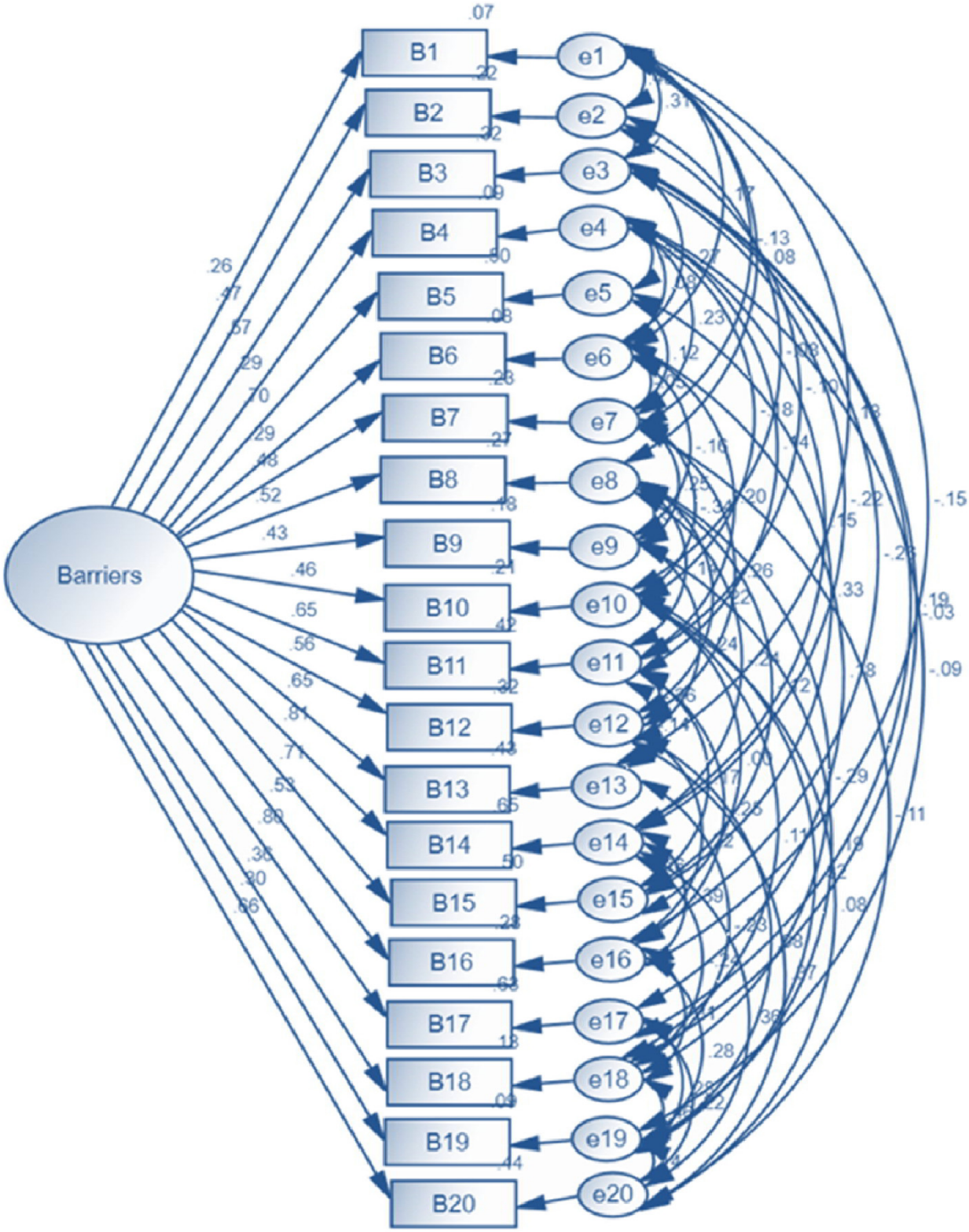

Fig.1. Confirmatory Factor Analysis

Another barrier was the 'availability of labour' with the regression coefficient of 0.472 and ranked 13. The entrepreneurs were dependent on migrant labour and during the pandemic, they had returned to their villages. This result agrees well with Mukherjee *et al*. (2020) who pointed out the effects of the reverse migration of the labour community.

The next identified barrier was the 'Environmental Conditions' having a regression coefficient of 0.430 and ranked 15. Even during the pandemic, there was no reduction in natural disasters that affected the entrepreneurs. This was supported by Hallema *et al*. (2020) who reported that the environmental changes during the pandemic like floods, cyclones, etc had a greater negative effect than during normal times.

Before the pandemic times, the significant barriers were mostly related to the enterprise like finance, marketing, etc. But during the pandemic, the most significant barriers were psychological in nature, with gender role conflict, uncertainty, and routine problems coming to the fore as the most important barriers. Therefore, it was recorded that there is a reversal of barriers normally faced by entrepreneurs.

CONCLUSION

The COVID-19 pandemic has had an unprecedented outcome on the world. The intensity of the impact has been significant across different sectors, and likewise, the agricultural sector has also encountered various barriers due to the lockdown and other restrictive measures. The study showed a reversal of barriers faced by the entrepreneurs. Barriers that were psychological in nature such as gender role conflict and uncertainty had come to the forefront replacing more enterprise-related barriers like labour, finance, and raw materials.

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FARMERS AWARENESS ON RESPONSIBLE USE OF PESTICIDES IN CUCURBIT GROWING AREAS OF GUNTUR DISTRICT

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ABSTRACT

The study on farmer's awareness on pesticides use and handling was conducted in cucurbit growing areas of Guntur district during the year 2020. A large number of cucurbit farmers (86.7%) were not aware about the registered and recommended pesticides on cucurbits as per the Insecticide Act, 1968, while, only 6.6% were aware about the ban of 'monocrotophos' on vegetables. All cucurbit farmers consulted pesticide dealers as source of recommendations, whereas, few young farmers consult Agricultural Officers in addition to the dealer. About 56.7% farmer's measured pesticide approximately, others used measuring cup while preparing spray fluid and all the farmers used stick for mixing spray fluid. More than half of the spray men (57.0%) did not use any kind of personal protection equipment, while, 20.0% wore separate clothes with full-sleeves covering the entire hands, only 17.0% spray men wear gloves, and only 6.7% used face mask. Empty pesticide bottles are re-used for household purposes by 33.3% of the farmers, and most of the farmers (86%) throw the empty / used pesticide bottles /containers in trash bins or open fields, and none of the farmers were aware of the proper disposal methods.

INTRODUCTION

Vegetables are important components of the human diet as they provide nutrition, and importantly cucurbits as a rich source of proteins, carbohydrates, vitamins, and minerals, grown in tropics and temperate areas. The cucurbit farmers' usually spray pesticides once in a week for insect pest management, importantly for leaf miner, fruit fly, beetles, etc. In view of the safety to spray men and environment, it is important to follow good practices during and after spraying. In India, about 13 to 14 percent of the total pesticides used in agriculture go to fruits and vegetable crops (IIVR, 2013) covering only three percent of the cropped area. Repeated application of pesticides on vegetables often results in the buildup of their residues and studies carried out in the country indicated that 50%-70% of the vegetables were detected with insecticide residues (Cherukuri *et al*., 2014). Furthermore, the responsible use of pesticides not only addresses the personal safety issues of the farmers, however, also addresses food

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safety *i.e.,* pesticide residues in food and environmental pollution. Keeping view of all these important problems, the study aimed to understand about the pesticide use pattern and existing practices in pesticide use and handling among cucurbit farmers in intensive cucurbit growing area of Narakoduru in Guntur district of Andhra Pradesh.

MATERIAL AND METHODS

The study was conducted during 2020 in intensive cucurbit growing area by selecting farmers' in Narakoduru locality (between 16.226258°N and 80.514671°E) of Guntur district. The area was purposefully selected as the farmers are known for growing cucurbit crops in large area in both creeping and pandal methods of cultivation over many years contributing majority of share to the total production of cucurbits in the state of Andhra Pradesh. A total of 30 cucurbit farmers were selected based on information from the Department of Horticulture and Agriculture. A focused group discussion (FGD) was conducted with all the selected farmers for collecting general information on age, education, type of cucurbit crop grown, farming area, season, sources available for pesticide recommendation, etc and visits were made on weekly intervals to all fields and on-site data on various parameters such as awareness / use of recommended / non-recommended/ banned pesticides, measurement of formulations, preparation of spray solutions, spraying practices, and disposal of empty containers was collected in a structured questionnaire format from spray men and farmers, for a period of eight months from April to November, 2020. The data collected was analysed using descriptive statistical tools *viz.,* frequency and percentage for the intended parameters to draw meaningful conclusions. Chi-Square test was used to measure the association between cucurbit farmers knowledge and pesticide handling practices with 95% CI.

RESULTS AND DISCUSSION

Majority of the cucurbit farmers in the study area were under the age group of 40-50 years (46.66%) followed by 30-40 years (26.66%) and>50 years (20.0%).Among all the farmers,43.33 percent of the farmers were illiterate, 20 percent had primary education, 16.66 percent completed high school education, 10percent each had secondary and college education, respectively (Table 1).The average land holding under cucurbit crops in the area was 0.5-1.0 acre (53.33%), whereas, 33.33 percent farmers cultivated their crop in 1.0 acre and above and only 13.33 percent farmers have grown their crop in less than 0.5 acre area. Based on the interaction with farmers, it was noted that the farmers' preferred to grow the crops in smaller areas as the crops are grown in pandal system and cultivation in large area might cause difficulties in intercultural and pest management practices. All farmers' were cultivating cucurbit vegetable crops during *kharif* season, whereas, 46.66 percent farmers were also growing during the *rabi* season, in view of assured water availability or irrigation source during *rabi* season (Table 1).

It was evident that the primary source of contact for advisories was the 'pesticide dealer' for pesticide recommendations. Cent percent of the farmers stated that they contacted dealers whenever the pest is noticed in the field, while few (13.33%) stated that they contacted Mandal Agricultural Officer (MAO).Only 6.67% farmers

consulted scientists, in addition to the dealers. All the farmers reported that they consulted Horticulture Officer/Agriculture Officer in case of serious pest infestations and out-breaks (Table 2). Based on the chi-square analysis, comparing literacy v/s contact person for pesticide advisory, it was clear that there was no relation (p=0.62), however, only educated farmers were contacting scientists. The studies on similar lines conducted by Sudhakar *et al*. (2016) and Swarupa *et al*. (2017) also reported that all vegetable farmers contacted pesticide dealers for pesticide recommendations. It was also evident that large majority of the farmers (86.67%) were not aware about the recommended pesticides on cucurbits against different pests, while, only 13.33% farmers stated that they were 'aware', and their unawareness might be because of their main contact was with only pesticide dealers, low literacy and lack of participation in specific extension activities. Shashi *et al*. (2016) and Sudhakar *et al*. (2016) reported that only 10 percent, and 16.67% of the respondents were aware of recommended pesticides against various pests, respectively.

Among the farmers, 96.67 percent were aware about the Government Order (G.O) on ban of endosulfan in India, however, only 6.67% were aware about the ban on the use of monocrotophos in cucurbits. The fact that most farmers were aware of the endosulfan ban in view of the non-availability in the market,while, majority of the farmers were unaware about monocrotophos ban on vegetables as it is not banned on all agricultural crops and is still available in the market (Table 2). These findings were in line with the reports of Shashi *et al*. (2016) and Swarupa *et al*. (2017) who reported that 95% and 90% of the respondents were aware of endosulfan ban, respectively, while only 11.66% of the respondents were aware about the ban of monocrotophos in vegetables. The analysis on knowledge on ban of endosulfan and monocrotophos *vis-à-vis* education level, indicated that there was no relation (p is >0.05) and, hence, it was concluded that the knowledge on monocrotophos ban on vegetables is poor even in educated farmers, which indicated the requirement of extension activities such as campaign on the issues of responsible and safe use of pesticides.

Pesticide formulation measurement for preparing spray fluid is important for pest management. In the study, it was noted that 56.67 percent farmers measure approximately, while, 43.33 percent of the farmers used bottle cap for measuring required quantity and all farmers mix spray fluid safely using a stick and none of the farmer does it with bare hands, irrespective of their education level. Shashi *et al*. (2016) in their studies conducted in Telangana reported that 45 percent of farmers measured chemical approximately and 96.66% mixed the chemical with the stick. The analysis on knowledge on pesticide measurement *vis-à-vis* education level, indicated that there was no relation (p=0.92) and hence, it was concluded that the farmers require training on such issues. Proper care during and after pesticide spray protects the spray men from pesticide poisoning and most importantly, use of personal protective equipment. In the study, it was record that none of the farmer / spraymen was wearing goggles / spectacles / eye gear for protecting his/ her eyes from pesticides, while, only 6.67% farmers were wearing face mask,16.67% were using hand gloves and only

20% farmers were wearing full-cover clothes, which are specially used while spraying for protecting the hands and legs. Similar to finding on other knowledge parameters, no relation on use of PPE and education was found. The knowledge levels on these critical issues were similar across India, and recent studies of Satya Sai *et al.* (2019) indicated that only 15.79 percent of the respondents wore the gloves while spraying.

Storing and disposal of pesticide containers in safe manner is an important practice in responsible use of pesticides. It was recorded that only 13.33 percent of farmers followed safe methods while storing pesticides and majority of the farmers (86.67%) threw the empty bottles / containers into open fields,while, 33.33 percent use empty bottles at home as they were not aware about proper disposal methods, which could put general population at higher risk.

CONCLUSION

The study indicated that there is a lack of awareness about ban of 'monocrotophos', measurement of pesticide formulations, use of personal protection equipment (PPE) while spraying and disposal of empty containers. The knowledge levels were correlated with the education levels of farmers and it was recorded that there was no relation as p value was more than 0.05 in all parameters, which indicated the

Table 1. Socio-personal profile of the cucurbit farmers in the study area

S.No	Parameter	Details		Percentage (%)
1	Age group of the farmer (years)	20-30		6.66
		31-40		26.66
		41-50		46.66
		>50		20.00
2	Education	Illiterate (can not read and write)		43.33
		Literate (5th std and above)	Primary (1st -6th grade)	20.00
			Secondary (7th -9th grade)	10.00
			High School (10 – 12th grade)	16.66
			College (>12th grade)	10.00
3	Crop area (acres)	<0.5		13.33
		>0.5 -1.0		53.33
		>1.0		33.33
4	Preferred season for cucurbit growing	*Kharif*		100.00
		Rabi		46.66

Table 2. Awareness of cucurbit farmers on responsible use of pesticides *vis-à-vis* literacy

S.No	Parameter	Details		Percent	P value
1	First source of information for pesticide recommendations	Pesticide dealer		100.00	--
		Agril / Horti officer		13.33	0.62
		Scientist		6.67	0.001
2	Awareness about recommended use of pesticides on cucurbits as per Insecticide Act	Good Knowledge (yes)		13.33	0.80
		Poor Knowledge (No)		86.67	
3	Awareness on ban of endosulfan in India	Good Knowledge (yes)		96.67	0.89
		Poor Knowledge (No)		3.33	
4	Awareness on ban of monocrotophos on vegetables	Good Knowledge (yes)		6.67	0.59
		Poor Knowledge (No)		93.33	
5	Measurement of pesticide formulation	Good Knowledge (use cap / cylinder)		43.33	0.92
		Poor Knowledge (use approximately)		56.67	
6	Mixing spray solution	Good Knowledge (GK) (use stick)		100	--
		Poor Knowledge (PK) (use hands)		0	
7	Use of PPE during spraying	Use of eye wear	GK	0	--
			PK	100	
		Use of nose Mask	GK	6.67	0.35
			PK	93.33	
		Use of hand gloves	GK	16.67	0.51
			PK	83.33	
		Use of clothes covering hands and legs	GK	20.00	0.31
			PK	80.00	
8	Use of empty pesticide bottles / containers	Good Knowledge (do not use)		66.67	0.51
		Poor Knowledge (use for household)		33.33	
9	Disposal of pesticide bottles / containers	Good Knowledge (burning / burying)		13.33	0.80
		Poor Knowledge (throw in trash / reuse)		86.67	

requirement of extension activities and intensive training programs on the responsible usage of pesticides so as to avoid use of banned pesticides, over use of pesticide doses, pesticide poisoning and environmental pollution.

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J. Res. ANGRAU 49 (3) 98-104, 2021

ANALYSIS OF RESEARCH PAPERS PUBLISHED INTHE JOURNAL OF RESEARCH ANGRAU

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ABSTRACT

This paper analysed 385 research articles comprising 263 full-length papers and 122 research notes published in The Journal of Research ANGRAU between 2013 and 2019 (Volumes 41-47).The main aim of the study was to find out the impact of the Journal in terms of number of research papers published; subject-wise distribution of research papers, author productivity, and citation analysis of the Journal. Some of the important findings are: sixty-eight percent articles published were full-length articles,'Plant Sciences' was the most published subject category, average number of citations per volume are 545 and more than one-fourth of the articles (nearly 30 percent) published in each volume were from researchers of various institutes across the country. The authorship pattern is towards collaboration and maximum authors/co-authors were nine in the published seven volumes.

Key Words: The Journal of Research ANGRAU, Citation analysis, Bibliometrics

INTRODUCTION

The word 'bibliometric' is derived from the Latin and Greek words 'biblio' and 'metrics' which refer tothe application of mathematics to the study of bibliography (Thanuskodi, 2010). Bibliometrics is a type of research method and researcher of any discipline can apply the bibliometric sub-areas for practical applications to scientific discipline (Andres, 2009).

The Journal of Research ANGRAU, the university publication of Acharya N.G. Ranga Agricultural University is being published quarterly since 1973. The Journal of Research ANGRAU (JOR ANGRAU) is a double-blind peer-reviewed journal that seeks to encourage research in agriculture, horticulture, agricultural engineering, veterinary sciences, community science/home science, and social sciences (agricultural economics and agricultural extension). The Journal of Research ANGRAU provides a platform to publish original research work in all these sciences. The main objective of the Journal is the promotion of research in agricultural and allied sciences. It is one of the leading agricultural journals with UGC- CARE approval and has a NAAS rating of 4.21 (2021). Articles from JOR ANGRAU are being regularly abstracted in CAB International, Indian Citation

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Index (ICI), AGRIS (FAO) database and has a presence in Google Scholar. This study is conducted with the overall objective of analysing the research quantity and quality of the Journal in terms of the number, subject categories of research published, citations, and national level participation in the Journal.

MATERIAL AND METHODS

The first author of this paper was the editor of the Journal for the volumes (2013-2019), and therefore, purposively selected those seven volumes as the criteria for this study. Document analysis was the major technique used by the researchers for this study. The study was conducted from June 2020 to February, 2021 by analysing the secondary data. Manual check of the published Journals and specially prepared data sheets were used for analysing the seven volumes and 22 issues of The Journal of Research ANGRAU. Data items for source contributions included index pages, counting total number of articles, counting number of authors, counting number of pages, institutes participation, and counting of citations in the references section. Subject categories of papers published in the JOR ANGRAU was analysed from the index pages of the Journal. After tabulating the data, the analysis was completed in MS-Excel version 2019.

RESULTS AND DISCUSSION

Year-wise distribution of research articles

During the period, a total of 385 research papers have been published. Out of these, 263 are published as 'full-length' articles and 122 are published as 'Research Notes'. This analysis revealed that more research articles on agriculture and allied sciences were published during the years 2013 and 2017 when compared to the years 2015 and 2016 (Table 1). The Journal published a minimum of 35 articles and maximum of 103 articles in a year/volume. To maintain standards of the NAAS and UGC-CARE, the Journal made it mandatory to publish only those articles that are accepted by the reviewers and Chief Editor, hence, a decline in number of articles published in each volume. However, owing to the focus on quality

Table 1. Year-wise distribution of the articles

S.No	Year	Full length papers	Research Notes	Total articles
1	2013	52	51	103
2	2014	34	23	57
3	2015	27	8	35
4	2016	28	10	38
5	2017	49	11	60
6	2018	44	7	51
7	2019	29	12	41
	Total	**263**	**122**	**385**

parameters the NAAS rating of the Journal gradually improved.

Subject categories of Papers

Research papers are categorised by the type of research conducted in different fields under broad heads such as Plant Sciences, Horticultural Sciences, Community Science and Social Sciences. It is observed that the Plant Sciences category was most published subject category with 165 published papers, followed by Social Sciences (57) and Home Science/ Community Science (18) during the study period. It might be due the reason that most of the research is happening in Plant Sciences and research in social sciences depends on individual interest rather than institute mandate. Moreover, research was the major mandate of scientists working in research stations while extension scientists are more involved in TOT activities. However, owing to the decline in research activities of social sciences, ANGRAU has included research mandate for social sciences in the recent times. A total of 113 papers were published as Research Notes (Table 2). 'Research Notes' published have all subject categories. These articles were of mostly secondary data analysis or one-season experiments of various crops.

Authorship Pattern

Authorship studies are descriptive bibliometric studies focused on authorship patterns. They describe author characteristics and authorship of articles and degree of collaboration of a specific group of authors (Navaneethan Krishnan, 2014). In case of this study, agricultural and allied sciences authorship pattern is studied. Out of the 385 published papers, 13 were by single authors, 79 papers were two-authors, 109 were by three authors, 112 were by four authors, and 72 were by more than five authors. Thus, it is observed that there is a degree of collaboration in agricultural and

Table 2. Subject-wise distribution of full-length articles

S. No.	Year/ Volume	Plant Sciences	Horti-culture	Agril. Engine-ering	Social Scien-ces	Home Scien-ces	Veter-inary Scien-ces	Rese-arch Notes	Total Arti-cles
1	2013/41	30	0	0	10	4	8	51	103
2	2014/42	19	1	2	11	2	0	22	57
3	2015/43	16	2	1	7	1	0	8	35
4	2016/44	17	1	1	6	2	0	3	38
5	2017/45	35	2	0	11	2	0	10	60
6	2018/46	30	1	2	9	3	0	7	51
7	2019/47	18	0	4	3	4	0	2	41
	Total	**165**	**7**	**10**	**57**	**18**	**8**	**113**	**385**

Table 3. Authorship pattern of the research articles

S. No.	Year/ Volume	Single-author	two-authors	three-authors	four-authors	five-authors	6-9 authors	Total Articles
1	2013/ 41	1	24	33	32	8	5	103
2	2014/42	1	17	17	14	5	3	57
3	2015/43	1	6	9	11	5	3	35
4	2016/44	1	7	11	12	6	1	38
5	2017/45	1	9	9	23	13	5	60
6	2018/46	5	10	16	13	6	1	51
7	2019/47	3	6	14	7	9	2	41
	Total	**13**	**79**	**109**	**112**	**52**	**20**	**385**
	Percentage to total (%)	**3.38**	**20.52**	**28.31**	**29.09**	**13.51**	**5.19**	**100.00**

allied sciences research among Indian researchers (Table 3). The reason for low number of single-author papers might be attributed to the reason that it is customary to include the name of major advisors for the research articles written as part of M.Sc/ Ph.D theses as an ethical practice. Singe-author research papers are mostly individual scientist's original research work.

Degree of Collaboration

Degree of collaboration indicates the trend of collaborative authorship pattern among the authors for publishing the papers (Table 4). The degree of collaboration ranged from 0.90 to 0.99 during 2013–2019 and the average degree of collaboration is 0.97 which indicates co-authors in the journal article contributions. The degree of collaboration was calculated by the formula as suggested by Subramanyam (1983):

Degree of Collaboration (DC) = Nm/(Nm + Ns),

Where, Nm is the number of multi-authored publications and *Ns* is number of single authored publications.

The increasing complexity of research and interdisciplinary projects might have forced the researchers to share their expertise and collaborate with other researchers. The results are in agreement with Navaneetha Krishnan (2014) who reported that the degree of collaboration progressively increased with some fluctuations in his bibliometric study on humanities and social sciences research publications of the Srilanka.

Number of Citations

References provided at the end of the text as a separate section was the basis for this citation analysis (Ramnivas Sharma *et al.,* 2016). A total of 3819 citations were recorded and average number of citations for each volume were 545 (Table 5). Few authors preferred to

Table 4. Degree of collaboration of published articles

S.No	Year/ Volume	Single authored papers	Multi-authored papers	Total	Degree of collaboration
1	2013/41	1	102	103	0.99
2	2014/42	1	56	57	0.98
3	2015/43	1	34	35	0.97
4	2016/44	1	37	38	0.97
5	2017/45	1	59	60	0.98
6	2018/46	5	46	51	0.90
7	2019/47	3	38	41	0.93
	Total	**13**	**372**	**385**	**0.97**
	Percentage	**3.00**	**97.00**	**100.00**	

cite only pertinent references and few authors were more through in their literature search (Kalyane and Sen, 1995). Only five authors have cited their one reference as 'Anonymous'. The reason might be that in this information era, it is not a practice to cite a source whose authors/ institutions is unidentified. None of the articles were devoid of references as the Journal template contains references section as mandatory. Authors whose specialization is of Agricultural Extension and Agricultural Economics have cited internet-based

Table 5. Number of citations per article of the JOR ANGRAU

S.No.	Year/ Volume	No. of citations/ No. of articles						Total Articles	Total Citations
		1-5	6-10	11-15	16-20	21-30	31-35		
1	2013/41	27	45	15	8	6	2	103	1032
2	2014/42	15	29	9	4	-	-	57	496
3	2015/43	5	8	13	7	-	2	35	400
4	2016/44	5	15	13	4	1	-	38	401
5	2017/45	15	25	14	3	3	-	60	565
6	2018/46	10	19	12	4	4	2	51	515
7	2019/47	7	11	12	9	2	-	41	410
	Total	**161**	**293**	**164**	**69**	**30**	**12**	**385**	**3819**

references, newspaper articles along with other cited sources. This might be due to the availability of latest statistics related to their research work in the newspaper articles, internet web pages of Governemnt organizations and hence cited them as sources of information (Table 6).

Forms of documents cited

Authors have cited various National and International Journals (78%) in their articles as sources followed by M.Sc and Ph.D theses and text books/ reference books (Table 6). The reasons might be due to the onlineaccess mode of many national and international journals in recent times. Furthermore, as Krishi Kosh portal contains all the published M.Sc and PhD theses it has become easy to access and cite the sources.

Contribution of research articles by National Level Institutes

The Journal of Research ANGRAU, a University Publication of ANGRAU is an important Journal at National level since 1973 and publishes research articles of not only ANGRAU but from institutions across the country duly maintaining the quality and standards. The Editors of the Journal encourage authors from various research institutes to submit their research papers to the Journal through wide publicity. More than one-fourth of the research papers (nearly 30 percent) published in every volume included research findings of ICAR institutes/SAUs/traditional universities in agriculture and allied sciences. In the year 2019, nearly half of the articles (46 percent) published were received from the national level institutes scholars and scientists, thus, indicating the reputation of the Journal across the Nation (Table 7).

CONCLUSION

The Journal of Research ANGRAU published a total of 385 articles in the study period, out of which nearly three-fourth (68 percent) were published as full-length articles. 'Plant Sciences' was the most published subject category with

Table 6. Forms of documents cited

S.No.	Forms of documents cited	Total number of citations	Percentage
1	Journals	2982	78.08
2	Dissertations	182	4.77
3	Text Books/ Reference Books	154	4.03
4	Annual Reports	126	3.30
5	Seminar/ Conferences	133	3.48
6	Internet based	135	3.53
7	Others (newspapers, bulletins, etc)	107	2.80
	Total	**3819**	**100.00**

Source: Author's document analysis

Table 7. National level institutes participation in the Journal

S.No.	Year	Total articles	National Level papers published	Percentage
1	2013	103	31	30.10
2	2014	57	15	26.32
3	2015	35	14	40.00
4	2016	38	10	26.32
5	2017	60	22	36.67
6	2018	51	20	39.22
7	2019	41	19	46.34
	Total	**385**	**131**	

nearly half (42 percent) of the published full-length articles covered the space in this category. The JOR had a good nation-wide coverage of research articles and average citations for each volume of the Journal was 545. Authorship pattern was towards collaborative research. There is a huge scope for enhancing research coverage in the social sciences category and also to highlight new contemporary areas of research in all the subjects. The current NAAS rating of 4.21 (NAAS, 2021) can further be enhanced through international articles coverage in futire volumes and more citations for each article.

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Research Note

J. Res. ANGRAU 49 (3) 105-109, 2021

ASSESSMENT OF SEASONAL VEGETATION DYNAMICS OVER PARTS OF THAR DESERT USING GEOSPATIAL TECHNIQUES

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Sattelite-based remote sensing techniques are known to be effective and inexpensive methods to estimate agricultural productivity. The health of the vegetation cover is a function of its biochemical and physiological characteristics and thus is a vital indicator of seasonal crop productivity and monitoring crop growth (Gonsamo and Pellikka, 2012). Multispectral remote sensing has been frequently used for assessing vegetation dynamics using specific vegetation indices (Frampton *et al.,* 2013). Vegetation indices (VIs) are widely used to analyse the vegetation changes on seasonal time scales, interannual, and decadal (Qi *et al.,* 1994). In the study, vegetation growth has been represented in terms of four vegetation indices, Normalized Difference Vegetation Index (NDVI), Red-Edge NDVI (NDVIre), Wide Dynamic Range Vegetation Index (WDRVI), Red-Edge Wide Dynamic Range Vegetation Index (WDRVIre).

NDVI

The normalized difference vegetation index (NDVI) isthe most common vegetation index to determine the vegetation cover area and varies between -1 to 1. The *Kharif* season is characterizedfrom July to October. Major crops grown during this season includes millets, bajra, and mung bean. In 2016, NDVI values showed an area of 23,596 km^2 (41%) under moderate category, followed by 22239 km^2 (39%) and 11,473.5 km^2 (20%) under poor and good categories, respectively. In 2019, NDVI values showed a maximum 24,629 km^2 (43%) area under the moderate category, followed by 21,769 km^2 (38%) and 10846 km^2 (19%) under the poor and good categories. NDVI variation map of *Kharif* season indicated that during the year 2016-2019, moderate and poor vegetation classes are high compared to good vegetation [Fig. 1. (a)].The *Rabi* season is considered from November to March. Major crops grown during this season include wheat, mustard, and rai. In 2016, NDVI values show a maximum area of 25,360 km^2 (44%) under a moderate category, followed by 21,480 km^2 (37%) and 10,470 km^2 (18%) under the poor and good categories, respectively. In 2019, NDVI values represented a maximum area of 28,178 km^2 (49%) under the poor category, followed by 17,945 km^2 (31%) and 11,185 km^2 (20%) under the moderate and good categories, respectively. *Rabi* season from 2016 to 2019 revealed that the poor and moderate vegetation classes are high compared

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to good vegetation, and the moderate vegetation cover area is slowly increasing.

The *Zaid* season is from April to June; this season is also known as the summer season. Principal crops are grown during this season for fodder purposes. In the year 2016, NDVI values showed the maximum area of 30,304 km^2 (53%) under the moderate category, followed by 24,433 km^2 (43%) and 2,573 km^2 (4%) under poor and good categories, respectively (Fig. 1. (b)). In the year 2019, NDVI values indicated a maximum area of 29,653 km^2 (52%) under moderate category, followed by 23,554 km^2 (41%) and 3,991 km^2 (7%) under the poor and good category, respectively [Fig. 1. (c)]. NDVI variation map of *Zaid* season from 2016 to 2019 indicated that the moderate and poor vegetation cover area is high compared to a good vegetation cover area.

Red-Edge NDVI

The Red-Edge Normalize difference vegetation index (NDVIre) isa handy vegetation index to determine the stress vegetation cover area.Usually, the value range of 0.3 to 0.6 is considered stress vegetation but varies from season to season and species to species. In the year 2016, red-edge NDVI represents a maximum area of 33,062 km^2 (58%) under a moderate category, followed by 16,984 km^2 (30%) and 7,154 km^2 (13%) of poor and good categories, respectively. In the year 2019, red-edge NDVI showed a maximum area of 28,086 km^2 (49%) under moderate category, followed by 15,686 km^2 (27%) and 13,535 km^2 (24%) in poor and good categories, respectively. Red-edge NDVI values during the *Kharif* season from 2016 to 2019 depicted that the moderate vegetation cover area is high compared to other vegetation areas, and an increase of good vegetation can be delineated in recent years [Fig. 2. (a)].

In the year 2016, red-edge NDVI showed a maximum area of 29,924 km^2 (52%) under a moderate category, followed by 20,498 km^2 (36%) and 6778 (12%) covered by poor and good categories, respectively. In 2019, red-edge NDVI showed a maximum 33,081.8 km^2 (58%) area under a moderate category, followed by 19,918.6 km^2 (35%) and 4,310 km^2 (8%) under poor and good category, respectively [Fig. 2. (b)]. *Rabi* season red-edge NDVI variation during 2016-2019 indicated that the moderate vegetation was high compared to poor and good vegetations.The Red-Edge Normalized Difference Vegetation Index helps determine the stress vegetation cover area. This red-edge NDVI index indicates poor to moderate vegetation.

The *Zaid* season in the year 2016 represented a maximum area of 2,22,274 km^2 (39%) under good category, followed by 20,000 km^2 (35%) and14,926 km^2 (26%) under poor and moderate categories, respectively. In the year 2019, red-edge NDVI showed a maximum area of 25,365 km^2 (44%) under a moderate category, followed by 2,412 km^2 (39%) and 9,422.2 km^2 (16%) under poor and good categories, respectively [Fig. 2. (c)]. In the *Zaid* season, red-edge NDVI values suggested that vegetation conditions varyfrom year to year and season to season. The index thus computed indicated high cover underpoor and moderate condition vegetation compared to other vegetation cover areas. During the last two years, good condition vegetation cover declined.

WDRVI

WDRVI is beneficial when Near Infrared (NIR)'s higher sensitivity is less compared to NDVI. These indices are also proportional to the estimation of the Leaf Area Index (LAI) over broad area. Using this index, the vegetation conditions were classified as poor, moderate, and good.

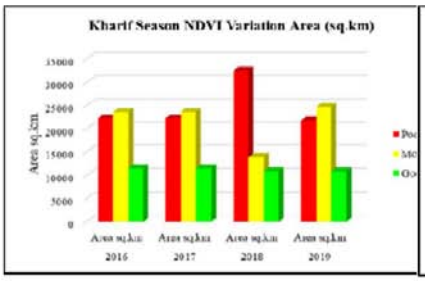

Fig. 1. (a) Area Statistics – *Kharif* season

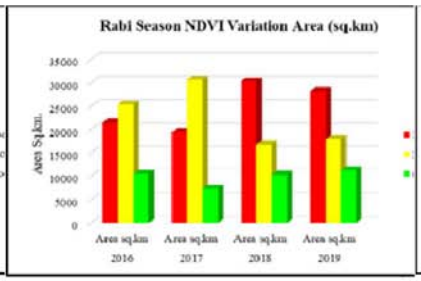

Fig. 1. (b) Area Statistics – *Rabi* season

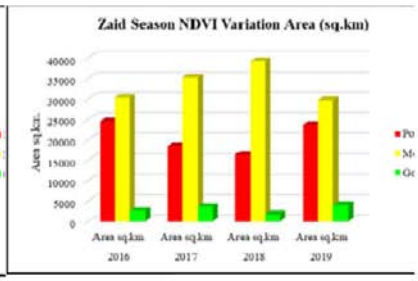

Fig. 1. (c) Area Statistics – *Zaid* season

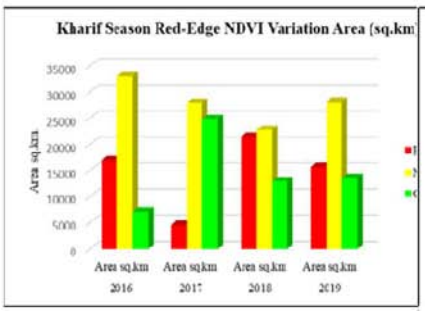

Fig. 2. (a) Area Statistics – *Kharif* season

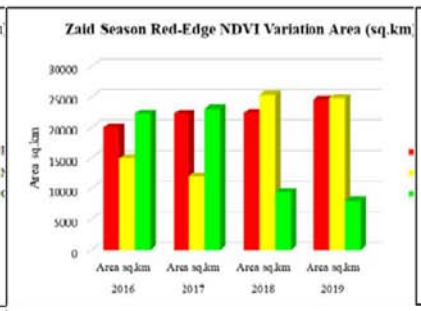

Fig. 2. (b) Area Statistics – *Rabi* season

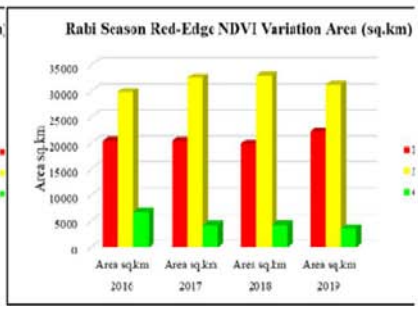

Fig. 2. (c) Area Statistics – *Zaid* season

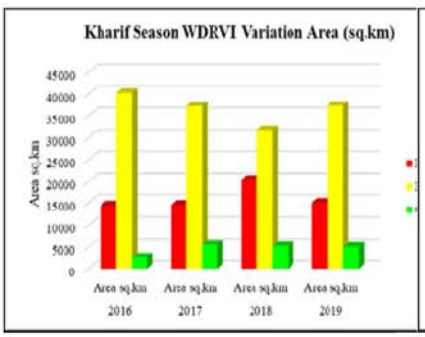

Fig. 3. (a) Area Statistics – *Kharif* season

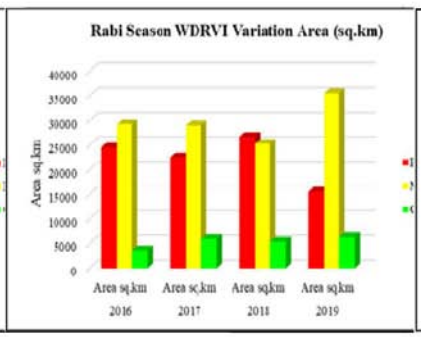

Fig. 3. (b) Area Statistics – *Rabi* season

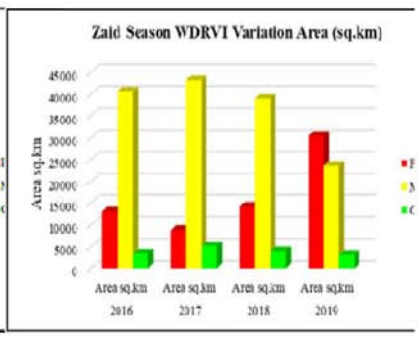

Fig. 3. (c) Area Statistics – *Zaid* season

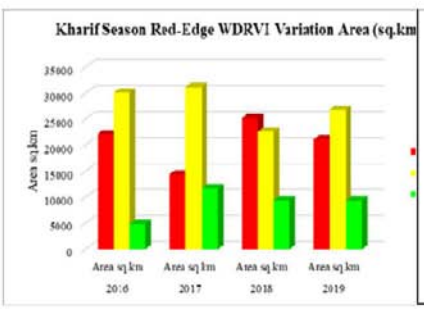

Fig. 4. (a) Area Statistics – *Kharif* season

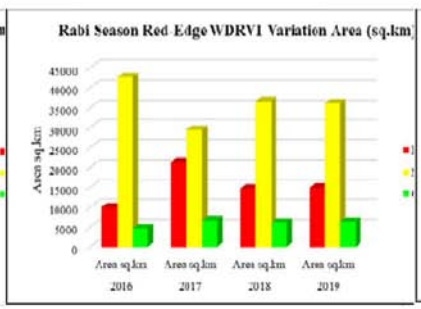

Fig. 4. (b) Area Statistics – *Rabi* season

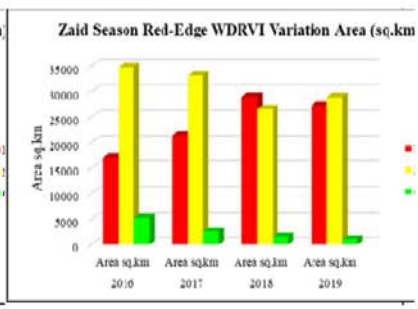

Fig. 4. (c) Area Statistics – *Zaid* season

The *Kharif* season is represented by a maximum 40,189 km^2 (70%) area under a moderate category, followed by 14,396 km^2 (25%) and 2,614 km^2 (5%) covered under poor and good classifications, respectively. In 2019, WDRVI showed a maximum extent of 37,301 km^2 (65%) under moderate category, followed by 15,030 km^2 (26%) and 4,976 km^2 (9%) under poor and good categories, respectively (Fig. 3. (a)). *Kharif* season indicated that the moderate condition vegetation is high every year in comparision to other vegetation categories.

The *Rabi* season of the year 2016 showed a maximum area of 29,097 km^2 (51%) under moderate category, followed by 24492 km^2 (43%) and 3611 km^2 (6%) under poor and good categories, respectively. In 2019, WDRVI showed a maximum of 35555 km^2 (62%) under moderate category, followed by 15,501 km^2 (27%) and 6,253 km^2 (11%) under poor and good categories, respectively [Fig. 3. (b)].

In the *Zaid* season, WDRVI values of 2016 showed a maximum area of 40,599 km^2 (71%) under moderate category, followed by 8,833 km^2 (15%) and 3,426 km^2 (6%) under poor and good categories, respectively. In the year 2019, WDRVI depicted a maximum area of 30,471 km^2 (53%), under a poor category, followed by 23566 km^2 (41%) and 3,163 km^2 (6%), under moderate and good categories, respectively [Fig. 3. (c)]. An overall analysis of WDRVI value during the *Zaid* season showed the high area under moderate and poor vegetation categories compared to the good vegetation, which is low.

Red-Edge WDRVI

The Red-edge WDRVI index measures the stress vegetation on a large area, and it was shown in three vegetation categories: poor, moderate, and good. In the *Kharif* season of 2016, the maximum area was 30,142 km^2 (53%) under moderate category, followed by 22141 km^2 (39%) and 4917 km^2(9%) under poor and good categories, respectively. In the year 2019, red-edge WDRVI showed a maximum area of 26,817.4 km^2 (47%) under moderate category, followed by 21167 km^2(37%) and 9,323 km^2 (16%) under poor and good categories, respectively [Fig. 4. (a)]. The Red-Edge WDRVI variation in

Table 1. Comparative analysis of the area of vegetation cover types using four different vegetation indices

S No.	Index	*Kharif (average area in km^2 2016–2019)*			*Rabi (average area in km^2 2016–2019)*			*Zaid (average area in km^2 2016–2019)*		
		Vegetation Cover Type			Vegetation Cover Type			Vegetation Cover Type		
		Poor	Moderate	Good	Poor	Moderate	Good	Poor	Moderate	Good
1	NDVI	24670.58	21448.58	11162.70	24851.43	22649.48	9808.85	20684.53	33607.80	2963.18
2	NDVIre	14677.45	27962.53	14615.00	20777.75	31734.20	4743.78	22309.48	19269.55	15676.45
3	WDRVI	16077.70	36597.75	4579.60	22283.98	29697.83	5301.08	16683.85	36617.05	3927.28
4	Red-Edge WDRVI	20737.30	27683.63	8834.13	15230.15	36170.18	5882.25	94737.10	123678.70	10607.00

this *Kharif* season indicated that the moderate and poor vegetation categories is high compared to the good vegetation,which is low.

Rabi season of 2016 indicated a maximum area of 42,645 km^2 (75%) was covered under a moderate category, followed by 9932 km^2 (17%) and 4623 km^2(8%) under poor and good categories, respectively. In 2019, spatial variation of red-edge WDRVI showed a maximum area of 36,066 km^2 (63%) under a moderate category, followed by 14,962 km^2 (26%) and 6,280 km^2(11%) covered under poor and good categories, respectively (Fig. 4. (b)). The Red-Edge WDRVI variation of *Rabi* season depicted that the moderate vegetation category is high compared to the good vegetation, which is low.

The *Zaid* season of 2016 characterizes a maximum area of 34855 km^2(61%) under moderate category, followed by 17,061 km^2 (30%) and 5,284 km^2 (9%) covered under poor and good categories, respectively. In 2019, the spatial variation of red-edge WDRVI showed a maximum area of 28,938 km^2 (50%) which was covered under moderate category, followed by 27,299 km^2 (48%) and 1,072 km^2 (2%) covered under poor and good categories, respectively (Fig. 4. (c)). The comparative analysis of the area of vegetation cover types using four different vegetation indices is shown in Table 1. These inferences were essential for understanding the role of the natural factors in governing crop productivity across different seasons. This helps in the efficient management of productivity-related issues during intensive agricultural practices.

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Research Note

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COMPARATIVE ANALYSIS OF MEAN SCORE VALUES OF LIVELIHOOD SECURITY INDEX OF AGRICULTURAL LABOURERS OF THREE REGIONS OF ANDHRA PRADESH

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Agriculture is the main occupation in Indian economy. India's arable land area of 159.7 million hectares is the second largest in the world, after the United States. Its gross irrigated crop area of 82.60 million hectares is the largest in the world. India is among the top three global producers of many crops such as wheat, rice, pulses, cotton, groundnut, fruits and vegetables. Agricultural labourers constitute the most neglected class in Indian rural structure. Often they are not in a position to earn just enough to keep their body and soul together and are frequently exposed to the hazards of unemployment or irregular employment and have or neither private nor social security. Being unorganized, they do not have the most needed muscle to seek better living and working condition. Their income is low and employment irregular. Since, they possess no skill or training, they have no alternative employment opportunities (Kulamani, 2007). The period between 2004-05 and 2011-12 was the first instance of workforce reduction in agriculture declined by around 30.57 million in spite of the total size of workforce continued to increase. Higher remuneration and availability of opportunities in alternate sectors is leading to the migration of workforce away from agriculture. This has resulted in labour shortage, increase in wages and consequent escalation of cost of cultivation. Government schemes like MGNREGA are affecting labour adversely and need immediate policy interventions, (FICCI, 2015). The number of agricultural labourers rose almost three times over the period in 1951 from 27.3 million to 74.6 million in 1991. As per the census of 2011, 263 million people are engaged in the agriculture sector and over half of them are now agricultural labourers, a trend observed for the first time in the past 40 years (down to earth). Considering the fact that large share of the working poor are engaged in agriculture, developments in that sector have a major impact on welfare throughout much of the world. Until the year 2000, agriculture was the mainstay of employment around the world. Since then, the services sector has assumed this mantle and the gap between the two has widened. Although employment growth in agriculture has slowed, the number of workers in this sector reached over one billion in 2009. An agricultural labourer is operationally defined as an individual who is a farmer/artisan and others, wherein, they work for more than half of the total number of days in a year as an agricultural labourer and derive more than 50 percent of income by doing agricultural

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work on other's farm for wages. Livelihood security of agricultural labourers was operationalized as the degree of accessibility, adequacy and utility of different resources to meet the basic needs of the family. Hence, the study was conducted focusing on the state of Andhra Pradesh with the specific objective of comparing mean score values of livelihood security of agricultural labourers in the three regions. As per the 2011 census of GoI, highest numberof agricultural labourers 4,42,295 were found in Srikakulam district from North Coastal Region; Guntur district from South Costal Region comprised 1,035,569 agricultural labourers; and Kurnool district from Rayalaseema Region consisted of 8,69,074 agricultural labourers. Hence, these three districts were included in the study.

An *ex-post facto* research design was followed for the study. Two mandals from each district and four villages from each of the mandals were selected by using simple random sampling procedure, thus, making a total of 24 villages. From each of the selected village, ten respondents were chosen randomly, thus,arriving to a total of 240 respondents.The data was collected by personal interview method. A total of, nine components namely asset, food and nutritional, education, habitat, social, clothing, health, transport and information securities selected to measure the overall livelihood security of agricultural labourers.The mean scores of each individual component were obtained by averaging the total respondents component scores. Then, overall livelihood index mean score value was arrived. Each component of livelihood security was categorised (low, medium, high) based on Mean and Standard Deviation.

Measurement of individual component of livelihood security values by using following formulas:

Overall mean of all the components

After arriving at index scores of all the nine components of livelihood security, the overall mean of livelihood security index was calculated by using the formula:

Overall Mean ofLivelihood Security Index =

$$\frac{(A+B+C+D+E+F+G+H+I)}{9}$$

Ranking of mean index scores values of different components of livelihood security of agricultural labourers in North Coastal Region

A. Mean score value of asset security$=\frac{(Sum\ of\ the\ all\ scores\ of\ asset\ security)}{240}$

B. Mean score value food and nutritional security$=\frac{(Sum\ of\ the\ all\ scores\ of\ food\ and\ nutritional\ security)}{240}$

C. Mean score value educational security$=\frac{(Sum\ of\ the\ all\ scores\ of\ educational\ security)}{240}$

D. Mean score value clothing security$=\frac{(Sum\ of\ the\ all\ the\ scores\ of\ clothing\ security)}{240}$

E. Mean score value habitat security$=\frac{(Sum\ of\ the\ all\ the\ scores\ of\ habitat\ security)}{240}$

F. Mean score value health security$=\frac{(Sum\ of\ the\ all\ scores\ health\ security)}{240}$

G. Mean score value information security$=\frac{(Sum\ of\ the\ all\ scores\ of\ of\ information\ security)}{240}$

H. Mean score value transport security$=\frac{(Sum\ of\ the\ all\ scores\ of\ transport\ security)}{240}$

I. Mean score value transport security$=\frac{(Sum\ of\ the\ all\ the\ scores\ of\ social\ security)}{240}$

Mean index score values of different components of livelihood security of agricultural labourers in North Coastal Region according to their percentage rank order of importance was in the orderclothing security(82.69%)-I, asset security (74.27%)-II, habitat security (58.16%)-III, food and nutritional security (54.98%)-IV,transport security (53.28%)-V, information security (47.80%)-VI, health security (46.25%)-VII, social security (45.54%)-VIII and educational security (31.25%)-IX. The overall mean of the all the components of livelihood security in North Coastal Region is 58.16 (Table 1).

Ranking of mean index scores values of different components of livelihood security agricultural labourers in South Coastal Region

Themean Index score values of different component of livelihood security of agricultural labourers in South Coastal Region wereclothing security(83.66%)-I, asset security (78.55%)-II, food and nutritional security (74.03%)-III, habitat security (68.62%)-IV, transport security (67.50%)-V, health security (51.03%)-VI, information security (51.03%)-VII, social security (49.25%)-VIIIand educational security (38.46%)-IX. The overall meanof the all the components of livelihood security in South Coastal Regionis 62.63.

Ranking of mean index score values of different components of livelihood security agricultural labourers in Rayalaseema Region

The mean index score values of different component of livelihood security of agricultural labourers in Rayalaseema Region inaccordance with percentage rank order of importance wereclothing security (82.07%)-I, asset security (69.08%)-II, food and nutritional security (56.41%)-III,habitat security (55.24%)-IV, transport security (52.79%)-V, health security (45.15%)-VI, information security (42.45%) -VII and social security (38.16%)-VIII and educational security (29.71%)-IX. The overall mean score of the all the components of livelihood security in Rayalaseema Region is 55.03.

Ranking based on overall mean scores ofdifferent components of livelihood security agricultural labourers

The overall mean index score values of different components of livelihood security of agricultural labourers in Andhra Pradesh in accordance with their percentage rank order importance was clothing security (82.83%)-I, asset security (71.59%)-II, food and nutritional security (64.71%)-III, transport security (57.85%)-IV, habitat security (55.54%)-V, health security (47.08%)-VI, information security (45.41%)-VII, social security (41.55%)-VIII and educational security (32.37%)- IX. The overall mean of the all the components of livelihood security in the total sample is 58.60. The results obtained were in line with the studies conducted by Harshitha and Prasad (2018); Jadhav and Venkat (2019).

Among the three regions, South Coastal region had better livelihood security mean index value compared to North Coastal region and Rayalaseema region. The overall livelihood security index was 58.60. The results obtained were in line with the similar studies conducted by Girish *et al.* (2020).

Table 1.Mean Index Scores values of different components of livelihood security agricultural labourers in three Regions and overall Andhra Pradesh

S.No.	Components of Livelihood Security	North Coastal Region	Ra-nk	South Coastal Region	Ra-nk	Rayala-seema Region	Rank	Overall mean score	Ra-nk
1.	Asset Security	74.27	II	78.55	II	69.08	II	71.59	II
2.	Food and Nutritional Security	54.98	IV	74.03	III	56.41	III	64.71	III
3.	Educational Security	31.25	IX	38.46	IX	29.71	IX	32.37	IX
4.	Habitat Security	58.16	III	68.62	IV	55.24	IV	55.54	V
5.	Social Security	45.54	VIII	49.25	VIII	38.16	VIII	41.55	VIII
6.	Clothing Security	82.69	I	83.66	I	82.07	I	82.83	I
7.	Health Security	46.25	VII	51.30	VI	45.15	VI	47.08	VI
8.	Transport Security	53.28	V	67.50	V	52.79	V	57.85	IV
9.	Information Security	47.80	VI	51.03	VII	42.45	VII	45.41	VII
	Mean	**58.16**	**-**	**62.63**	**-**	**55.03**	**-**	**58.60**	**-**
	SD	**14.68**	**-**	**16.22**	**-**	**12.38**	**-**	**15.45**	**-**

The livelihood security index score ranges from 0-100. Based on the livelihood security index, the agricultural labourers were grouped into three categories (Table 2).

Table 2. Comparision between the mean score values of three regions and overall sample mean (n=80)

S.No.	Region	Mean Livelihood Security Index	Rank
1	North Coastal Region	58.16	II
2	South Coastal Region	62.63	I
3	Rayalaseema Region	55.03	III
	Overall mean of livelihood security index	**58.60**	

LSI=Livelihood Security Index

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Research Note

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HETEROSIS FOR PHYSIOLOGICAL TRAITS IN SUNFLOWER (*Helianthus annuus* L.)

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Sunflower (*Helianthus annuus* L.) is important oilseed crop grown for edible purposes in the world after groundnut, soybean, rapeseed - mustard. In the study, 24 experimental hybrids were evaluated to measure the magnitude of heterosis over mid parent, better parent and standard heterosis against NDSH 1012, DRSH 1, KBSH 44 and Kaveri hybrids for seed yield and yield contributing physiological traits in sunflower from *rabi* 2018 to rabi 2019 in a Randomized Block Design and replicated twice. It is very important to study heterosis from the physiological, morphological and biochemical points of view, because these aspects directly determine yield levels, germination energy, plant growth, size of leaf area, intensity of photosynthesis, respiration, intensity of resynthesis and accumulation of organic substances in the seed, enzymatic activity, etc (Æupina and Sakaè, 1989).

Heterosis breeding or exploitation of hybrid vigour is one of the methods of plant breeding to develop hybrids with high yield potential. The results pertaining to heterotic behaviour of yield and its physiological components over mid parent, better parent and hybrids were discussed (Table 1 to Table 4). SPAD chlorophyll meter reading was one of the most important trait influencing seed yield since it is reflection of leaf photosynthetic activity. The cross combination CMS 30 A x NO-30 recorded positive heterosis over mid parent, better parent and against all the checks. The parents involved in this hybrid were with low x high *gca* effects indicating the non-additive x additive type of gene action with high mean performance (Table 5). The cross combinations *viz*., CMS 17 A x R-106, CMS-17 A x RHA-271 and NDLA-4 x R-106 showed highly significant positive heterosis over mid parent, better parent and standard heterosis over all the checks for leaf area index. These hybrids represent the parents of low x low, low x high and high x high *gca* effects.

For specific leaf area, magnitude of heterosis varied from -44.82 (NDLA-3 x RHA-271) to 6.70 (NDLA-4 x NO-30) over mid parent and -48.54 (CMS-30 A x NO-30) to -8.83 (NDLA-4 x NO-30) over better parent. None of the hybrids showed significant negative standard heterosis over all the checks (NDSH-1012, DRSH-1, KBSH-44 and Kaveri). However, five crosses over NDSH-1012, six crosses over Kaveri and a single cross over KBSH-44 recorded negative values. Among these, the cross CMS-30 A x NO-30 exhibited high negative value. For stem girth, eleven hybrids over mid

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parent and a single hybrid over better parent recorded significant positive heterosis. A single cross combination *i.e.,* CMS 30 A x R-106 represented high significant positive heterobeltiosis and standard heterosis over the checks NDSH-1012 and Kaveri with positive *sca* effect involving parents of high x high *gca* effect and showed high *per se* performance for the trait stem girth (Habib *et al*., 2006).

Number of leaves per plant had significant contribution towards yield since the ultimate yield is dependent on the extent of photosynthetic portion of plant. The cross CMS-30 A x NGM-16 recorded significantly positive heterobeltiosis with high *sca* effect and parents with high x high *gca* effects and high mean performance indicating the role of additive x additive gene action. These results were in line with Neelima and Parameshwarappa (2009), Reddy and Nadaf (2013), Ingle *et al*. (2016) and Singh and Kumar (2017). The trait number of seeds per head also exhibit positive correlation with yield since the increase of this trait will result in increased yields and thus positive heterosis was desirable. Twenty hybrids over mid parent and only ten hybrids over better parent exhibited significant positive heterosis (Neelima and Parameshwarappa 2013). The cross NDLA-4 x NGM-16 (103.05) recorded high significant better parent heterosis with high *sca* effects and high x high *gca* combination of parental lines exhibiting high *per se* performance indicating the major role of additive gene action in the expression of this trait.

Seed set percentage is one of the limiting factors in sunflower production and there is need to exploit the desirable cross combinations with high seed set percent. The crosses CMS-17A x CPI-1, CMS-30A x CPI-1 and NDLA-4 x CPI-1 were rated as highly heterotic over better parent. Prevalence of significant heterosis for this trait was in accordance with the studies of Ingle *et al*. (2016) and Singh and Kumar (2017). Eleven hybrids over better parent and all hybrids over the check Kaveri, nine hybrids over KBSH-44, six hybrids over DRSH-1 and five hybrids over NDSH-1012 recorded significant positive heterosis. For seed yield, the crosses CMS-30 A x R-106 (216.58) followed by CMS-30 A x RHA-271 (207.99) over mid parent, while the crosses NDLA-4 x NGM-16 (133.81) and CMS-17A x NGM-16 (131.06) over better parent showed high heterotic values. However, more number of crosses showed significant and positive standard heterosis over the checks Kaveri and KBSH-44 (Chandra *et al*., 2013; Neelima and Rafi, 2013 and Kale *et al*., 2019). The cross NDLA-4 x NGM-16 recorded significant and high positive heterosis over better parent and standard heterosis over DRSH-1, KBSH-44 and Kaveri and high positive standard heterosis over the check NDSH-1012.

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Table 1. Percent heterosis over mid parent (MP), better parent (BP) and check hybrids for SPAD chlorophyll meter reading and leaf area index in sunflower

S.No.	Crosses	SPAD chlorophyll meter reading						Leaf area index					
		MP	BP	NDSH1012	DRSH-1	KBSH-44	Kaveri	MP	BP	NDSH1012	DRSH-1	KBSH-44	Kaveri
1.	NDLA-3 X NO-15	-1.32	-12.69 **	-10.07 **	-0.92	-9.42 **	5.78	151.16 **	145.45 **	3.18	6.58	16.55 **	18.25 **
2.	NDLA-3 X R- 106	1.00	-6.05 *	-3.24	6.61 *	-2.54	13.82 **	130.63 **	103.17 **	-18.47 **	-15.79 **	-7.91	-6.57
3.	NDLA-3 X CPI-1	1.81	-11.64 **	-8.99 **	0.26	-8.33 **	7.05 *	51.56 **	49.23 **	-38.22 **	-36.18 **	-30.22 **	-29.20 **
4.	NDLA-3 X RHA-271	-3.50	-8.50 **	-5.76 *	3.83	-5.07	10.86 **	143.24 **	114.29 **	-14.01 **	-11.18 *	-2.88	-1.46
5.	NDLA-3 X NGM-16	2.95	-6.52 *	-3.72	6.08	-3.02	13.26 **	110.61 **	101.45 **	-11.46 *	-8.55	0.00	1.46
6.	NDLA-3 X NO- 30	-7.49 **	-8.73 **	-6.00 *	3.57	-5.31	10.58 **	128.97 **	102.44 **	5.73	9.21	19.42 **	21.17 **
7.	NDLA-4 X NO-15	-1.43	-10.59 **	-12.95 **	-4.10	-12.32 **	2.40	162.41 **	146.67 **	17.83 **	21.71 **	33.09 **	35.04 **
8.	NDLA-4 X R- 106	-3.29	-7.64 **	-10.07 **	-0.92	-9.42 **	5.78	225.20 **	166.67 **	27.39 **	31.58 **	43.88 **	45.99 **
9.	NDLA-4 X CPI -1	2.08	-9.24 **	-11.63 **	-2.64	-10.99 **	3.95	92.86 **	80.00 **	-14.01 **	-11.18 *	-2.88	-1.46
10.	NDLA-4 X RHA-271	-10.11 **	-12.44 **	-14.75 **	-6.08 *	-14.13 **	0.28	178.05 **	128.00 **	8.92	12.50 *	23.02 **	24.82 **
11.	NDLA-4 X NGM-16	4.16	-2.96	-5.52 *	4.10	-4.83	11.14 **	162.50 **	152.00 **	20.38 **	24.34 **	35.97 **	37.96 **
12.	NDLA-4 X NO- 30	-5.46 *	-6.82 *	-6.59 *	2.91	-5.92 *	9.87 **	97.45 **	89.02 **	-1.27	1.97	11.51 *	13.14 *
13.	CMS 17A X NO-15	10.55 **	0.50	-2.64	7.27 *	-1.93	14.53 **	170.80 **	131.82 **	-2.55	0.66	10.07	11.68 *
14.	CMS 17AX R- 106	1.23	-3.09	-6.12 *	3.43	-5.43	10.44 **	276.84 **	272.92 **	14.01 **	17.76 **	28.78 **	30.66 **
15.	CMS 17A X CPI-1	7.92 **	-3.84	-6.83 *	2.64	-6.16 *	9.59 **	146.43 **	112.31 **	-12.10 *	-9.21	-0.72	0.73
16.	CMS 17A X RHA-271	0.63	-1.73	-4.80	4.89	-4.11	11.99 **	175.79 **	172.92 **	-16.56 **	-13.82 *	-5.76	-4.38
17.	CMS 17A X NGM-16	-1.26	-7.80	-10.67 **	-1.59	-10.02 **	5.08	179.31 **	134.78 **	3.18	6.58	16.55 **	18.25 **
18.	CMS 17AX NO- 30	0.12	-1.56	-1.32	8.72 **	-0.60	16.08 **	126.36 **	78.05 **	-7.01	-3.95	5.04	6.57
19.	CMS 30A X NO-15	-5.54 *	-15.51 **	-15.11 **	-6.47 *	-14.49 **	-0.14	176.81 **	165.28 **	21.66 **	25.66 **	37.41 **	39.42 **
20.	CMS 30AX R- 106	-3.61	-9.31 **	-8.87 **	0.40	-8.21 **	7.19 *	158.33 **	115.28 **	-1.27	1.97	11.51 *	13.14 *
21.	CMS 30A X CPI-1	4.63	-8.23 **	-7.79 **	1.59	-7.13 *	8.46 *	127.74 **	116.67 **	-0.64	2.63	12.23 *	13.87 *
22.	CMS 30A X RHA-271	-5.60 *	-9.43 **	-8.99 **	0.26	-8.33 **	7.05 *	185.00 **	137.50 **	8.92	12.50 *	23.02 **	24.82 **
23.	CMS 30A X NGM-16	-4.48	-12.29 **	-11.87 **	-2.91	-11.23 **	3.67	170.92 **	165.28 **	21.66 **	25.66 **	37.41 **	39.42 **
24.	CMS 30A X NO- 30	0.36	0.24	0.72	10.96 **	1.45	18.48 **	101.30 **	89.02 **	-1.27	1.97	11.51 *	13.14 *

*- Significant at 5% level ** - Significant at 1% level

Table 2. Percent heterosis over mid parent (MP), better parent (BP) and check hybrids for specific leaf area and number of leaves per plant in sunflower

S.No.	Crosses	Specific leaf area						Number of leaves per plant					
		MP	BP	NDSH1012	DRSH-1	KBSH-44	Kaveri	MP	BP	NDSH1012	DRSH-1	KBSH-44	Kaveri
1.	NDLA-3 X NO-15	-28.06**	-36.36**	3.86	22.76*	10.64	0.57	12.96*	1.67	-18.67**	-7.58	-22.78**	-6.15
2.	NDLA-3 X R-106	-35.03**	-39.38**	-1.07	16.94	5.40	-4.19	26.00**	21.15**	-16.00**	-4.55	-20.25**	-3.08
3.	NDLA-3 X CPI-1	-38.16**	-41.42**	-4.41	13.00	1.84	-7.43	-8.57	-15.79**	-36.00**	-27.27**	-39.24**	-26.15**
4.	NDLA-3 X RHA-271	-44.82**	-48.50**	-3.03	14.62	3.30	-6.10	18.00**	13.46*	-21.33**	-10.61	-25.32**	-9.23
5.	NDLA-3 X NGM-16	-27.20**	-28.42**	16.81	38.08**	24.44*	13.12	17.65**	11.11	-20.00**	-9.09	-24.05**	-7.69
6.	NDLA-3 X NO-30	-25.11**	-33.01**	9.32	29.22*	16.47	5.87	21.01**	1.41	-4.00	9.09	-8.86*	10.77*
7.	NDLA-4 X NO-15	-31.30**	-41.90**	5.49	24.70*	12.39	2.16	15.79	5.48	2.67	16.67**	-2.53	18.46**
8.	NDLA-4 X R-106	-34.35**	-41.62**	6.00	25.30*	12.93	2.65	20.00**	2.74	0.00	13.64*	-5.06	15.38**
9.	NDLA-4 X CPI-1	-38.17**	-44.23**	1.27	19.70	7.88	-1.93	0.00	-10.96*	-13.33**	-1.52	-17.72**	0.00
10.	NDLA-4 X RHA-271	-41.09**	-42.13**	8.95	28.78*	16.07	5.51	13.60**	-2.74	-5.33	7.58	-10.13*	9.23
11.	NDLA-4 X NGM-16	-37.32**	-41.43**	6.35	25.71*	13.30	2.99	21.26**	5.48	2.67	16.67**	-2.53	18.46**
12.	NDLA-4 X NO-30	6.70	-8.83	65.55**	95.69**	76.37**	60.32**	4.17	2.74	0.00	13.64*	-5.06	15.38**
13.	CMS 17A X NO-15	-24.07**	-33.78**	11.71	32.05**	19.01	8.18	21.60**	16.92**	1.33	15.15**	-3.80	16.92**
14.	CMS 17AX R-106	-25.86**	-31.86**	14.94	35.86**	22.45*	11.31	21.37**	9.23	-5.33	7.58	-10.13*	9.23
15.	CMS 17A X CPI-1	-31.54**	-36.14**	7.72	27.33*	14.76	4.31	3.28	-3.08	-16.00**	-4.55	-20.25**	-3.08
16.	CMS 17A X RHA-271	-35.53**	-38.88**	15.08	36.03**	22.60*	11.44	24.79**	12.31*	-2.67	10.61	-7.59	12.31*
17.	CMS 17A X NGM-16	-27.96**	-30.30**	17.59	38.99**	25.27*	13.87	29.41**	18.46**	2.67	16.67**	-2.53	18.46**
18.	CMS 17AX NO-30	-23.97**	-32.97**	13.08	33.67**	20.47*	9.51	0.00	-4.23	-9.33*	3.03	-13.92**	4.62
19.	CMS 30A X NO-15	-27.81**	-38.07**	8.62	28.40*	15.72	5.19	20.31**	13.24**	2.67	16.67**	-2.53	18.46**
20.	CMS 30AX R-106	-38.31**	-44.29**	-2.29	15.50	4.10	-5.38	16.67**	2.94	-6.67	6.06	-11.39*	7.69
21.	CMS 30A X CPI-1	-29.06**	-35.01**	13.99	34.74**	21.44*	10.39	4.00	-4.41	-13.33**	-1.52	-17.72**	0.00
22.	CMS 30A X RHA-271	-34.19**	-36.44**	19.67*	41.45**	27.49*	15.89	16.67**	2.94	-6.67	6.06	-11.39*	7.69
23.	CMS 30A X NGM-16	-32.97**	-36.35**	11.65	31.98**	18.95	8.12	31.15**	17.65**	6.67	21.21**	1.27	23.08**
24.	CMS 30A X NO-30	-40.64**	-48.54**	-9.73	6.70	-3.84	-12.59	7.91*	5.63	0.00	13.64*	-5.06	15.38**

*- Significant at 5% level ; ** - Significant at 1% level

Table 3. Percent heterosis over mid parent (MP), better parent (BP) and check hybrids for stem girth and seed set percent in sunflower

S.No.	Crosses	Stem girth						Seed set per cent					
		MP	BP	NDSH1012	DRSH-1	KBSH-44	Kaveri	MP	BP	NDSH1012	DRSH-1	KBSH-44	Kaveri
1.	NDLA-3 X NO-15	10.34	0.00	0.00	-20.00 *	-5.88	0.00	17.60 **	10.56	7.53	9.79	12.95	76.40 **
2.	NDLA-3 X R- 106	7.14	-6.25	-6.25	-25.00 **	-11.76	-6.25	6.35	-5.63	-8.22	-6.29	-3.60	50.56 **
3.	NDLA-3 X CPI-1	3.45	-6.25	-6.25	-25.00 **	-11.76	-6.25	7.46	1.41	-1.37	0.70	3.60	61.80 **
4.	NDLA-3 X RHA-271	11.11	-6.25	-6.25	-25.00 **	-11.76	-6.25	34.76 **	10.56	7.53	9.79	12.95	76.40 **
5.	NDLA-3 X NGM-16	28.57 **	12.50	12.50	-10.00	5.88	12.50	10.11	3.52	0.68	2.80	5.76	65.17 **
6.	NDLA-3 X NO- 30	20.00 *	12.50	12.50	-10.00	5.88	12.50	5.84	2.11	-0.68	1.40	4.32	62.92 **
7.	NDLA-4 X NO-15	9.68	-5.56	6.25	-15.00	0.00	6.25	20.15 **	14.49 *	8.22	10.49	13.67 *	77.53 **
8.	NDLA-4 X R- 106	26.67 **	5.56	18.75	-5.00	11.76	18.75	33.87 **	20.29 **	13.70 *	16.08 *	19.42 **	86.52 **
9.	NDLA-4 X CPI-1	9.68	-5.56	6.25	-15.00	0.00	6.25	31.82 **	26.09 **	19.18 **	21.68 **	25.18 **	95.51 **
10.	NDLA-4 X RHA-271	3.45	-16.67	0.00	-20.00 *	-5.88	0.00	22.27 **	1.45	-4.11	-2.10	0.72	57.30 **
11.	NDLA-4 X NGM-16	20.00 *	0.00	12.50	-10.00	5.88	12.50	20.15 **	14.49 *	8.22	10.49	13.67 *	77.53 **
12.	NDLA-4 X NO- 30	-6.25	-16.67	-6.25	-25.00 **	-11.76	-6.25	-2.22	-4.35	-9.59	-7.69	-5.04	48.31 **
13.	CMS 17A X NO-15	17.24	6.25	6.25	-15.00	0.00	6.25	12.25 *	10.94	-2.74	-0.70	2.16	59.55 **
14.	CMS 17AX R- 106	28.57 **	12.50	12.50	-10.00	5.88	12.50	32.77 **	23.44 **	8.22	10.49	13.67 *	77.53 **
15.	CMS 17A X CPI-1	10.34	0.00	0.00	-20.00 *	-5.88	0.00	33.07 **	32.03 **	15.75 *	18.18 **	21.58 **	89.89 **
16.	CMS 17A X RHA-271	18.52	0.00	0.00	-20.00 *	-5.88	0.00	31.51 **	12.50 *	-1.37	0.70	3.60	61.80 **
17.	CMS 17A X NGM-16	21.43 *	6.25	6.25	-15.00	0.00	6.25	23.32 **	21.88 **	6.85	9.09	12.23	75.28 **
18.	CMS 17AX NO- 30	13.33	6.25	6.25	-15.00	0.00	6.25	10.00	8.33	-2.05	0.00	2.88	60.67 **
19.	CMS 30A X NO-15	21.43 *	13.33	6.25	-15.00	0.00	6.25	10.53 *	4.26	0.68	2.80	5.76	65.17 **
20.	CMS 30AX R- 106	48.15 **	33.33 **	25.00 *	0.00	17.65	25.00 *	33.07 **	18.44 **	14.38 *	16.78 *	20.14 **	87.64 **
21.	CMS 30A X CPI-1	21.43 *	13.33	6.25	-15.00	0.00	6.25	33.33 **	26.24 **	21.92 **	24.48 **	28.06 **	100.00 **
22.	CMS 30A X RHA-271	30.77 **	13.33	6.25	-15.00	0.00	6.25	39.66 **	14.89 *	10.96	13.29 *	16.55 *	82.02 **
23.	CMS 30A X NGM-16	33.33 **	20.00	12.50	-10.00	5.88	12.50	9.02	2.84	-0.68	1.40	4.32	62.92 **
24.	CMS 30A X NO- 30	17.24	13.33	6.25	-15.00	0.00	6.25	7.69	4.26	0.68	2.80	5.76	65.17 **

*- Significant at 5% level ; ** - Significant at 1% level

Table 4. Percent heterosis over mid parent (MP), better parent (BP) and check hybrids for number of seeds per head and seed yield in sunflower

S.No.	Crosses	Number of seeds per head						Seed yield					
		MP	BP	NDSH1012	DRSH-1	KBSH-44	Kaveri	MP	BP	NDSH1012	DRSH-1	KBSH-44	Kaveri
1.	NDLA-3 X NO-15	44.83*	8.47	-23.12	9.32	27.45	4.88	95.77**	45.27*	-4.83	9.53	26.62	56.82*
2.	NDLA-3 X R-106	39.87*	10.09	-21.97	10.96	29.36	6.45	48.03	-1.05	-35.17*	-25.39	-13.75	6.82
3.	NDLA-3 X CPI-1	24.08	-5.29	-32.87*	-4.54	11.29	-8.42	57.14*	15.80	-24.13	-12.69	0.93	25.01
4.	NDLA-3 X RHA-271	63.62**	14.53	-18.82	15.44	34.58	10.74	120.19**	37.90	-9.65	3.98	20.19	48.87*
5.	NDLA-3 X NGM-16	35.81	7.75	-23.63	8.60	26.61	4.18	92.88**	53.27**	0.42	15.57	33.59	65.46**
6.	NDLA-3 X NO-30	40.46*	25.11	-11.32	26.09	47.00*	20.96	43.75*	42.26*	-4.83	9.53	26.62	56.82*
7.	NDLA-4 X NO-15	99.41**	53.38**	0.55	42.98*	66.69**	37.17*	179.11**	122.92**	18.35	36.21*	57.45**	95.02**
8.	NDLA-4 X R-106	98.40**	60.78**	5.41	49.88*	74.74**	43.79*	162.39**	85.75**	-1.39	13.49	31.19	62.49*
9.	NDLA-4 X CPI-1	70.21**	33.57	-12.43	24.52	45.17*	19.45	149.19**	97.45**	4.83	20.64	39.46*	72.73**
10.	NDLA-4 X RHA-271	98.73**	42.34*	-6.68	32.69	54.69*	27.29	133.71**	53.28*	-18.62	-6.34	8.26	34.09
11.	NDLA-4 X NGM-16	148.47**	103.05**	33.12*	89.29**	120.68**	81.59**	170.73**	133.81**	24.13	42.86*	65.14**	104.54**
12.	NDLA-4 X NO-30	22.00	12.53	-26.22	4.90	22.30	0.64	16.10	4.12	-30.34*	-19.84	-7.33	14.78
13.	CMS 17A X NO-15	56.07*	32.49	-32.99*	-4.72	11.08	-8.59	155.84**	129.35**	-8.27	5.57	22.04	51.15*
14.	CMS 17AX R-106	95.15**	76.09**	-10.94	26.63	47.64*	21.49	157.79**	100.04**	-19.99	-7.92	6.44	31.84
15.	CMS 17A X CPI-1	58.45*	37.71	-30.35*	-0.97	15.46	-4.99	152.42**	124.17**	-10.34	3.19	19.28	47.74*
16.	CMS 17A X RHA-271	88.78**	47.31	-25.50	5.93	23.50	1.63	182.98**	100.04**	-19.99	-7.92	6.44	31.84
17.	CMS 17A X NGM-16	87.53**	70.88**	-13.58	22.88	43.26	17.89	135.13**	131.06**	-7.58	6.36	22.95	52.28*
18.	CMS 17AX NO-30	26.24	20.75	-33.12*	-4.90	10.87	-8.77	36.76	9.26	-26.90	-15.88	-2.75	20.45
19.	CMS 30A X NO-15	139.53**	101.48**	4.21	48.18*	72.76**	42.16*	155.77**	105.26**	7.60	23.83	43.14*	77.30**
20.	CMS 30AX R-106	121.74**	98.11**	2.47	45.70*	69.87**	39.78*	216.58**	124.95**	6.21	22.24	41.30*	75.01**
21.	CMS 30A X CPI-1	88.24**	62.06*	-16.18	19.19	38.96	14.34	142.91**	93.38**	1.37	16.66	34.86	67.03**
22.	CMS 30A X RHA-271	115.52**	66.83**	-13.71	22.70	43.05	17.71	207.99**	102.61**	6.21	22.24	41.30*	75.01**
23.	CMS 30A X NGM-16	54.47*	39.34	-27.93*	2.48	19.48	-1.68	120.62**	91.56**	0.42	15.57	33.59	65.46**
24.	CMS 30A X NO-30	42.37*	37.66	-23.75	8.41	26.39	4.01	66.47**	48.45*	-0.69	14.30	32.12	63.65**

*- Significant at 5% level ; ** - Significant at 1% level

Table 5. Superior crosses with heterosis over better parent, *sca* and *gca* effects and mean performance for eight traits studied in sunflower

S.No.	Character	Crosses with high heterotic performance over better parent	Heterosis over better parent	*sca* effect	*gca* status		Mean perfor-mance
					Female	Male	
1	SPAD chlorophyll meter reading	CMS 17A x NO-15 CMS 30A x NO-30	0.50 0.24	2.21* 2.09*	HL	LH	40.06 42.00
2	Leaf area index	CMS 17A x R-106 CMS 17A x RHA-271 NDLA-4 x R-106	272.92** 172.92 ** 166.67**	1.00** -0.73* 1.00**	LLH	HLH	8.95 6.55 10.00
3	Specific leaf area (cm^2/g)	CMS 30A x NO-30 NDLA-3 x RHA-271	-48.54 ** -48.50 **	-21.15 ** -5.53	LH	HH	72.33 77.70
4	Number of leaves per plant	NDLA-3 x R-106 CMS 17A x NGM-16 CMS-30A x NGM-16	21.15 ** 18.46 ** 17.65**	1.13 0.83 1.58	LLH	LHH	32 39 40
5	Stem girth (cm)	CMS 30A x R-106	33.33 **	0.60	H	H	10
6	Number of seeds per head	NDLA-4 x NGM-16 CMS 30A x NO-15 CMS 30A x R-106	103.05 ** 101.48 ** 98.11**	319.40** 170.98 73.23	HLL	HLH	1564 1224 1204
7	Seed set (%)	CMS 17A x CPI-1 CMS 30A x CPI-1 NDLA-4 x CPI-1	32.03 ** 26.24** 26.09**	1.83 3.50 3.00	LHL	HHH	85 89 87
8	Seed yield (kg ha^{-1})	NDLA-4 x NGM-16 CMS 17A x NGM-16 CMS 17A x NO-15	133.81 ** 131.06 ** 129.35**	483.27 -77.56 -62.56	LLL	HHH	4167 3102 3079

*- Significant at 5% level ; ** - Significant at 1% level

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Research Note

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PHYTOCHEMICAL SCREENING OF *PELTOPHORUM PTEROCARPUM* FLOWER AND BARK EXTRACTS

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Natural dyes are used since ancient time and are being revived with an aim to reduce pollution. Increased conscious on sustainability has induced the need for exploring newer dye sources and understanding its chemistry and optimize its application on textiles. Flowers and barks of *Peltophorum pterocarpum* (Yellow flame tree), a commonly found tree can be used as natural and sustainable dye source for cellulosic fabrics. Natural dyes are sustainable, as they are mostly from plants . Many parts of plants produce natural dyes (Treesa and Vaithiyanathan, 2018). At present, proper utilization of natural resources in textiles, pharmaceutical and food materials, need to be thought rather than their synthetic counterparts (Parthasarathi and Lokesh, 2015). Though natural dyes have some limitations such as availability, fastness on textiles, dyeing process and reproduction of shades, they have their own place in the market.

Peltophorum pterocarpum commonly called as Copper pod or Yellow flame tree, is a shade tree usually found along road sides. Flowering period of the tree is usually from March-May. In young trees, sporadic flowering may occur throughout the year (Orwa *et al.*, 2009).The floral resources are wasted and unutilized, though it flowers twice a year. It serves as a nectar source for many economicaly important vasps (Sukumaran *et al.*, 2011).

The photochemical constituents of each plants differ from one part to another. In plants, steroids, flavonoids, alkaloids, tannins, terpenoids, glycosides, etc. are important bioactive compounds (Milan *et al.*, 2017).

Preliminary phytochemical screening of the dye extracts was carrried to determine the presence of saponins, flavonoids, alkaloids, carbohydrates, tannins, glycosides, phenolic compounds, phytosterols, and terpenoids. This study attempts to evaluate the phytochemicals of dye extracts from flowers and bark of *Peltophorum pterocarpum.*

Plant material

The fresh flowers and bark of *Peltophorum pterocarpum* were collected from Avinashilingam Institute campus in the month of May, 2018. The plant materials were taxonomically identified and authenticated by Tamil Nadu Agricutural University, Coimbatore. The freshly collected flowers and barks were dried in shade and made into coarse powder in a mechanical grinder and preserved in air tight container (Fig. 1).

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pterocarpum Tree

pterocarpum Bark

pterocarpum Flower

Fig. 1 DYE SOURCE- *Peltophorum pterocarpum*

Preparation of plant extract

Aqueous and alkaline medium were used for dye extraction and two types of extracts were prepared from each source.

Aqueous extract: Fifty grams each of powdered flower and bark mixed with 500 ml (1:10 ratio) of soft water separately and boiled at 60^0 C for one hour with constant stirriring and filtered through Whatsman Filter paper No1.

Alkali Extract: One percent alkaline solution was prepared by mixing 1 mg sodium carbonate in 100 ml soft water. In this solution 10 grams of powdered *Peltophorum pterocarpum* flower and bark were added separately and boiled for one hour. The extract is then filtered and stored for further phytochemical studies.

Phytochemical Screening of Peltophorum pterocarpum flower and bark extract

Phyto chemical tests were conducted by following the standard procedures.

Presence of alkaloids in *Peltophorum pterocarpum* flower and bark was found by Dragendroff's test and Mayer's test (Treesa and Vaithiyanathan, 2018). Presence of flavonoids by alkaline reagent test, steroids by Salkowski Test and Libermann Burchard's test, Terpenoids by Salkowski Test and Tannins by Ferric chloride test and lead acetate solution test (Jayapriya and Bagyalakshmi, 2016).

Presence of Phenols were also determined by following Ferric chloride test, Glycosides by Keller – Killiani Test, Carbohydrates by Benedict's test and Fehling's Test, Saponins by Foam test and Froth test (Amala and Poonguzhali, 2015).

Peltophorum pterocarpum aqueous flower extracts show the presence of the flavonoids, proteins, phenolics and carbohydrates, while alkali extracts of flower has alkaloids, flavonoids, tannins, phenolics and saponins. Tannins and saponnins did not make obvious presence in the aqueous extract of flower.

The aqueous extract of bark shows flavonoids, steroids, terpenoids, proteins, phenolics carbohydrates and saponins, while alkakine extract of bark shows alkaloids, flavonoids, steroids, terpenoids, proteins, phenolics, glycosides and saponins.

Earlier studies have been reported on the alcoholic extracts of flowers of *Peltophorum pterocarpum*. Tannins, flavonoids and phenolic

Table 1. Phytochemical screening of *Peltophorum pterocarpum* flower and bark extracts

Solvents	Flower extract		Bark extract	
	Aqueous	Alkaline	Aqueous	Alkaline
Phytochemicals				
Alkaloids	_	+	_	+
Flavonoids	+	+	+	+
Steroids	_	_	+	+
Terpenoids	_	_	+	+
Tannins	_	+	_	_
Phenolics	+	+	+	+
Glycosides	_	_	_	+
Carbohydrates	+	_	+	_
Saponins	_	+	+	+

Note: + indicates present; _ indicates absent

compounds in methanol extracts have been reported to exert multiple biological effects including antioxidant, free radical scavenging abilities, anti-inflammatory, anti-carcinogenic etc (Milan *et al.*, 2017). Different phytochemicals have been found to possess a wide range of activities, which may help in protection against chronic diseases. (Amala and Poonguzhali, 2015)

The preliminary phytochemical screening of natural dye of *Peltophorum pterocarpum* flower and bark extracts in aqueous and alkali medium revealed the presence of alkaloids, flavonoids, steroids, terpenoids, phenolics and saponins. This provides an idea of phytochemical constituents occurrence in the dye extracts. Flavonoids and phenolics were found in all the four extracts. Flavonoids have long been known to be responsible for the colour and aroma of flowers (Panche *et al.*, 2016). The presence of flavonoid in the aqueous and alkai extract of flower and bark of *Peltophorum pterocarpum* indicates colour components. Hence, it can be used as potential dye source for dyeing of cotton fabrics (Wanyama *et al.*, 2011). Also, Saponins were found in the bark exracts and the alkaline flower extract. Hence, the plant source extracts can be successfully applied as dye on cotton fabrics.

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