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CONTENTS

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EVALUATION OF GROUNDNUT (*Arachis hypogaea* L.) GENOTYPES FOR YIELD, YIELD ATTRIBUTES AND WATER USE EFFICIENCY RELATED TRAITS

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ABSTRACT

Thirty-six groundnut genotypes were grown during *Rabi*, 2021-2022 in order to evaluate the performance of elite genotypes of groundnut for 14 characters. The experiment was laid out in randomized block design with three replications. Analysis of variance showed that mean sum of squares due to genotypes was highly significant for all characters studied. For pod yield plant^{-1}; the genotypes TCGS-2223, TCGS-2040, TCGS-2039, TCGS-2230, TCGS-2053, TCGS-2055, TCGS-2317, TCGS-2278, TCGS-2233 and TCGS-2052 showned improved performance. TCGS-2223 exhibited better performance for all the characters studied except for the trait plant height. TCGS-2053 outperformed all the other genotypes in terms of pod yield plant^{-1}.

KEYWORDS: Genotypes, RBD, Pod yield, Plant height.

INTRODUCTION

Cultivated groundnut or peanut (*Arachis hypogaea* L.) is an annual self pollinated legume crop with chromosome number of 2n = 4x = 40. It is the only legume crop in which pods are formed inside the soil. It belongs to the family fabaceae. It is native to South America, grown throughout the tropical and sub-tropical regions of the world between the latitudes of 40^{o} N to 40^{o} S.

It is an important oilseed crop known for its several purposes including edible oil production, direct human consumption as food and for animal consumption in the form of silage, hay and oilcake. It is a rich source of high quality oil (44-56%), protein (22-30%) on dry seed basis, carbohydrates (10-25%), vitamins (E and B complex), minerals (Ca, P, Mg, Zn and Fe) and fiber. Being a legume it adds nitrogen and organic matter to soil.

It is grown as a sole crop, intercrop or mixed crop (Rao *et al*., 1990; Ghosh *et al.,* 2004). With its multiple uses; groundnut is now a great cash crop for both local and international trade in a number of emerging and developed nations.

Globally, it is cultivated in an area of 29.92 Mha with annual production of 55.30 Mt and productivity of 1851 kg ha^{-1} (FAOSTAT, 2021). In India, groundnut covers an area of 6.09 Mha with a production of 10.21 Mt and productivity of 1676 kg ha^{-1}. In Andhra Pradesh, it is cultivated in an area of 0.87 Mha with a production of 0.78 Mt and productivity of 894 kg ha^{-1} (Directorate of Economics and Statistics, 2021).

Mainly groundnut is cultivated as a rainfed crop but is also grown as irrigated crop. During *rabi* season, due to the depletion of ground water resources, water shortage is usual during the crop period. Hence, there is a need to find out Water Use Efficiency (WUE) genotypes in groundnut. WUE is an important trait which contributes to productivity when there are limited water resources. The productivity of the crop can be enhanced by identifying the genotypes that utilise the scarce resources of water more efficiently (Arunkumar *et al*., 2017).

WUE in groundnut is correlated with the specific leaf area (SLA) and SPAD Chlorophyll Meter Reading (SCMR). SCMR and SLA can be utilised as surrogate traits to choose genotypes with high WUE (Sab *et al.* 2018). These physiological traits will greatly aid us in bringing genetic improvements for WUE in groundnut genotype improvement ultimately leading to the evolution of better genotypes adapted to drought conditions, when used as selection criteria in breeding programmes or in the selection of efficient genotypes.

Considering the above factors, the research was undertaken to study the *per-se* performance for yield, yield attributes and water use efficiency related traits in 36 genotypes of groundnut.

MATERIAL AND METHODS

The experiment was laid out in Randomized Block Design (RBD) with three replications and 36 genotypes of groundnut were evaluated at dry land farm of S.V. Agricultural College, Tirupati, during *rabi,* 2021-2022. The data was recorded on fourteen traits *viz.,* days to 50%

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flowering, days to maturity, plant height (cm), number of primary branches plant^{-1}, number of secondary branches plant^{-1}, kernel yield plant^{-1} (g), hundred kernel weight (g), shelling per cent, sound mature kernel per cent, harvest index (%), SPAD Chlorophyll Meter Reading at 60 DAS, Specific Leaf Area at 60 DAS (cm^2 gm^{-1}), Relative Water Content (%) and pod yield plant^{-1} (g). The data was analyzed through software – INDOSTAT.

RESULTS AND DISCUSSION

The phenotypic variation manifested by the genotype has two components namely genotypic and environmental. Analysis of variance among 14 characters revealed significant differences among the means of all the genotypes. Thus, it indicated considerable scope for selection of high yielding and genotypes with more yield and water use efficiency. The differences can be attributed to variations present in the genotypes as well as the environmental factors.

Mean performance of genotypes for different yield, yield attributes and water use efficiency related traits

1. Days to 50 % flowering

The mean number of days to 50% flowering ranged from 22.00 days (TCGS-2233) to 31.33 days (TCGS-2044). When compared to the average, nineteen genotypes reached blooming early (26.60 days). As a result, these genotypes can be used as donor parents in the hybridization programme to develop short duration genotypes.

2. Days to maturity

The mean number of days to maturity ranged from 101.67 (TCGS-2233) to 112.00 days (TCGS-2052). Twenty one genotypes reached maturity sooner than the average of 106.25 days. In order to develop short duration genotypes, these genotypes can be used in the hybridization programme as donor parents.

3. Plant height (cm)

With a general mean of 35.41 cm, the mean values for plant height ranged from 25.67 cm (TCGS-2051) to 45.97 cm (TCGS-2052). Eighteen genotypes showed better *per se* performance than the average (35.41 cm).

4. Number of primary branches plant^{-1}

Number of primary branches plant^{-1} count ranged from 3.87 (TCGS-2230) to 8.82 (TCGS-2053). Fifteen genotypes recorded more number of primary branches plant^{-1} than the average of 5.26.

5. Number of secondary branches plant^{-1}

Number of secondary branches plant^{-1} were between 0.20 (TCGS-2068 and Narayani) and 2.73 (TCGS-2229). Nineteen genotypes recorded more secondary branches plant^{-1} than the average of 1.50.

6. Kernel yield plant^{-1} (g)

Kernel yield plant^{-1} mean varied from 7.74 g (Greeshma) to 15.36 g TCGS-2053 and twenty genotypes showed higher yields than general mean of 10.93 g.

7. Hundred kernel weight (g)

The mean values for hundred kernel weight ranged from 40.67 g (TCGS-2068) to 66.40 g. (TCGS-1798). Sixteen genotypes recorded hundred kernel weights greater than the average of 50.40 g.

8. Shelling per cent

Nineteen genotypes had higher shelling per cent than the overall mean of 71.73%, with mean values for shelling per cent ranging from 57.26% (TCGS-2230) to 79.87% (TCGS-2235).

9. Sound mature kernel (%)

With an overall mean value of 51.00%, the mean values for this character ranged from 34.03% (Tirupati-4) to 72.17% (Rohini). Seventeen genotypes registered sound mature kernel percentages that were higher than the average of 51.00%.

10. Harvest index (%)

Nineteen genotypes recorded higher harvest indices than the average of 51.17%. The genotype means varied from 24.95% (TCGS-2044) to 71.45% (TCGS-2053).

11. SPAD chlorophyll meter reading (SCMR) at 60 DAS

With a general mean of 47.55, the mean values for the SPAD chlorophyll meter reading (SCMR) at 60 DAS ranged from 43.30 (K-6) to 50.77 (TCGS-2223). Eighteen genotypes obtained higher SPAD chlorophyll readings than the average of 47.55.

12. Specific leaf area at 60 DAS (SLA) (cm^2 g^{-1})

The mean values of specific leaf area at 60 DAS from 119.22 cm^2 g^{-1} (TCGS-1798) to 265.35 cm^2 g^{-1} (TCGS-2068) and seventeen genotypes showed lower specific leaf area than their overall mean of 207.55 cm^2 g^{-1}.

13. Relative water content (%)

The mean percentages of relative water content ranged from 69.24% (TCGS-2060) to 92.53% (TCGS-

Table 1. Analysis of variance for yield, yield attributes and water use efficiency (WUE) related traits in 36 genotypes of groundnut

S. No.	Characters	Mean sum of squares		
		Replications (df : 2)	Genotypes (df : 35)	Error (df : 70)
1.	Days to 50% flowering	2.815	14.701**	2.710
2.	Days to maturity	1.861	18.198**	1.680
3.	Plant height (cm)	1.685	56.210**	4.728
4.	Number of primary branches plant^{-1}	0.328	3.831**	0.109
5.	Number of secondary branches plant^{-1}	0.180	1.659**	0.069
6.	Kernel yield plant^{-1} (g)	0.108	9.454**	0.476
7.	Hundred kernel weight (g)	39.433	73.824**	24.466
8.	Shelling per cent (%)	1.757	157.744**	17.271
9.	Sound mature kernel (%)	112.236	270.267**	84.253
10.	Harvest index (%)	64.824	367.870**	67.886
11.	SPAD chlorophyll meter reading at 60 DAS	1.629	11.539**	4.670
12.	Specific leaf area at 60 DAS (cm^2 gm^{-1})	259.032	3595.106**	407.379
13.	Relative water content (%)	32.903	54.532**	23.053
14.	Pod yield plant^{-1} (g)	0.285	19.792**	0.923

** Significant at 1% level

Table 2. *Per se* performance for yield, yield attributes and water use efficiency (WUE) related traits in 36 genotypes of groundnut

Genotypes	DFF	DM	PH	NPB	NSB	KYP	HKW	SP	SMK	HI	SCMR	SLA	RWC	PYP
TCGS-1694	23.67	105.33	38.87	6.63	2.20	8.29	56.13	58.01	52.60	57.26	44.47	225.78	82.06	14.28
TCGS-1798	29.00	107.33	35.93	5.73	0.53	8.18	66.40	69.37	38.97	32.00	47.27	119.22	80.08	11.78
TCGS-2004	26.00	105.00	34.40	4.43	2.53	11.54	42.93	77.84	54.17	55.55	46.77	236.47	87.67	14.82
TCGS-2038	30.00	111.00	29.70	4.50	2.13	9.17	52.47	74.34	49.30	55.08	45.60	256.67	81.54	12.33
TCGS-2039	26.33	107.00	34.60	5.80	2.40	11.99	53.93	71.04	60.03	45.63	48.47	218.43	85.56	16.88
TCGS-2040	26.33	105.33	33.10	6.87	2.40	14.31	49.47	73.19	60.93	62.88	48.63	176.30	83.48	19.55
TCGS-2041	27.33	107.33	30.53	6.45	1.40	11.07	56.87	67.41	55.73	58.01	49.27	194.93	84.40	16.41
TCGS-2044	31.33	111.00	41.40	5.00	1.20	9.62	56.13	79.29	56.53	24.95	49.67	203.86	81.64	12.13
TCGS-2049	30.00	111.67	38.83	5.03	0.27	8.09	43.47	58.56	37.67	60.71	45.77	229.07	89.23	13.81
TCGS-2051	28.33	107.67	25.67	7.57	1.27	12.05	49.00	75.13	42.43	58.32	46.43	233.62	79.55	16.04
TCGS-2052	30.33	112.00	45.97	7.08	0.80	10.43	44.87	63.46	41.40	62.84	50.33	241.22	78.29	16.43
TCGS-2053	27.33	104.67	34.11	8.82	0.80	15.36	50.13	63.60	63.80	71.45	49.50	217.65	84.25	24.14
TCGS-2055	27.00	107.33	33.33	4.52	1.47	12.31	48.53	70.17	57.33	51.73	48.63	165.61	88.60	17.54
TCGS-2057	28.00	105.67	36.17	4.57	1.27	10.27	57.80	76.20	60.37	33.12	49.80	227.47	82.04	13.48
TCGS-2060	28.67	108.67	37.07	4.67	1.20	12.25	50.53	78.36	55.03	46.29	48.73	210.58	69.24	15.63
TCGS-2068	25.33	105.33	30.87	4.30	0.20	8.94	40.67	69.67	41.13	57.60	45.27	265.35	85.53	12.83
TCGS-2217	25.00	104.67	33.20	5.33	2.20	9.94	50.33	64.46	39.47	57.06	50.40	242.60	92.53	15.41
TCGS-2219	24.33	105.00	33.27	4.33	1.53	10.02	52.60	78.37	43.97	43.09	45.97	141.47	86.45	12.79
TCGS-2223	24.33	105.67	36.20	6.62	2.07	14.54	52.60	78.48	56.93	66.04	50.77	167.12	86.58	18.52
TCGS-2227	26.67	106.33	36.50	4.15	1.53	9.84	53.80	73.07	44.37	42.94	49.60	198.94	84.61	13.46
TCGS-2229	25.67	107.33	36.40	4.23	2.73	8.77	51.80	77.75	38.47	51.74	43.83	202.06	90.54	11.28
TCGS-2230	24.33	103.67	26.13	3.87	2.47	10.00	50.80	57.26	49.20	69.79	48.53	226.22	85.23	17.46
TCGS-2233	22.00	101.67	36.47	4.07	1.80	11.51	48.93	67.22	50.77	51.17	46.80	217.82	86.29	17.11
TCGS-2235	27.33	106.67	38.00	5.97	2.07	12.15	54.07	79.87	60.70	34.26	48.30	227.81	86.87	14.21
TCGS-2278	23.67	103.00	32.80	5.65	0.33	11.57	50.00	62.38	47.37	46.78	47.43	178.87	83.63	18.54

Cont...

Table 2. Cont...

Genotypes	DFF	DM	PH	NPB	NSB	KYP	HKW	SP	SMK	HI	SCMR	SLA	RWC	PYP
TCGS-2317	28.00	106.00	38.93	5.13	1.60	12.17	53.13	69.58	68.43	47.86	46.83	136.33	84.85	17.48
Dharani	24.00	105.33	33.71	4.78	2.47	11.36	49.07	71.69	52.93	47.09	47.97	192.16	86.30	15.85
Dheeraj	26.00	104.00	35.07	4.25	0.40	11.07	54.47	72.26	50.47	48.32	46.17	201.85	88.67	15.31
Greeshma	23.67	103.00	40.80	4.22	0.80	7.74	45.07	63.73	40.83	60.77	47.97	204.48	86.16	12.15
K-6	26.00	103.33	39.33	4.65	1.60	11.42	47.40	74.69	60.53	46.28	43.30	164.54	80.46	15.28
K-9	27.67	107.67	42.13	5.42	1.20	10.77	48.27	65.98	42.47	65.02	50.33	204.49	89.89	16.32
Narayani	24.67	104.00	32.78	5.27	0.20	11.56	44.53	75.39	45.67	49.98	47.30	233.02	84.24	15.33
Rohini	25.67	105.67	32.13	4.73	1.53	10.06	45.33	74.38	72.17	34.22	48.03	193.95	83.09	13.52
TAG-24	30.00	109.00	30.70	4.85	2.33	11.31	47.40	77.19	62.41	51.35	44.47	263.66	81.22	14.65
Tirupati-1	27.33	105.67	40.27	4.23	1.87	12.77	47.53	77.50	47.53	38.22	47.23	241.98	79.19	15.36
Tirupati-4	26.33	105.00	39.27	5.48	1.27	11.14	47.87	78.25	34.03	56.54	45.87	210.27	80.79	13.22
MEAN	**26.60**	**106.25**	**35.41**	**5.26**	**1.50**	**10.93**	**50.40**	**71.73**	**51.00**	**51.17**	**47.55**	**207.55**	**84.19**	**15.32**
MAX	**31.33**	**112.00**	**45.97**	**8.82**	**2.73**	**15.36**	**66.40**	**79.87**	**72.17**	**71.45**	**50.77**	**265.35**	**92.53**	**24.14**
MIN	**22.00**	**101.67**	**25.67**	**3.87**	**0.20**	**7.74**	**40.67**	**57.26**	**34.03**	**24.95**	**43.30**	**119.22**	**69.24**	**11.28**
C.V	**6.19**	**1.22**	**6.14**	**6.29**	**17.55**	**6.31**	**9.81**	**5.79**	**18.00**	**16.10**	**4.55**	**9.72**	**5.70**	**6.27**
SE(m)	**0.94**	**0.74**	**1.24**	**0.19**	**0.15**	**0.39**	**2.82**	**2.37**	**5.23**	**4.69**	**1.23**	**11.49**	**2.73**	**0.55**
SE(d)	**1.34**	**1.06**	**1.78**	**0.27**	**0.21**	**0.56**	**4.04**	**3.40**	**7.49**	**6.73**	**1.76**	**16.47**	**3.92**	**0.78**
C.D	**2.68**	**2.11**	**3.54**	**0.54**	**0.45**	**1.12**	**8.05**	**6.77**	**14.95**	**13.42**	**3.52**	**32.87**	**7.82**	**1.56**

DFF : Days to 50% flowering; DM : Days to maturity; PH : Plant height (cm); NPB : Number of primary branches plant^{-1}; NSB : Number of secondary branches plant^{-1}; KYP : Kernel yield plant^{-1} (g); HKW : Hundred kernel weight (g); SP : Shelling per cent (%); SMK : Sound mature kernel (%); HI : Harvest index (%); SCMR : SPAD chlorophyll meter reading at 60 DAS; SLA : Specific leaf area at 60 DAS (cm^2 gm^{-1}); RWC : Relative water content (%); PYP : Pod yield plant^{-1} (g)

Table 3. List of top five genotypes based on *per se* performance in groundnut

S. No	Characters	Genotypes
1.	Days to 50% flowering	TCGS-2233, Greeshma, TCGS-2278, TCGS-1694 and Dharani
2.	Days to maturity	TCGS-2233, Greeshma, TCGS-2278, TCGS-2230 and K6
3.	Plant height (cm)	TCGS-2051, TCGS-2230, TCGS-2038, TCGS-2041 and TAG-24
4.	Number of primary branches plant^{-1}	TCGS-2053, TCGS-2051, TCGS-2052, TCGS-1694 and TCGS-2223
5.	Number of secondary branches plant^{-1}	TCGS-2229, TCGS-2004, TCGS-2230, Dharani and TCGS-2039
6.	Kernel yield plant^{-1} (g)	TCGS-2053, TCGS-2223, TCGS-2040, Tirupati-1 and TCGS-2055
7.	Hundred kernel weight (g)	TCGS-1798, TCGS-2057, TCGS-2041, TCGS-2044 and TCGS-1694
8.	Shelling per cent (%)	TCGS-2235, Tirupati-4, Tirupati-1, TCGS-2044 and TCGS-2223
9.	Sound mature kernel (%)	Rohini, TCGS-2317, TCGS-2053, TAG-24 and TCGS-2040
10.	Harvest index (%)	TCGS-2053, TCGS-2230, TCGS-2223, TCGS-2040 and TCGS-2052
11.	SPAD chlorophyll meter reading at 60 DAS	TCGS-2223, TCGS-2217, TCGS-2052, K9 and TCGS-2057
12.	Specific leaf area at 60 DAS (cm^2 gm^{-1})	TCGS-1798, TCGS-2317, TCGS-2219, K6 and TCGS-2055
13.	Relative water content (%)	TCGS-2217, TCGS-2229, K9, TCGS-2049 and TCGS-2055
14.	Pod yield plant $^{-1}$ (g)	TCGS-2053, TCGS-2040, TCGS-2278, TCGS-2223 and TCGS-2055

Table 4. Identification of promising genotypes for yield, yield attributes and water use efficiency (WUE) related traits in groundnut

S. No.	Genotypes	Characters
1.	TCGS-2223	DFF, DM, NPB, NSB, KYP, HKW, SP, SMK, HI, SCMR, SLA, RWC and PYP.
2.	TCGS-2040	DFF, DM, PH, NPB, NSB, KYP, SP, SMK, HI, SCMR, SLA and PYP.
3.	TCGS-2039	DFF, PH, NPB, NSB, KYP, HKW, SMK, SCMR, RWC and PYP.
4.	TCGS-2230	DFF, DM, PH, NSB, HKW, HI, SCMR, RWC and PYP.
5.	TCGS-2053	PH, NPB, KYP, SMK, HI, SCMR, RWC and PYP.
6.	TCGS-2055	PH, KYP, SMK, HI, SCMR, SLA, RWC and PYP.
7.	TCGS-2317	DM, NSB, KYP, HKW, SMK, SLA, RWC and PYP.
8.	TCGS-2278	DFF, DM, PH, NPB, KYP, SLA and PYP.
9.	TCGS-2233	DFF, DM, NSB, KYP, RWC and PYP.
10.	TCGS-2052	NPB, HI, SCMR and PYP.

DFF : Days to 50% flowering; DM : Days to maturity; PH : Plant height (cm); NPB : Number of primary branches plant^{-1}; NSB : Number of secondary branches plant^{-1}; KYP : Kernel yield plant^{-1} (g); HKW : Hundred kernel weight (g); SP : Shelling per cent (%); SMK : Sound mature kernel (%); HI : Harvest index (%); SCMR : SPAD chlorophyll meter reading at 60 DAS; SLA : Specific leaf area at 60 DAS (cm^2 gm^{-1}); RWC : Relative water content (%); PYP : Pod yield plant^{-1} (g)

2217). 21 genotypes revealed higher relative water content than their average (84.19%).

14. Pod yield plant^{-1} (g)

Genotypes for pod yield plant^{-1} ranged from 11.28 g (TCGS-2229) to 24.14 g (TCGS-2053) and eighteen genotypes showed higher pod yield plant^{-1} than the general mean of 15.32 g.

The top five genotypes for each character was determined based on *per se* performance, and they were listed in Table 3. Table 4 provides a list of the promising genotypes that were identified for several traits. For pod yield plant^{-1}; the genotypes TCGS-2223, TCGS-2040, TCGS-2039, TCGS-2230, TCGS-2053, TCGS-2055, TCGS-2317, TCGS-2278, TCGS-2233 and TCGS-2052 shown improved performance. These genotypes are deserving of use in the improvement of characters. Among the 36 genotypes examined, TCGS-2223 and TCGS-2040 are adjudged as promising genotypes not only for high yield and yield components, but also for water use efficiency related traits such as SPAD chlorophyll meter readings, specific leaf area and relative water content. Therefore, these genotypes may be involved in the crossing programme for by duly estimating their general and specific combining abilities in the future breeding programmes. Further, multi-location testing of these entries over years could be recommended to test their suitability and stability.

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EVALUATION OF BLACKGRAM [*Vigna mungo* (L.) Hepper] GENOTYPES FOR YIELD AND YIELD ATTRIBUTING TRAITS

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ABSTRACT

Thirty five blackgram genotypes were grown during *Rabi*, 2021-2022 in order to evaluate the performance of elite genotypes of blackgram for 12 quantitative characters. The experiment was laid out in randomized complete block design with three replications. Analysis of variance for all quantitative traits showed that mean sum of squares due to genotypes was highly significant for all characters studied. Based on mean performance, the genotypes LBG-645, MBG-1058 and TU-94-2 were adjudged as the best genotypes for improving yield, while the genotypes PU-31 and P-1032 for improving yield and yield attributes coupled with early maturing traits in blackgram.

KEYWORDS: Genotype, RBD, ANOVA, Yield, Early maturity.

INTRODUCTION

Blackgram (*Vigna mungo* L. Hepper), a diploid (2n = 2x = 22), short duration legume crop of family *Fabaceae*, was domesticated in Northern South Asia from progenitor *Vigna mungo* var. *silvestris* (Lukoki *et al.,* 1980). It is cultivated throughout Southeast Asia because of its multiple benefits to soil and human health. It is nutritionally important crop with about 25 per cent protein nearly three times that of cereals, 60 per cent carbohydrates, 1.3 per cent fat as well as important vitamins and minerals, making it a balanced vegan diet when supplemented with cereals. The ability of its roots to fix atmospheric nitrogen (42 kg/ha/year) (Dey *et al.,* 2020) contribute towards soil health while deep-roots prevents soil erosion by binding soil particles. Short duration of blackgram makes it suitable for intercropping with corn or millet or rotation with cereals like rice or wheat (Muthusamy and Pandiyan, 2018), adding another benefit for farmer.

India is the largest producer as well as the consumer of pulses accounting for more than 70 per cent of global production. It ranks fourth in position after bengalgram, redgram, greengram and cultivated in an area of about 4.14 M ha, with an annual production of 2.23 M t and with a productivity of 538 kg ha^{-1}. Andhra Pradesh is one of the major blackgram growing states of India with an area of 3.93 lakh hectares, with a production of 3.65 lakh tons and a productivity of 929 kg ha^{-1} (Directorate of Economics and Statistics, DAC & FW 2020-2021).

Though India is the largest producer of pulses, around 2-3 million tons of pulses are imported annually to fulfill the domestic consumption requirement as the current yield increase trends may not be sufficient in dealing with the growing demand (Singh *et al.,* 2022). In order to ensure hunger free society with nutritious food, there is a need to boost the yield potential of pulses including blackgram. Hence, for a major breakthrough in yield and productivity of blackgram, it is imperative to identify high yielding varieties with desirable traits.

Considering the above factors, the research was undertaken to study the *per se* performance for yield and yield attributing traits in 35 blackgram genotypes.

MATERIAL AND METHODS

The field experiment was conducted at dryland farm of Sri Venkateswara Agricultural College, Tirupati, Acharya N.G. Ranga Agricultural University during *rabi* 2021-22 in RBD with three replications. The observations were recorded on randomly selected five plants in each genotype in each replication for plant height, number of primary branches per plant, number of clusters per plant, number of pods per cluster, number of pods per plant, number of seeds per pod, pod length, hundred seed weight, seed yield per plant, and harvest index while, the data for days to 50% flowering and days to maturity were recorded on plot basis. The data was analyzed through software – INDOSTAT.

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RESULTS AND DISCUSSION

Analysis of variance for 12 traits revealed significant differences among the means of all the genotypes (Table 1). Thus, it indicated considerable scope for selection of high yielding genotypes with more yield. The variations present in the genotypes can be attributed to the influence of environmental factors.

MEAN PERFORMANCE

The mean performance of 35 blackgram genotypes were presented trait wise in Table 2.

1. Days to 50% Flowering

Days to 50% flowering ranged from 33.67 to 41.00 days. Among all the genotypes, VBG-10-010 (33.67 days) was the earliest to flower, whereas LBG 648 and LBG 645 were late in flowering (41.00 days). Ten genotypes were significantly earlier in flowering when compared to the general mean of the days to 50% flowering (36.97 days).

2. Days to Maturity

The trait number of days to maturity varied from 68.33 to 80.33 days with a mean maturity of 71.51 days. The genotypes P 112 and COBG 653 were early in maturity (68.33 days), while LBG 648 was found to be late in maturity (80.33 days). Nine genotypes were significantly early in maturity when compared with the mean maturity of the genotypes.

3. Plant Height (cm)

The shortest plant height was registered by IPU-10-4 (17.97), while the tallest was recorded by LBG 645 (41.77). The general mean was found to be 23.71. Two genotypes were significantly taller in height when compared to the general mean height.

4. Number of Primary Branches per Plant

Number of primary branches expressed in a range from 1.73 to 4.60. Among all the genotypes, more number of primary branches per plant was recorded by the

Table 1. Analysis of variance for yield and yield attributing traits in 35 blackgram genotypes

S. No	Characters	Mean sum of squares		
		Replications (df = 2)	Genotypes (df = 34)	Error (df = 68)
1.	Days to 50% flowering	1.37	10.03**	0.46
2.	Days to maturity	2.66	24.38**	1.38
3.	Plant height (cm)	0.86	78.48**	17.45
4.	Number of primary branches per plant	0.28	0.92**	0.09
5.	Number of clusters per plant	2.39	3.01**	0.78
6.	Number of pods per cluster	0.36	0.33**	0.16
7.	Number of pods per plant	34.36	25.93**	11.73
8.	Number of seeds per pod	0.17	0.77**	0.09
9.	Pod length (cm)	0.08	0.25**	0.04
10.	100 seed weight (g)	0.52	0.67**	0.18
11.	Seed yield per plant (g)	0.65	1.82**	0.41
12.	Harvest index (%)	4.45	87.58**	43.79

** Significant at 1% level

Table 2. Mean performance of 35 blackgram genotypes for yield and yield attributing traits

S. No.	Genotypes	DFF	DM	PH	NPB	NCP	NPC	NPP	NSP	PL	100 SW	SYP	HI
1.	KDRS-136	35.33*	71.33	26.93	4.27*	7.20	4.20	23.27	6.73*	5.24*	5.32	5.24	36.27
2.	SB-25-19	35.33*	69.33*	22.23	3.80	5.53	4.40	17.40	6.13	4.50	5.39	4.23	49.13*
3.	PU-205	36.67	69.00*	18.42	3.93	5.47	4.27	19.27	5.67	4.25	4.74	4.07	45.32
4.	COBG-653	35.33*	68.33*	18.83	3.10	5.53	4.60	18.87	6.07	4.23	4.52	5.40	40.67
5.	P-726	36.67	68.67*	20.23	3.80	7.10	4.00	20.53	5.80	4.56	5.18	5.44	42.72
6.	VBG-11-6	35.33*	69.33*	23.93	4.07	6.40	3.93	18.47	6.27	4.93	5.43	4.54	38.24
7.	VBN-7	37.33	72.33	20.90	3.67	4.67	4.13	16.07	5.87	4.61	5.15	4.22	43.49
8.	SB-40-5	36.33	70.00	20.70	3.67	4.80	4.07	17.47	6.13	4.39	5.17	5.07	41.04
9.	TBG-104	36.33	70.33	21.80	3.50	5.73	4.47	19.67	6.47	4.75	5.38	5.11	37.86
10.	NDU-11-204	38.33	78.33	26.45	3.63	5.53	4.27	19.40	6.13	4.82	5.70	5.24	39.26
11.	IPU-10-4	36.33	71.67	17.97	1.73	6.03	4.73	25.67*	5.60	4.25	5.15	5.19	42.97
12.	P-1032	38.00	68.67*	20.73	4.33*	5.80	4.00	19.87	5.87	4.98	5.42	6.14	35.66
13.	MBG-1058	37.00	73.00	24.13	4.60*	7.67*	4.80*	28.33*	6.60*	4.91	5.16	5.44	36.59
14.	PU-31	34.33*	69.67	22.87	3.87	7.07	4.07	20.47	6.47	4.59	5.46	5.71	40.75
15.	VBG-10-010	33.67*	72.33	18.33	3.93	5.33	4.00	18.93	6.13	4.57	4.62	4.28	38.32
16.	MBG-1061	38.67	74.33	26.23	3.07	4.93	4.27	17.00	6.13	4.88	5.86	4.07	28.91
17.	UG-708	35.67*	68.67*	21.37	3.80	6.13	4.33	18.07	5.87	4.46	5.12	4.88	44.77
18.	VBN-4	39.00	71.67	20.77	3.80	4.27	4.00	12.87	5.73	4.45	5.63	3.67	32.43
19.	MBG-1051	39.67	73.33	26.33	3.80	5.93	4.40	16.27	6.80*	5.31*	6.40*	4.18	28.90
20.	TU-94-2	35.33*	70.00	24.30	3.47	7.67*	4.60	20.67	6.60*	4.56	5.72	5.79*	39.76
21.	P-728	36.00	72.00	21.80	3.47	7.00	4.20	19.27	6.00	4.60	5.75	3.78	38.40
22.	WBG-26	37.67	72.00	22.97	2.73	5.27	3.67	17.20	6.27	4.65	5.24	4.04	39.83
23.	LBG-22	39.67	72.67	25.10	3.57	5.80	3.87	20.40	5.27	4.57	5.65	5.21	38.83
24.	LBG-787	37.00	73.00	24.17	2.70	6.00	3.93	16.87	5.53	4.75	5.85	3.87	29.93
25.	LBG-752	34.67*	71.33	24.43	3.07	5.27	3.87	16.60	6.93*	4.72	5.56	4.00	34.43

Cont...

Table 2. Cont...

S. No.	Genotypes	DFF	DM	PH	NPB	NCP	NPC	NPP	NSP	PL	100 SW	SYP	HI
26.	TU-67	38.33	69.67	23.03	3.47	4.07	4.27	16.33	6.07	4.53	4.81	3.50	48.53
27.	MBG-223	36.67	69.00*	19.80	2.73	4.00	4.33	14.67	6.33	4.99	5.79	3.50	34.86
28.	P-112	34.33*	68.33*	20.30	3.07	5.67	4.40	21.80	5.33	4.44	4.31	4.90	42.80
29.	LBG-709	37.67	72.67	23.30	3.90	6.13	4.00	17.33	6.67*	4.95	6.02	4.65	34.09
30.	MBG-1050	39.33	72.67	23.77	3.93	5.33	4.27	18.47	6.40	4.89	5.50	4.13	34.32
31.	RVSU-60	36.67	70.67	24.20	3.93	6.27	4.07	21.80	5.27	4.67	5.53	5.01	34.02
32.	LBG-648	41.00	80.33	41.25*	4.13*	7.00	3.07	17.93	6.80*	5.36*	5.41	5.03	24.56
33.	LBG-645	41.00	78.00	41.77*	3.93	7.60*	3.67	21.67	6.93*	5.05*	4.83	6.43*	35.78
34.	LBG-20	37.00	71.67	27.77	3.67	6.93	3.87	20.07	5.20	4.53	6.19*	5.77*	38.08
35.	VBG-11-31	36.33	68.67	22.83	3.60	4.87	4.40	17.53	5.27	4.97	4.71	3.94	37.22
	General Mean	**36.97**	**71.51**	**23.71**	**3.59**	**5.89**	**4.15**	**19.04**	**6.10**	**4.71**	**5.36**	**4.73**	**37.96**
	Minimum	**33.67**	**68.33**	**17.97**	**1.73**	**4.00**	**3.07**	**12.87**	**5.20**	**4.23**	**4.31**	**3.50**	**24.56**
	Maximum	**41.00**	**80.33**	**41.77**	**4.60**	**7.67**	**4.80**	**28.33**	**6.93**	**5.36**	**6.40**	**6.43**	**49.13**
	C.D. 5%	**1.10**	**1.92**	**6.81**	**0.49**	**1.44**	**0.65**	**5.58**	**0.48**	**0.33**	**0.70**	**1.04**	**10.78**
	S.E. (d)	**0.55**	**0.96**	**3.41**	**0.25**	**0.72**	**0.33**	**2.79**	**0.24**	**0.16**	**0.35**	**0.52**	**5.40**
	S.E. (m)	**0.39**	**0.67**	**2.37**	**0.17**	**0.50**	**0.23**	**1.94**	**0.17**	**0.11**	**0.24**	**0.36**	**3.77**
	C.V. (%)	**1.83**	**1.64**	**17.62**	**8.38**	**15.03**	**9.66**	**17.98**	**4.86**	**4.27**	**8.00**	**13.52**	**17.43**

DFF: Days to 50 % flowering, **DM:** Days to maturity, **PH:** Plant height (cm), **NPBP:** Number of primary branches per plant, **NCP:** Number of clusters per plant, **NPC:** Number of pods per cluster, **NPP:** Number of pods per plant, **PL:** Pod length (cm), N**SP:** Number of seeds per pod, **100 SW:** 100 seed weight (g), **SYP:** Seed yield per plant (g) and **HI:** Harvest index (%).

genotypes MBG 1058 (4.60), whereas the lesser number was registered by IPU-10-4 (1.73). A significantly greater number of primary branches per plant than the general mean of the genotypes (3.59) was shown by four genotypes.

5. Number of Clusters per Plant

Maximum number of clusters per plant was recorded by the genotypes MBG 1058 and TU-94-2 (7.67), while it was minimum in MBG 223 (4.00). Three genotypes significantly surpassed the general mean (5.89) of the genotypes.

6. Number of Pods per Cluster

The difference for this trait was between 3.07 to 4.80 with a general mean of 4.15. Among the genotypes, more or less number of pods per cluster was registered by MBG 1058 (4.80) and LBG 648(3.07). One genotype showed significantly greater number of pods per cluster than the general mean (4.15).

7. Number of Pods per Plant

Number of pods per plant ranged from 12.87 to 28.33. MBG 1058 (28.33) registered maximum number of pods per plant, whereas VBN 4 recorded a minimum (12.87) number of pods per plant. Two genotypes significantly excelled the general mean (19.04).

8. Number of Seeds per Pod

Number of seeds per pod was highest in the genotypes LBG 645 (6.93), LBG 752 (6.93) and lowest in LBG 20 (5.20). Eight genotypes exhibited a significantly greater number of seeds per pod when compared to the general mean (6.10).

9. Pod Length (cm)

The genotype, COBG 653 (4.23 cm) registered the shortest pod length while LBG 648 (5.36 cm) was found to be the longest. Four genotypes were significantly longer in length when compared to the general mean (4.71 cm).

10. 100 Seed Weight (g)

Among 35 genotypes, MBG 1051 recorded the maximum 100 seed weight (6.40 g), while P 112 had the minimum 100 seed weight (4.31 g). The general mean of 5.36 g was significantly exceeded by two genotypes for 100 seed weight.

11. Seed Yield per Plant (g)

Seed yield per plant ranged from 3.50g to 6.43 g with a general mean of 4.73g. Out of 35 genotypes tested, LBG 645 recorded the highest seed yield (6.43 g), whereas MBG 223 and TU 67 registered the lowest seed yield per plant (3.50 g). Three genotypes put forth significantly higher seed yield per plant than general mean.

12. Harvest Index (%)

The maximum and minimum harvest index was observed in SB-25-19 (49.13%.) and LBG 648 (24.56%) respectively. One out of 35 genotypes were found to exhibit significantly higher harvest index than that of the general mean (37.96%). In any plant breeding programme for developing high yielding varieties or hybrids the basic need is the choice of parents with high mean values as they are expected to produce desirable segregants upon crossing (Gilbert, 1958). Hence, selection of the genotypes with high *per se* performance are to be identified first for each of the traits under study, aimed towards development of high yielding blackgram varieties.

A perusal of mean values in the present investigation revealed that the genotypes P-112 followed by COBG-653, SB-25-19, UG-708 and VBG-11-6 were earliest to flower as well as earliest to mature. These genotypes may provide useful genetic variability in breeding programs aimed at developing short duration blackgram varieties.

Considering the plant height, the genotypes LBG-645 was the tallest followed by LBG-648, LBG-20, KDRS-136 and NDU-11-204. Similarly, higher number of primary branches per plant registered for the genotypes MBG-1058, P-1032, KDRS-136, LBG-648 and VBG-11-6. The genotypes with tall height and more primary branches per plant would produce increased number of clusters and number of pods per plant thereby seed yield per plant will be increased. Hence, these genotypes could be utilized in future breeding programme for improving these traits.

In blackgram, the seed yield mainly depends on the contribution of yield determining characters and among them, number of clusters per plant, number of pods per plant, number of pods per cluster and number of seeds per

pod are very important. Plant types with more number of above said traits usually produce higher yields. In the present study, the genotypes TU-94-2, MBG-1058, LBG-645, KDRS-136, and P-726 registered more number of clusters per plant. Similarly, the genotypes MBG-1058, IPU-10-4, TU-94-2, COBG-653 and TBG-104 for number of pods per cluster; the genotypes MBG-1058, IPU-10-4, KDRS-136, P-112 and RVSU-60 for number of pods per plant and the genotypes LBG-645, LBG-752, LBG-648, MBG-1051 and KDRS-136 for number of seeds per pod registered superior performance. Hence, these genotypes have the maximum potential for utilization in hybridization programme to improve the seed yield in blackgram.

Hundred seed weight is one of the important attributes among the seed yield components as it has greater contribution towards seed yield. Higher test weight was registered by MBG-1051 followed by LBG-20, LBG-709, MBG-1061 and LBG-787. Hence, these genotypes could be utilized in future breeding programme for improving this trait.

Higher yield potential of genotypes is mainly attributed to increased biomass coupled with enhanced harvest index. The genotype SB-25-19 recorded the highest *per se* for harvest index followed by TU-67, PU-205, VBN-7, UG-708. Hence, these genotypes could be exploited for higher yield coupled with higher harvest index.

The ultimate aim of any breeding programme is to improve the yield and hence the breeding procedures have to be carefully formulated to increase the potentiality of this complex character. Among the genotypes, LBG-645 recorded high mean for seed yield per plant followed by P-1032, TU-94-2, LBG-20 and PU-31 suggesting that these genotypes might be successfully exploited for blackgram yield improvement.

Based on the overall mean performance of genotypes, several genotypes showed high mean performance for more than one traits. Among the genotypes, LBG-645 and MBG-1058 registered high *per se* for seven yield attributes *viz.,* plant height, number of seeds per pod, number of primary branches per plant, number of clusters per plant and number of pods per plant, pod length and seed yield per plant. The next best genotype was TU-94-2 as it showed high *per se* for six yield traits *viz.,* number of clusters per plant, number of pods per plant, number of seeds per pod, 100 seed weight and seed yield per plant. hence, these genotypes could be utilized for the development of high yielding blackgram varieties. Further, PU-31 exhibited high *per se* for five yield and yield attributing traits *viz.,* number of clusters per plant, number of pods per plant, number of seeds per pod, seed yield per plant, harvest index and low *per se* for days to 50 per cent flowering. Similarly, P-1032 showed high *per se* for three yield and its attributing traits *viz.,* number of primary branches per plant, pod length, seed yield per plant and low *per se* for days to maturity Hence, these genotypes could be well exploited as donors for development of short duration blackgram genotypes along with high yield. Bharathi (2019) and Kalpana (2021) reported several genotypes showed high mean performance for more than one traits including yield and yield attributes in blackgram.

From the foregoing discussion based on *per se*, it could be concluded that the genotypes LBG-645, MBG-1058 and TU-94-2 were adjudged as the best genotypes for improving yield, while the genotypes PU-31 and P-1032 for improving yield and yield attributes coupled with early maturing traits in blackgram.

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ASSESSMENT OF GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE AMONG ADVANCED BREEDING LINES OF GROUNDNUT (*Arachis hypogea* L.)

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ABSTRACT

A Field experiment with 30 advanced breeding lines of groundnut was carried out for assessment of genetic variance, heritability (broad sense) and genetic advance as per cent of mean for 17 metric traits. The analysis of variance revealed the existence of highly significant differences among the entries for all the characters studied. The phenotypic coefficient of variation (PCV) was greater than genotypic coefficient of variation (GCV) for all the traits studied implying that these characters were highly influenced by the environmental effects. High PCV and GCV values (>20%) was recorded for Pod yield plant^{-1}, Kernel yield plant^{-1}, dry haulms yield plant^{-1} and number of mature pods plant^{-1}. High heritability (> 60%) coupled with high genetic advance as per cent of mean was registered for plant height, hundred pod weight, kernel yield plant^{-1}, dry haulms yield plant^{-1}, number of primary branches plant^{-1}, number of mature pods plant^{-1}, harvest index and pod yield plant^{-1} indicating that these characters were governed by additive gene effects and could be chosen as selection criteria for formulating breeding strategies in groundnut.

KEYWORDS: PCV, GCV, Heritability, Genetic Advance as per cent of mean, RBD.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is a self-pollinated crop belongs to the botanical family Fabaceae of sub-family Papilionaceae, commonly known as the legume, bean, or pea family. Groundnut is rich in essential nutrients (USDA nutrient data, 2020). In 100-gram groundnuts provide 2,385 kilojoules (570 kilocalories) of food energy and are an excellent source (defined as more than 20% of the Daily Value, DV) of several B vitamins, vitamin E, and several dietary minerals.

In 2021, world production of groundnut (reported as peanuts in shells) was 49 MT. China had 16.6 million tonnes about 36 per cent of global production, followed by India (14%). Other significant producers were Nigeria, Sudan and the United States. In India the total cultivated area under groundnut is 60.9 lakh ha, production is 10.21 MT with productivity of 1676 kg ha^{-1}. In Andhra Pradesh, it is cultivated in an area of 8.69 lakh ha, production is 7.74 MT with productivity of 894 kg ha^{-1}. (Directorate of Economics and Statistics, 2021).

Growing demand for food security has spiked the need of genetic improvement of crop germplasm. Genetic variability being a best option for crop cultivar improvement has intensively used in the past (Jaganathan *et al*., 2020).

Genetic parameters such as genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) are useful in detecting the amount of variability present in the genotypes. Heritability estimates along with genetic advance are more helpful in predicting the gain under selection than heritability estimates alone.

MATERIAL AND METHODS

Thirty advanced breeding lines of groundnut were evaluated during *kharif*, 2021 in a Randomized Block Design (RBD), replicated thrice at Dry land farm, RARS, Tirupati. Each genotype was represented by three row plot of 5 m length with inter and intra-row spacing of 30 cm and 10 cm respectively. Standard crop husbandry practices and plant protection measures suggested for this crop were followed to raise a healthy crop. Data were recorded on five randomly selected competitive plants of each genotype replication^{-1} for 17 metric traits.

The pooled data were subjected to statistical analysis to test the homogeneity for error variance was applied by utilizing the Barlletts method (Panse and Sukhatme, 1961). Heritability (broad sense and narrow sense) was estimated by formula given by Allard (1960) and Lush (1940). Genetic advance as percent of mean can be classified according to proposed by Johnson *et al.*, (1955) as low (0-10%); moderate (10-20%) and

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high (20% and above). The phenotypic and genotypic coefficients of variation were computed by the following formulae given by Burton (1952). The data was analysed through software - Indostat 9.2 version.

RESULTS AND DISCUSSION

The analysis of variance for 17 metric traits in 30 groundnut genotypes (Table 1) revealed existence of ample genetic variation in the material studied. Phenotypic and genotypic coefficients of variation, heritability in broad sense, genetic advance and genetic advance as per cent of mean for 17 characters involving 30 advanced breeding lines of groundnut are presented in Table 2. For all the characters studied, phenotypic coefficient of variation was found to be greater than genotypic coefficient of variation indicating the effect of environment on these traits. These results are in accordance with the findings of Narasimhulu *et al*. (2012), John *et al.* (2013), Kamdi *et al.* (2017), Mahesh *et al.* (2018), Nagaveni and Khan (2019), Rao *et al.* (2019), Kumari and Sashidharan (2020), Gali *et al.* (2021) and Bharath *et al.* (2022).

The characters, Pod yield plant^{-1} (GCV: 40.10%; PCV: 41.23%), Kernel yield plant^{-1} (GCV: 38.12%; PCV: 39.68%), dry haulms yield plant^{-1}(GCV: 37.81%; PCV: 38.08%), number of mature pods plant^{-1} (GCV: 32.75%; PCV: 33.47%), number of primary branches plant^{-1} (GCV: 26.94%; PCV: 28.04%), harvest index (GCV: 21.93%; PCV: 22.54%) and plant height (GCV: 20.81%; PCV: 20.92%) exhibited high GCV and PCV. These results are in accordance with the findings of Hampannavar *et al*. (2018), Meghala *et al*. (2019), Venkataravana *et al.* (2020), Veer *et al.* (2021), Gali *et al*. (2021) and Mitra *et al.* (2021).

Moderate GCV and moderate PCV was exhibited by hundred pod weight (GCV: 17.31%; PCV: 17.41%) and hundred kernel weight (GCV: 13.67%; PCV: 14.43%)

Table 1. Analysis of variance for physiological, yield attributes and quality traits in advanced breeding lines of groundnut

S. No	Characters	Mean sum of squares		
		Replications (df : 2)	Genotypes (df : 29)	Error (df : 58)
1.	Days to 50% flowering	2.033	4.031**	0.860
2.	Days to maturity	1.88	4.132**	0.870
3.	SPAD chlorophyll meter reading at 45 DAS	1.027	7.263**	1.783
4.	Specific leaf area at 45 DAS (cm^2 g^{-1})	126.317	1166.803**	341.840
5.	Relative water content (%)	35.901	85.278**	26.113
6.	Harvest index (%)	5.047	306.989**	5.643
7.	Plant height (cm)	5.616	516.552**	1.821
8.	Number of primary branches plant^{-1}	0.525	10.726**	0.289
9.	Number of mature pods plant^{-1}	2.593	58.560**	0.847
10.	Hundred pod weight (g)	14.233	1486.055**	5.785
11.	Hundred kernel weight (g)	8.611	124.691**	4.599
12.	Shelling per cent	31.061	97.270**	10.061
13.	Kernel yield plant^{-1} (g)	6.437	76.746**	2.080
14.	Dry haulms yield plant^{-1} (g)	2.968	221.013**	1.034
15.	Pod yield plant^{-1}(g)	6.955	183.806**	3.450
16.	Oil content (%)	0.119	10.752**	0.077
17.	Protein content (%)	0.252	10.610**	0.084

** Significant at 1% level

Table 2. Estimates of genetic parameters for physiological, yield attributes and quality traits in advanced breeding lines of groundnut

S. No.	Character	Mean	Range		Variance		Coefficient of Variation		Heritability (Broad sense) (%)	Genetic advance (GA)	Genetic advance as per cent of mean (%)
			Min.	Max.	Genotypic	Phenotypic	Genotypic	Phenotypic			
1.	Days to 50% flowering	27.03	24.00	29.33	1.05	1.91	3.80	5.12	55.10	1.57	5.81
2.	Days to maturity	103.04	100.00	105.33	1.09	1.95	1.01	1.36	55.68	1.60	1.55
3.	SPAD chlorophyll meter reading at 45 DAS	40.31	36.00	42.73	1.82	3.61	3.35	4.71	50.59	1.98	4.91
4.	Specific leaf area at 45 DAS (cm^2 g^{-1})	169.93	140.43	237.90	274.98	616.83	9.75	14.61	44.58	22.80	13.42
5.	Relative water content (%)	56.38	49.89	72.87	19.72	45.83	7.87	12.00	43.03	6.00	10.64
6.	Harvest index (%)	45.68	26.06	65.69	100.44	106.09	21.93	22.54	94.68	20.08	43.97
7.	Plant height (cm)	62.92	33.11	89.67	171.57	173.39	20.81	20.92	98.95	26.84	42.65
8.	Number of primary branches $plant^{-1}$	6.92	5.00	12.40	3.47	3.76	26.94	28.04	92.31	3.69	53.32
9.	Number of mature pods $plant^{-1}$	13.38	6.53	23.87	19.23	20.08	32.75	33.47	95.78	8.84	66.04
10.	Hundred pod weight (g)	128.26	77.66	179.33	493.42	499.20	17.31	17.41	98.84	45.49	35.46
11.	Hundred kernel weight (g)	46.27	33.33	61.00	40.03	44.63	13.67	14.43	89.69	12.34	26.67
12.	Shelling per cent	68.38	52.44	79.78	29.06	39.13	7.88	9.14	74.29	9.57	13.99
13.	Kernel yield $plant^{-1}$ (g)	13.08	5.56	25.90	24.88	26.96	38.12	39.68	92.29	9.87	75.43
14.	Dry haulms yield $plant^{-1}$ (g)	22.64	12.40	45.47	73.32	74.36	37.81	38.08	98.61	17.51	77.35
15.	Pod yield $plant^{-1}$ (g)	19.33	7.73	35.77	60.11	63.56	40.10	41.23	94.57	15.53	80.33
16.	Oil content (%)	49.44	45.62	53.39	3.55	3.63	3.81	3.85	97.87	3.84	7.77
17.	Protein content (%)	25.31	21.28	28.48	3.50	3.59	7.40	7.48	97.65	3.81	15.06

suggesting that individual trait selection can be resorted for improvement of these traits. The similar results are also observed in the findings of Roy *et al.* (2018) and Mitra *et al.* (2019).

High heritability was recorded for plant height (98.95%), hundred pod weight (98.84%), dry haulms yield plant^{-1} (98.61%), oil content (97.87%), protein content (97.65%), number of mature pods plant^{-1} (95.78%), harvest index (94.68%), pod yield plant^{-1} (94.57%), number of primary branches plant^{-1} (92.31%), kernel yield plant^{-1} (92.29%), hundred kernel weight (89.69%) and shelling per cent (74.29%) indicating that the effect of environment is least in expression of these characters. The results are in conformity with findings of Veer *et al*. (2021).

Higher genetic advance as per cent of mean was recorded for pod yield plant^{-1} (80.33%), dry haulms yield plant^{-1} (77.35%), kernel yield plant^{-1} (75.43%), number of mature pods plant^{-1} (66.04%), number of primary branches plant^{-1} (53.32%), harvest index (43.97%), plant height (42.65%), hundred pod weight (35.46%) and hundred kernel weight (26.67%) indicating that these characters were governed by additive gene effect and the selection for these characters will be rewarding in crop improvement.

High heritability coupled with high genetic advance as per cent of mean for pod yield plant^{-1}, plant height, number of mature pods plant^{-1}, shelling per cent, harvest index, number of primary branches plant^{-1} and kernel yield plant^{-1} were also reported by Narasimhulu *et al.* (2012), Rao *et al*. (2014), Gupta *et al.* (2015), Vasanthi *et al.* (2015), Choudhary *et al.* (2016), Chavadhari *et al*. (2017), Yusuf *et al*. (2017), Mahesh *et al.* (2018), Nagaveni and Khan (2019), Gali *et al*. (2021), Shuro (2021) and Bharath *et al.* (2022),

The characters, Pod yield plant^{-1}, Kernel yield plant^{-1}, dry haulms yield plant^{-1} and number of mature pods plant^{-1} exhibited high GCV and PCV indicating ample amount of variation among the genotypes and the selection would be effective for further improvement of these characters.

High heritability coupled with high genetic advance as per cent of mean were recorded for characters *viz.,* plant height, hundred pod weight, dry haulms yield plant^{-1}, number of mature pods plant^{-1}, harvest index, pod yield plant^{-1}, number of primary branches plant^{-1}, kernel yield plant^{-1} and hundred kernel weight indicating preponderance of additive gene action in expression of these characters and selection would be effective for improvement of these characters.

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ASSESSMENT OF PARENTS AND F_1 CROSSES FOR YIELD AND YIELD COMPONENTS UNDER SICK PLOT AND CONTROL CONDITION IN GROUNDNUT (*Arachis hypogaea* L.)

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ABSTRACT

In the present investigation, twenty F_1 crosses along with nine parents (5 lines and four testers) were evaluated for 23 yield, yield components and stem rot resistance during *rabi*, 2019 in order to assess the *per se* performance of parents and crosses under sick plot and control condition. Analysis of variance for all 23 yield, yield components and stem rot resistance revealed that mean sum of squares due to treatments were highly significant for all characters investigated. Among parents, the line ICGV-07262 and tester J-11 and CS-19 were registered as the best performers as they outperformed desirable *per se* performance for most of the yield and yield components together with stem rot resistance under sick plot and control condition. Hence, these lines and testers could be considered as a potential parent in hybridization for the improvement of groundnut productivity under sick plot and control conditions. The cross ICGV-07262 × TCGS-1862 recorded as superior cross for most of the yield and yield components and could be exploited in breeding programme to develop high pod yielding stem rot resistant genotypes in groundnut.

KEYWORDS: *Per se* performance, Pod yield, Stem rot resistance, Sick plot, Groundnut.

INTRODUCTION

Groundnut is well known important oilseed crop in the world as well as in India because of its economic importance. The seed is comprised of 40-54 per cent oil, 25-28 per cent protein and 18 per cent of carbohydrates in addition to minerals and vitamins including vitamin E, niacin, phosphorus, falcin, calcium, riboflavin, magnesium, zinc, iron, thiamine, and potassium (Jilbrin *et al*., 2016).

Globally, it is cultivated in an area of 29.92 Mha with annual production of 55.30 Mt and productivity of 1851 kg ha^{-1} (FAOSTAT, 2021). In India, groundnut covers an area of 60.9 lakh ha with a production of 10.21 Mt and productivity of 1676 kg ha^{-1}. In Andhra Pradesh, it is cultivated in an area of 8.69 lakh ha with a production of 7.74 Mt and productivity of 894 kg ha^{-1} (Directorate of Economics and Statistics, GOI, 2021). Among the major groundnut growing states of India, Gujarat and Andhra Pradesh are ranking first and second, respectively in terms of area.

Among various biotic stresses limiting groundnut production, stem rot disease caused by soil-borne fungal pathogen *Sclerotium rolfsii* is predominant, accounting for yield loss to an extent of 10–25 per cent and even upto 80 per cent in severely infected fields annually (Backman and Brenneman, 1997, Rakholia and Jadeja, 2010). Persistence of pathogen in the soil and wide range of host often limits the cultural and chemical control of this disease. The use of resistant varieties is the practical method for the control of stem rot disease. It is evident that stem rot disease has significant effect on yield loss (Pujer *et al.,* 2013). Hence, simultaneous evaluation of groundnut genotypes for pod yield as well as stem rot incidence (%) would be more reliable to develop resistant varieties as well as for their future use in resistance breeding programme.

MATERIAL AND METHODS

The experiment was carried out during *rabi*-2019 in sick plot and control condition maintained at Regional Agricultural Research station, Tirupati situated at an altitude of 182.9 m above mean sea level (MSL), 32.27°N latitude and 79.36°E longitude, geographically in southern agro climatic zone of Andhra Pradesh. In sick plot, the crop was artificially inoculated with *sclerotium* fungus multiplied in sorghum grains between inter rows followed by mulching with paddy straw to entire field after 30 DAS, 60 DAS and irrigation was given frequently through drip pipes to conserve moisture which aggravate the mycelium and aids in further multiplication while all the necessary recommended practices in control condition

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were followed for maintenance of control condition. The material for the present investigation comprised of nine parents (5 Lines and 4 testers) and their F_1s generated through crossing these parents in a Line × Tester mating fashion were grown in a Randomized Block Design and replicated twice. Each entry was grown in two rows of 3 m length and the spacing adopted was 22.5 × 10 cm. Data was recorded in 5 randomly selected plants for pod yield and yield components whereas PDI at Maturity was recorded as per the procedure outlined by Ashok *et al*. (2004).

At the time of crop maturity, total number of plants per row and number of affected plants in the same row were counted as calculated in the following formula to obtain percent index in terms of percentage.

Per cent disease incidence (%) =

$$\frac{\text{Total number of plants in a row}}{\text{Number of affected plants in a row}} \times 100$$

RESULTS AND DISCUSSION

Analysis of Variance

Twenty F_1 cross combinations generated from nine parents (Five lines and Four testers) were together evaluated for 23 yield, yield components and stem rot incidence during *rabi*, 2019 under sick plot and control condition. The analysis of variance for yield, yield components and stem rot resistance was presented in the Table 1.

The analysis of variance revealed highly significant differences among the parents and F_1 crosses for all the 23 characters justified the presence of considerable amount of genetic variation for all the traits examined in experimental material comprised of parents and F_1s.

Mean Performance of Parents and F_1 Crosses

The assessment of the mean performance of genotypes is a key to decide the real field performance. Hence, critical examination of *per se* performance is the prime factor that determines the fate of breeding program. The mean performance of nine parents (five lines and four testers) and 20 F_1 crosses for yield, yield components and stem rot resistance was furnished in the Table 2. The graph depicting the mean performance of the parents and crosses for pod yield plant^{-1} (g) and PDI at maturity.

The results revealed that line ICGV-91114 attained early flowering (27.50 days) and maturity (93.50 days) in sick plot condition while Narayani was early in flower (28.00 days) and maturity (99.00 days) in control condition, respectively. The tester TCGS-2149 attained early flowering (31.50 days) in sick plot and early maturity (113.00 days) in control condition. Similarly CS-19 was early in flowering (25.50 days) in control condition and attained early maturity (107.50 days) in sick plot condition. Thus, these parents could be exploited to develop short duration varieties with high pod advantage, thereby escaping from drought.

The lines *viz*., Kadiri-6 in sick plot condition (44.75) and ICGV-07262 in control condition (45.25) recorded higher SCMR at 60 DAS. The line, ICGV-07262 registered desirable least SLA at 60 DAS in sick plot condition (81.02 cm^2 g^{-1}) and in control condition (205.69 cm^2 g^{-1}). Similarly, TAG-24 in sick plot (66.70%) and 91114 (66.29%) in control condition displayed higher mean performance for harvest index. The tester J-11 displayed high SCMR at 60 DAS in sick plot (44.35) and CS-19 in control condition (43.40) while TCGS-1862 recorded desirable lower SLA at 60 DAS in both sick plot (118.89 cm^2 g^{-1}) and control condition (255.56 cm^2 g^{-1}). High mean performance for harvest index was displayed in TCGS-1862 (66.55%) in sick plot condition and J-11 in control condition (65.11%). Therefore, these lines and testers could be exploited in breeding programme to develop high pod yielding, water use efficient genotypes.

For plant height, line TAG-24 in sick plot condition (30 cm) and Narayani in control condition (16.25 cm) in control condition while the tester J-11 in sick plot condition (37.60 cm) and TCGS-1862 in control condition (19.30 cm) were identified as shortest genotypes.

In sick plot, the line Kadiri-6 recorded higher *per se* performance for number of pegs plant^{-1} (21.55), number of pods plant^{-1} (20.80), number of mature pods plant^{-1} (18.20), sound mature kernel % (80.85) and dry haulm weight plant^{-1} (10.75 g) while it recorded higher mean performance for 100 kernel weight (59.85 g) and shelling per cent (85.66%) in control condition. Similarly, Narayani is identified as the best line as it registered desirable *per se* performance for plant height (41.50 cm), number of immature pods plant^{-1} (1.20) and protein content (26.60%) in sick plot condition while it recorded desirable mean for plant height (16.25 cm) and number of pegs plant^{-1} (9.95) in control condition. Interestingly,

Table 1. Analysis of variance for yield, yield components and stem rot resistance in groundnut

S. No.	Character	Mean sum of squares					
		Replications (df : 1)		Treatments (df : 28)		Error (df : 28)	
		Sick	Control	Sick	Control	Sick	Control
1.	Days to 50% flowering	4.41	0.84	5.85**	8.34**	1.24	2.52
2.	Days to maturity	6.90	41.40	44.41**	38.44**	3.83	10.33
3.	SCMR at 60 DAS	3.98	0.40	14.41**	9.05**	11.74	0.32
4.	SLA at 60 DAS (cm^2 g^{-1})	18.07	368.47	847.98**	2630.47**	58.08	114.04
5.	Harvest index (%)	0.14	4.76	49.83**	49.77**	0.69	1.76
6.	Plant height (cm)	6.48	7.23	43.25**	20.15**	3.43	5.92
7.	Number of primary branches $plant^{-1}$	0.33	0.30	1.63**	1.52**	0.31	0.44
8.	Number of secondary branches $plant^{-1}$	0.04	0.14	2.14**	0.64**	0.17	0.13
9.	Number of flowers $plant^{-1}$ from 25 to 50 DAS	1.40	2.91	289.50**	312.00**	4.58	6.77
10.	Number of pegs $plant^{-1}$	1.31	0.05	31.48**	12.06**	5.02	0.38
11.	Number of pods $plant^{-1}$	1.37	0.00	24.27**	34.73**	0.43	0.68
12.	Number of immature pods $plant^{-1}$	0.07	0.02	2.23**	2.05**	0.06	0.09
13.	Number of mature pods $plant^{-1}$	0.83	0.01	24.60**	38.95**	0.40	0.70
14.	100 pod weight	73.86	2.83	485.92**	91.68**	57.85	1.71
15.	100 kernel weight	2.00	2.37	55.19**	61.02**	3.12	0.87
16.	Sound mature kernel (%)	5.08	0.13	67.97**	23.96**	1.29	0.54
17.	Shelling per cent	0.05	25.62	268.41**	180.05**	20.79	15.35
18.	Dry haulm weight $plant^{-1}$	0.22	0.22	21.36**	23.64**	0.07	0.31
19.	Pod yield $plant^{-1}$	2.89	0.39	16.84**	13.68**	0.22	0.15
20.	Kernel yield $plant^{-1}$	0.04	0.33	29.53**	18.37**	0.34	0.36
21.	Oil content (%)	0.31	0.38	0.23**	0.78**	0.08	0.16
22.	Protein content (%)	0.28	1.06	0.74**	2.21**	0.18	0.29
23.	Per cent disease incidence (%) at maturity	74.08	5.89	1310.10**	17.32**	27.97	3.25

TAG-24 excelled in shelling percent (81.53%) in sick plot condition.

The next superior line ICGV-07262 recorded more mean performance for number of flowers plant^{-1} (114.50), 100 kernel weight (49.21 g), pod yield plant^{-1} (18.45 g), kernel yield plant^{-1} (12.90 g) and oil content (48.40%) in sick plot condition while the same line displayed high mean performance for number of flowers plant^{-1} (119.00), number of pods plant^{-1}(26.35), number of mature pods plant^{-1} (24.25), 100 pod weight (126.33 g), SMK % (82.23%), dry haulm weight plant^{-1} (12.14 g), pod yield plant^{-1} (22.42 g), kernel yield plant^{-1} (18.95 g), oil (49.10%) and protein content (27.75%) in control condition.

Line ICGV-91114 outperformed for number of primary branches plant^{-1} (4.60), number of secondary branches plant^{-1} (3.65) and 100 pod weight (139.33 g) in sick plot condition while it excelled for number of primary branches plant^{-1} (6.30), number of secondary branches plant^{-1} (2.45) and number of immature pods plant^{-1} (1.75) in desirable direction in control condition.

Among testers, CS-19 recorded higher mean performance for the traits *viz*., number of flowers plant^{-1} (114.50), number of pegs plant^{-1} (22.09), 100 pod weight (129.44 g), dry haulm weight plant^{-1} (8.90 g) and kernel yield plant^{-1} (14.83 g) in sick plot condition while the same tester outperformed for plant height (22.50 cm), number of secondary branches plant^{-1} (2.00), number of flowers plant^{-1} (117.50), 100 kernel weight (55.10 g), shelling percent (91.79%), dry haulm weight plant^{-1} (12.26 g) and kernel yield plant^{-1} (18.70 g) in control condition.

Moreover, the tester TCGS-2149 displayed high mean performance for number of secondary branches plant^{-1} (3.20), number of pods plant^{-1} (23.20), number of immature pods plant^{-1} (1.50), number of mature pods plant^{-1} (21.70) and 100 kernel weight (55.32 g) in sick plot condition while it outperformed for number of pegs plant^{-1} (10.85), sound mature kernel % (81.49), oil (48.35%) and protein content (26.85%) in control condition, respectively.

In contrary, J-11 exhibited desirable mean performance for SCMR at 60 DAS (44.35), plant height (37.60 cm), sound mature kernel % (81.80%), shelling per cent (92.66%) and oil content (48.10%) in sick plot condition and it excelled for pod yield plant^{-1} (21.75 g) in control condition.

The tester TCGS-1862 also registered higher mean performance for harvest index (66.55%), pod yield plant^{-1} (17.30 g) and protein content (26.25%) whereas in control condition, it exceeded in number of primary branches plant^{-1} (6.70), number of pods plant^{-1} (23.30), number of mature pods plant^{-1} (21.95) and 100 pod weight (125.09 g).

Among F_1 crosses, ICGV-91114 × TCGS-2149 attained early flowering (27.00 days) and maturity (99.50 days) in sick plot condition. In contrary, the crosses *viz.*, Kadiri-6 × TCGS-2149 and Narayani × CS-19 flowered earlier (27.50 days) while Narayani x J-11 matured early (101.50 days) in control condition. Besides, Narayani × J-11 is found to record more number of pegs plant^{-1} (27.57) in sick plot condition while it also registered high SCMR at 60 DAS (47.80) and oil content (49.50%) in control condition.

On the other hand, ICGV-07262 × TCGS-2149 outperformed in SCMR at 60 DAS (47.00) and shelling per cent (94.20%) in sick plot condition while the same cross exceeded in mean performance for number of pods plant^{-1} (33.20), number of mature pods plant^{-1} (30.65) and SMK% (85.60) in control condition.

Another best cross, Kadiri-6 × CS-19 displayed higher mean performance for number of secondary branches plant^{-1} (4.10), number of immature pods plant^{-1} (1.09), number of mature pods plant^{-1} (22.21) and recorded desirable lowest PDI at maturity (11.82%) in sick plot condition. The same cross also outperformed for the traits *viz*., number of secondary branches plant^{-1} (2.90), number of pegs plant^{-1} (15.45), 100 pod weight (136.65 g), 100 kernel weight (61.35 g) and protein content (27.40%) in control condition.

However, the cross ICGV-07262 × TCGS-1862 reported higher mean performance for number of primary branches plant^{-1} (6.50), number of secondary branches plant^{-1} (1.00), number of pods plant^{-1} (24.76), sound mature kernel % (86.30%), dry haulm weight plant^{-1} (18.40 g), pod yield plant^{-1} (22.90 g) and kernel yield plant^{-1} (22.80 g) in sick plot condition. In addition, the same cross registered higher mean performance for dry haulm weight plant^{-1} (19.60 g), pod yield plant^{-1} (24.29 g) and kernel yield plant^{-1} (21.35 g) in control condition.

Table 2. Mean performance of nine parents and 20 F_1 crosses for yield, yield components and stem rot resistance in groundnut

Genotypes	Days to 50% flowering		Days to maturity		SCMR at 60 DAS		SLA at 60 DAS ($cm^2 g^{-1}$)		Harvest index (%)	
	Sick	Control	Sick	Control	Sick	Control	Sick	Control	Sick	Control
Lines										
Kadiri-6	31.50	33.00	111.00	105.00	44.75	41.50	138.67	264.79	60.49	64.41
Narayani	30.50	28.00	108.50	99.00	42.90	43.05	136.57	216.90	65.00	65.13
TAG-24	32.00	33.00	113.00	109.00	41.65	40.25	123.72	252.96	66.70	65.83
ICGV-07262	28.50	31.00	116.50	112.00	42.30	45.25	81.02	205.69	64.39	64.87
ICGV-91114	27.50	28.50	93.50	112.00	41.20	39.50	123.79	256.05	63.15	66.29
Mean of Lines	**30.00**	**30.70**	**108.50**	**107.40**	**42.56**	**41.91**	**120.75**	**239.28**	**63.95**	**65.31**
Testers										
TCGS-1862	34.50	30.00	110.00	119.00	42.10	41.90	118.89	255.56	66.55	61.45
TCGS-2149	31.50	27.00	112.00	113.00	40.75	41.40	137.92	301.35	63.73	63.75
J-11	32.00	30.00	111.50	113.50	44.35	42.00	154.62	271.95	65.31	65.11
CS-19	33.00	25.50	107.50	115.00	42.65	43.40	139.49	305.51	64.69	62.44
Mean of Testers	**32.75**	**28.13**	**110.25**	**115.13**	**42.46**	**42.18**	**137.73**	**283.59**	**65.07**	**63.19**
F_1 Crosses										
Kadiri-6 x TCGS-1862	31.50	29.00	109.00	111.00	44.15	41.60	111.84	204.45	57.65	68.13
Kadiri-6 x TCGS-2149	30.50	27.50	111.00	111.50	44.46	40.10	106.75	191.73	58.60	64.83
Kadiri-6 x J-11	32.00	30.00	106.00	112.50	44.55	40.20	124.41	221.84	55.20	66.15
Kadiri-6 x CS-19	32.00	31.50	109.50	113.00	46.15	44.85	178.74	211.00	56.43	56.45
Narayani x TCGS-1862	30.50	29.50	110.00	106.00	43.20	42.05	106.21	215.12	51.50	68.48
Narayani x TCGS-2149	31.00	28.50	107.50	106.00	35.43	41.40	104.20	156.06	60.70	69.59
Narayani x J-11	30.00	28.00	110.50	101.50	45.10	47.80	124.59	203.39	57.03	58.09
Narayani x CS-19	31.50	27.50	108.00	107.50	40.35	42.55	118.99	209.16	54.95	69.20
TAG-24 x TCGS-1862	32.50	30.50	110.50	107.50	41.35	40.35	123.67	200.12	65.85	66.57
TAG-24 x TCGS-2149	32.00	28.00	106.00	109.50	40.90	41.10	111.14	196.00	66.77	71.85
TAG-24 x J-11	32.00	29.00	108.50	108.50	35.65	42.15	89.97	161.40	61.23	67.91
TAG-24 x CS-19	31.00	29.00	110.50	109.50	40.74	42.75	137.65	204.00	54.92	70.51
ICGV-07262 x TCGS-1862	31.50	28.50	113.50	111.50	46.35	47.05	131.65	188.62	55.45	55.35
ICGV-07262 x TCGS-2149	30.50	33.50	109.00	113.00	47.00	47.05	113.84	192.92	54.95	55.72
ICGV-07262 x J-11	31.00	33.50	111.50	109.50	42.85	42.35	113.89	205.29	48.69	64.87
ICGV-07262 x CS-19	32.00	29.50	109.00	115.50	42.75	41.90	83.25	184.90	56.69	72.69
ICGV-91114 x TCGS-1862	28.50	31.50	99.50	113.50	43.70	41.65	101.19	211.38	56.57	72.59
ICGV-91114 x TCGS-2149	27.00	31.50	99.50	115.00	40.25	42.45	109.74	217.06	62.22	66.28
ICGV-91114 x J-11	28.00	31.50	102.00	112.00	40.10	40.35	135.37	193.05	64.98	62.78
ICGV-91114 x CS-19	29.00	31.00	105.50	104.00	42.75	41.75	111.62	203.55	57.34	55.00
Mean of F_1 crosses	**30.70**	**29.93**	**107.83**	**109.90**	**42.39**	**42.57**	**116.93**	**198.55**	**57.88**	**65.15**
Max. value	**32.50**	**33.50**	**113.50**	**115.50**	**47.00**	**47.80**	**178.84**	**221.84**	**66.77**	**72.69**
Min. value	**27.00**	**27.50**	**99.50**	**101.50**	**35.43**	**40.10**	**83.25**	**156.06**	**48.69**	**55.00**
General mean	30.86	29.81	108.28	110.19	42.43	42.40	120.46	217.30	59.92	64.90
CD	2.27	3.25	4.00	6.58	2.27	1.15	15.62	21.89	1.70	2.72
SEm	0.78	1.12	1.38	2.27	0.78	0.39	5.38	7.55	0.58	0.93
SEd	1.11	1.58	1.95	3.21	1.10	0.56	7.62	10.67	0.83	1.32
CV	30.86	5.33	1.81	2.92	2.62	1.33	6.33	4.91	1.39	2.04

Cont...

Table 2. Cont...

Genotypes	Plant height (cm)		No. of primary branches plant^{-1}		No. of secondary branches plant^{-1}		No. of flowers plant^{-1} from 25 to 50 DAS		No. of pegs plant^{-1}	
	Sick	Control	Sick	Control	Sick	Control	Sick	Control	Sick	Control
Lines										
Kadiri-6	41.20	18.95	4.50	4.10	1.50	0.90	85.00	88.00	21.55	9.45
Narayani	41.50	16.25	4.20	5.80	3.40	2.20	86.00	89.50	17.10	9.95
TAG-24	30.00	18.30	3.15	5.70	3.60	2.40	84.50	85.00	15.80	8.29
ICGV-07262	37.30	21.05	3.35	4.65	3.25	1.75	114.50	119.00	18.05	9.25
ICGV-91114	36.35	19.50	4.60	6.30	3.65	2.45	113.00	117.00	17.10	7.55
Mean of Lines	**37.27**	**18.81**	**3.96**	**5.31**	**3.08**	**1.94**	**96.60**	**99.70**	**17.92**	**8.90**
Testers										
TCGS-1862	39.75	19.30	4.90	6.70	1.45	0.25	107.5	108.50	19.34	10.15
TCGS-2149	39.70	22.10	3.60	6.40	3.20	1.90	108.00	115.00	18.90	10.85
J-11	37.60	21.80	4.30	5.65	2.20	1.00	110.50	115.50	21.75	9.45
CS-19	39.20	22.50	5.50	4.55	3.20	2.00	114.5	117.50	22.09	10.2
Mean of Testers	**39.06**	**21.43**	**4.58**	**5.83**	**2.51**	**1.29**	**110.13**	**114.13**	**20.52**	**10.16**
F_1 Crosses										
Kadiri-6 × TCGS-1862	49.30	29.40	4.60	5.30	1.50	2.00	95.00	101.50	22.94	8.60
Kadiri-6 × TCGS-2149	40.10	22.30	4.50	5.10	1.50	1.75	107.00	112.50	16.78	7.93
Kadiri-6 × J-11	49.00	23.80	3.35	4.60	3.20	2.00	104.50	109.50	25.19	8.74
Kadiri-6 × CS-19	45.40	21.90	3.30	6.40	4.10	2.90	114.00	114.50	15.00	15.45
Narayani × TCGS-1862	47.20	22.60	4.30	5.00	3.60	2.40	115.50	120.00	17.10	9.73
Narayani × TCGS-2149	38.40	19.70	3.80	4.70	3.90	2.05	118.00	120.50	20.25	8.03
Narayani × J-11	43.25	19.70	4.20	4.50	1.50	1.50	122.00	125.50	27.57	15.00
Narayani × CS-19	40.30	23.80	4.85	4.40	1.50	1.85	117.50	120.00	26.70	8.01
TAG-24 × TCGS-1862	35.30	22.70	5.00	5.30	1.00	1.25	98.00	100.00	21.60	7.61
TAG-24 × TCGS-2149	39.60	23.00	3.70	4.50	3.00	1.55	101.00	99.00	19.95	7.85
TAG-24 × J-11	42.60	24.50	3.10	4.45	2.00	1.50	96.00	100.00	13.70	8.65
TAG-24 × CS-19	41.10	24.60	4.60	4.65	1.50	1.20	103.50	103.00	21.91	8.12
ICGV-07262 × TCGS-1862	48.60	24.90	6.50	4.15	1.00	1.50	118.00	119.00	25.45	14.55
ICGV-07262 × TCGS-2149	46.80	26.50	6.30	3.80	1.50	1.50	122.50	126.50	22.60	15.05
ICGV-07262 × J-11	41.80	24.10	4.45	3.85	2.00	1.00	117.50	122.00	22.90	7.65
ICGV-07262 × CS-19	46.40	23.00	5.55	4.20	1.00	1.15	126.50	129.50	27.50	8.45
ICGV-91114 × TCGS-1862	37.45	14.30	3.85	6.30	1.50	1.50	125.00	127.00	20.90	7.95
ICGV-91114 × TCGS-2149	41.80	16.60	5.80	5.45	1.50	1.10	122.50	128.00	25.70	7.24
ICGV-91114 × J-11	35.20	20.20	3.65	6.50	1.50	1.10	121.50	125.50	16.18	7.58
ICGV-91114 × CS-19	36.31	20.50	3.90	4.40	1.00	1.50	116.50	121.00	15.09	7.14
Mean of F_1 crosses	**42.30**	**22.41**	**4.47**	**4.88**	**1.97**	**1.62**	**113.10**	**116.23**	**21.25**	**9.47**
Max. value	**49.30**	**29.40**	**6.50**	**6.50**	**4.10**	**2.90**	**126.50**	**129.50**	**27.57**	**15.45**
Min. value	**35.20**	**14.30**	**3.10**	**3.80**	**1.00**	**1.00**	**95.00**	**99.00**	**13.70**	**7.14**
General mean	40.98	21.65	4.39	5.08	2.23	1.63	109.84	113.09	20.57	9.46
CD	3.79	4.98	1.13	1.36	0.87	0.76	4.36	5.33	4.59	1.27
SEm	1.30	2.43	0.39	0.46	0.30	0.26	1.51	1.84	1.58	0.43
SEd	1.85	1.72	0.55	0.66	0.43	0.37	2.13	2.60	2.24	0.61
CV	4.52	11.24	12.61	13.06	15.33	17.85	1.95	2.30	10.89	6.55

Cont...

Table 2. Cont...

Genotypes	No. of pods plant^{-1}		No. of immature pods plant^{-1}		No. of matured pods plant^{-1}		Hundred pod weight (g)		Hundred kernel weight (g)	
	Sick	Control	Sick	Control	Sick	Control	Sick	Control	Sick	Control
Lines										
Kadiri-6	20.80	25.65	2.60	3.95	18.20	21.70	128.22	122.07	48.98	59.85
Narayani	17.60	22.80	1.20	3.05	16.40	19.75	104.24	124.14	43.93	52.20
TAG-24	16.15	18.80	1.45	2.80	14.70	16.00	103.58	114.77	46.17	35.06
ICGV-07262	16.30	26.35	1.90	2.10	14.40	24.25	106.56	126.33	49.21	56.00
ICGV-91114	17.10	19.00	1.30	1.75	15.80	17.25	139.33	123.56	48.20	46.20
Mean of Lines	**17.59**	**22.52**	**1.69**	**2.73**	**15.90**	**19.79**	**116.39**	**122.17**	**47.30**	**49.86**
Testers										
TCGS-1862	22.65	23.30	1.90	1.35	20.75	21.95	99.67	125.09	51.53	51.00
TCGS-2149	23.20	20.20	1.50	1.60	21.70	18.60	84.83	122.41	55.32	49.80
J-11	19.40	19.85	1.80	1.90	17.60	17.95	91.61	123.34	54.14	49.95
CS-19	20.40	22.35	2.35	4.25	18.05	18.10	129.44	124.56	53.58	55.10
Mean of Testers	**21.41**	**21.43**	**1.89**	**2.28**	**19.53**	**19.15**	**101.39**	**123.85**	**53.64**	**51.46**
F_1 Crosses										
Kadiri-6 × TCGS-1862	18.50	21.15	3.25	2.10	15.25	19.05	102.64	117.06	53.87	49.62
Kadiri-6 × TCGS-2149	16.85	21.05	3.35	3.20	13.50	17.85	95.91	115.58	41.97	47.35
Kadiri-6 × J-11	16.40	22.45	2.35	3.25	14.05	19.20	134.22	116.68	42.64	47.94
Kadiri-6 × CS-19	23.30	27.90	1.09	2.85	22.21	25.05	107.87	136.65	52.48	61.35
Narayani × TCGS-1862	14.50	22.10	1.70	2.50	12.80	19.60	118.08	120.67	52.36	49.35
Narayani × TCGS-2149	13.75	21.60	2.95	2.15	10.80	19.45	111.63	119.41	45.05	47.25
Narayani × J-11	23.35	30.40	3.30	2.40	20.05	28.00	104.52	136.00	52.85	57.10
Narayani × CS-19	16.75	17.50	4.30	1.80	12.45	15.70	98.62	128.63	43.30	52.85
TAG-24 × TCGS-1862	16.60	22.80	1.25	1.90	15.35	20.90	92.03	113.35	40.52	46.48
TAG-24 × TCGS-2149	16.00	19.50	1.98	2.10	14.02	17.40	100.27	119.88	39.50	45.55
TAG-24 × J-11	14.10	18.30	2.10	2.05	12.00	16.25	97.83	129.59	42.42	51.90
TAG-24 × CS-19	16.30	20.65	2.35	1.50	13.95	19.15	114.70	118.54	42.35	48.69
ICGV-07262 × TCGS-1862	24.70	29.20	4.60	2.55	20.10	26.65	103.53	133.15	53.80	58.55
ICGV-07262 × TCGS-2149	24.30	33.20	3.45	2.55	20.85	30.65	106.05	134.35	53.40	60.90
ICGV-07262 × J-11	17.90	21.70	4.40	2.25	13.50	19.45	135.87	121.27	40.70	52.60
ICGV-07262 × CS-19	16.30	18.00	4.10	5.25	12.20	12.75	91.01	114.35	40.79	48.60
ICGV-91114 × TCGS-1862	16.70	15.30	2.70	4.95	14.00	10.35	105.47	113.96	48.48	48.40
ICGV-91114 × TCGS-2149	14.95	17.35	3.90	2.10	11.05	15.25	122.78	114.25	40.31	46.40
ICGV-91114 × J-11	12.65	20.60	2.50	2.40	10.15	18.20	138.85	117.52	44.97	51.72
ICGV-91114 × CS-19	13.05	18.45	1.40	4.25	11.65	14.20	127.51	124.70	43.93	46.95
Mean of F_1 crosses	**17.35**	**21.96**	**2.85**	**2.71**	**14.50**	**19.26**	**110.47**	**122.28**	**45.78**	**50.98**
Max. value	**24.70**	**33.20**	**4.60**	**5.25**	**22.21**	**30.65**	**138.85**	**136.65**	**53.87**	**61.35**
Min. value	**12.65**	**15.30**	**1.09**	**1.50**	**10.15**	**10.35**	**91.01**	**113.35**	**39.50**	**45.55**
General mean	17.95	21.98	2.52	2.65	15.43	19.33	110.23	122.48	47.13	50.85
CD	1.34	1.69	0.50	0.60	1.29	1.71	15.59	2.68	3.62	1.91
SEm	0.46	0.58	0.17	0.20	0.44	0.59	5.37	0.92	1.24	0.65
SEd	0.65	0.82	0.24	0.29	0.63	0.83	7.60	1.30	1.76	0.93
CV	3.66	3.75	9.85	11.13	4.11	4.34	6.90	1.07	3.75	1.84

Cont...

Table 2. Cont...

Genotypes	Sound mature kernel (%)		Shelling per cent		Dry haulm weight plant^{-1} (g)		Pod yield plant^{-1} (g)		Kernel yield plant^{-1} (g)	
	Sick	Control	Sick	Control	Sick	Control	Sick	Control	Sick	Control
Lines										
Kadiri-6	80.85	80.53	74.77	85.66	10.75	11.23	16.46	20.32	12.30	17.41
Narayani	74.79	82.15	73.51	78.67	9.15	11.40	17.00	21.29	12.50	16.75
TAG-24	69.98	69.31	81.53	73.03	6.19	9.55	12.39	18.38	10.08	13.40
ICGV-07262	70.70	82.23	69.96	84.57	10.20	12.14	18.45	22.42	12.90	18.95
ICGV-91114	76.50	74.42	78.20	70.76	7.70	8.89	13.19	17.42	10.32	12.32
Mean of Lines	**74.56**	**77.73**	**75.59**	**78.54**	**8.80**	**10.64**	**15.50**	**19.97**	**11.62**	**15.77**
Testers										
TCGS-1862	80.88	79.38	84.53	79.93	8.70	11.55	17.30	18.41	14.61	14.72
TCGS-2149	79.56	81.49	71.63	89.70	8.65	11.57	15.20	20.35	10.89	18.25
J-11	81.80	81.40	92.66	79.09	7.85	11.66	14.80	21.75	13.84	17.20
CS-19	80.90	81.45	87.91	91.79	8.90	12.26	16.30	20.38	14.83	18.70
Mean of Testers	**80.79**	**80.93**	**84.18**	**85.13**	**8.53**	**11.76**	**15.90**	**20.22**	**13.54**	**17.22**
F_1 Crosses										
Kadiri-6 × TCGS-1862	70.90	78.15	49.93	85.43	11.19	8.70	15.22	18.59	7.60	15.87
Kadiri-6 × TCGS-2149	70.13	75.38	41.62	75.60	11.38	10.50	16.10	19.33	6.70	14.61
Kadiri-6 × J-11	73.28	77.56	83.88	92.87	12.58	8.95	15.50	17.49	13.01	16.23
Kadiri-6 × CS-19	85.10	82.55	87.93	92.90	16.50	17.15	21.40	22.23	18.75	20.65
Narayani × TCGS-1862	69.70	80.18	84.76	92.51	13.10	8.30	13.91	18.03	11.79	16.68
Narayani × TCGS-2149	73.90	77.61	75.31	74.74	8.15	8.58	12.58	19.64	9.45	14.68
Narayani × J-11	84.45	84.90	91.79	82.46	16.05	16.85	21.30	23.35	20.55	19.25
Narayani × CS-19	75.40	79.59	81.11	81.14	12.50	8.67	15.24	19.47	15.36	15.80
TAG-24 × TCGS-1862	71.16	77.04	70.72	89.04	7.45	8.22	14.35	16.34	10.15	14.55
TAG-24 × TCGS-2149	73.21	74.25	72.75	72.88	6.60	7.73	13.25	19.71	9.63	14.37
TAG-24 × J-11	72.41	80.00	75.39	86.68	8.74	7.56	13.79	15.98	10.40	13.85
TAG-24 × CS-19	71.06	78.31	82.32	63.78	11.69	8.06	14.24	19.21	11.72	12.25
ICGV-07262 × TCGS-1862	86.30	82.06	83.40	87.92	18.40	19.60	22.90	24.29	22.80	21.35
ICGV-07262 × TCGS-2149	85.40	85.60	94.20	91.10	17.71	18.24	21.60	22.95	20.35	20.90
ICGV-07262 × J-11	74.37	75.72	66.03	94.06	14.70	8.97	13.95	16.54	9.22	15.56
ICGV-07262 × CS-19	70.35	78.93	74.39	92.72	10.47	5.78	13.70	15.38	10.19	14.26
ICGV-91114 × TCGS-1862	72.25	78.00	71.15	69.26	9.56	6.11	12.44	16.16	12.30	11.20
ICGV-91114 × TCGS-2149	68.65	79.39	77.51	61.47	10.05	9.99	16.55	19.62	12.83	12.05
ICGV-91114 × J-11	69.39	74.89	90.49	75.74	8.30	9.74	15.40	16.39	13.93	12.42
ICGV-91114 × CS-19	65.32	77.27	80.12	68.57	9.49	11.00	12.75	13.46	10.21	9.15
Mean of F_1 Crosses	**74.14**	**78.87**	**76.74**	**81.54**	**11.73**	**10.44**	**15.81**	**18.71**	**12.85**	**15.28**
Max. value	**86.30**	**85.60**	**94.20**	**94.06**	**18.40**	**19.60**	**22.90**	**24.29**	**22.80**	**21.35**
Min. value	**65.32**	**74.89**	**41.62**	**61.47**	**6.60**	**5.78**	**12.44**	**13.46**	**6.70**	**9.15**
General mean	75.13	78.95	77.57	81.52	10.78	10.65	15.77	19.13	12.73	15.63
CD	2.32	1.50	9.34	8.03	0.56	1.14	0.95	0.79	1.19	1.23
Sem	0.80	0.51	3.22	2.77	0.19	0.39	0.32	0.27	0.41	0.42
SEd	1.13	0.73	4.55	3.91	0.27	0.55	0.46	0.38	0.58	0.60
CV	1.51	0.93	5.88	4.81	2.54	5.23	2.96	2.02	4.57	3.85

Cont...

Table 2. Cont...

Genotypes	Oil content (%)		Protein content (%)		Percent disease incidence (%) at maturity	
	Sick	Control	Sick	Control	Sick	Control
Lines						
Kadiri-6	47.90	47.85	26.30	24.80	79.55	7.28
Narayani	47.40	49.10	26.60	26.80	72.08	10.91
TAG-24	48.33	48.25	26.20	26.05	66.37	1.79
ICGV-07262	48.40	48.70	25.65	27.75	65.91	0.00
ICGV-91114	47.90	48.75	25.90	25.90	84.39	7.14
Mean of Lines	**47.99**	**48.53**	**26.13**	**26.26**	**73.66**	**5.42**
Testers						
TCGS-1862	48.10	48.30	26.25	25.65	13.64	0.00
TCGS-2149	48.10	48.35	26.20	26.85	9.09	0.00
J-11	48.10	48.30	26.00	25.10	7.05	0.00
CS-19	48.05	47.11	26.10	25.60	10.87	0.00
Mean of Testers	**48.09**	**48.02**	**26.14**	**25.80**	**10.16**	**0.00**
F_1 Crosses						
Kadiri-6 × TCGS-1862	48.15	48.10	26.40	26.10	27.92	1.86
Kadiri-6 × TCGS-2149	47.25	47.50	25.80	25.80	23.27	5.49
Kadiri-6 × J-11	48.50	48.20	24.55	24.80	21.59	3.58
Kadiri-6 × CS-19	47.75	48.25	25.55	27.40	11.82	0.00
Narayani × TCGS-1862	48.25	48.40	26.30	27.00	48.92	5.36
Narayani × TCGS-2149	47.90	47.73	26.85	26.20	64.95	3.57
Narayani × J-11	48.05	49.50	24.90	25.40	17.50	0.00
Narayani × CS-19	47.40	48.21	26.60	25.85	26.37	0.00
TAG-24 × TCGS-1862	48.10	48.00	25.80	25.25	72.50	0.00
TAG-24 × TCGS-2149	48.30	48.20	26.00	26.30	65.91	5.36
TAG-24 × J-11	48.55	47.50	24.60	25.70	29.29	3.57
TAG-24 × CS-19	48.40	48.50	26.15	24.40	21.43	3.58
ICGV-07262 × TCGS-1862	48.10	48.55	25.85	27.10	17.50	0.00
ICGV-07262 × TCGS-2149	47.80	48.20	25.70	23.33	19.32	0.00
ICGV-07262 × J-11	47.90	48.35	25.60	25.00	12.26	5.36
ICGV-07262 × CS-19	48.05	47.95	26.55	24.30	56.82	0.00
ICGV-91114 × TCGS-1862	48.10	47.90	25.85	24.35	65.26	0.00
ICGV-91114 × TCGS-2149	47.25	47.55	25.70	24.90	22.50	1.79
ICGV-91114 × J-11	47.90	48.20	26.20	24.65	61.37	3.64
ICGV-91114 × CS-19	47.75	46.05	24.45	24.55	20.89	0.00
Mean of F_1 crosses	**47.97**	**48.04**	**25.77**	**25.42**	**35.37**	**2.16**
Max. value	**48.55**	**49.50**	**26.85**	**27.40**	**11.82**	**5.49**
Min. value	**47.25**	**46.05**	**24.55**	**23.33**	**72.50**	**0..00**
General mean	47.99	48.12	25.88	25.62	38.49	2.43
CD	0.57	0.82	0.87	1.10	10.84	3.69
Sem	0.19	0.28	0.30	0.38	3.73	1.27
SEd	0.28	0.40	0.42	0.53	5.28	1.80
CV	0.59	0.84	1.65	2.10	13.74	74.30

From the above premise, it was concluded that among lines, ICGV-07262 was identified as superior as it registered for most of the yield and yield attributing traits in both sick plot and control condition while the testers *viz*., CS-19 and J-11 in sick plot condition and CS-19 and TCGS-2149 in control condition were identified as best performers for yield and yield components. The cross ICGV-07262 x TCGS-1862 is identified as the outstanding cross for pod and kernel yield plant^{-1} in both sick plot and control condition.

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EFFECT OF SEED PRIMING ON GERMINATION AND SEEDLING GROWTH OF DRY DIRECT SOWN RICE (*Oryza sativa* L.)

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ABSTRACT

Poor seedling establishment is one of the major constraints in adopting dry direct sown rice. The objective of this study was to determine the effectiveness of seed priming treatments for improving crop stand establishment, seedling vigour index and speed of germination. Two laboratory experiments were conducted at dept. of Crop Physiology, S. V. Agricultural College, Tirupati, Acharya N.G. Ranga Agricultural University, Andhra Pradesh, India, during 2021-22 with eight seed priming treatments broadly consisting of untreated control; hydropriming; priming with GA_3 @ 100 ppm; priming with KNO_3 @ 0.5%; priming with DAP @ 2% and their possible combinations. Seed priming improved germination percentage, crop stand establishment and seedling vigour index along with speed of germination. Faster and uniform emergence of seedlings might be due to improved α-amylase activity by GA_3 which in turn increased the levels of soluble sugars in priming treatments. Priming combination of GA_3 @ 100 ppm + KNO_3 @ 0.5% + DAP @ 2% gave superior results among all the treatments in both laboratory experiments.

KEYWORDS: Dry direct seeded rice, Seed priming, Crop stand establishment, Seed vigour index, Speed of germination.

INTRODUCTION

Rice (*Oryza sativa* L.) is the most predominant crop grown in more than 100 countries of the world. Ninety percent of world's rice is both produced and consumed in Asia which accounts for sixty per cent of world's population. Traditionally, rice is transplanted after puddling the soil which requires huge amount of water at a time. Late onset of monsoon and shortage of labour often delay rice transplantation and decrease the productivity of crop. Furthermore, in the view of decreasing water resources the system of rice cultivation has to undergo changes from transplanted conditions towards dry direct sown rice where utilization of water will be minimal during initial stages and provides assured yields. Dry direct sown rice may have certain benefits like elimination of puddling and labour for nursery maintenance and transplanting and also provides an option to resolve the soil related conflict. Dry direct sown rice has two major constraints like weed management and seedling emergence which requires serious attention and necessitates finding strategies to ensure faster and uniform establishment of the crop (Balasubramanian and Hill, 2002).

Improved seed priming techniques are used to reduce germination time and accomplish uniform seedling emergence in field crop (Farooq *et al*., 2006). The priming techniques include hydropriming, osmopriming, nutripriming and harmonal priming (Basra *et al.,* 2005). Seed priming is beneficial in many aspects of crop growth in rice. For instance, seed priming with GA_3 induces biosynthesis of α-amylase, a key metabolic event in producing vigour seedlings.

MATERIAL AND METHODS

Two laboratory experiments were conducted during 2021-22 using seeds of rice cultivar Nellore Mahsuri (NLR 34449) in completely randomized block design (CRD) with four replications and eight treatments. Seed priming treatments includes, untreated control; hydropriming; priming with GA_3 @ 100 ppm; DAP @ 2%; KNO_3 @ 0.5%; GA_3 @ 100 ppm + KNO_3 @ 0.5%; GA_3 @ 100 ppm + DAP @ 2% and GA_3 @ 100 ppm + KNO_3 @ 0.5% + DAP @ 2%. Seeds were soaked in priming solutions for 12 hours and then shade dried for 12 hours. In laboratory experiment I, 10 seeds were placed in each Petri plate whereas, in laboratory experiment II twenty-five seeds were placed by hand drilling in soil trays and irrigated when soil moisture was low. The parameters like germination percentage (ISTA, 2011), mean germination time (Ellis and Robert, 1981), co-efficient of velocity of germination (Kotowski, 1926) and seedling vigour index (SVI-I and II) (Abdul and Anderson, 1973) were calculated.

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Statistical Analysis

The obtained data from the laboratory experiments were analysed statistically with SPSS software and ANOVA. The critical difference was carried out at 5 per cent (0.05) probability or corrections among parameters were at 95% of significant level.

RESULTS AND DISCUSSION

Effect of seed priming on seedling vigour of dry direct sown rice (laboratory study I)

Germination percentage

Germination percentage was recorded in laboratory experiment I at 5, 10 and 15 DAS whereas in laboratory experiment II it was recorded at 7, 14 and 21 DAS. There was no significance difference in germination percentage at 5,10 and 15 days after priming the seeds in laboratory experiment I. Priming treatment with GA_3 @ 100 ppm + KNO_3 @ 0.5% + DAP @ 2% recorded the highest germination percentage (95.00) followed by priming with GA_3 @ 100 ppm + KNO_3 @ 0.5% (85.00) which is at par with all other treatments at 5 DAS. There was slight variation in germination percentage at 10 days after treating the seeds and no significant difference was noticed in seed germination at 15 DAS 9 (Table 1).

Seedling vigour index

Seed priming treatments significantly changed seedling vigour index in dry direct sown rice. Priming with GA_3 @ 100 ppm + KNO_3 @ 0.5% + DAP @ 2% recorded the highest seedling vigour index (5 DAS- 884.40, 10 DAS- 1212.75 and 15 DAS- 1279.78) among all the treatments. Whereas, least was recorded in untreated control at all the stages (5 DAS- 313.35, 10 DAS- 442.10 and 15 DAS- 635.43) (Table 1).

Speed of germination

Speed of germination was analyzed with the help of mean germination time, coefficient of velocity of germination and germination index.

Mean germination time (MGT)

The mean germination time of seed for different treatments ranged from 4.50 to 4.88 days. Among the treatments, the highest mean germination time was recorded in T1 (Control) (4.88) which was followed by T_5 (Priming with DAP @ 2%) (4.58) and it was par with all other priming treatments (Table 1). The results revealed that, priming enhanced the rapid germination of seeds compared with non-primed seeds. The significant enhancement in germination might because due to increased α-amylase activity which was positively correlated with reserve mobilization and mean germination time in rice. Similar results were also obtained by earlier workers (Lee and Kim, 2000; Harris *et al*., 2001).

Coefficient of Velocity of Germination (CVG) (%)

Among all the treatments, T_2 (hydropriming) performed well (99.72) which was at par with other priming treatments except T_1 (Control) which recorded the lowest CVG (50.00) (Table 1). The results were in corroboration with reports of Raun *et al*. (2002) that, enhanced velocity of germination was obtained with priming in rice.

Germination index (GI)

A significant difference was observed among the treatments for germination index. The highest germination index was noticed in treatment T_8 (Priming with GA_3 @ 100 ppm + DAP @ 2% + KNO_3 @ 0.5%) (76.75) which was at par with all other priming treatments and the lowest value was found in T_1 (Control) (59.50) (Table 1). These findings were in line with Raun *et al*. (2002).

Effect of seed priming on seedling vigour of dry direct sown rice (laboratory study II)

Germination percentage (%)

A significant difference was observed in the germination percentage at all three intervals. Among all the treatments, T_8 (Priming with GA_3 @ 100 ppm + DAP @ 2% + KNO_3 @ 0.5%) had recorded the highest germination percentage at 7DAS (97.00) and 14DAS (98.00). There was no increase in the germination percentage of the seeds as the seeds which are viable were all emerged by 14 days. Hence, there was no further enhancement in germination percentage at 21 DAS (Table 2).There was a positive influence of seed priming in rice on germination percentage which might be due to increased α-amylase content in the seed during germination, which might be due to the synergistic effect of gibberellic acids (GA_3), Di- ammonium phosphate (DAP) and potassium nitrate (KNO_3) on seed germination. These results were found to be similar to those of Harris *et* al., (2002) and Farooq *et al*., (2007).

Seedling Vigour Index

Seedling vigour index differed significantly at 7, 14 and 21 DAS. The data revealed that, the highest seedling vigour index was recorded in T_8 (Priming with GA_3 @ 100 ppm + DAP @ 2% + KNO_3 @ 0.5%) with values of 1537.82, 1808.09 and 2108.73, followed by T_7 (Priming with GA_3 @ 100 ppm + KNO_3 @ 0.5%)

Table 1. Effect of seed priming treatments on germination percentage, seedling vigour index and speed of germination of dry direct sown rice (Laboratory study I)

Treatments	Germination percentage			Seedling vigour index			Speed of germination		
	5 DAS	10 DAS	15 DAS	5 DAS	10 DAS	15 DAS	MGT	CVG	GI
T_1: Control	85.00	85.00	85.00	313.35	442.10	635.43	4.88	50.00	59.50
T_2: Hydro priming with water	85.00	85.00	85.00	481.20	669.35	783.83	4.50	97.73	69.75
T_3: Priming with GA_3 @ 100 ppm	85.00	85.00	85.00	629.90	926.83	977.45	4.50	97.50	69.75
T_4: Priming with KNO_3 @ 0.5%	85.00	90.00	90.00	484.25	632.25	857.48	4.56	82.14	69.50
T_5: Priming with DAP @ 2%	85.00	90.00	90.00	483.50	753.73	851.95	4.58	83.81	73.75
T_6: Priming with GA_3 @ 100 ppm + DAP @ 2%	85.00	90.00	90.00	675.50	1056.15	1171.58	4.56	80.78	71.00
T_7: Priming with GA_3 @ 100 ppm + KNO_3 @ 0.5%	85.00	90.00	90.00	697.73	1065.38	1124.33	4.56	81.70	71.25
T_8: Priming with GA_3 @ 100 ppm + DAP @ 2% + KNO_3 @ 0.5%	95.00	95.00	95.00	884.40	1212.75	1279.78	4.53	91.67	76.75
C.D	8.43	7.30	7.30	76.71	83.64	88.24	0.15	22.50	7.31
C.V	NS	NS	NS	9.04	6.78	6.30	2.28	18.53	7.14

Table 2. Effect of seed priming treatments on germination percentage and seedling vigour index of dry direct sown rice (Laboratory study II)

Treatments	Germination Percentage			Seedling vigour index		
	7 DAS	14 DAS	21 DAS	7 DAS	14 DAS	21 DAS
T_1: Control	88.00	92.00	92.00	742.50	1060.30	1447.84
T_2: Hydro priming with water	90.00	93.00	93.00	961.55	1186.85	1559.45
T_3: Priming with GA_3 @ 100 ppm	90.00	96.00	96.00	1130.11	1512.72	1840.08
T_4: Priming with KNO_3 @ 0.5%	92.00	96.00	96.00	1044.66	1329.20	1600.56
T_5: Priming with DAP @ 2%	92.00	97.00	97.00	1043.74	1328.01	1728.69
T_6: Priming with GA_3 @ 100 ppm + DAP @ 2%	92.00	96.00	96.00	1234.88	1495.20	1813.92
T_7: Priming with GA_3 @ 100 ppm + KNO_3 @ 0.5%	93.00	94.00	94.00	1336.73	1557.30	1890.86
T_8: Priming with GA_3 @ 100 ppm + DAP @ 2% + KNO_3 @ 0.5%	97.00	98.00	98.00	1537.82	1808.09	2108.73
C.D	3.67	3.67	3.67	58.39	74.56	73.11
C.V	2.74	2.64	2.64	3.54	3.62	2.86

(1336.73, 1557.30 and 1890.86) and the lowest SVI was observed in T_1 (Control) (742.50, 1060.30 and 1447.84) at 7, 14 and 21 DAS respectively. The positive influence of GA_3, DAP and KNO_3 on seedling vigour index was also suggested by earlier researchers (Rood *et al*., 1990, Hussain *et al*., 2006)

The results of the laboratory studies showed that, seed priming with GA_3 @ 100 ppm + DAP @ 2% + KNO_3 @ 0.5%) had increased physiological parameters like, germination percentage, seedling vigour index, speed of germination in dry direct sown rice.

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AWARENESS OF FARMERS TOWARDS RYTHU BHAROSA KENDRAS (RBKs) PRODUCTS AND SERVICES IN KURNOOL DISTRICT OF ANDHRA PRADESH

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ABSTRACT

The present study was conducted to analyse farmer's awareness towards products and services offered by Rythu Bharosa Kendras (RBKs), particularly in the Kurnool district of Andhra Pradesh. A total of 120 farmers from six RBKs were purposively chosen for the study. The results of the study indicated that the sample farmers had high level of awareness towards products and services offered by RBKs for statements such as availability of agriculture and veterinary assistant staff for guidance, operations of RBKs confined to a revenue village and availability of agri inputs (seeds, fertilizers and pesticides, *etc.*) services. The majority of sample farmers (65.83%) had medium level of awareness towards RBKs products and services, followed by 21.67 per cent and 12.50 percent with high and low awareness level towards RBKs products and services.

KEYWORDS: Rythu Bharosa Kendras (RBKs), farmer's awareness, products and services.

INTRODUCTION

Andhra Pradesh is India's rice bowl and one of the country's most important agricultural states. Andhra Pradesh rural population is around 63 per cent (Statista, 2021). In 2021-22, the Gross Value Added (GVA) is 18.8 per cent. While agricultural and allied sectors reported a growth rate of 14.50 per cent, while agriculture alone contributed to a growth rate of 6.30 per cent. The horticulture and livestock sector witnessed a growth rate of 13.24 per cent and 11.46 per cent respectively. With the increase in population, the demand for agricultural commodities has been increasing day by day. Thus, to gain its viability by bringing it on a higher growth track, there is an urgent need to recognize the magnitude of problems faced by the agriculture and allied sectors.

Andhra Pradesh government launched Rythu Bharosa Kendras (RBKs) for the farmers as one-stop solution for all agriculture and allied firm's products and services on May 30, 2020. RBKs is one of the Andhra Pradesh Government interventions towards increasing the farmer's income.

The products offered at RBKs includes the supply of good quality and certified inputs like seeds (OPV's), hybrid seeds, fertilizers, agrochemicals, micronutrients, bio-fertilizers, livestock feed and services like enrollment and processing of input subsidy, enrollment of Crop insurance, E-Karshak (Digital Crop Records), Polambadi (Farm School), MSP Procurement services, yield and damage Assessment, farm advisory services, technology transfer (Agriculture Extension Service), market price information, weather forecasting information, soil and seed testing services, JLG(Joint Liability Groups) formation and credit linkage, custom hiring centers and veterinary services etc. Based on the crop area and allied sectors, Rythu Bharosa Kendras (RBKs) are led by a Village Agriculture Assistant/ Horticulture Assistant/ Veterinary Assistant.

The extent of farmer's awareness towards the products and services offered by RBKs is essential for Andhra Pradesh government in taking policy decisions for improving the availability of products and services at RBKs, further the findings will aid academics, and the department of agriculture, Andhra Pradesh in developing strategies for successful penetration and functioning of RBKs. In this context, the present study is aimed to analyze farmer's awareness towards products and services offered at Rythu Bharosa Kendras (RBKs), particularly in the Kurnool district of Andhra Pradesh.

MATERIAL AND METHODS

Ex post facto research design was followed for conducting the study. This design was appropriate because the phenomenon has already occurred. Kerlinger

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(1973) defined *Ex post facto* research design as any systematic empirical enquiry in which the independent variables have not been directly manipulated because they have already occurred or they are inherently not manipulable. He further stated that *Ex post facto* studies can be devised to deduce theories, identify behavioural phenomenon and explore conditions under which a phenomenon occurs.

Andhra Pradesh state was selected purposively for the study as the researcher hails from the same state and is familiar with the local language. Kurnool district of Andhra Pradesh was selected purposively for the study as the researcher hails from the same district. Nandyal revenue division was selected as the researcher hails from the same Nandyal revenue division. Out of 29 mandals in the Nandyal revenue division, two mandals were selected randomly namely Bandi Atmakuru and Mahanandi. Three villages were selected from each of the selected mandals based on the number of farmers in the villages. The villages selected from Bandi Atmakuru mandal were Banda Atmakuru, Santha Juturu, and Parnapalle. From Mahanandi mandal, Bukkapuram, Thammadapalle and Abbipuram villages were selected. A total of six RBKs were purposively chosen based on larger number of farmers in RBK's for the study. Beneficiaries of Rythu Bharosa Kendras were listed and 20 farmers from each Rythu Bharosa Kendras were randomly selected for the survey thus making the total sample size to 120.

Farmers Awareness towards RBKs products and services

The awareness of sample farmers towards Rythu Bharosa Kendras products and services was measured by a schedule that comprised of 3 dimensions namely unaware, aware and completely purchased/ experienced. The responses were taken on a 3-point continuum with dimensions of unaware, aware and completely aware or experienced.

The awareness score of the respondents was then classified into 3 categories based on mean and standard deviation as shown below.

S. No.	Category	Score
1.	Low level	Below mean – S.D.
2.	Medium level	Between mean ± S.D.
3.	High level	Above mean + S.D.

RESULTS AND DISCUSSION

Awareness of farmers towards Rythu Bharosa Kendra's products and services in Kurnool district of Andhra Pradesh

Farmer's Awareness towards products and services offered by RBKs was intended to know about farmer's general awareness towards products and services offered by RBKs in the sampled area.

The analysis was conducted using a three-point rating scale and scores of 1, 2, and 3 were assigned to the levels of unawareness, awareness, and completely purchased (or) experienced, respectively. Mean scores were determined and the aspects were assigned rankings based on the mean score. Table 2 shows the results of a simple percentage analysis performed on the data gathered.

Table 1. Overall Farmer's awareness of Rythu Bharosa Kendras products andservices

(n = 120)

S. No.	Participatory category	Participatory criteria	Participatory score	Farmers	
				No.	Percentage (%)
1	Low	< (Mean – SD)	< 36.07	15	12.50
2	Medium	(Mean ± SD)	36.077 – 38.68	79	65.83
3	High	> (Mean + SD)	> 41.28	26	21.67
			Total	120	100
			Mean	**38.67**	
			Standard deviation	**2.52**	

Table 2. Farmer's awareness of Rythu Bharosa Kendra's products and services

(n = 120)

S. No.	Awareness about RBK	Unaware	Aware	Completely aware (or) purchased (or) experienced	Mean Score	Rank
1.	Agriculture & Veterinary (Technical) staff are available at RBK for guidance.	0	11	109	2.91	**I**
2.	RBK area of operations are confined to Revenue village as a Unit	0	16	104	2.87	**II**
3.	RBK also supplies agri inputs to the farmers (seeds, fertilizers etc.)	5	20	95	2.75	**III**
4.	E-Karshak (Digital crop records) is maintained by RBK staff by capturing crop images and geo-tag the location of the crop	6	23	91	2.71	**IV**
5.	There are agriculture & allied audio- visual aids like charts, boards, books are displayed at RBK to create awareness regarding current works & new technological advancements.	8	25	87	2.66	**V**
6.	Enrollment and Processing for Input Subsidy and crop insurance is done at RBK	0	46	74	2.62	**VI**
7.	RBK is one stop solution for agriculture and allied activities	0	49	71	2.59	**VII**
8.	RBK assess the yield and damage of crops and those records are maintained?	6	46	68	2.52	**VIII**
9.	RBK has all the information about agriculture & allied supporting schemes offered by the state government	6	52	62	2.47	**IX**
10.	RBK provides extension services like farm school, weather forecasting information, soil, seed and water testing services etc.	9	49	62	2.44	**X**
11.	Digital kiosk is available at RBK for placing order of agri inputs	20	44	56	2.30	**XI**
12.	RBK provides marketing services like market price information and MSP procurement services.	21	61	38	2.14	**XII**
13.	RBK disseminates information related to agriculture & allied firms via WhatsApp groups.	14	89	17	2.03	**XIII**
14.	Veterinary services like medication, guidance regarding maintenance and feed etc.	60	36	24	1.70	**XIV**
15.	RBK supplies livestock feed to the farmers	66	36	18	1.60	**XV**
16.	Formation and credit linkage of 4S groups (JLG) is done at RBK	92	19	9	1.31	**XVI**

Table 2 showed that the sample farmers had high level of awareness towards aspects of availability of agriculture and veterinary assistant staff for guidance, operations of RBK are confined to a revenue village, supply of Agri inputs(seeds, fertilizers, pesticides, etc.), e-Karshak, a digital crop records database maintained by RBK staff by taking crop images and geo-tagging the location of the crop as evidenced from the mean scores of 2.91, 2.87, 2.75 and 2.71 respectively followed up by the aspects that audio- visual aids such as charts, boards, and books to raise awareness about availability of new technological advancements are available at RBK, enrolment and processing for input subsidy and crop insurance, RBK was one-stop solution for agriculture and allied activities and assessment of the crop and yield damage by RBKs, RBK has all of the information about agriculture and allied activities followed up by the provision of extension services like weather forecasting information, Polambadi(farm school), soil and seeds testing services, digital kiosk availability at RBK for placing orders of agri inputs. RBK provides market price information and procurement services and also disseminates information regarding agriculture and allied activities with mean scores of 2.66, 2.62, 2.59, 2.52, 2.47, 2.30, 2.14, and 2.03 respectively. The sampled farmers had low level of awareness towards provision of veterinary services like medication and guidance availability, RBK supplies livestock feed to the farmers due to veterinary staff were unavailable at RBK and for the formation and provision of credit linkage to 4S groups (JLG) at RBK with low mean scores of 1.70, 1.60 and 1.31 respectively.

Overall Farmer's Awareness towards Rythu Bharosa Kendra's Products and Services

Overall farmer awareness towards Rythu Bharosa Kendra's products and services was collected from respondent farmers in the current study. This refers to farmer's interpretations towards awareness aspects concerning general aspects of products and services offered by RBKs.

The scale was developed to assess farmers awareness towards Rythu Bharosa Kendras' products and services. The scale contained 16 assertions about RBKs, covering general aspects, products, and services offered by RBKs. The responses were collected on a three-point scale: known, well-known, and completely experienced/ Purchased, with each receiving a score of one, two, and three respectively. The lowest and highest levels of awareness were 16 and 48, respectively. The awareness score of a respondent was calculated by adding the scores he or she earned on all 16 items/statements. The respondents were classified into three groups based on their total score: "low," "medium," and "high," with the mean (38.67) and standard deviation (2.52) serving as a check to measure.

Table 1 revealed that sampled farmers had 65.83 per cent of sampled farmers had medium level of awareness towards Rythu Bharosa Kendras, while 21.67 per cent of the sampled farmers had high level of awareness and remaining 12.5 percent of the farmers had low level of awareness. Therefore, it showed that majority of the sampled farmers had medium to high level of awareness towards products and services offered by Rythu Bharosa Kendras with 87.50 per cent. Farmers were less familiar towards formation and credit linkages of 4S groups (JLG) and livestock feed supplied to the farmers by RBK respectively.

Majority of the sample farmers (86.83%) had medium to high level of awareness towards products and services offered by RBKs. Therefore, RBKs no need to modify their behaviour to raise awareness. It should continue to be consistent in its campaigns to raise awareness of Rythu Bharosa Kendra's products and services offered.

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COMPETENCIES AND INFRASTRUCTURE REQUIREMENTS FOR DIGITAL MARKETING OF AGRICULTURAL PRODUCE BY FPOs IN ANANTAPUR DISTRICT

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ABSTRACT

In the era of globalisation and free trade liberalisation, it is imperative to develop rural entrepreneurship by implementing the idea of collectivization or group initiation through local level organization. Indian farmers are capable of producing large quantities, but they struggle to sell their products at profitable prices due to lack of efficient technology, poor infrastructure and poor marketing structure. A potential alternative for effective marketing, information sharing, marketing and profit making is mobilising farmers for group action through developing farmer producer organisations which enables them to make decisions collectively for income enhancement. This helps the farmers go from merely producers of agricultural produce to sellers of the produce. In India, majority of farmers are small and marginal. There is a need to develop effective delivery system which fulfil the needs of small and marginal farmers. A suitable technology is required to improve sustainable food production and marketing for revenue enhancement.

KEYWORDS: Globalisation, Liberalisation, Marketing, Digital platforms.

INTRODUCTION

Agricultural sector plays an important role in both economic development and nation building. The contribution of GDP from agricultural sector had increased from 17.8 per cent (2019-20) to 19.9 per cent (2020-21). In India, 82 per cent of the farmers are having small to marginal land holdings. In order to reap the benefits of large scale farming by small and marginal farmers, it is very much necessary to give them access to better technology, finance, better inputs, and better markets. Keeping this in view, the Government of India has launched a scheme titled "Formation and Promotion of Ten Thousand FPOs" with a budgetary provision of 6,865 crores. The biggest obstacle in increasing farmers income in India are the profiteering middlemen, commission agents, traders and wholesalers take a major chunk of profit from farmers produce. This leaves very little for the farmers. The agricultural marketing plays a major role for getting better prices for the farmers. To solve these problems efficient marketing plays a very important role. Agricultural marketing activities are to create, explore and deliver quality products to the consumers. Agricultural marketing identifies the unfilled needs, desires and wants of the targeted customers. It will support the digital agriculture business and opportunities to sell and buy agricultural produce by farmers and consumers using digital platforms. Through these digital platforms, they may reach wide range of customers and they have different opportunities for the marketing of agricultural produce through B2B, B2C, B2B2C marketing channels. Reliance group, Bigbasket, Vegrow, Ninjacart, Waycool *etc.* are some of the digital platforms.

MATERIAL AND METHODS

Andhra Pradesh was selected purposively as the researcher belonged to this state. Anantapur district is having maximum number of FPOs and hence Anantapur district has been selected purposively. Out of ninety registered and functional FPOs in the district, five FPOs with maximum membership was selected purposively. The total sample size is 100 that constitute 25 board of directors and 75 farmer members. Primary as well as secondary data were collected to fulfill the designed objectives. The primary data was collected from farmers through the personal interview method by using a structured schedule. The secondary data regarding the agro-economic aspects of the study area were collected from the District Chief Planning Officer, Anantapur district.

RESULTS AND DISCUSSION

The analysis of the collected data revealed that most of the board of directors and farmers belonged to

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middle age group between 36 to 55 years with medium family size, most of the respondents pursued primary education and engaged in agriculture alone with small land holding. Medium level of annual income and mass media exposure with medium scientific orientation.

Competency and infrastructure requirement for digital marketing of agricultural produce

From the Table 1, we can conclude that 84 per cent of BODs did not have enough skill to operate the computer followed by 80 per cent of BODs said that sales process is lengthy and complex, 76 per cent of respondents were aware of uploading and grading of agricultural produce and 72 per cent of BODs cannot easily handle the process of digital marketing. With regard to farmers (92%) said that they did not have skill to operate the computer followed by 81.33 per cent of farmers cannot easily handle the process of digital marketing, 78.67 per cent farmers said that sales process is lengthy and complex and 70.67 per cent of respondents were aware of uploading and grading of agricultural produce.

Awareness on digital platforms

Table 2 revealed that 60 per cent of Board of Directors opinioned that by using of digital platforms market access may be increased, 24 per cent of respondents were less aware on digital platforms because transparency may or may not be increased, 16 per cent of BODs aware that by using of digital platforms volume of produce for sale may be increased.

Table 2 revealed that 56 per cent of respondent farmers aware using of digital platforms may increase in the price for the produce whereas 32 per cent of respondents expressed that quality produce may be exported by using digital platforms while 12 per cent of farmers expressed that value- added produce may get good price in digital platforms.

Inventory Handling

It is evident from the Table 3 that 76 per cent of Board of Directors of Five FPOs were following push strategy to handle the inventory and 24 per cent of BODs were following pull strategy to handle the inventory.

From the respondent farmers 81.33 per cent were following push strategy to handle the inventory and 18.67 per cent were following pull strategy to handle the inventory respectively.

Pull strategy initiates production as a reaction to present demand, while push strategy initiates production in anticipation of future demand.

Infrastructure Requirement

Poor infrastructure is available in five farmer producer organizations. None of the infrastructures is available in Five FPOs. This poor infrastructure can be a significant constraint for the storage and quality of the produce.

Transportation

Table 4 shows that 92 per cent of sampled board of directors transport their agricultural produce through hired vehicle on road while 8 per cent of sampled board of directors had own vehicle for transportation.

Table 1. Distribution of sample respondents based on competencies

(n = 100)

S. No.	Competency	No of BODs (n = 25)				No of Farmers (n = 75)			
		Yes		No		Yes		No	
		F	%	F	%	F	%	F	%
1.	Handling the process of digital marketing	7	28.00	18	72.00	14	18.67	61	81.33
2.	Having enough skill to operate the computer	4	16.00	21	84.00	6	8.00	69	92.00
3.	The sales process lengthy and complex	20	80.00	5	20.00	59	78.67	16	21.33
4.	Aware of the operations like grading, sorting and specification of the food items	19	76.00	6	24.00	53	70.67	22	29.33

Table 2. Distribution of sample respondents based on awareness on digital platforms

(n = 100)

S. No.	Awareness on digital platforms	No of BODs (n = 25)		No of Farmers (n = 25)	
		Frequency	Percentage	Frequency	Percentage
1.	Low	6	24%	24	32%
2.	Medium	15	60%	42	56%
3.	High	4	16%	9	12%
	Total	**25**	**100**	**75**	**100**
		Mean = 7.64; S.D = 1.11		**Mean = 7.52; S.D = 1.30**	

Table 3. Distribution of sample respondents based on inventory handling

(n = 100)

S. No.	Inventory handling	No of BODs (n = 25)		No of Farmers (n = 25)	
		Frequency	Percentage	Frequency	Percentage
1.	Pull strategy	6	24.00%	14	18.67%
2.	Push strategy	19	76.00%	61	81.33%
	Total	**25**	**100.00**	**75**	**100.00**

Table 4. Distribution of the sample respondents based on transportation of agricultural produce

(n = 100)

S. No.	Transportation	No of BODs (n = 25)		No of Farmers (n = 25)	
		Frequency	Percentage	Frequency	Percentage
1.	Own vehicle	2	8.00%	3	4.00%
2.	Hired vehicle	23	92.00%	72	96.00%
	Total	**25**	**100.00**	**75**	**100.00**

Table 5. Distribution of sample respondents based on packaging material

(n = 100)

S. No.	Packaging material	No of BODs (n = 25)		No of Farmers (n = 25)	
		Frequency	Percentage	Frequency	Percentage
1.	Bags	4	16.00%	20	26.67%
2.	Crates	21	84.00%	55	73.33%
	Total	**25**	**100.00**	**75**	**100.00**

In case of farmers 96 per cent of sampled farmers transport their agricultural produce through hired vehicles on road and 4 per cent of sampled farmers have own vehicles for transportation. Transportation of agriculture produce is generally carried out by tractors, lorry and Ashok Leyland.

Packaging material

From the table 5 it can be seen that majority (84%) of the respondents were using crates as packaging material for transporting agricultural produce while 16 per cent of Board of Directors were using bags as packaging material.

With regard to farmers, it can be inferred that more than one third (73.33%) of the members were using crates as packaging material for mango, tomato *etc.*, whereas 26.67 per cent of farmers were using bags as packaging material for potato, citrus etc.

Competency revealed that majority of respondents did not have enough skill to operate the computer. The respondents were aware that that by using of digital platforms market access may be increased and price for the produce may be increased. The majority of respondents were following push strategy to handle the inventory. FPOs are not having adequate infrastructure facilities. Transportation revealed that majority of respondents transport their agricultural produce through hired vehicles. Packaging material revealed that majority of respondents using crates.

SUGGESTIONS

1. Most of the FPOs have poor infrastructure facilities. So, it is necessary to improve infrastructure facilities.

2. The present study was confined to competencies and infrastructure facilities. Further studies may be taken up on logistics, transportation costs and economic factors such as net savings and commodity prices.

3. Most of the farmers are not aware of digital marketing. So, the government should organize awareness campaigns.

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PESTICIDES USAGE PATTERN IN GUNTUR DISTRICT OF ANDHRA PRADESH

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ABSTRACT

The present study was done to pesticides usage pattern of cotton farmers in Guntur district of Andhra Pradesh. Guntur district ranks first in the production of cotton in the state. To conduct study two mandals were selected randomly, from which 100 cotton farmers were selected. The majority of the farmers were sourcing credit from the money lenders. Most of the farmer had smart phone for the communication. Greater percentage of farmers had 2.5-5 acres of land size. The mass media exposure was medium among the farmers group. Majority of the farmers were using pendimethalin 30% EC as herbicide, while monocrotophos 36% SL, acephate 75% SP as insecticides and carbendazim 12% + Mancozeb 63% WP as fungicide. The soluble liquids and solube powders were used maximum by the farmers.

KEYWORDS: Mass media, pesticides, money lenders, cotton farmers.

INTRODUCTION

Pesticides are chemicals that are used to kill weeds, insects, and illnesses that may cause up to 50, 30 and 20 per cent, respectively, of damage to crops. These were manufactured or natural made. These substances were categorised as herbicides, fungicides, rodenticides, etc. based on their nature. According to the UN Food and Agriculture Organization, 40 per cent of crops in developing nations suffer damage from pests. Around 2 million tonnes of pesticides are used globally, of which herbicides account for 47.50 per cent of usage, insecticides for 29.50 per cent, fungicides for 17.5 per cent and other pesticides for 5.5 per cent. India accounted for 0.3 per cent of the global usage of pesticides with its 62193 metric tonnes of plant protection chemical use.

On an area of 6.06 lakh hectares, Andhra Pradesh produces the most cotton, generating 19 lakh bales. Uneven pesticide use has led to low pesticide use, which has reduced agricultural yields. However, spraying pesticides excessively can harm both humans and crops. To avoid crop losses, farmers must use pesticides at the optimum rate and at the appropriate time. To achieve good yields with minimal crop losses, farmers must be knowledgeable about the product's usage, including the right pesticide to use, when to apply it, how to spray, etc.

The study helps to understand the pesticide usage pattern in cotton crop.

MATERIAL AND METHODS

The survey was done in the Andhra Pradesh district of Guntur, which ranked first in pesticide consumption, land area, and cotton production in the state. Out of 58 mandals, two were chosen at random for the study. A total of 10 villages were created by randomly choosing five from each mandal. A sample size of 100 farmers was obtained by randomly choosing 10 from each hamlet. The study's necessary information will be gathered from the farmers using a pre-tested timetable and numerous in-person visits.

TO STUDY THE SOCIO-ECONOMIC PROFILE OF FARMERS

Sources of Credit

The data pertaining to the source of credit was collected and categorized into five categories namely money lenders, neighbors/friends/relatives, government departments, input dealers, and commercial banks. The data was collected and presented in Table 1.

The above Table 1, shows that among sample cotton farmers, 34 per cent of respondents were depended credit on money lenders, 30 per cent were depended on commercial banks, 22 per cent were depended on input dealers, 8 per cent were depended credit on friends/ neighbors, and 6 per cent were depended on government departments. It shows that the majority of sample cotton farmers depended credit on money lenders.

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Table 1. Sources of credit categorization of sample cotton farmers

S. No.	Categories	Frequency	Percentage
1.	Money Lenders	**34**	**34.00**
2.	Neighbours/Friends/Relatives	8	8.00
3.	Government Departments	6	6.00
4.	Input Dealers	22	22.00
5.	Commercial Banks	30	30.00
	Total	**100**	**100.00**

Mobile phone usage

The data regarding mobile phone usage of sample cotton farmers was collected and classified into two groups namely smart phone and basic mobile. The data collected was analyzed and presented in Table 2**.**

A study of Table 2 shows that among sample cotton farmers, 78 per cent of sample cotton farmers had smart phones while 22 per cent of the sample cotton farmers had basic mobile for their daily communication and also for getting the information about production, marketing, post-harvest. This shows that majority of farmers were having smart phones.

Table 2. Mobile phone usage categorization of sample cotton farmers

S. No.	Categories	Frequency	Percentage
1	Smart phone	78	78.00
2	Basic mobile	22	22.00
	Total	**100**	**100.00**

Farm size

The data regarding the Farm size of the sample cotton farmers was collected and categorized into seven groups namely no land, less than 1 acre, 1-2.5 acres, 2.5-5 acres, 5-10 acres, 10-15 acres, and >15 acres. The data was collected and presented in Table 3.

From the above table 3, it reveals that 48 per cent of respondents were having land holdings between 2.5-5 acres, 17 per cent growers were having land holding between 1-2.5 acres, likewise 16 per cent of farmers were having land holdings between 5-10 acres, 12 per cent respondents were having less than 1 acre of land, 4 per cent of respondents were having land holding between 10-15 acres of land and 3 per cent of respondents were having more than 15 acres of land. Thus, it may be concluded that the maximum percentage of cotton growers *i.e.* (48%) have landholding between 2.5-5 acres.

Table 3. Farm size categorization of sample cotton farmers

S. No	Categories	Frequency	Percentage
1.	No land	0	0
2.	Less than 1 acre	12	12.00
3.	1-2.5 acres	17	17.00
4.	2.5-5 acres	48	48.00
5.	5-10 acres	16	16.00
6.	10-15 acres	4	4.00
7.	>15 acres	3	3.00
	Total	**100**	**100.00**

Mass media exposure

The data regarding mass media exposure of the sample cotton farmers were collected and grouped into three categories *viz.*, low, medium, high. The collected data was analyzed and shown in Table 4.

From the Table 4, it shows that 77 per cent of respondents were having medium level of mass media exposure and 13 per cent of respondents were having high level of mass media exposure, 10 per cent of the respondents were having low level of mass media exposure. Thus, it can be concluded that majority (77 per cent) of the cotton growers were having medium level of mass media exposure.

Major Occupation of Sample Farmer

The data regarding the major occupations of sample farmers were collected and divided into three groups *viz*.,

Table 4. Mass media exposure categorization of sample cotton farmers

S. No.	Categories	Frequency	Percentage
1.	Low	10	10.00
2.	Medium	77	77.00
3.	High	13	13.00
	Total	**100**	**100.00**

Agriculture and Horticulture and Animal husbandry. The data collected was analyzed and presented in Table 5.

From the above Table 5, Agriculture was the major occupation for 76 per cent of the sample cotton farmers, horticulture was the major occupation for 22 per cent of the sample cotton farmers and only 2 per cent of the farmers were having animal husbandry as their major occupation. This infers that agriculture was the major occupation for most of the farmers.

Table 5. Major occupation categorization of sample cotton farmers

S. No.	Categories	Frequency	Percentage
1.	Agriculture	76	76.00
2.	Horticulture	22	22.00
3.	Animal husbandry	2	2.00
	Total	**100**	**100.00**

PESTICIDES USAGE PATTERN IN COTTON CROP BY THE SAMPLE FARMERS

To understand the pesticide usage pattern of cotton farmers, broadly divided into three categories namely herbicides, insecticides, fungicides. The data collected was analyzed and presented with following sub heads.

Pesticides Usage Pattern in Cotton by the Sample Farmers

The information regarding pesticides to effectively control various weeds, pests, and diseases in the field was collected, analyzed and presented in Table 6.

From Table 6, it shows that the top two chemicals used by sample cotton farmers were Pendimethalin 30% EC, Glyphosite 40% SL which was used by 82 per cent, 56 per cent of the sample farmers respectively and the least two herbicides used by sample farmers were Propaquizafop 10% EC, Quizalofop ethyl 5% EC were used by 35 per cent and 28 per cent respectively.

The top three insecticides were Monocrotophos 36% SL, Acephate 75% SP, Chlorantraniliprole 18.5% SC SP were used by 100 per cent, 100 per cent, 77 per cent of the sample cotton farmers respectively. The least three insecticides used by the farmers were Imidacloprid 70% WG, Dicofol 18.5% EC, Emamectin benzoate 5% SG were used by 14 per cent, 21 per cent, 28 per cent of sample cotton farmers respectively.

The top three fungicides were Carbendazim 12% + Mancozeb 63% WP, Streptomycin sulphate 90% w/w, Copper oxychloride 50% WP used by 58 per cent, 45 per cent, 34 per cent of sample cotton farmers respectively. The least three fungicides used by the farmer were Carbendazim 50% WP, Mancozeb 75% WP, Pyraclostrobin 20% WG used by 29 per cent, 16 per cent, 11 per cent respectively by the sample cotton farmers.

Among herbicides the deviation was highest for pendimethalin 30% EC with 71.43 per cent and least for quizalofop ethyl 5% EC with deviation of 28 per cent of sample cotton farmers. Among insecticides the deviation was highest for 81.82 per cent Imidacloprid 17.8% SL, least deviation (negative) was Diafenthiuron 50% WP with -42.86 per cent.

Usage of pesticides according to the form of pesticide

The data regarding the usage of pesticides according to the form pesticide was classifies as soluble powders, soluble liquids, soluble concentrates, emulsifying concentrates, wettable powders, water granules, soluble granules. The data was collected and presented in the below table.

From the table 7 it shows that 100 per cent of the sample were using soluble powders, soluble liquids as the form of pesticide, followed by 85 per cent of the sample farmers use emulsifying concentrates, 73 per cent of the sample farmers used wettable powders, 71 per cent of the sample farmers used water granules and 28 per cent of the sample farmers used soluble granules. This shows that majority of the farmers used soluble powders and soluble liquids form of pesticides.

Among herbicides the deviation was highest for pendimethalin 30% EC with 71.43 per cent and least for quizalofop ethyl 5% EC with deviation of 28 per cent of sample cotton farmers. Among insecticides the deviation was highest for 81.82 per cent Imidacloprid 17.8% SL, least deviation (negative) was Diafenthiuron 50% WP

Table 6. Usage of pesticides in sample cotton farmers

a. Herbicides usage pattern in sample cotton farmers

S. No.	Type of pesticide	Name of pesticide	Recommended dosage per hectare	Average quantity used per hectare	Variation in pesticide usage	Deviation (%)	Target for	Number of sample farmers used	Per cent
1	Herbicide	Pendimethalin 30% EC	800 ml	2800 ml	2000	71.43	Broad leaved weeds and grassy weeds	82	82
2	Herbicide	Quizalofop ethyl 5% EC	400 ml	1200 ml	800	66.67	Broad leaved weeds and grass weeds	28	28
3	Herbicide	Propaquizafop 10% EC	450 ml	620 ml	170	27.42	Broad leaved weeds and grass weeds	35	35
4	Herbicide	Glyphosate 41% SL	1200 ml	2500 ml	1300	52.00	Non selective herbicide	56	56

b. Insecticides usage pattern in sample cotton farmers

1	Insecticide	Monocrotophos 36% SL	400 ml	1250 ml	850	68.00	Sucking pests	**100**	**100**
2	Insecticide	Acephate 75% SP	500 gms	1625 gms	1125	69.23	Sucking pests	**100**	**100**
3	Insecticide	Imidacloprid 17.8% SL	100 ml	550 ml	450	81.82	Sucking pests	53	53
4	Insecticide	Imidacloprid 30.5% SC	210 ml	250 ml	40	16.00	Sucking pests	38	38
5	Insecticide	Imidacloprid 70% WG	150 gms	187.5 gms	37.5	20.00	Sucking pests	14	14
6	Insecticide	Acetamiprid 20% SP	200 gms	500 gms	300	60.00	Sucking pests	72	72
7	Insecticide	Thiamethoxam 25% WG	180 gms	375 gms	195	52.00	Sucking pests	62	62
8	Insecticide	Fipronil 5% SC	1500 ml	1500 ml	0	0.00	Sucking pests	85	85
9	Insecticide	Diafenthiuron 50% WP	1250 gms	875 gms	-375	-42.86	Sucking pests	73	73
10	Insecticide	Flonicamid 50% WG	75 gms	200 gms	125	62.50	Sucking pests	71	71
11	Insecticide	Profenofos 50% EC	320 ml	1250 ml	930	74.40	Lepidopteran insects	33	33
12	Insecticide	Spinosad 45% SC	75 ml	150ml	75	50.00	Sucking, lepidopteran and coleoptera	48	48
13	Insecticide	Spinetoram 11.7% SC	188 ml	500ml	312	62.40	Thrips and lepidopteran insects	46	46
14	Insecticide	Quinalphos 25% EC	625 ml	1875 ml	1250	66.67	Lepidopteran insects	34	34
15	Insecticide	Chlorpyrifos 20% EC	750 ml	1875 ml	1125	60.00	Lepidopteran insects	48	48

Cont...

Table 6. Cont...

S. No.	Type of pesticide	Name of pesticide	Recommended dosage per hectare	Average quantity used per hectare	Variation in pesticide usage	Deviation (%)	Target for	Number of sample farmers used	Per cent
16	Insecticide	Indoxacarb 15.8% EC	250 ml	500 ml	250	50.00	Lepidopteran insects	30	30
17	Insecticide	Emamectin benzoate 5% SG	125 gms	375 gms	250	66.67	Lepidopteran insects	28	28
18	Insecticide	Flubendiamide 20% WG	120 gms	200 gms	80	40.00	Lepidopteran insects	28	28
19	Insecticide	Chlorantraniliprole 18.5% SC	75 ml	225 ml	150	66.67	Lepidopteran insects	77	77
20	Insecticide	Novaluron 10% EC	250 ml	925 ml	675	72.97	Lepidopteran insects	28	28
21	Insecticide	Lamda-cyhalothrin 25% EC	250 ml	875 ml	625	71.43	Lepidopteran insects	75	75
22	Acaricide	Dicofol 18.5% EC	220 ml	625 ml	405	64.80	Mites	21	21

c. Fungicides usage pattern in sample cotton farmers

1	Fungicide	Carbendazim 12% + Mancozeb 63% WP	300 gms	625gms	325	52.00	Leaf spot	58	58
2	Fungicide	Metalaxyl 35% WS	350 gms for 100 kg seed	500 gms for 100 kg seed	150	30.00	Seed borne diseases	33	33
3	Fungicide	Copper oxychloride 50% WP	750 gms	1875 gms	1125	60.00	Root rot and wilt	34	34
4	Fungicide	Carbendazim 50% WP	250 gms	1250 gms	1000	80.00	Leaf spot and wilt	29	29
5	Fungicide	Mancozeb 75% WP	625 ml	1250 gms	625	50.00	Leaf spot	16	16
6	Fungicide	Pyraclostrobin 20% WG	500 gms	500 gms	0	0.00	Leaf spot	11	11
7	Bactericide	Streptomycin sulphate 90%w/w	120 gms	250 gms	130	52.00	Broad spectrum antibiotic	45	45

Table 7. Usage of pesticides according to the form

S. No.	Formulations of pesticides	Name of the pesticide	Number of sample farmers used
1	Soluble powders	Acephate 75%	100
2	Soluble liquids	Monocrotophos 36% Imidacloprid 17.8%	100
3	Soluble concentrates	Imidacloprid 30.5% Spinosad 45% Spinetoram 11.7% Chlorantraniliprole 18.5%	85
4	Emulsifying concentrates	Pendimethalin 30% Quizalofop ethyl 5% Propaquizafop 10% Profenofos 50% Quinalphos 25% Chlorpyrifos 20% Indoxacarb 15.8% Novaluron 10% Lamda-cyhalothrin 2.5% Dicofol 18.5%	82
5	Wettable powders	Diafenthiuron 50% Carbendazim 12% + Mancozeb 63% Copper oxychloride 50% Carbendazim 50% Mancozeb 75%	73
6	Water granules	Imidacloprid 70% Thiamethoxam 25% Flonicamid 50% Flubendiamide 20% Pyraclostrobin 20%	71
7	Soluble Granules	Emamectin benzoate 5%	28

with -42.86 per cent. 100 per cent of farmers were using monocrotophos 36% SL and Acephate 75% SP. Majority of the farmers used soluble powders and soluble liquids form of pesticides.

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STUDY ON RURAL CONSUMERS BUYING BEHAVIOUR ON SELECTED FMCG PRODUCTS IN KRISHNA DISTRICT

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ABSTRACT

The paper entitled "Buying behavior of rural consumers towards selected Fast Moving Consumer Goods (FMCG)" was undertaken to investigate the awareness, perception, buying pattern of rural consumers for factors like price, quality parameters, discounted offers, switching facility, packaging aspects, quantity, availability, variety, purchase experience. affecting the purchasing behavior of rural consumers and constraints faced by them while purchasing the FMCG products. Dental care, soft drinks, soaps, detergent powder, and biscuits are the products chosen for this survey. Krishna district was specifically chosen for the study because the researcher is from there. Two mandals were chosen at random from among the 53 mandals in the Krishna district. It was found that most customers are willing to purchase things from Kirana stores since it is easy for them, when compared to supermarkets, haats, and online shopping. Few customers choose to buy FMCG products from their favorite stores three times a year, with the majority choosing to do so once each month. When compared to information from friends, it was found that television is the most popular information source for purchasing FMCG products most of the villagers were having TV at their homes.

KEYWORDS: Fast Moving Consumer Goods, Rural consumers, Buying behaviour, Awareness.

INTRODUCTION

Fast Moving Consumer Goods (FMCG) or Consumer-Packaged Goods (CPG) are products that have a high shelf turnover, are generally inexpensive, and require little thought, time, or money to purchase. FMCG refers to any product that is often used, sometimes on a regular basis, and moves quickly (at least once a month) at the store level. FMCGs are all commodities that people buy on a regular basis (except food and pulses). The most regularly purchased items on the list, include toilet soaps, detergents, shampoos, toothpaste, shaving products, shoe polish, prepared meals, and domestic accessories. These items are designed to be used on a daily or regular basis and provide a high return on investment. The three main segments of the FMCG industry are personal care, food and beverages, and domestic care. The FMCG industry is primarily responsible for the manufacture, distribution, and marketing of consumer-packaged goods. The FMCG supply chain is a complex network of operations and resources. Suppliers, manufacturers, logistics service providers, warehouses, distributors, wholesalers, and all other organizations are involved in the delivery of goods to the final client are included.

MATERIAL AND METHODS

The sample for the study was chosen using a random sampling procedure. Using standard random selection technique three villages from each Mandal, yielding a total of six villages and a random selection of 15 consumers from each village were done. Hence, a sample size of 90 consumers was developed. Five brands from each of the three categories of FMCG products - food and beverage (biscuits and soft drinks), oral care, and home care (toilet soaps and detergents) - will be chosen for further analysis. The survey method was used to gather the data for the current study, and pre-tested schedules were used to conduct the interviews. The period covered for the analysis was 2021–22. To achieve a set of objectives, descriptive statistics and Garrett ranking were utilized.

RESULTS AND DISCUSSION

STUDY ON RURAL CONSUMERS BUYING BEHAVIOUR ON SELECTED FMCG PRODUCTS

Product Preference of the rural consumer

Consumers preferences varies towards FMCG products. The Table 1 indicates the preference of FMCG products according to branded, neutral, non-branded FMCG goods by the consumers in the present study

The above Table 1 depicted that; majority of the respondents preferred to buy branded product as they are brand conscious.

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Table 1. Product preference of respondents

	Branded	%	Neutral	%	Generic	%
Dental care	56	62	25	28	9	10
Detergents	58	64	28	31	4	4
Soft drinks	64	71	19	21	7	8
Soaps	58	64	26	29	6	7
Biscuits	59	66	24	27	7	8

Market preference of the respondents

From the Table 2 shows that 41 per cent of respondents in the study area prefer to buy from the Kirana store, followed by 28 per cent of consumers buy from haat / mela, 21 per cent of them buy from super markets, 10 per cent buy from E-shopping. Majority of the sample respondents prefer to buy products from Kirana stores as they are convenient for them to approach

Consumer behaviour towards frequency of product purchase

According to Table 3, majority of survey respondents - roughly 71.1 percent of the overall sample size - purchase goods from their favourite stores once a month since it is more convenient for them. 13.3 per cent of all customers in the sample size made weekly purchases as their next action. Similar, 4.44 per cent of rural consumers buying things every two weeks,

Table 2. Market preference of the respondents

(N = 90)

S. No.	Preferable markets	Number of respondents	Percentage (%)
1	Haat/mela	25	28
2	super market	19	21
3	Kirana store	37	41
4	E-shopping	9	10
	Total	**90**	**100**

Table 3. Consumer behavior towards frequency of product purchase

(N = 90)

S. No.	Purchasing	Frequency (f)	Percentage (%)
1	Fortnightly	4	4.44
2	Weekly once	12	13.30
3	Monthly once	64	71.10
4	Quarterly	10	11.10
	Total	**90**	**100.00**

Table 4. Sources of information for the consumers to buy Fast moving consumer goods products

(N = 90)

S. No.	Sources Of Information	Frequency (f)	Percentage (%)
1	Retail shop display	6	7.00
2	Newspaper/magazine	5	6.00
3	Tv	65	72.00
4	Friends and relatives	11	12.00
5	Other	3	3.00
	Total	**90**	**100.00**

Table 5. Perception of rural consumers on FMCG products

Perception on FMCG products	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Mean Score	Rank
Are good for the environment	0	3	38	21	28	3.82	IV
Are healthy	0	11	21	43	15	3.69	II
Have better quality/performance than conventional products	0	18	38	23	11	3.30	V
Are reasonably priced	6	26	38	17	3	2.83	VI
Are well promoted	0	10	21	26	33	3.91	I
Are accessible/available in the market	0	0	43	23	24	3.79	III

and 11.10 per cent of the total consumers buy FMCG products quarterly from their preferred stores.

Sources of information for the consumers to buy FMCG products

Consumers purchase products after being collected information from various sources. The following table 4.11 shows the sources of information for purchase of FMCG.

Television (72%) has been identified as the popular information source for FMCG product purchases since, over time, almost all villages have installed TVs in their houses and often watch TV. The TV commercials that run in the middle of the programmes are factor influences viewers to favour products. Out of all respondents, 12 per cent acquire knowledge from friends and family, 7 per cent get it from retail store displays, 6 per cent get it from newspapers/magazines, and just 3 per cent get it from other sources.

Perception of Rural Consumers on FMCG Products

Table 5 shows that respondents from rural areas have different opinions on "fast-moving consumer goods" products. Most rural consumers strongly agree that FMCG products are well advertised and have greater brand awareness than good for the environment products, with a mean score of 3.91 compared to 3.8. With a mean score of 3.79, the majority of customers concur that they are offered in local stores, although some respondents are undecided about how easily accessible, they are and that a diversity of brands are not offered there. While many consumers think that they are healthy, a significant minority believe otherwise since chemicals are used in the production of these items, which they believe to be unhealthy. Many consumers believe that they are healthier than conventional items but are not higher quality. With a mean score of 2.86, many consumers believe that many FMCG products are overpriced.

The present study concluded that the consumers prefer to buy FMCG brands (food and beverage (biscuits and soft drinks), oral care, and home care (toilet soaps and detergents)) from kirana stores because of the easy availability. The consumer prefers specific brand as they were practiced to use that brand influence since long and thus have developed a faith on those specific product brands. Most of the consumers prefer to purchase produced brand as they were brand conscious. Majority of the consumers stick to brand for more time because they think it suits to them. The consumers purchase brands on monthly basis. With time all most all the villagers were having TV in their homes and they watch TV in their free time, so the most prominent source of information for buying FMCG brand was television.

Among the different age group young age group people were mostly likely influenced by the advertisement and attractive packing hence Advertisement was the most influencing factor while buying any FMCG brand advertisement plays major role for brand preference among rural consumers. high income group people purchasing FMCG products in higher volume when compare to low-income group

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CONSTRAINTS IN PURCHASING OF FROZEN MEAT AND MEAT PRODUCTS IN ANDHRA PRADESH

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ABSTRACT

The present study was done to identify the constraints in purchasing of frozen meat and meat products in Andhra Pradesh. A representative sample of 120 meat consumers in three cities of Andhra Pradesh i.e., Vishakhapatnam, Vijayawada, and Tirupati were taken for the study. A consumer purchasing behaviour model was developed from the results of study for purchasing of the fresh meat and frozen meat. The major market stimuli for buying of meat was driven from consumer stimuli and consumer motives towards meat. The major consumer constraints in purchasing frozen meat and meat products reveals that high price and non-availability are important constraints. The moderately important constraints were non acceptance among family members, Frozen meat products are stale, Non traceability of source of origin, Poor packaging' and Poor taste, respectively.

KEYWORDS: Consumer constraints, frozen meat, meat products, consumer behaviour model.

INTRODUCTION

Consumption of meat played a crucial role in human evolution and is an important component of a healthy and well-balanced diet due to its nutritional richness. A healthy balanced diet can include protein, meat being one of the important and affordable sources of protein. Meat is mostly made up of beneficial proteins, lipids, vitamins, minerals, omega 3 fatty acids, and conjugated linoleic acid that provide a variety of nutrients for human health.

According to the 2021 report by the market research company, IMARC, the frozen food, industry in India is spreading its wings and is expected to expand at a Compound Annual Growth Rate (CAGR) of 17 per cent between 2019-2024. The market for frozen foods comprises of "frozen meat products," "frozen greens," "frozen fruits," and "frozen vegetables." Since frozen foods don't require any of the additional preparation or culinary skill, they are becoming more and more popular in India. Moreover, frozen food products, especially the frozen meat products offer enhanced palatability when compared to their home-cooked counterparts, these products are available all-year-round regardless of the season. Furthermore, the end-users can buy those products through different distribution channels such as supermarkets and hypermarkets, convenience stores, departmental stores, etc.

The study helps to understand the constraints in purchasing of frozen meat and meat products in Andhra Pradesh.

MATERIAL AND METHODS

The survey was done in the Andhra Pradesh state, which ranked third in meat production. This study was conducted purposively in Vishakhapatnam, Vijayawada, and Tirupati. These cities consist of wide variety people with different religions, castes, occupations, culture, languages and food habits. These cities act as an educational hub for whole state and also rapidly incorporating the urban culture. The study's necessary information will be gathered from corresponding references and the meat consuming respondents using a pre-tested timetable and numerous in-person visits.

STUDIES ON CONSTRAINTS FACED BY CONSUMERS WHILE BUYING FROZEN MEAT AND MEAT PRODUCTS.

Information regarding constraints in purchasing of frozen meat and meat products were analyzed. In

Table 1. Categorizing the constraints based on total scores

S. No.	Total score	Category
1	0 – 120	Not important
2	120 – 240	Slightly important
3	240 – 360	Moderately important
4	360 – 480	Important
5	480 – 600	Very important

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Table 2. Constraints in purchasing of frozen meat and meat products

S. No.	Constraints	Total score	Mean score	Category
1	High price	432	86.40	Important
2	Non-Availability	408	81.60	Important
3	Poor quality of meat	378	75.60	Important
4	Non acceptance among family members	359	71.80	Moderately important
5	Frozen meat products are stale	350	70.00	Moderately important
6	Non traceability of source of origin	348	69.60	Moderately important
7	Poor packaging	347	69.40	Moderately important
8	Poor taste	340	68.00	Moderately important
9	Low range and variety	210	42.00	Slightly important
10	Poor buying experience	140	28.00	Slightly important

order to measure constraints in purchasing of the frozen meat and meat products., the opinion of the sampled consumers was analyzed using a five-point rating scale, with the least considered statement rated as one (1) and the most considered statement rated as five (5). The scores obtained for each identified parameter were summated, and the respective means were estimated and are arranged in ascending order as per the mean values obtained. The identified parameters were categorized into very important, important, moderately important, slightly important and not important according to their mean values, as shown in the Table 2.

The constraints are categorized in to five categories based on the total score given below.

The constraints obtaining the total score 0-120 falls under 'not important' category, the constraints obtaining the total scores of ranges 120-140, 240-360, 360-480 and 480-600 falls under categories slightly important, moderately important, important and very important, respectively.

The results of Table 2 indicates the constraints in purchasing of frozen meat and meat products. The constraints like "High price", "non-availability" and "Poor quality of meat" are categorised as important constraints with mean scores of 86.40, 81.60 and 75.60 respectively as frozen meat is not available as widely as fresh meat in the sample area. The constraints like non-acceptance among family members frozen meat products are stale, non-traceability of source of origin, poor packaging and poor taste falls under moderately important constraints with their mean score of 71.80, 70.00, 69.60, 69.40, and 68.00, respectively. Whereas the constraints like low range and variety and Poor buying experience lies in the category of slightly important constraints with mean score of 42.00 and 28.00, respectively. Hence, the most important constraints in purchasing of the frozen meat and meat products were high price, non-availability and poor quality of meat.

Consumer purchasing behaviour model for frozen meat and meat products

Figure 1 shows, the consumer purchasing behaviour model was developed from the results of study. The major market stimuli for buying of meat was driven from consumer stimuli and consumer motives towards meat. The critical consumer stimuli for meat purchasing decision making were meat being considered as rich source of protein and tasty. The consumer motives were influenced from beliefs like "meat is good for healthy lifestyle", "consumption of meat is in family/religion culture" and "consumption of meat gives social esteem (social status)". The consumer psychology towards preferring of fresh meat over frozen meat was considering frozen meat products as stale, harmful for health and poor in taste. While perception of consumers favouring towards frozen products were frozen meat suitability for preserving long time when compared to fresh meat, Various meats available in off season in frozen form with wide range of products.

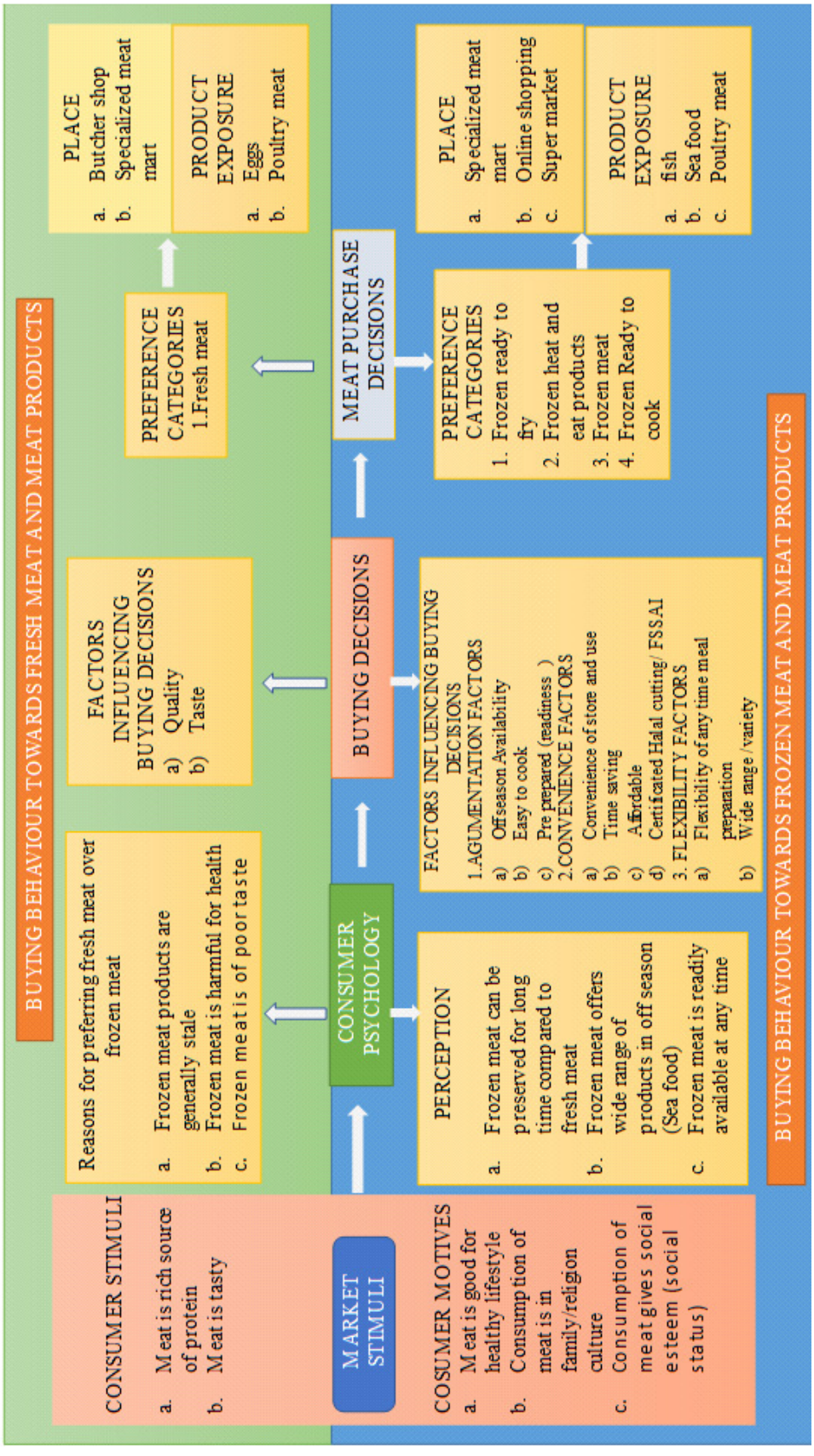

Fig. 1. Consumer purchasing behaviour model for frozen meat and meat products.

The buying decisions towards fresh meat was due to the influencing factors like quality and taste. the major factors influencing the buying decisions of frozen meat products were mostly augmentation factors like off season availability, easy to cook and pre-preparedness of products followed by convenience factors like Convenience of storing and using as per requirement, Time saving, affordability and certificated Halal cutting/ FSSAI and the flexibility factors also influences the buying decisions which includes wide range/ variety and flexibility of any time meal preparation. Based on the market stimuli, consumer psychology and buying decisions the purchasing decision are taken by consumers whether to buy fresh meat or frozen products. Further across the consumers willing to buy frozen meat take purchase decisions for frozen ready to fry, frozen heat and eat products, frozen ready to cook and frozen meat as per their buying decision previously made. The consumers after deciding to purchase they decide the place of purchasing, for fresh meat places preferred by consumers are butcher shop and specialized meat mart, where as for frozen products they choose super markets and online shopping. While final decisions depend on products, they are willing to purchase based on earlier market stimuli they receive. Consumers were mostly preferring products like fish, sea food and poultry meat in frozen form where as eggs and poultry meat were mostly consumed in fresh form.

The constraints like "high price", "non-Availability" and "Poor quality of meat" are categorised as important constraints respectively as frozen meat is not available as widely as fresh meat in the sample area. The constraints like Non acceptance among family members 'Frozen meat products are stale', 'Non traceability of source of origin', 'Poor packaging' and 'Poor taste' falls under moderately important constraints. Whereas the constraints like 'Low range and variety' and 'Poor buying experience' lies in the category of slightly important constraints.

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FARMERS AWARENESS TOWARDS DIFFERENT Bt-COTTON BRANDS IN GUNTUR DISTRICT OF ANDHRA PRADESH

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ABSTRACT

The present study entitled "farmers awareness towards different Bt-cotton brands in Guntur district of Andhra Pradesh" was undertaken mainly to study about the aspects of farmer buying behaviour towards Bt cotton seed. India is 3rd largest producer of cotton with area under cotton crop is 134.77 lakh ha, were as Andhra Pradesh account for 6.57 lakh ha, in A.P., Guntur stands first in terms of production with 9.86 lakh bales and second in terms of area under cultivation with 1,82,000 ha. Guntur district was purposively selected for the study and the top two mandals were chosen which has maximum area and production under cultivation of cotton crop and two villages from each was selected with a sample size of 100 farmers. The selected villages were Gudipudi, Dhulipalla, Mandadi and Veldurithi. There is always a positive relationship between education and awareness of a product. Through Chi square analysis, it was observed that there is a strong association between education of farmers and awareness, also revealed that there is no association between age, income, land holding size with brand awareness. Most of the farmers i.e. 60.26 per cent depended up on the fellow farmers and relatives to select the BT cotton brands, most of the farmers buy the seed from dealers with credit option. Seed regulation authorities should increase the vigilance and ensure the quality of the seed thoroughly before seed certification. Private companies should follow the good CRM to create the more awareness among the rural people.

KEYWORDS: Buying behaviour, awareness level, CRM (customer relationship management), Bt cotton.

INTRODUCTION

Cotton (botanically known as *Gosspyium linn*; *Gossypium arboreum, G. herbaceum, G. hirsutum and G. barbadense*) is one of the most important cash and commercial crops of India, which is cultivated throughout the nation. In 2019-20, the area and production of cotton was 365.77 lakh ha and 365.00 lakh bales respectively (Committee on cotton production and consumption 2019-20). Major cotton cultivating states in India includes Maharashtra, Gujarat, Andhra Pradesh, Telangana, which aggregate to nearly 2/3rd of the total cotton grown area. In cotton production, Maharashtra, Gujarat stands first and second followed by Andhra Pradesh and Telangana which are collectively known as 'cotton basket of India'. (Agricultural Market Intelligence Centre, ANGRAU 2019-20). In India, total area under cotton crop was 134.77 lakh ha out of this Andhra Pradesh account for 6.57 lakh ha that is nearly 5 per cent and India produce 134.77 lakh bales where Andhra Pradesh produce 18.00 lakhs bales which is about 13.35 per cent, Guntur stands with an area of 1,82,000 ha and in production 9.86 lakh bales *i.e*., 54.77 per cent of total production in Andhra Pradesh. Farmers buying behavior results from individual and environmental influences. It is sum total of consumer's attitudes, preferences, intentions and decisions on purchasing the product or service and is also complex because each farmer has different attitude towards buying, utilization and disposal of product. Buying behavior is the process where in individuals decide whether, what, when, where, how and from whom to purchase goods and services.

MATERIAL AND METHODS

Andhra Pradesh was selected purposively as the researcher belonged to this state. Guntur district , Guntur district as it always ranked second in cotton cultivation with an area of 83,381 hectare and first in production with 148.89 MT. In the second stage, purposively selected two mandals in the district which had highest area and production of cotton. The selected two mandals in the district were Sattenapalli and Veldurthy with maximum area of cultivation and production of crop. In third stage, villages in each mandal were selected which had highest area and production of cotton. Hence, a total of 4 villages were selected for the study. The selected villages were Gudipudi, Veldurthy, Dhulipalla and Mandadhada. From each village 25 farmers were selected randomly and total sample size of farmers was 100 from four villages of

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Table 1. Awareness of farmers towards brands available in study area

S. No.	BT Cotton brands	Completely aware		Moderately aware		Aware but depends		Not aware		Total score	Mean score	Rank
		NR	Score	NR	Score	NR	Score	NR	Score			
1	Khiladi	22	88	52	156	25	50	1	1	295	2.95	1
2	Kaveri jaadoo	39	156	21	63	20	40	20	20	279	2.79	2
3	NCS-456 Puja BG-II	23	92	34	102	35	70	8	8	272	2.72	3
4	Akira BG II	15	60	28	84	47	94	10	10	248	2.48	4
5	Lotus	10	40	39	117	35	70	16	16	243	2.43	5
6	ATM	13	52	31	93	40	80	16	16	241	2.41	6
7	Kaveri money market	16	64	27	81	37	74	20	20	239	2.39	7
8	Bhakti	16	64	27	81	33	66	24	24	235	2.35	8
9	King	20	80	19	57	36	72	25	25	234	2.34	9
10	Ujwal	14	56	25	75	41	82	20	20	233	2.33	10

selected two mandals.

RESULTS AND DISCUSSION

The study revealed about demographic segmentation of sample farmers, most of farmers were between 30-29 years age group members were about 71 per cent, and 49 per cent educated up to tenth class, most of the sample farmers 85 per cent *i.e.* with 3 members family size, the average land holding of sample farmers is 5 acres, 94 per cent of farmers occupation is only farming, 81 per cent of farmers with 6-10 years farming experience, the annual income of 81 per cent of the farmers is fifty thousand to one lakh.

It was found that 85 per cent of respondent farmers belongs to small family size, 15 per cent of the respondent farmers belonged to medium family size and none of the respondents have large family size.

Thus, the majority of the respondents had up to 3 members in the family as there are more proportion of small families in the present society which are much aware of leading seed brands and making individual purchasing decision.

Majority of the respondent farmers were medium farmers (up to 5 acres) with 48.00 per cent and 36.0 per cent of respondent farmers were holding above 5 acres, were as only 16 per cent of farmers holding up to 2.5 acres land in study area.

81 per cent of respondent farmers were having 6-10 years of farming experience, followed by 8 per cent of farmers having 1-5 years of farming experience, 6 per cent of farmers were having above 15 years experience.

The major occupation of respondents is only farming *i.e.* 94 per cent of the total respondents in the study area and 4 per cent of them involved in business enterprises apart from farming.

Awareness of farmers on usage of Bt cotton brands

Based on the brand name and their yields, past experiences of farmers, ten brands were based on the brand name and their yields, past experiences of farmers, ten brands were selected randomly in the study area in order to calculate the level of awareness towards Bt cotton brands. For the analysis, a four point scale (1, 2, 3, 4) were taken as scores which indicates completely aware, moderately aware, aware but depends, unaware respectively. Calculation of mean scores was done and ranking was given accordingly in descending order. From the Table 1, it was concluded that the level of awareness was high for Khiladi brand with a mean score of 2.95 followed by Kaveri jaadoo and NCS-456 Puja BG-II with mean score 2.79 and 2.72 respectively.

Test for significance between Age group and level of awareness towards Bt cotton brands by sample farmers.

Cumulative scores for the level of awareness were calculated to which three quartile points were taken and grouped as low, medium, and high levels of awareness. A Chi-square test was done to analyze the relationship between the age of sample farmers and their level of awareness towards Bt cotton seeds *viz.,* low, medium, and high. Null Hypothesis (H_0): The level of awareness was independent of the age of sample farmers. Alternative Hypothesis (H_1): The level of awareness was dependent of the age of sample farmers.From the chi-square test the "p" value was 0.87 which was more than 0.05. This concludes that null hypothesis is accepted i.e. level of awareness towards Bt cotton brands was independent on the age of farmers.

Test for the significance between Education and level of awareness towards Bt cotton brands by sample farmers

Cumulative scores for level of awareness particulars were calculated to which three quartile points were taken and grouped as low, medium, and high levels of awareness. A Chi-square test was done to analyze the relationship between the education of sample farmers and their level of awareness towards Bt cotton brands viz., low, medium, and high Null Hypothesis (H_0): The level of awareness was independent of the education of sample farmers. Alternative Hypothesis (H_1): The level of awareness was dependent of the education of sample farmers. From the chi-square test the "p" value was 0.009 which was less than 0.05 .This concludes that null hypothesis is rejected i.e. level of awareness towards Bt cotton brands was dependent on the education of sample farmers

Test for the significance between land holding size and level of awareness towards Bt cotton brands by sample farmers

Cumulative scores for level of awareness particulars were calculated to which three quartile points were taken and grouped as low, medium, and high levels of awareness. A Chi-square test was done to analyze the relationship between the land holding size of sample

Table 2. Test for the significance between age group and level of awareness towards Bt cotton brands

Particulars		Level of awareness							
		Low		Medium		High		Total	
		Frequency	Per cent	Frequency	Per cent	Frequency	Per cent	Frequency	Per cent
Age	Less than 30 years	0	0	1	100	0	0	1	100
	30- 39 years	4	5.6	55	77.46	12	16.90	71	100
	40-49 years	7	29.16	13	54.16	4	16.66	24	100
	Above 50 years	1	25	2	50	1	25	4	100
	Total	**12**	**12**	**71**	**71**	**17**	**17**	**100**	**100**
Chi-square value = 11.04								**p-value = 0.87 (>0.05)**	

Table 3. Test for the significance between education and level of awareness towards Bt cotton brands

Particulars		Level of awareness							
		Low		Medium		High		Total	
		Frequency	Per cent	Frequency	Per cent	Frequency	Per cent	Frequency	Per cent
Education	Illiterate	2	8.3	16	66.6	6	25	24	100
	10^{th} and below 10^{th}	6	11.1	34	62.9	14	25.9	54	100
	Intermediate	3	20	12	80	0	0	15	100
	Degree and above	3	42.8	4	57.1	0	0	7	100
	Total	**14**	**14**	**66**	**66**	**20**	**20**	**100**	**100**
Chi-square value = 17.08								**p- value = 0.009(<0.05)**	

Table 4. Test for the significance between landholding size and level of awareness towards Bt cotton brands

Particulars		Level of awareness							
		Low		Medium		High		Total	
		Frequency	Per cent	Frequency	Per cent	Frequency	Per cent	Frequency	Per cent
Land holding size	Small	2	12.5	12	75	2	12.5	16	100
	Marginal	10	20.8	28	58.3	10	20.8	48	100
	Large	2	5.5	26	72.2	8	22.2	36	100
	Total	**14**	**14**	**66**	**66**	**20**	**20**	**100**	**100**
Chi-square value = 4.85								p- value = 0.30 (>0.05)	

Table 5. Test for the significance between farming experience and level of awareness towards Bt cotton brands

Particulars		Level of awareness							
		Low		Medium		High		Total	
		Frequency	Per cent	Frequency	Per cent	Frequency	Per cent	Frequency	Per cent
Farming experience	1-5 years	5	20	19	76	1	4	25	100
	6-10 years	5	10	34	68	11	22	50	100
	11-15 years	1	4.1	18	75	5	20.83	24	100
	Above 15 years	1	100	0	0	0	0	1	100
	Total	**12**	**12**	**71**	**71**	**17**	**17**	**100**	**100**
Chi-square value = 13.69								p- value =0.33 (>0.05)	

farmers and their level of awareness towards Bt cotton brands *viz.,* low, medium, and high. Null Hypothesis (H_0): The level of awareness was independent of the land holding size of sample farmers. Alternative Hypothesis (H_1): The level of awareness was dependent of the education of sample farmers. From the chi-square test the "p" value was 0.30 which was more than 0.05 (Table 4). This concludes that null hypothesis is accepted *i.e.* level of awareness towards Bt cotton brands was independent on the education of sample farmers.

Test for the significance between farming experience and level of awareness towards Bt cotton brands by sample farmers

A Chi-square test was done to analyze the relationship between the farming experience of sample farmers and their level of awareness towards Bt cotton seed brands viz., low, medium, and high. Null Hypothesis (H_0): The level of awareness was independent of the farming experience of sample farmers

Alternative Hypothesis (H_1): The level of awareness was dependent of the farming experience of sample farmers. From the chi-square test, the "p" value was 0.33 which was greater than 0.05 (Table 5). This concludes that the null hypothesis is accepted *i.e.* level of awareness towards BT cotton seed brands was independent on the farming experience of sample farmers

There is always a positive relationship between education and awareness of a product. Through Chi square analysis, it was observed that there is a strong association between education of farmers and awareness, also revealed that there is no association between age, income, land holding size with brand awareness. The result show that education play vital role in the awareness regarding the various brand performance and regarding the product characteristics.

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DISTRIBUTION OF FARMERS USING DIFFERENT BRANDS OF FERTILIZERS, TYPES AND NUTRIENT GRADES OF FERTILIZERS AND MARKETING CONSTRAINTS OF WATER-SOLUBLE FERTILIZERS IN EAST GODAVARI DISTRICT OF ANDHRA PRADESH

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ABSTRACT

The study was undertaken in one district *i.e.,* East Godavari district of Andhra Pradesh. Andhra Pradesh state was chosen as the locale of the study, as the state ranks second in consumption of water-soluble fertilizers in India. East Godavari extends over an area of 12,805 square kilometer. It is predominantly an agricultural district and it contributes over 10 per cent of food production in Andhra Pradesh. The study was conducted on the crops which were using water soluble fertilizers to know the usage pattern and its scope for marketing of water soluble fertilizers. The selected crops were Paddy, a field crop; Banana and Mango, a plantation crops; and Chilli, a commercial crop, as they have the largest area under cultivation in East Godavari districts. 4 mandals *viz.,* Ambajepeta mandal, Kunavaram mandal, Tuni mandal, Athreyapuram mandal were selected purposively for the study as they have the highest acreage of the above-mentioned crops and where farmers were using WSF and liquid fertilizers. The selected villages were Pasupalli, Nedhunuru, Kunavaram, Pochavaram, Lolla Athreyapuram, Tuni and Dondavaka villages. The study is based on both primary and secondary data. The primary data needed for the study has been collected from 120 sample population selected purposive cum simple random sampling technique from selected district, duly categorised into 80 farmers (10 farmers from each of 8 villages), 40 dealers (10 dealers each of 4 mandals*).* The secondary data pertaining to area of above-mentioned crops was obtained from the agriculture department of erstwhile East Godavari district. Most of the farmers were facing a constraint of having poor knowledge on how to prepare the solutions and cost of the water-soluble fertilizers. A few farmers also complained about insufficient water for usage as water is sufficient enough for cultivation in study area and non-availability of WSF. Factors dealers considered while recommending WSFs were based on the quality of fertilizers. Major influential factor on farmers while purchasing WSFs were sales promotional activities. Major constraint for dealers during selling of WSFs was lack of government support on subsidizing the WSFs.

KEYWORDS: WSF-Water soluble fertilizers, Market constraints, Usage pattern, farmers.

INTRODUCTION

Before green revolution first fertilizer industry was established in 1906 as a single super phosphate (SSP) manufacturing unit having 6000 MT annual capacity near Ranipet. After that The Fertilizer and Chemicals Travancore of India Ltd. (Fact) at cochin in Kerala and fertilizers corporation of India (FCI) in Sindri in Bihar (now Jharkhand) were established in forties and fifties. Green revolution took place in India in the 1960s and this increased the use of fertiliser in the country.

Fertilizer industry is highly regulated and monitored by government in India. The cost of production of fertilizer is higher than the price of the fertilizer. The gap between the cost of production and the price at which it is sold is reimbursed by government in the form of subsidies. Under Nutrient Based Subsidy (NBS), the subsidy given to the companies is fixed annually on the basis of its nutrients content (*i.e.,* Nitrogen, Phosphate, Potash and Sulphur) on per kg basis which is converted into subsidy per tonne depending upon the nutrient content in each grade of the fertilizers. These rates are determined taking into account the international and domestic prices of P and K fertilizers, exchange rate, inventory level in the country. During 2020-21 FY, the central subsidy on urea is 94,947 Crores and 38,917 Crores for Nutrient based subsidies. Therefore, the total subsidies on all fertilizers given by central government are 1,33,947 Crores. (Source: The Fertilizer Association of India). Under nutrient based subsidy scheme 22 grades of decontrolled fertilizers namely DAP, MAP, TSP, DAP Lite, MOP, SSP, Ammonium Sulphate etc. and 15 grades of complex fertilizers are present. Additional subsidy is also provided on the fertilizers that are fortified with secondary and micro nutrients such as Boron (B) and Molybdenum (Mo) as per the FCO.

WSF are fertilizers that can easily dissolve in water and nutrient uptake efficiency is high in water soluble fertilizers as compared to traditional fertilizers. So, with WSF it is very easy to make nutrients easily available

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for plants and we can give controlled amount of nutrient precisely to crops in a given time period. Again, WSF are of two types -1.) Dry water-soluble fertilizers and 2.) Liquid fertilizers. Dry water-soluble fertilizers occupy major part of market share in WSF. WSF has a market value of USD 6.8 billion in 2019and is expected to increase at a CAGR of 7.3 per cent from 2020 to 2026.

Liquid water-soluble fertilizers are easy to apply as they are applied in liquid state or through foliar applications. They can easily blend with plant protection chemical and we can use them in mid -season of the crop. But water insoluble fertilizers are less costly than dry water soluble and liquid fertilizers. In India WSF are mainly used in horticulture crops and now a days we can see penetration of water-soluble fertilizers usage into few cash crops like Cotton. And they are majorly used in ornamental nursery plants.

MATERIAL AND METHODS

The Andhra Pradesh state was chosen as the locale of the study, as the state ranks second in consumption of water-soluble fertilizers in India. Second stage of sampling pertains to the selection of district in Andhra Pradesh. East Godavari district is selected from Andhra Pradesh East Godavari is predominantly an agricultural district.

First crop that is considered is paddy as it is the major agriculture crop that is cultivated in East Godavari district. Then from horticulture segment, plantation segment and commercial crop segment banana, mango and chilly crops are considered respectively as they have the largest area under cultivation in East Godavari districts. Ambajepeta mandal is selected randomly for paddy crop farmers as researcher hails from same mandal. Kunavaram mandal is selected for chilly farmers as it is 4th largest gross cropped area with 115 hectares (2021-22) and stands first place in drip irrigation. Tuni mandal is selected for mango farmers as it stands first place in gross cropped area with 2101 hectares (2021-22). Athreyapuram mandal is selected for Banana farmers as it stands first place in Gross cropped area with 1556 hectares (2021-22). Villages are selected randomly from each mandal. Pasupalle and Mukkamala are selected from Ambajepeta mandal. Kunavaram village and Pochavaram village are selected from Kunavram Mandal. Lolla and Athreyapuram village are selected from Athreyapuram mandal. Tuni and Dondavaka villages are selected from Tuni mandal. 10 Farmers from each village are selected randomly. 20 from each mandal, totally 80 farmers data is collected from 4 mandals, 10 dealers are selected randomly from the respective mandal. (40 dealers from 4 mandals). Thus, making a sample size of 40.

Objectives

A) Distribution of Brand of fertilizer and Type of fertilizers and Nutrient grades that are used by farmers in the given study area

B) To study marketing constraints of WSF

RESULTS AND DISCUSSION

A) Distribution of Brand of fertilizer and Type of fertilizers and Nutrient grades that are used by farmers in the given study area

Brand of the fertilizer

The data regarding the brand of the fertilizer of sample farmers in farming were collected and divided into 5 groups *viz*., Nagarjuna fertilizers, IFFCO, Gromor, Coromandel, Multiplex.

As shown in the above Table 1, 12 per cent of farmers were using IFFCO fertilizers which are particularly liquid urea bottles, 32.5 per cent of farmers were using Nagarjuna fertilizers, Gromor and coromandel fertilizers were used by 13.75 per cent farmers each, 15 per cent of farmers were using multiplex fertilizer. Here most of the farmers are using Nagarjuna fertilizers with 32.5 per cent. And least number of farmers are multiplex with using percentage of 15 per cent.

Type of fertilizer

The data regarding the type of fertilizer of sample farmers in farming were collected and divided into 2 groups *viz*., Liquid fertilizers and granular type of fertilizers.

Table 1. Brand of fertilizer

Brand of the fertilizer	Frequency	Percentage
IFFCO	20	25.00
Nagarjuna	26	32.50
Gromor	11	13.75
Coromandel	11	13.75
Multiplex	12	15.00
Total	**80**	**100.00**

As shown in the above Table 2, 25 per cent of farmers are using liquid fertilizer and 75 per cent of farmers are using granular fertilizers. Here in the sample most number of fertilizers are using granular fertilizers.

Nutrient grades used by farmers

The data regarding the nutrient grade of sample

Table 2. Type of fertilizer

Method of Irrigation	Frequency	Percentage
Liquid water-soluble fertilizers	20	25%
Dry water-soluble fertilizers	60	**75%**
Total	80	100

Table 3. Nutrient grades used by farmers

	Paddy	Chili	Banana	Mango
Liquid Urea				
19-19-19				
20-20-20				
13-0-45				
13-0-46				

farmers in farming were collected and divided into 5 types. There are 5 different types of fertilizers used by sample farmers they are Liquid urea, 19-19-19, 20-20-20, 13-0-45,13-0-46. Only paddy farmers are using liquid urea bottles. 19-19-19 nutrient grade is used by chilly and banana farmers. 20-20-20 fertilizer is used by chilly and banana. 13-0-45 is used by Banana farmers, 13-0-46 is used by mango farmers.

B) To study marketing constraints of WSF

To study the marketing constraints faced by dealers while selling WSF

Few particulars that are considered to determine the marketing constraints faced by dealers while selling WSF are lack of promotional activities, availability of WSF, No support from the government, Subsidy on regular fertilizers, poor acceptance, Farmers affordability, Economical unviability.

Information was collected from sample and for the analysis three-point scale was taken. 3,2,1 are the scores and they are taken against agree, dis agree, don't know, respectively.

The details of the constraints faced by dealers while marketing WSF are collected from a sample of 40 dealers and analysed the collected data by using Likert scale technique and the results are provided in the below Table 4.

From Table 4 it is analysed that the major constraint faced by the dealers was no support from the Govt. and subsidy on regular fertilizers with the highest mean scores of 1.85 and 1.8 respectively. And least constraints faced by the dealers are famers affordability and economical unviability of WSF with the least mean scores of 2.275 and 1.5 respectively. The major constraint for marketing WSF is poor support from government regarding WSF and subsidy on regular fertilizers. The minor constraint regarding marketing is economical in viability to farmers.

Table 4. To study the marketing constraints faced by dealers while selling WSF

S. No.	Constraints	Major constraint		Minor constraint		Not a constraint		Total score	Mean score	Rank
		NR	S	NR	S	NR	S			
1	Poor support from government on WSF	10	30	14	28	16	16	174	1.85	1
2	Subsidy on regular fertilizers	4	12	24	48	12	12	72	1.8	2
3	Lack of promotions on WSF	12	36	7	14	21	21	71	1.775	3
4	Poor acceptance of WSF	28	84	9	18	3	3	105	2.625	4
5	Availability of WSF	24	72	13	26	3	3	101	2.525	5
6	Farmers can't afford WSF	19	57	13	26	8	8	91	2.275	6
7	WSF are economically unviable to farmers	3	9	14	28	23	23	60	1.5	7

Most of the farmers are using Nagarjuna fertilizers with 32.5 per cent. And least number of farmers are multiplex with using percentage of 15 per cent. Only 25 per cent of farmers are using liquid fertilizer and 75 per cent of farmers are using granular fertilizers.

The major constraint faced by the dealers in marketing of water soluble fertilizers is no support from the Govt. and subsidy on regular fertilizers with the highest mean scores of 1.85 and 1.8 respectively. And least constraints faced by the dealers are famers affordability and economical unviability of WSF with the least mean scores of 2.275 and 1.5 respectively.

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UNDERSTANDING AND ASSESSING THE CURRENT BUSINESS OPERATIONS PERFORMED BY IDENTIFIED FARMER PRODUCER ORGANISATION IN GUNTUR DISTRICT OF ANDHRA PRADESH

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ABSTRACT

The paper entitled "Understanding and assessing the current business operations performed by identified FPOs in Guntur district of Andhra Pradesh" was undertaken to investigate the current business operations performed by FPOs, the operations offered by FPOs have been categorized into pre harvest (production centric services), post-harvest, marketing operations. Perception of Board of Directors and satisfaction levels of member farmers were analysed to assess current business operations. Andhra Pradesh state of Southern India was purposively selected for the study as the researcher hails from the same state. Guntur, being agriculturally vibrant was an important district of Andhra Pradesh, due to diversified farming well established FPOs were operating in this area. Five FPOs were identified randomly from 5 mandals of Guntur district. According to the analysed data, the FPOs were extending their operations in production, post-harvest, marketing, forward linkage facilitation, backward linkage facilitation, capacity building and training to member farmers. It was found that the major production centric service offered by selected FPOs was crop advisory services, and post-harvest service offered by selected three FPOs was grading and sorting. While major marketing service offered by all the five selected FPOs were aggregation of produce and access to new markets. The major forward linkage facilitated was for access to market information and backward linkage facilitated was for input supplies. While major trainings on crop management techniques offered were soil health and crop management.

KEYWORDS: FPOs, Current business operations, Forward linkage facilitation, Backward linkage facilitation, Capacity building.

INTRODUCTION

India was at the forefront of agricultural growth worldwide, it was the backbone of the economy, where it contribution was about 18 per cent to GDP and nearly 58 per cent of Indian population depends on agriculture in which 70 per cent of rural population was directly dependent on agriculture as a primary source of income. It was dominated by small and marginal farmers by over 86 per cent. To provide strength and efficiency to the marketing system, alternatives were necessary for enhancing their income levels. One of the potential alternatives was grouping the farmers for collective action. To facilitate this process initially, there were three implementing agencies whose function was formation and promotion of FPOs, namely Small Farmers Agri-business Consortium (SFAC), National Cooperative Development Corporation (NCDC), National Bank for Agriculture and Rural Development (NABARD). The State and Central governments along with other agencies works on formation and promotion of active FPOs with the help of financial institutes and resources from various state sponsored and central funded schemes. The NABARD, SFAC, other Government agencies provides financial support to Producer Organisation Promoting Institution (POPI) to enhance the performance of PO.

MATERIAL AND METHODS

Parimala Flower Producer Company (PFPC), Sehamitha Agri Producer Company Limited (SAPCL), Sahajamitra Farmer Producer Company Limited (SFPCL), Spoorthi Chilli Producer Company Ltd (SCPCL), Prathipadu Farmer Producer Company Limited (PFPCL) were the five FPOs selected for the study. Purposive cum simple random sampling design was employed to investigate the variables in the study. Fifteen member farmers from each of the FPOs were randomly selected and interviewed. Thus, making sample size of 75 member farmers. While 5 Board of directors were selected purposively based on their activeness, making a total of 25 BODs from identified 5 FPOs. Thus, a total of 100 respondents were selected for the study.

RESULTS AND DISCUSSION

Particulars of different operations extended by selected FPOs

The Farmer Producer Organizations in the study area performs operations related to Pre- harvest(production), post-harvest, marketing, backward and forward linkages

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facilitation, technical support, capacity building to the farmers as mentioned below.

Activity	Major	Minor	Not offered

From Table 1, the analysed data of production centric operations by identified five FPOs commonly include crop advisory solutions as major activity.

From Table 2, the analysed data of post-harvest operations by selected five FPOs include Grading and sorting of harvested produce as major activity of SCPCL, PFPC, SAPCL. The remaining FPOs offers grading and sorting as a minor activity.

From Table 3, the marketing services by identified five (5) FPOs commonly include aggregation of produce from farmer members and providing access to new markets. All the rest of marketing services such as branding, retailing were being considered either as major or minor activities by each FPO.

From Table 4, the backward linkages services by selected five FPOs commonly include facilitation with input suppliers, majority these FPOs has input supply

Table 1. Production centric services offered by identified FPOs

S. No.	Input services	SMFPCL	PFPCL	SCPCL	PFPC	SAPCL
1.	Crop advisory					
2.	Seeds/ Planting materials					
3.	Fertilizers sales					
4.	Pesticides sales					
5.	Farm machinery					
6.	Inputs for allied activities					

Table 2. Post harvest services offered by identified FPOs

S. No.	Input services	SMFPCL	PFPCL	SCPCL	PFPC	SAPCL
1.	Grading & sorting					
2.	Value addition					
3.	Warehousing services					

Table 3. Marketing services offered by identified FPOs

S. No.	Marketing services	SMFPCL	PFPCL	SCPCL	PFPC	SAPCL
1.	Aggregation of produce					
2.	Access to new markets					
3.	Branding					
4	Retailing					

Table 4. Backward linkages services offered by identified FPOs

S. No.	Backward linkages (facilitation)	SMFPCL	PFPCL	SCPCL	PFPC	SAPCL
1.	With Input suppliers					
2.	For Technology Transfer					
3.	For issue of production Credit					
4	With CHC					

Table 5. Forward linkages services offered by identified FPOs

S. No	Forward linkages (Facilitation)	SMFPCL	PFPCL	SCPCL	PFPC	SAPCL
1	For access to market information (price)					
2	For procurement services					
3	Access to processing facilities					
4	For transportation					
5	For storage (warehouses)					
6	For value chain financing					
7	For issue of market credit					
8	Other					

Table 6. Capacity building services offered by identified FPOs

S. No.	Training on crop management techniques	SMFPCL	PFPCL	SCPCL	PFPCL	SAPCL
1	Soil health management					
2	Crop management					
3	Pest management					
4	Organic farming					
5	Govt. schemes					
6	Value addition					
7	Latest technology					
8	Other income generating activities					

dealings with Coramandel International company for supply of seeds and fertilisers as a major business activity.

From Table 5, the forward linkages facilitation services offered by selected five FPOs include access to Market information (price) as a major activity by SCPCL, PFPC, SAPCL.

From Table 6, the training and capacity building activities by selected five (5) FPOs commonly include soil health, crop, pest management, organic farming, Govt. schemes, value addition

Objectives, Reasons considered by Board members while identifying current business operations

It was important to understand the BODs and CEO's criteria regarding the objectives, reasons considered while identifying current business operations.

From Table 7, we can interpret that the major objective considered by BODs and CEO of an FPO while identifying a business operation was to address the major marketing problems of member farmers with a highest mean score of 72.8 followed by the business activities those have higher impact on member farmers, which fits with available resources and builds trust among the members.

From Table 8, we can interpret that the major reasons considered for implementing a business operation were suggestion of a business opportunity by promoting agency which has obtained a highest mean score of 82.0 followed by the suggestion of BODs, member farmers, CEOs all these reasons were the primary considerations to choose the current business operations by an FPO.

Satisfaction levels of farmers towards current operations offered by Farmer Producer Operations in the study area.

The current business operations of the selected FPOs were being classified as input/pre-harvest services, post-harvest services, marketing services and the sample respondent's satisfaction levels towards these activities were recorded. This five -point scale indicated the satisfaction level of member farmers by classifying them into extremely satisfied (ES), satisfied (S), partially satisfied (PS), dissatisfied (DS), service not offered (NO)

From Table 9, the satisfaction levels of member farmers towards production centric services infers that member farmers were dissatisfied towards farm machinery and partially satisfied towards sale of pesticides and fertilisers, production credit and inputs for allied activities.

From Table 10, the satisfaction levels of member farmers towards post harvest services infers that member farmers were dissatisfied towards grading and sorting, value addition services and partially satisfied towards warehousing services.

Table 7. Objectives considered by BODs while identifying current business operations

S. No.	Objectives considered	Garrette score	Rank
1	To address major marketing problems of member farmers	72.8	I
2	Business operations with highest impact on member farmers	63.8	II
3	Any business that fits to available Resource	59.6	III
4	Business that builds trust among the member farmers	56.4	IV
5	Focus on business that have financial support (subsidy) for promoting agencies	55.2	V
6	To address major production problems of member farmers	54.2	VI
7	To identify most Profitable business	48.6	VII
8	Business that creates value for farming community and society	40.2	VIII

Table 8. Reasons considered by BODs while identifying current business operations

S. No.	Reason considered	Garrette Score	Rank
1	Suggested by promoting agency	82.0	I
2	Identified by BOD	63.6	II
3	Suggested by FPO members	62.4	III
4	Suggested by CEO	56.6	IV
5	Suggested by technical staff	55.2	V
6	Experience of other FPOs doing the same business	45.0	VI
7	Other	42.0	VII
8	Recommended by consultants hired for the purpose	37.2	VIII
9	Suggested by Govt. Departments	37.0	IX

Table 9. Satisfaction levels of farmers towards production centric operations

S. No	Input services	(NO)	(DS)	(PS)	(S)	(ES)	Mean score	Rank	Status
		1	2	3	4	5			
i	Need-based training	0 (0.00)	0 (0.00)	8 (0.32)	33 (1.76)	34 (2.26)	4.35	I	ES
ii	Crop advisory services	0 (0.00)	0 (0.00)	17 (0.68)	27 (1.44)	31 (2.06)	4.19	II	ES
iii	Seeds sales	0 (0.00)	3 (0.08)	18 (0.72)	32 (1.70)	22 (1.46)	3.97	III	S
iv	Fertilizers sales	30 (0.40)	0 (0.00)	10 (0.40)	11 (0.58)	24 (1.60)	2.99	IV	PS
v	Pesticides sales	30 (0.40)	0 (0.00)	9 (0.36)	14 (0.74)	22 (1.46)	2.97	V	PS
vi	Production credit	30 (0.40)	2 (0.53)	13 (0.52)	19 (1.01)	11 (0.73)	2.72	VI	PS
vii	Inputs for allied activities	16 (0.21)	15 (0.40)	23 (0.92)	17 (0.90)	4 (0.26)	2.71	VII	PS
viii	Farm machinery	32 (0.42)	3 (0.08)	20 (0.80)	16 (0.85)	4 (0.26)	2.43	VIII	DS
ix	Technology Transfer	45 (0.60)	10 (0.26)	13 (0.52)	7 (0.37)	0 (0.00)	1.76	IX	NO
x	CHC services	60 (0.80)	9 (0.24)	5 (0.20)	1 (0.05)	0 (0.00)	1.29	X	NO

Table 10. Satisfaction levels of farmers towards post harvest operations

S. No.	Post- harvest services	(NO)	(DS)	(PS)	(S)	(ES)	Mean score	Rank	Status
		1	2	3	4	5			
i	Warehousing services	30 (0.4)	0 (0.00)	15 (0.6)	18 (0.96)	12 (0.8)	2.76	I	PS
ii	Grading &sorting service	30 (0.4)	0 (0.00)	20 (0.8)	15 (0.8)	10 (0.66)	2.67	II	DS
iii	Value addition services	45 (0.6)	0 (0.00)	17 (0.68)	7 (0.37)	6 (0.40)	2.05	III	DS

Table 11. Satisfaction levels of farmers towards marketing operations

S. No.	Marketing Services	(NO)	(DS)	(PS)	(S)	(ES)	Mean score	Rank	Status
		1	2	3	4	5			
i	Access to Market information	0 (0.00)	0 (0.00)	6 (0.24)	25 (1.33)	44 (2.93)	4.51	I	ES
ii	Aggregation & procurement	0 (0.00)	0 (0.00)	18 (0.72)	31 (1.65)	26 (1.73)	4.11	II	S
iii	Access to new markets	0 (0.00)	3 (0.08)	22 (0.88)	27 (1.44)	23 (1.53)	3.93	III	S
iv	Branding/ Retailing	15 (0.2)	0 (0.00)	22 (0.88)	26 (1.38)	12 (0.8)	3.27	VI	PS
v	Transportation	30 (0.4)	0 (0.00)	14 (0.56)	21 (1.12)	10 (0.66)	2.75	V	PS
vi	Value chain Financing	30 (0.4)	11 (0.29)	17 (0.68)	14 (0.74)	3 (0.2)	2.32	IV	DS

From Table 11, the satisfaction levels of member farmers towards marketing services infers that member farmers were dissatisfied towards value chain financing and partially satisfied towards branding/ retailing, transportation services.

The major production centric services offered by selected FPOs was crop advisory services, and post-harvest service offered by selected three FPOs was grading and sorting. While major marketing service offered by all the five selected FPOs were aggregation of produce and access to new markets. The major forward linkage facilitated was for access to market information and backward linkage facilitated was for input supplies. While major trainings on crop management techniques offered were soil health and crop management.

The major objective considered while identifying current business operations were addressing the major marketing problems of member farmers, business activities those have higher impact on member farmers, which fits with available resources and builds trust among the members were major objectives of BODs in considering current operations. According to the analysed data majority of the identified business operations were suggested by promoting agency. The BODs, member farmers, CEO also participates in identifying business operations for FPOs.

By analysing the satisfaction levels of member farmers towards current business operations performed

by FPOs, it was clear that member farmers were highly satisfied with training programmes conducted by FPOs under input services and it infers that member farmers were dissatisfied towards farm machinery and partially satisfied towards sale of pesticides and fertilisers, production credit and inputs for allied activities. The member farmers were moderately satisfied with post-harvest operations provided by FPOs, it infers that member farmers were dissatisfied towards grading and sorting, value addition services and partially satisfied towards warehousing services. Member farmers were extremely satisfied with timely market information provided by FPOs as a part of marketing service, it infers that member farmers were dissatisfied towards value chain financing and partially satisfied towards branding/ retailing, transportation services.

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EVALUATION OF DIFFERENT METHODS OF ARTIFICIAL INOCULATION OF *Rhizoctonia solani* OF RICE

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ABSTRACT

Diseased samples of sheath blight was collected from the fields of RARS, Nandyal and isolation of pathogen was done by following different methods. Evaluation of different methods of artificial inoculation of *R. solani* was carried out**.** The efficiency of *R. solani* infection was tested on susceptible cultivar, NLR-34449 using four different methods (agar block, liquid cultured mycelia ball, mycelia suspension and typha bit method). Observations were taken 10 days after inoculation by measuring the relative lesion height (RLH), where RLH in each tiller was calculated. Typha bit inoculation method of *R. solani* longer lesions than other methods, liquid cultured mycelia balls, including agar block and mycelia suspension. Inoculation by Typha bit method was found to be more efficient for artificial inoculation of *R. solani*. The pathogen was re-isolated and maintained in PDA slants for further studies.

KEYWORDS: Isolation, Inoculation, Pathogenicity, Koch postulates.

INTRODUCTION

Rice (*Oryza sativa*) is the most important food crop in the world, feeding more people than any other crop. It is the staple food across Asia and is becoming increasingly important in Africa and Latin America. In India, rice is cultivated in an area of 44.5 M ha and 117.94 Mt of production with 2650 Kg ha^{-1}(Govt. of India, Ministry of Agriculture, Department of Agriculture and Cooperation, Directorate of Economics & Statistics, 2020).

Low productivity of rice is due to several biotic and abiotic factors. It is very important to protect the crop from biotic factors. Rice is attacked by a number of fungal, bacterial and viral diseases. Among the fungal diseases of rice, rice sheath blight is regarded as an internationally important disease along with rice blast. Sheath blight is a soilborne disease caused by the fungus *Rhizoctonia solani* Kuhn AG1-IA (Anastamosis Group -IA). Pathogen survives in the soil as hard, weather resistant structure known as sclerotia which survive in the soil for more extended periods and tend to accumulate in the soil. This disease causes both qualitative and quantitative losses and yield losses usually range from 4-50 per cent depending on the crop stage at which the disease appears, extent of severity and the environmental condition. (Singh *et al*., 2004; Bhunkal *et al*., 2015).

Many different inoculum sources have been used for studying rice sheath blight like tooth picks colonized with *R. solani* (Rodrigues *et al*., 2003), colonized agar plugs (Eizenga *et al.,* 2002), infected rice grain–rice hull mixtures (Kim and Rush, 1986), blended mycelia (Sato *et al*., 2004), and sclerotia (Singh *et al*., 2001). Most of these inoculum sources introduce considerable variability into the infection process. Sclerotia, for example, vary widely with respect to their germination rate before infection based on their age and size (Singh *et al.,* 2001). Each of these inoculum sources was used with its own inoculation method, under controlled conditions. As effective inoculation method is a critical component of an accurate disease assay for quantifying levels of sheath blight resistance among rice cultivars.

This study was undertaken to evaluate an effective, uniform, and reproducible technique for infecting rice plants with *R. solani.*

MATERIAL AND METHODS

Collection of Diseased samples

Diseased samples of sheath blight of rice were collected from Regional Agricultural Research Station (RARS), Nandyal. The samples were collected in brown paper bags and labelled with the information of date, place and name of the sample collected. The samples were bought to the laboratory for isolation of pathogen, *Rhizoctonia solani.*

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Isolation of *Rhizoctonia solani*

Rhizoctonia solani causing sheath blight of rice was isolated from the rice plants showing typical sheath blight symptoms by tissue segment method (Rangaswami and Mahadevan, 1999).

Leaf sheath showing typical symptoms was washed in tap water for few minutes and leaf bits of 3-8 mm size were surface sterilized with 1% sodium hypochlorite for one minute and then rinsed thrice with sterile distilled water to remove the traces of sodium hypochlorite. The surface sterilized leaf bits were dried on two folds of sterilized filter blotting papers to remove excess moisture under aseptic conditions and were transferred aseptically to petri plates containing PDA and incubated at 28 ± 1°C. When the growth of fungus from leaf bits was seen on PDA surface, the hyphal bits from the periphery of culture growing in the petri plates was transferred to PDA in culture tubes. The culture thus purified by hyphal tip method and the culture was maintained in PDA slants.

Isolation of *Rhizoctonia solani* from sclerotial bodies

Rhizoctonia solani was also isolated from sclerotial bodies by placing sterile sclerotial bodies sterilized with 70% and washed thrice with sterile distilled water on a petri plate containing sterilized PDA medium. Plates were incubated at 28 ± 1°C and observed periodically for growth of the fungus. The culture was purified by single hyphal tip method and maintained on PDA by periodical transfer throughout the present investigation.

Identification of *Rhizoctonia solani*

R. solani was identified based on its mycelial and sclerotial characters described by Lee and Rush (1983).

Evaluation of different artificial inoculation methods

One of the sheath blight susceptible varieties of rice, NLR-34449 (Nellore Mahsuri) was used in this study. To compare the effects of different artificial inoculation methods on the severity of sheath blight, four inoculation methods were used *viz.,* (i) agar block (diameter 0.5 cm), (ii) liquid cultured mycelia ball (diameter 0.5 cm), (iii) 100-µl mycelial suspension (10^5 CFU/ml) and typha bit method (4-5 bits per hill).

Agar block method

After placing *R. solani* mycelia or sclerotia onto potato dextrose agar (PDA) and grown at room temperature (22 to 24°C) under continuous light, agar blocks (0.5-cm squares) were cut and prepared from the outer edge of a 3-day-old culture.

Liquid cultured mycelia ball

Liquid cultures were obtained by inoculating 200 ml of potato dextrose broth. Rice plants at late tillering stage were inoculated with *R. solani* by placing a mycelial ball beneath the leaf sheath. The inoculated sheath was covered immediately with aluminum foil. When typical lesions appeared after 3 days, the aluminum foil was removed. *R. solani* infected plants were left in a humidity chamber made of clear plastic for 3 weeks to allow for disease development. Plants were grown at 28°C under 14-h days in both the greenhouse and the humidity chamber.

Mycelial suspension

Inoculations using the agar block (3-day cultures) and mycelial suspensions were the same as described for the mycelia ball. For the mycelial suspension, 100 µl of homogenized mycelium was applied for each inoculation using a pipette. *R. solani* isolate was inoculated at the maximum tillering stage. Seven days after inoculation, the lesion length on the sheath of the inoculated plants was measured. Three replications were used for each inoculation method in the study. The results were verified by repeating the experiment two times. The pathogen was re-isolated from artificially inoculated plants. Culture which was found similar to the original culture were maintained to carry out further studies.

Typha bit method

The culture of *R. solani* was grown for 10 days on autoclaved typha stem cutting (*T. angustata*; an aquatic weed) soaked with a solution containing 2% sucrose and 1% peptone. *R. solani* isolate was inoculated at the maximum tillering stage by placing 4-5 typha stem cuttings colonized with pathogen inside each hill The humidity was maintained between 80 and 100% in humidity chambers from the time of inoculation to disease evaluation.

Disease evaluation

To evaluate efficacy of artificial inoculation method, the lesion length and in each sheath of inoculated plants were recorded. The total lesion length was the sum of the lesion length of leaves in a culm. Severity of symptoms was observed by recording relative lesion height (RLH) following Vidhyasekaran *et al*. (1997) where RLH in

each tiller was calculated as

$$\text{Relative lesion height \%} = \frac{\text{Highest point a lesion is seen (cm)}}{\text{Plant height (cm)}} \times 100$$

RESULTS AND DISCUSSION

Collection of sheath blight infected rice plants.

The disease was characterized by large spots with irregular margins formed in bands resembling rattlesnake skin pattern. Symptoms were seen on leaf sheaths spreading from base, extending upto boot leaf sheath and also up to panicles in severe cases. Sclerotial bodies were formed on the infected portions of rice plant which were white and brown in colour indicating early and maturity stages of scleotial bodies.

Isolation of *Rhizoctonia solani*

Rhizoctonia solani was isolated from infected samples by tissue segment method (Rangaswami and Mahadevan, 1999).

Identification of *R. solani*

Cultural and morphological characters are important factors for identification of fungi. The cultural characteristics were recorded from the fully grown cultures in Petri plates. The culture obtained on PDA at 28±1°C was occupying the entire Petriplate in 3-4 days of incubation. The pathogen isolate produced irregular type of sclerotial bodies on PDA. While morphological characters were recorded by adapting slide culture technique under microscope. Microscopic examination of the fungal cultures revealed broad brown coloured hyphae branching at right angles. The culture of *R. solani* produced white mycelia characters. The size of scleotial bodies

Based on the morphological and colony characteristics described by Lee and Rush (1983) the causal organism was identified as *R. solani*.

Evaluation of different artificial inoculation methods

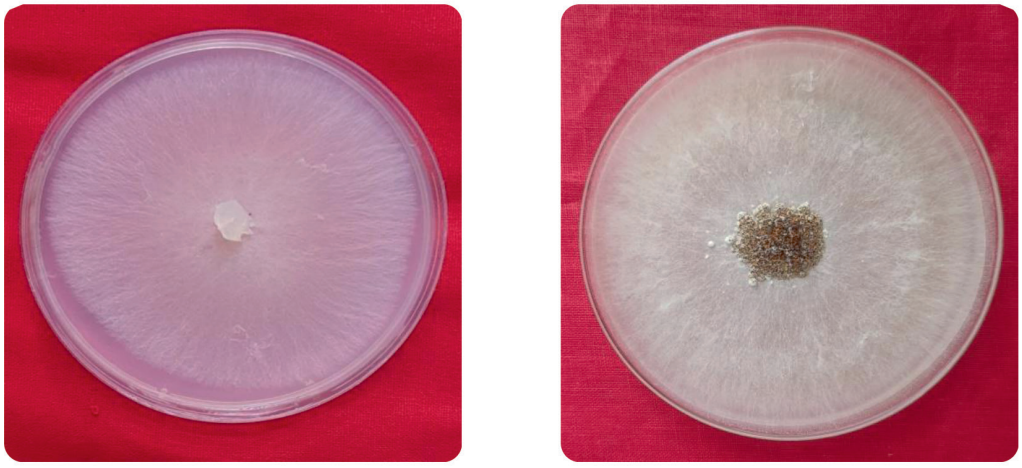
Typha bit inoculation method produced the longest lesions on rice sheaths 7 days after inoculation. These results were significant and consistent across all replications tested ($P < 0.001$). Typha bits are hallow and have large surface area which helps in the penetration of *R. solani* into it and thus provide greater fungal biomass than the other inoculation methods. Mycelial suspensions were the least efficient inoculation method, possibly because the mycelium has been broken apart, preventing the allocation of nutrients through the mycelial network to the point of infection. Also, the mycelial suspensions were liquid and their retention at the site of inoculation varies depending on the architecture of the cultivar inoculated. The colonized agar block contained organized mycelia only on the top surface and does not have the same fungal biomass of the mycelial balls. Also, the nutrients provided by the agar block may have encouraged saprophytic growth in the fungus rather than the development of an infection cushion needed for disease development. Rapid and uniform infection reduces the variation in the disease assays. In this study, infection rate was high with typha bit method. The isolate produced typical sheath blight symptoms on the susceptible variety NLR, 34449 that was characterized by large spots with irregular margins formed in bands resembling rattlesnake skin pattern. The

Table 1. Comparison of four methods for rating the disease severity was made to determine which method produced the most accurate disease severity data among

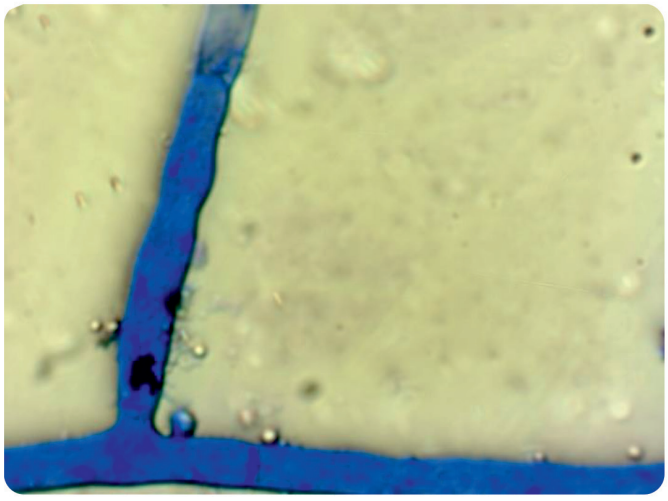
S. No.	Inoculation method	Relative lesion height %
1	Agar block	31.326[c] (34.64)
2	liquid cultured mycelia ball	37.618[b] (38.23)
3	Mycelial suspension	24.316[d] (31.07)
4	Typha bit method	47.978[a] (42.20)
	C.D.	2.432
	SE(m)	0.734
	SE(d)	1.039
	C.V.	3.603

*Figures in the parentheses indicate arc sign transformed values; Figures in a column with same letter indicate that they are not significantly different.

Sheath blight symptoms in the field

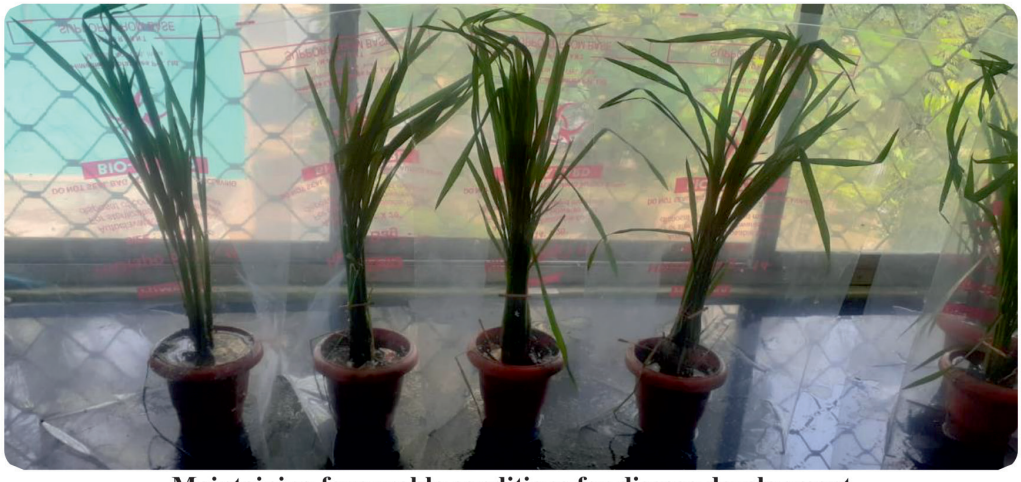


Isolation of *Rhizoctonia solani* on PDA media

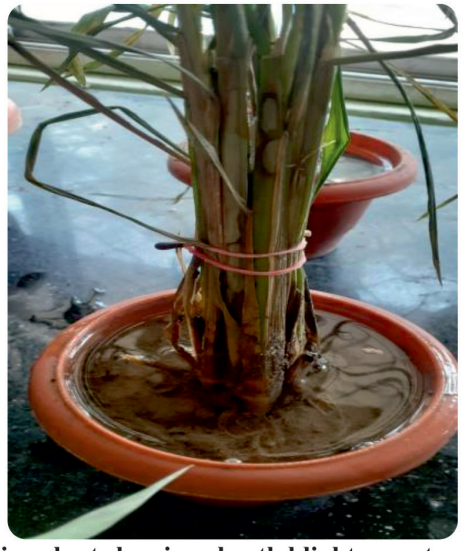


Branching of hypha at right angle

Mass multiplication of the pathogen, *R. solani* on Typha stem bits



Maintaining favourable conditions for disease development



Rice plant showing sheath blight symptoms

Control

Artificial inoculation of *R. solani* by typha bit inoculation method

pathogen was re-isolated from the diseased sample and it culture was similar to originally inoculated pathogen.

Artificial inoculation of *R. solani* by typha bit method was found more effective to develop an effective, uniform, and reproducible technique for infecting rice plants with *R. solani.*

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PERFORMANCE EVALUATION OF RURAL GODOWNS IN IMPROVING RURAL ECONOMY

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ABSTRACT

Rural godowns are the storage infrastructure that creates scientific storage capacity in the rural areas to meet the requirements of farmers for storing farm produce. The study aims to investigate the performance and economics of rural godowns and their impact on the farming community. A primary survey was carried out in the Rayalaseema region of Andhra Pradesh. It is evident that rural godowns were purely agri-based, storing paddy, maize, and pulses for short duration of three months and profiting from a 5-30 per cent increase in price for the stored produce during the study period. However, the users of rural godowns were limited. Though the rural godowns scheme has generally been successful and has been able to meet many of its objectives, there are certain key issues that need to be considered and/or strengthened.

KEYWORDS: Credit-link, pledge loan, rural godowns, storage capacity.

INTRODUCTION

Storage is a crucial marketing function that involves holding and preserving produce from the time of production until trade. Storage is an exercise of human prudence through which commodities are protected from deterioration and surplus supplies in times of plenty are carried over to the season of scarcity. At the marketing level, storage is to balance the supply and demand of agricultural products, thereby stabilizing market prices. Storage is required for inter-temporal and inter-spatial adjustments. In economics parlance, storing implies value addition to a commodity by enhancing its "Time Utility". Hence, it generates revenue by arbitraging temporal and spatial commodity price differences. However, this involves a risk of qualitative and quantitative loss of the produce, which is termed "Post Harvest Losses" (PHL). However, the PHL is not only for storage. It does occur at various stages, starting from the harvesting, threshing, drying, and transportation also. Nevertheless, these losses were found to be decreasing in recent years, which may be due to various infrastructure development activities by the governments in post-harvest management, a sub sector of agriculture in the country.

Godowns, a sort of infrastructure development, are centres of economic activity and indicate a dynamic aspect of commercial storage. It provides for the safe and scientific storage of goods in an orderly manner at suitable locations for easy retrieval when required for use. The necessity for storage arises fundamentally out of a lack of adjustment between the time and location of production of products and the time and place of consumption of those items. Various agencies have been functioning in the organised sector of the country, such as FCI, CWC, SWC, other state agencies, cooperatives, and the private sector. As per the secondary data, the current capacity of the organised warehouses operated by all these agencies is about 166.2 million tonnes, as detailed in Table 1. However, realisation of the importance of scientific post-harvest management has led the government to introduce the RGS to enable private participation through incentivization as a subsidy.

For the development of agricultural marketing infrastructure, including storage infrastructure, the Ministry of Agriculture & Farmers' Welfare has implemented a capital investment subsidy sub-scheme "Agricultural Marketing Infrastructure (AMI)" under the Integrated Scheme for Agricultural Marketing (ISAM). The erstwhile two schemes, *viz.,* (i) Grameen Bhandaran Yojana (GBY) implemented since 2001, and (ii) Scheme for Strengthening/ Development of Agricultural Marketing Infrastructure, Grading & Standardization (AMIGS) implemented since 2004, have been implemented. The main objectives of the scheme are to develop agricultural marketing infrastructure, including storage infrastructure, for effectively managing the marketable surplus of agriculture, including horticulture and allied sectors; to promote the creation of scientific storage capacity for storing farm produce, processed

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Table 1. Storage Capacity of Warehouses with various Institutions in India and A.P.

S. No.	Name of the Organization/ Sector	Storage Capacity in Lakh Tonnes	
		India	A.P.
1	FCI (excluding CAP and the capacity hired from CWC, SWCs, State Agencies, and Private	127	8.71
2	CSW	145	-
3	SWC (Excluding CAP storage) and Other State Agencies (Excluding CAP Storage)	439.1	0.251
4	Cooperative Sector	165.3	-
5	Private Sector	785.6	0.22
	Total	**1662**	**9.181**

***Source**:* Annual Report 2021, WDRA

farm produce, and agricultural inputs, etc. to reduce post-harvest and handling losses; to provide infrastructure facilities for grading, standardisation, and quality certification of agricultural produce; and to promote pledge financing and marketing credit, and a negotiable warehousing receipt system. It is a credit-linked, capital investment back-end subsidy implementing as a central sector sub-scheme.

Rural godowns are a kind of storage structure that creates scientific storage capacity in the rural areas to meet the requirements of farmers for storing farm produce. Rural godowns in India are agriculture-based and their utilization depends mainly on agricultural production. In India, the majority of the farming community is composed of small and marginal farmers, who don't have the facility to retain the farm products themselves till the market prices are favourable. The establishment of rural godowns will enable small and marginal farmers to increase their holding capacity, which will enable them to sell their produce at remunerative prices and avoid distress sales. Accordingly, Gramin Bhandaran Yojana (GBY), a capital investment subsidy scheme for the construction /renovation /expansion of rural godowns, has been introduced by the Govt. of India to create a scientific storage capacity with allied facilities in rural areas to meet various requirements of farmers for storing farm produce, processed farm produce, agricultural inputs, etc., and to prevent distress sales by creating the facility of pledge loan and marketing credit. Under the scheme, 38964 godowns (sanctioned by NABARD & NCDC) were established across the country with a capacity of 65,548,247 tonnes. Andhra Pradesh was also one of the beneficiary states, having 1338 godowns with a storage capacity of 5,408,801 tonnes, with an average capacity of 4042.45 MT. The state avails a subsidy amount of Rs. 26,365.81 lakhs under this scheme (Ramappa *et al.,* 2020). The Rayalaseema region of the state has a large number of rural godowns. Hence, the study was carried out to assess the performance and impact of rural godowns on the farming community.

MATERIAL AND METHODS

The study is based on both primary and secondary data. The Rayalaseema region was purposively chosen for the study since a maximum of the total number of rural godowns in A.P. lies in this region. The study region consists of four districts, namely Ananthapur, Chittoor, Kadapa, and Kurnool. Three mandals from Kurnool district, namely Allagadda, Nandyal, and Panyam, and two mandals from Ananthapur district, namely Tadipatri and Gooty, were selected based on the highest number of rural godowns. A purposive sampling technique was adopted for the selection of sample farmers based on the nature of ownership and the use of rural godowns. However, a total of 60 respondents were selected @ 12 from each mandal. Scientifically prepared, pre-tested questionnaires and checklists were used to collect the relevant information from these stakeholders through one-to-one interactions and focus group discussions.

Among the selected stakeholders, 30 were non-

owner users and 30 were owner users of rural godowns equally distributed across the selected mandals. Primary data was collected about crop types stored, crop quantity and duration, realised price, pledge loan obtained, and constraints encountered. The data collected pertains to the cropping year 2021-22 for *kharif* and *rabi/ summer* seasons. Tabular analysis with simple averages, percentages and Garrett ranking technique were worked out.

RESULTS AND DISCUSSION

Socio-economic characteristics of stakeholders

The education profile of the respondents (as shown in Figure 1) reveals that mostly individuals who are educated below the 10th standard, or those who have graduate level qualifications, have constructed more rural godowns in the region than those who are unschooled. This distribution implies that the scheme has attracted people who either have a very basic level of education or those who have higher qualifications. Further classifications revealed that the godown owners who were educated only up to the 10th standard were primarily farmers, whereas godown owners with graduate degree and higher degrees were either traders or engaged in other businesses. However, farmers with basic education qualifications and having a medium-to-large acerage of landholding were more likely to use the rural godown services.

From Figure 3, it can be seen that a majority of the entrepreneurs who have availed of the rural godowns scheme are medium to large landowners (having

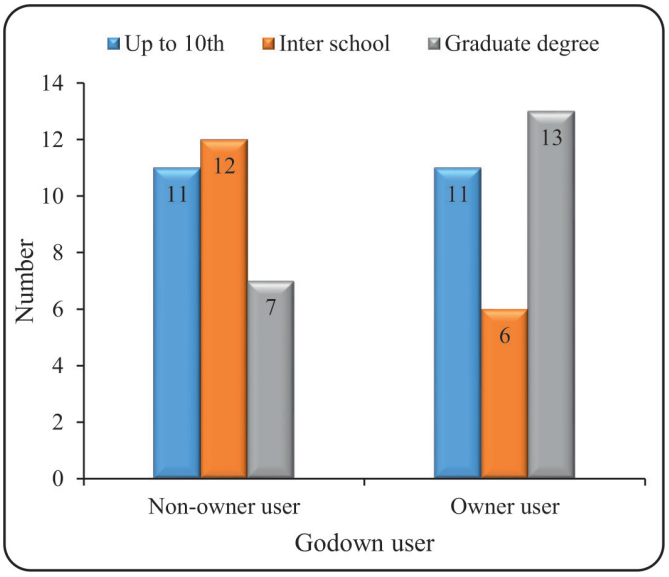

Figure 1. Education status of sample stakeholders.

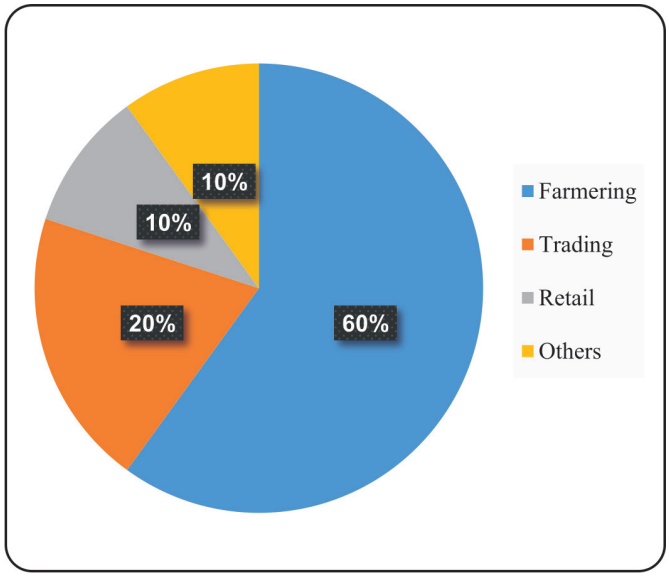

Figure 2. Occupation of sample owners.

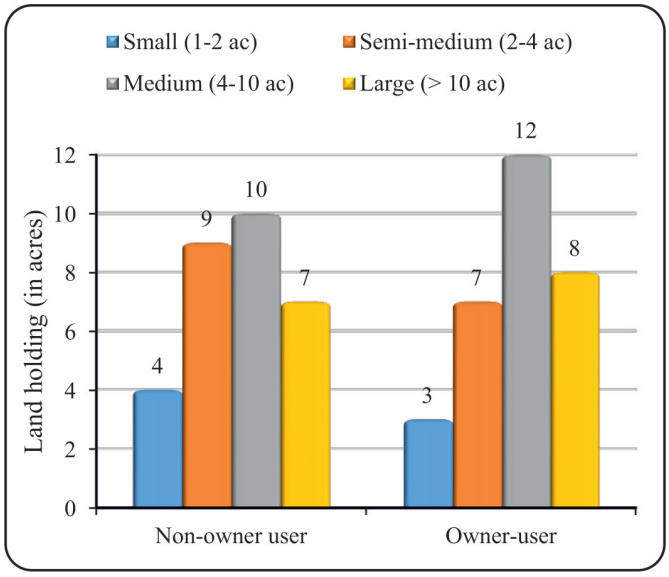

Figure 3. Extent of land holding of sample stakeholders

holdings of between 4 and 10 acres of land). Meanwhile, farmers who have utilised the rural godowns services are medium-sized landowners.

It can be inferred that during the last decade or so, small farmers have been availing the scheme more than other entrepreneurs. This indicates that farmers have begun to realise the intrinsic value of having their own storage facilities and are willing to take the risk of constructing these facilities by availing the benefits provided by the scheme. This is a promising development and needs to be encouraged further.

Utilization pattern of Rural godowns

Most of the godowns in the state constructed are under operation. The remaining are either under renovation or are partially constructed but operational. The field survey also revealed that more than 92 per cent of the godowns are used to store agricultural produce only. Only about 8 per cent of the godowns are used to store both farm inputs and output produce, occasionally. It was also found that godowns that were completely constructed and operational typically see occupancy rates that are generally above 75 per cent of their total storage capacities. The commodity-wise utilization of storage space created through the godowns is presented in Table 2.

Table 2. Commodity wise utilization of storage space of rural godowns

Capacity of rural godowns	Types of crops stored			
	10 to 25%	25 to 50%	50 to 75%	75 to 100%
Small (< 1000 MT)	Maize, Blackgram	Redgram, Bengalgram	-	Rice / Paddy
Medium (1000 ~ 4999 MT)	Groundnut, Grams	-	-	Rice / Paddy
Large (> 5000 MT)	Pulses, Groundnut	-	-	Rice / Paddy

Thus, usage is determined by the local production profile of the area. This data clearly brings out the fact that storage has been created to meet the local storage needs and, to that extent, the storage facilities that have been created are helping the farmers of the area by assisting in remunerative marketing of their produce.

Table 3. Average duration of commodity storage in the rural godowns

S. No.	Duration (months)	% of users
1.	1 to 3	61.3
2.	3 to 6	32.6
3.	6 to 12	6.1

Based on the duration of the storage period (Table 3), the highest number of users (61%) stored their produce in the godowns for a period up to three months, followed by three to six months (33%) and a few of them (6%) stored beyond six months, especially paddy and bengalgram, which is influenced by the size of the landholding and the economic status of the farmer.

Extent to which Farmers have benefited from the Scheme

Concerning the focus group discussion, it can be observed that most of the rural godowns in the state have been constructed by individual entrepreneurs on their lands. The study observed that, the primary occupation of godown owners is farming, trade, and other business occupations, apart from the co-operative and state-owned godowns. The overall view of beneficiaries and users is positive, and the godowns have helped them to store their produce that was prone to losses in the past. To that extent, the entrepreneurs appear extremely satisfied as they serve the farming community with the role that the godowns have had to play in reducing the extent of physical losses of agricultural produce, and they can withhold the produce to sell at remunerative prices later on. The farmers who are regularly storing their produce in the godowns, felt that they realized better prices for the goods stocked. The majority of respondents stated that they were able to enjoy a 5 to 30 per cent increase in prices for their produce by holding the same to avoid distress sales after harvest and because scientific storage allowed for quality preservation, which helped them fetch both better realization on the saleable volumes and the prices received. However, the price difference may vary and even become negative, which is influenced by market prices. Hence, market price information dissemination plays a critical role in taking decisions on marketing plans as well as better crop production.

In the studied region, a limited number of farmers have started to access credit from banks and other formal institutional sources, against goods stored in the godowns. Farmers will be able to obtain a credit loan of up to 60 to 70 per cent of the original value of the goods with the assistance of the godown owner. Small and medium-sized farmers were limited in their use of rural godowns due to a lack of awareness about such credit facilities, as well as bank officials' reluctance to

Table 4. Crop-wise average price realized by the users of rural godowns (Rs./Qtl)

Commodity	Price at the time of storage	Realized/ Sale price	Per cent difference
Paddy	1,800	1,900	5.56
Bengalgram	5,000	6,100	22
Redgram	5,800	6,900	18.96
Blackgram	5,000	5,950	19
Greengram	4,900	5,900	20.41
Maize	1,400	1,800	28.57
Groundnut	5,050	5,500	8.91

extend such credit to farmers, which had cumbersome procedures to access such credit facilities.

Role of Rural Godowns in helping the Rural Economy

The enhanced income has not only helped to marginally raise the standard of living of the farmers but also seems to have enabled the farmers to augment their household asset base, pay off debts, acquire more livestock and other consumer goods, and/or build their savings base. Further, the establishment of rural godowns provides employment opportunities to the rural poor for purposes like security, loading and unloading, management of the godowns, etc. It's already evidenced by previous studies by (Anonymous, 2006; Ramappa *et al.,* 2020), and others that a small godown generates 5 jobs, a medium-scale godown generates 5 to 10 jobs, and a large scale godown generates 10 to 20 jobs. It can be inferred that the higher the capacity of the godowns, the better the infrastructure and skill level of the workforce. Thereby, separate administrative, security and casual staff are required to perform efficiently.

Perception of the stakeholders

An attempt has been made to collect information from the owners as well as users of the godowns on different aspects of agricultural produce storage and its benefits. The Garrett ranking technique has been used to analyse various factors influencing distress sales after harvest. The results (Table 5) indicated that immediate financial requirements to pay debt, expenses, and purchase inputs, etc., are the major constraint faced by farmers, as the majority of farmers cannot have stable finance to meet all their requirements. Farmers' unawareness about pledge loans providing for stored produce was the next important reason, followed by uncertainty about market price fluctuations, which led the farmers to sell their produce immediately after harvest and further led to less profit. More importantly, farmers have expressed their misconception that storage reduces the weight in the later stages. They explained that because of the thresher harvest, immediate sale helps to gain advantages in weight because of the higher moisture content; the seller may reduce the meagre value of the same.

Table 5. Ranking reasons associated with distress sales

S. No.	Factors	Rank
1.	To meet the financial requirements (pay debt, purchase of inputs and family expenses)	I
2.	Quality and Quantity deterioration while storage	IV
3.	No storage facilities	V
4.	Price changes are uncertain.	III
5.	Unaware of pledge loans	II

Table 6. Constraints and Suggestions expressed by the rural godowns owners

S. No.	Particulars	Per cent of owners
Constraints		
I	**Economical Constraints**	
	High cost for storage pest management (fumigation)	23.33
	Paucity of working capital	16.67
	High rate of interest	23.33
	Requirement of large capital	40.00
II	**Technical constraints**	
	Lack of technical supervision	20.00
	Non-availability of skilled labours	23.33
	Maintenance problem	43.33
III	**General/other constraints**	
	Lack of demand by local farmers	46.67
	Lack of awareness	23.33
	Risk of quality and quantity deterioration	30.00
	Administrative constraints	-
Suggestions		
	Increase the volume of loan	53.33
	Making it simple and quick to obtain pledge loans for stored produce in godowns	86.67
	Need to create awareness among farmers	43.33
	Providing a supplemental subsidy for godown repairs and renovations	76.67

Similarly, the constraints experienced by the godown owners and suggestions to overcome or improve the rural godown scheme were asked. Accordingly, the specified points were categorized and discussed in Table 6. The table discloses that the requirement of large capital, maintenance issues, risk of deterioration in quality and quantity, and low demand by the local farmers were the major constraints faced by (40% each) of the owners, followed by the high rate of interest, non-availability of skilled labour, inadequate technical supervision, lack of awareness of the benefits of godowns among farmers, and the high cost of fumigation, the next line of issues as uttered by 23 percent of the owners. From these issues, it is understood that the owners of the godowns require a lot more than the government's subsidy to manage plenty and an awareness program to educate farmers about rural godowns in avoiding distress sales.

In the same way, a few suggestions reported by the owners of the godowns were also mentioned on the table. The highest proportion of farmers (87%) suggested making easy access to pledge loan facility to the produce retainers in the godowns, followed by the requirement of supplemental subsidy for godown repairs and renovations, increment in the loan amount, and the need for creating awareness of the benefits of storage

among farmers were the major suggestions provided by the owners of the godowns. These suggestions seem to be relevant and need immediate attention from the policymakers to take away the farmers' distress sales and double their income in the near future.

Post-harvest management is critical in the production and marketing of valuable produce because a significant amount of the produce is lost each year due to improper post-harvest management. Crisis in food availability is not only caused by natural disasters but also by an absolute lack of post-harvest management. With this backdrop, the government of India as well as the state government have introduced many schemes to improve post-harvest management practices. In this context, an effort was made to assess the performance and impact of rural godowns on the farming community, which supports farmers to protect farm produce from post-harvest losses and consequently avoids distress sales.

It may be concluded from the study that rural godowns in Andhra Pradesh are agriculture-based. The rural godown scheme seems to have encouraged farmers to create storage capacities for their produce and marginally increase their living standards for all classes of farmers. As a result, these storage practises may have an impact on the market surplus, which has a significant impact on the price stabilisation process.

From the findings of the evaluation study, it can be seen that the rural godowns scheme has generally been successful and has been able to meet many of its objectives. However, there are certain key issues that need to be considered and/or strengthened.

- The rural godown scheme has to be continued for the coming years with revised cost, design, and other specifications for the godowns, and encouraging small and marginal farmers of the state for the construction of smaller capacity godowns (less than 100MT).
- Establishing of a separate digital platform or merge with state's warehouse corporation portal which has to provide information about name, owner, location, address and capacities created/available of all rural godowns in the state.
- A programme to expand the scope and to create awareness using radio spots in the local radio channels, seminars, focused workshops in potential areas, ads in TV and local cinema halls (before the beginning of movies and at the interval period), creative posters and pamphlets, *etc*. to popularise the scheme amongst the rural communities.
- Involve local NGOs and Govt. institutions in creating awareness about the scheme and then providing training to small farmers in scientific aspects of storage at village level.
- Educating and training the godown owners with various modules like basic management of the godown, repair and maintenance, account keeping, and business development: capacity utilization through multi-product storage, *etc*.
- Planned storage at production points of organically certified products, value-added millets, processed fruit and vegetables, and export potential products like rice and chilli etc., will enhance the economic efficiency of growers led to improving the exportable commodity performance from Andhra Pradesh.

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