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Effect of varieties, dates of sowing, growth regulators and their interaction on yield and quality of dolichos bean (*Lablab purpureus* L.) during offseason under coastal Andhra Pradesh conditions

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Abstract
The present investigation entitled "Effect of varieties, dates of sowing, growth regulators and their interaction on yield and quality of Dolichos Bean (*Lablab purpureus* L.) during offseason under coastal Andhra Pradesh conditions" was carried out during summer at Horticultural Research Station, Ambajipeta, East Godavari District of Andhra Pradesh. The experiment was laid out with 36 different treatment combinations in a Factorial Randomized Block Design (FRBD) each replicated thrice in open field. The experiment was carried out with four varieties *viz.*, Arka Jay, Arka Amog, Arka Sambhram and Arka Sowmya with three different dates of sowing *viz.*, December 15th, January1st and January15th with foliar spray of growth regulators *viz.*, NAA 25 ppm, Triacontanol 2 ppm and control. The data were recorded on yield and quality parameters and the data were statistically analyzed based on ANOVA. Arka Sowmya recorded significantly highest pod yield per plant (237.72 g) and Arka Jay recorded highest shelling percentage of fresh pod (35.63%). January 1st sown crop recorded significantly the highest pod yield (232.68 g) and highest shelling percentage of fresh pod (35.18%). Triacontanol @ 2 pm foliar spray recorded significantly the highest pod yield (226.30 g) and highest shelling percentage of fresh pod (36.44%). However highest protein and fibre content was observed with NAA @ 25 ppm spray 15.35% and 33.69% respectively. Arka Sowmya sown on January 1st in combination with Triacontanol 2 ppmspray ($V_4S_2G_2$) recorded the highest pod yield of 293.90 g. Arka Jay sown on January 1st without spray ($V_1S_2G_3$) recorded the lowest green pod yield per plant (143.74 g).

Keywords: Dolichos bean, dates of sowing, growth regulators, offseason

Introduction
In India, *Lablab* is a field crop mostly confined to the peninsular region and is cultivated to a large extent in Karnataka and adjoining districts of Tamil Nadu, Andhra Pradesh and Maharashtra. Karnataka contributes a major share, accounting for nearly 90 per cent in terms of both area and production in the country. The normal growing seasons for field bean are *Kharif* and *Rabi*. The beans are not available in Andhra Pradesh after February month. By growing beans in off season *i.e.*, summer, the produce will be made available to the consumers all throughout the year and also the farmers can fetch better price for their produce. Among the agronomic practices, optimum sowing time is considered as an important non-cash input, results in considerable increase in the yield and quality. Productivity in most of the vegetable crops depends on prevailing environmental conditions to which phenological stages of the crop are being exposed. The staggered dates of sowing may thus influence the crop growth, flowering and yield. The plant growth regulators are either natural or synthetic compounds applied to the target plants to modify either developmental or morphological structure or both by manipulating the hormonal levels in different plant organs at various growth stages of the plant in the life cycle so as to enhance its yield and quality (Setia *et al.*, 1991) [9]. The information on suitable varieties, optimum sowing date and growth regulators on off season production of field bean is scanty. Hence, the present study is conducted to find out the field bean varieties suitable for growing in off season for coastal Andhra Pradesh with optimum date of sowing and suitable growth regulator.

Materials and Methods
The investigation entitled "Effect of varieties, dates of sowing, growth regulators and their

interaction on yield and quality of Dolichos Bean (*Lablab purpureus* L.) during offseason under coastal Andhra Pradesh conditions" was carried out during summer at Horticultural Research Station, Ambajipeta, East Godavari District of Andhra Pradesh which is situated at 16.4^0 N latitude and 81.5^0 E longitudes with an altitude of 34 m above mean sea level. The experimental site receives an annual rainfall of 1186 mm. The pH of irrigated water was 7.3 and EC is of 0.7 dSm^{-1}. The experiment was laid out with 36 different treatment combinations in a Factorial Randomized Block Design (FRBD) each replicated thrice under shade net. The experiment was carried out with four varieties *viz.,* Arka Jay (V_1), Arka Amog (V_2), Arka Sambhram (V_3) and Arka Sowmya (V_4) with three different dates of sowing *viz.,* December 15th (S_1) January1st (S_2) and January 15th (S_3) with foliar spray of growth regulators *viz.,* NAA 25 ppm (G_1), Triacontanol 2 ppm (G_2), and control (G_3). Growth regulators were sprayed at 30 DAS and 60 DAS. The experimental area was thoroughly ploughed and brought into a fine tilth. Recommended dose of FYM and basal dose of fertilizers were incorporated into the soil before the final ploughing. The recommended dose of N, P and K (20:60:50 kg per ha) were applied in the form of urea, single super phosphate and muriate of potash respectively. Nitrogen was applied in 2 splits, half of the nitrogen (*i.e.* 10 kg) was applied as basal dose and the remaining half of the nitrogen (*i.e.* 10 kg) was applied as top dressing at 30 days after sowing. The entire dose of phosphorus and potash were applied at the time of sowing as basal dose. The various observations on growth and yield parameters were recorded on five plants which were tagged. Days to 50% flowering was calculated as number of days taken from the date of sowing to the day when 50 per cent of the plants in a plot were flowered. The two years data were recorded on yield and quality parameters and the pooled data were statistically analyzed based on ANOVA.

Results and Discussion

The data regarding the effect of sowing time and growth regulators and their interaction on green pod yield per plant of field bean varieties under open field condition was presented in Table 1. Significant differences were noticed among the varieties for green pod yield per plant. Highest pod yield (355.25 g) was recorded with Arka Sowmya (V_4) followed by Arka Sambhram (V_3) (332.61 g) whereas, Arka Jay (V_1) recorded the lowest pod yield of 260.39 g. The variation in pod yield per plant among the varieties was also due to positive expression of the genes related to the above characters in the prevailing environmental factors at the experimental site. The present findings are corroborate with the results obtained by Singh *et al*. (2011) [14], Lima *et al*. (2012) [2], Ravinaik *et al*. (2015) [7], Salim *et al*. (2013) [8], Verma *et al*. (2014) [16], Sharma *et al*. (2014) [11] and Ravinaik *et al*. (2015) [7] in dolichos bean.

Dates of sowing also showed significant influence on pod yield per plant. Highest pod yield per plant was recorded with January 1st sowing (S_2) (367.99 g) followed by January 15th sowing (S_3) (312.64 g). The lowest pod yield per plant was recorded by December 15th sowing (S_1) (274.15 g). The climatic factors prevailed during January 1st sowing were favourable for better vegetative growth of plant and lead to the formation of higher photosynthates which ultimately translocated to the pods and results in higher fresh pod yield per plant in dolichos bean. The increase in pod yield per plant could be attributed to better development of yield attributes, *i.e.,* number of pods per plant and pod weight which might be due to optimum prevailing temperatures during reproductive phase of the crop. Uddin (2005) [15], Moniruzzaman *et al.* (2007) [3] and Islam (2008) [1] reported the similar results in french bean.

Growth regulators also showed significant influence on pod yield. Highest pod yield per plant was recorded with Triacontanol 2 ppm foliar spray (G_2) (342.19 g), followed by NAA 25ppm (G_1) (318.0 g) and without growth regulator spray (control) (G_3) (294.6 g). The increase in yield per plant by spraying of Triacontanol has been reported by Sharma (1994) [12] in capsicum, Nargis Jahan *et al*. (1997) [4] in okra and Tripti Shrivastava *et al.* (2001) [14] in chickpea.

The interaction of varieties and dates of sowing also recorded significant effect on pod yield. Arka Sowmya recorded the highest green pod yield per plant with 409.26 g when sown on January 1st (V_4S_2), followed by Arka Sambhram with same date of sowing (V_3S_2) (390.86 g). Arka Jay recorded the lowest pod yield per plant (236.76 g) when sown on December 15th (V_1S_1).

The interaction of varieties and growth regulators as well as the interaction of dates of sowing and growth regulators showed non significant effect on pod yield per plant. The interaction of varieties, dates of sowing and growth regulators recorded significant effect on pod yield. Arka Sowmya recorded the highest pod yield with 471.83 g when sown on January 1st and the plants were sprayed with Triacontanol 2 PPM ($V_4S_2G_2$) followed by same variety with January 15th and sprayed with Triacontanol 2 ppm ($V_4S_3G_2$) (428.30 g). Arka Jay recorded the lowest green pod yield per plant (202.07 g) when sown on January 15th without growth regulator spray ($V_1S_1G_3$).

The influence of varieties, dates of sowing and growth regulators on shelling per cent of fresh pod and are presented in Table 1.Among varieties, the highest shelling per cent of fresh pod (36.28%) was noticed with Arka Jay (V_1) and it was on par with Arka Sambhram (V_3) (35.44%) and Arka Amog (V_2) (35.42%). The lowest shelling per cent of fresh pod was noticed with Arka Sowmya (34.56%). The variation in shelling percent of fresh pod among the varieties could be attributed to their genotypic variation and their interaction with the prevailing environmental factors.

Dates of sowing showed non-significant effect on shelling per cent of fresh pod, whereas the growth regulators showed significant influence on shelling per cent of fresh pod. The highest shelling per cent of fresh pod was recorded with Triacontanol 2 ppm foliar spray (G_2) (38.5) followed by NAA 25 ppm foliar spray (G_1) (35.31%). The lowest shelling per cent (32.46%) was recorded with control treatment (G_3).The variation in shelling percentage of fresh pod among the growth regulator treatments could be attributed to the better partitioning of photoassimilates from source to sink organs at the time of pod filling stage.

The effect of varieties, dates of sowing, growth regulators and their interactions on protein content of field bean are presented in Table 2. Though non-significant, Arka Sowmya recorded the highest protein content of 16.76 per cent followed by Arka Jay (16.69%) and Arka Sambhram (16.48%). The lowest protein content was noticed in Arka Amog (16.26%). Dates of sowing also showed non-significant effect on protein content, whereas the growth regulators showed significant effect on protein content. Spraying of

Triacontanol 2 ppm recorded the highest protein of 17.22 per cent and it was on par with spraying of NAA 25 ppm (16.60%). The lowest protein content was recorded in control (G_3) (15.82%). It leads to an increase in protein content of field bean by spraying of Triacontanol as earlier reported by Bhatnagar *et al.* (1992) [1] and Radha Krishnan *et al.* (2004) [5] in french bean.The interaction of varieties and dates of sowing, varieties and growth regulators, sowing dates and growth regulators and the interaction of varieties, sowing dates and growth regulators were found non-significant for protein content.

The influence of varieties, dates of sowing, growth regulators and their interactions on pod fibre content are depicted in Table 2. Significant differences were noticed among varieties for pod fibre content. The highest pod fibre content (35.17%) was noticed with Arka Amog (V_2) and it was on par with Arka Sambhram (V_3) (34.91%) and Arka Jay (34.72%). The lowest pod fibre content (33.99%) was noticed with Arka Sowmya. The present results are in conformity with the findings of Sood *et al.* (2003) [13] and Ramana *et al.* (2011) [6] in french bean and Sharma *et al.* (2014) [11] in country bean (*Dolichos lablab*). Dates of sowing showed non-significant effect on pod fibre content. Growth regulators showed significant influence on pod fibre content. Highest pod fibre content (35.19%) was noticed in pods harvested from the plants sprayed with NAA 25 ppm spray (G_1) and it was on par with fibre content of harvested from the plants sprayed with Triacontanol 2 ppm (G_2) (35.02%). The lowest fibre content was recorded with control treatment (G_3) (33.87%). The interaction of varieties and dates of sowing showed significant influence on pod fibre content. Arka Amog recorded the highest pod fibre content (36.10%) when the crop was sown on December 15th (V_2S_1) and it was on par with other combinations except V_4S_1 (33.25%). The interaction of varieties and growth regulators showed significant effect on pod fibre content. Arka Amog recorded the highest fibre content (36.15%) in pods harvested from the plants sprayed with NAA 25 ppm (V_2G_1) and it was on par with Arka Sambhram plants were sprayed with NAA 25 ppm (V_3G_1) (35.37%) and Arka Amog pods harvested from the plants sprayed with Triacontanol 2 ppm (V_2G_2) (35.33%), Arka Jay and Arka Sambhram pods harvested from the plants sprayed with Triacontanol 2 ppm (V_1G_2) (35.16%) (V_3G_2) (35.01%), Arka Jay pods harvested from the plants sprayed with NAA 25 ppm (V_1G_1) (34.90%), Arka Sowmya pods harvested from the plants sprayed with Triacontanol 2 ppm (V_4G_2) (34.59%) and with NAA 25 ppm (V_4G_1) (34.35%). Arka Sowmya recorded the lowest fibre content (33.03%) in pods harvested from the plants without growth regulator spray (V_4G_3). The interaction of dates of sowing and growth regulators showed significant effect on pod fibre content. January 1st sown crop recorded the highest fibre content (35.39%) in pods harvested from the plants sprayed with NAA 25 ppm (S_2G_1) and it was on par with other combinations except the fibre content of pods harvested from December 15th, January 1st and January 15th sown crops without growth regulator spray (S_1G_3) (33.96%), (S_2G_3) (33.96%) and (S_3G_3) (33.70%). The interaction of varieties dates of sowing and growth regulators showed significant effect on pod fibre content. The highest pod fibre content was noticed with Arka Sambhram sown on January 1st and the plants sprayed with NAA 25ppm ($V_3S_2G_1$) (36.71%) and the lowest pod fibre content (32.6%) in Arka Sowmya sown on 15th December and the crop was not sprayed with growth regulator ($V_4S_1G_3$).

Table 1: Effect of varieties, dates of sowing, growth regulators and their interaction on green pod yield per plant and shelling percentage of fresh pod in field bean in open field.

Varieties (V)		Green pod yield/plant (g)				Shelling percentage of fresh pod(%)				
		Dates of sowing (S)				Dates of sowing (S)				
		S_1	S_2	S_3	Mean	Varieties (V)	S_1	S_2	S_3	Mean
V_1		236.76	305.83	238.56	260.39	V_1	37.32	35.19	36.32	36.28
V_2		279.07	366.01	329.29	324.79	V_2	35.83	37.13	33.28	35.42
V_3		304.53	390.86	302.45	332.61	V_3	32.91	37.36	36.05	35.44
V_4		276.23	409.26	380.26	355.25	V_4	34.34	34.18	35.16	34.56
Mean		274.15	367.99	312.64	--	Mean	35.10	35.97	35.20	--
Varieties (V)		Growth Regulators (G)				Varieties (V)	Growth Regulators (G)			
		G_1	G_2	G_3	Mean		G_1	G_2	G_3	Mean
V_1		261.77	284.62	234.76	260.39	V_1	36.53	39.15	33.15	36.28
V_2		327.03	344.83	302.51	324.79	V_2	34.79	37.94	33.52	35.42
V_3		336.19	340.86	320.83	332.61	V_3	35.72	38.92	31.68	35.44
V_4		346.98	398.43	320.34	355.25	V_4	34.20	38.01	31.47	34.56
Mean		318.00	342.19	294.60	--	Mean	35.31	38.50	32.46	--
Dates of sowing(S)		Growth Regulators (G)				Dates of sowing (S)	Growth Regulators (G)			
		G_1	G_2	G_3	Mean		G_1	G_2	G_3	Mean
S_1		272.21	295.80	254.43	274.15	S_1	35.25	37.97	32.09	35.10
S_2		368.10	390.20	345.63	367.99	S_2	35.92	38.71	33.26	35.97
S_3		313.65	340.55	283.73	312.64	S_3	34.76	38.84	32.02	35.20
Mean		318.00	342.19	294.60	-	Mean	35.31	38.50	32.46	--
Interaction (VxSxG)		Growth Regulators (G)				Interaction (VxSxG)		Growth Regulators (G)			
		G_1	G_2	G_3				G_1	G_2	G_3	Mean
V_1	S_1	231.04	277.19	202.07	--	V_1	S_1	38.11	40.99	32.85	--
	S_2	303.98	313.51	300.00	--		S_2	35.00	36.45	34.11	--
	S_3	250.31	263.17	202.22	--		S_3	36.47	40.01	32.46	--
V_2	S_1	278.66	299.37	259.18	--	V_2	S_1	35.38	38.30	33.80	--
	S_2	374.10	376.95	347.00	--		S_2	36.44	39.28	35.68	--
	S_3	328.35	358.18	301.35	--		S_3	32.53	36.23	31.07	--
	S_1	307.34	311.51	294.74	--		S_1	32.96	35.42	30.35	--

V_3	S_2	407.64	398.53	366.41	--	V_3	S_2	38.68	41.94	31.44	--
	S_3	293.60	312.55	301.19	--		S_3	35.50	39.38	33.26	--
V_4	S_1	271.80	295.15	261.74	--	V_4	S_1	34.52	37.15	31.34	--
	S_2	386.83	471.83	369.12	--		S_2	36.55	37.17	31.80	--
	S_3	382.33	428.30	330.15	--		S_3	34.52	39.71	31.26	--

Source	SE.m ±	C.D at 5%	SE.m ±	C.D at 5%
V	4.41	12.30	0.39	1.02
S	3.81	10.66	0.31	NS
G	3.81	10.66	0.31	0.88
VxS	7.63	21.32	0.63	1.77
VxG	7.63	NS	0.63	NS
SxG	6.61	NS	0.55	NS
VxSxG	13.23	36.92	1.10	NS

Varieties (V)	**Dates of sowing (S)**	**Growth Regulators (G)**
V_1 - Arka Jay	**S_1** - December 15th	**G_1** - NAA 25 ppm
V_2 - ArkaAmog	**S_2** - January 1st	**G_2** - Triacontanol 2 ppm
V_3 - ArkaSambhram	**S_3** - January 15th	**G_3** - Control
V_4 - ArkaSowmya		

Table 2: Effect of varieties, dates of sowing, growth regulators and their interaction on protein content and fibre content in field bean in open field.

Varieties (V)	**Protein content (%)**				**Pod Fibre content (%)**				
	Dates of sowing (S)				**Dates of sowing (S)**				
	S_1	**S_2**	**S_3**	**Mean**	**Varieties (V)**	**S_1**	**S_2**	**S_3**	**Mean**
V_1	16.88	16.01	17.19	16.69	V_1	34.78	34.72	34.65	34.72
V_2	16.53	15.83	16.42	16.26	V_2	36.10	34.19	35.22	35.17
V_3	15.98	17.31	16.13	16.48	V_3	34.44	35.79	34.49	34.91
V_4	16.80	17.12	16.36	16.76	V_4	33.25	34.47	34.25	33.99
Mean	16.55	16.57	16.52	--	Mean	34.64	34.79	34.65	--
Varieties (V)	Growth Regulators (G)				Varieties (V)	Growth Regulators (G)			
	G_1	G_2	G_3	Mean		G_1	G_2	G_3	Mean
V_1	16.57	17.16	16.35	16.69	V_1	34.90	35.16	34.08	34.72
V_2	16.48	17.30	15.00	16.26	V_2	36.15	35.33	34.04	35.17
V_3	16.52	17.37	15.54	16.48	V_3	35.37	35.01	34.34	34.91
V_4	16.82	17.06	16.41	16.76	V_4	34.35	34.59	33.03	33.99
Mean	16.60	17.22	15.82	--	Mean	35.19	35.02	33.87	--
Dates of sowing(S)	Growth Regulators (G)				Dates of sowing (S)	Growth Regulators (G)			
	G_1	G_2	G_3	Mean		G_1	G_2	G_3	Mean
S_1	16.66	17.32	15.67	16.35	S_1	35.14	34.83	33.96	34.64
S_2	16.53	17.21	15.95	16.57	S_2	35.39	35.03	33.96	34.79
S_3	16.60	17.13	15.85	16.52	S_3	35.04	35.21	33.70	34.65
Mean	16.60	17.22	15.82	--	Mean	35.19	35.02	33.87	--
Interaction (VxSxG)	Growth Regulators (G)				Interaction (VxSxG)	Growth Regulators (G)			
	G_1	G_2	G_3			G_1	G_2	G_3	Mean
V_1 S_1	16.78	17.37	16.49	--	V_1 S_1	35.99	34.36	33.98	--
V_1 S_2	16.01	16.17	15.85	--	V_1 S_2	34.45	33.37	33.32	--
V_1 S_3	16.91	17.93	16.72	--	V_1 S_3	34.24	35.27	33.94	--
V_2 S_1	16.51	17.99	15.06	--	V_2 S_1	36.46	36.90	34.93	--
V_2 S_2	16.27	16.65	14.54	--	V_2 S_2	33.60	33.87	33.08	--
V_2 S_3	16.65	17.23	15.37	--	V_2 S_3	36.38	35.20	34.08	--
V_3 S_1	16.47	16.67	14.80	--	V_3 S_1	34.59	34.40	34.32	--
V_3 S_2	16.91	18.83	16.18	--	V_3 S_2	36.71	35.38	35.27	--
V_3 S_3	16.16	15.59	16.63	--	V_3 S_3	34.79	35.25	33.43	--
V_4 S_1	16.85	17.23	16.31	--	V_4 S_1	33.49	33.64	32.60	--
V_4 S_2	16.93	17.19	17.22	--	V_4 S_2	34.79	35.47	33.14	--
V_4 S_3	16.66	16.73	15.67	--	V_4 S_3	34.75	34.63	33.34	--

Source	SE.m ±	C.D at 5%	SE.m ±	C.D at 5%
V	0.39	NS	0.35	0.99
S	0.33	NS	0.31	NS
G	0.33	0.94	0.31	0.86
VxS	0.67	NS	0.62	1.73
VxG	0.67	NS	0.62	1.73
SxG	0.58	NS	0.53	1.49
VxSxG	1.17	NS	1.07	2.99

Varieties (V)	Dates of sowing (S)	Growth Regulators (G)
V_1 - Arka Jay	S_1 - December 15th	G_1 - NAA 25 ppm
V_2 - ArkaAmog	S_2 - January 1st	G_2 - Triacontanol 2 ppm
V_3 - ArkaSambhram	S_3 - January 15th	G_3 - Control
V_4 - ArkaSowmya		

Conclusion

Arka Sowmya sown on January 1st in combination with Triacontanol 2 ppmspray ($V_4S_2G_2$) recorded the highest pod yield of 293.90 g.

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