Int.J.Curr.Microbiol.App.Sci (2020) *9*(9): 933-942

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 9 Number 9 (2020)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2020.909.115

Effect of Varieties, Dates of Sowing, Growth Regulators and their Interaction on Growth and Yield of Dolichos Bean (*Lablab purpureus* L.) During off Season under Coastal Andhra Pradesh Conditions

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Keywords

Dolichos Bean, (*Lablab purpureus* L.)

Article Info

Accepted:
10 August 2020
Available Online:
10 September 2020

A B S T R A C T

The present investigation entitled "Effect of varieties, dates of sowing, growth regulators on growth and yield of Dolichos Bean (*Lablab purpureus* L.) during offseason under coastal Andhra Pradesh conditions was carried out during summer 2014-15 and 2015-16 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 various growth, and yield parameters and the data were statistically analyzed based on ANOVA. Arka Sowmya (V_4) recorded significantly highest leaf area (1113.8 cm^2) number of buds per node (5.07), pod weight (4.54 g) and highest pod yield per ha (197.36 q) in open field. Arka Jay took least number of days for 50 per cent flowering (41.62 days). January 1st sown crop recorded significantly the highest plant height (67.77cm), leaf area (1113.8 cm^2) number of buds per node (4.81) and highest pod yield per ha (204.43q) and also took less number of days for 50 per cent flowering (41.02) in open field . Triacontanol @2 pm foliar spray recorded significantly the highest plant height (68.4 cm), leaf area (1077.0 cm^2), number of buds per node (4.87) and pod yield(190.1q/ha) and took least number of days to 50% flowering (41.64 days). Arka Sowmya recorded the highest pod yield per hectare (262.12q) when sown on January 1st and sprayed with Triacontanol 2 ppm foliar spray ($V_4S_2G_2$).

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. In Andhra Pradesh, beans are cultivated in an area of 228000 ha with a production of 2277000 MT (National Horticulture Board Statistics 2017-18). 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). 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 in open field 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 growth and yield of Dolichos Bean (*Lablab purpureus* L.) during offseason under coastal Andhra Pradesh conditions " was carried out during summer 2014-15 and 2015-16 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 in open field. 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 15^{th} (S_1) January1^{st} (S_2) and January15^{th} (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 various growth and yield 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 growth characters of field bean varieties under open field condition was presented in

Table 1. Non significant differences were found among the field bean varieties for plant height at harvest. Regarding sowing time, January 1st sown crop recorded the highest plant height (67.77 cm) followed by January 15th sown crop (67.31 cm) and December 15th sown crop (66.56 cm). The January 1st sown crop recorded highest plant height which might be due to prevailing environmental conditions especially photoperiod and temperature prevailed during vegetative growth. The results are in agreement with the findings of Patel *et al.,* (2008) in moth bean and Joshi and Rahevar (2014) in Indian bean. Growth regulators significantly influenced the plant height at harvest. At harvest, significantly highest plant height (68.41 cm) was observed with Triacontanol 2 ppm spray (G_2) and the lowest plant height (65.90 cm**)** was observed without growth regulator spray (control treatment). The increase in plant height by foliar application of 2 ppm Triacontanol could be attributed to an enhanced cell division. Similar results were reported by Chaudhary *et al.,* (2006) in chilli and Singh (2010) in fenugreek.

The interaction between varieties and dates of sowing showed significant effect on plant height at harvest. At harvest, Arka Sambhram recorded the highest plant height (68.31 cm) when sown on January 1st (V_3S_2) and Arka Sambhram recorded the lowest plant height (65.55 cm) when sown on December 15th (V_3S_1). The field bean varieties Arka Jay, Arka Sowmya and Arka Sambhram performed well when sown on January 1st than sown on December 15th and January 15th. The interaction between varieties and growth regulators, sowing dates and growth regulators, varieties, dates of sowing and growth regulators showed non significant effect on plant height at harvest.

With regard to leaf area per plant, the data was found significant with different varieties, dates of sowing and growth regulators and their interactions. Arka Sowmya (V_4) recorded significantly highest leaf area per plant (1065.9 cm^2) at harvest whereas, Arka Jay (V_1) recorded lowest leaf area (910.2 cm^2) Similar results have been reported Esakkiammal *et al.,* (2015) in dolichos bean and Prakash *et al.,* (2015) in french bean. Significant differences were noticed among the dates of sowing with regard to leaf area per plant. Significantly highest leaf area per plant (1028.3 cm^2 at harvest) was observed with January 1st sowing (S_1) whereas, the lowest leaf area per plant (975.7 cm^2) at harvest was observed with January 15th sowing (S_3). Sowing of field bean on January 1st recorded maximum leaf area per plant when compared to other dates of sowing might be due to presence of favourable environmental conditions such as temperature, day length and light intensity during this period. Similar results were obtained Abido and Seadh (2014) in dolichos bean.The influence of growth regulators on leaf area per plant was also significant. Significantly the highest leaf area (1077.0 cm^2 at harvest) was recorded with Triacontanol 2 ppm whereas, lowest leaf area (933.0 cm^2 at harvest) was recorded in control. The increase in leaf area due to Triacontanol foliar spray may be attributed to an increase in meristematic activity of leaf primordia.

The interaction between varieties and sowing dates was found significant with respect to leaf area per plant. Significantly the highest leaf area per plant (1113.8 cm^2 at harvest) was recorded by Arka Sowmya with January 15th sowing (V_4S_3). Significant interaction was observed between varieties and growth regulators with respect to leaf area per plant. Significantly the highest leaf area per plant at harvest (1142.6 $cm^{2)}$ was observed by Arka Sowmya sprayed with Triacontanol @ 2ppm (V_4G_2) whereas, lowest leaf area (779.5 cm^2 at harvest respectively) was observed by Arka

Jay without growth regulator spray (V_1G_3). No significant differences for leaf area were observed at harvest among SxG interactions. Among VxSxG interactions, Arka Sowmya sown on January 15th with Triacontanol 2 ppm foliar spray ($V_4S_3G_2$) recorded the highest leaf area per plant (1148.71 cm^2).

Varieties, dates of sowing, growth regulators and their interactions showed significant effect on number of buds per node and days to 50% flowering and the data are presented in Table 2. The effect of variety on number of buds per node was significant. The highest number of buds per node was observed in Arka Sowmya (V_4) (5.07) and the lowest in Arka Sambhram (V_3) (4.38). The variation in number of buds per node among the varieties could be attributed to their inherent genetic character and influence of environmental factors. Similar variation in number of buds per node was reported by Das *et al.,* (2012) in country bean. The effect of dates of sowing on number of buds per node was also significant. The highest number of buds per node were observed in January 1st sown crop (S_2) (4.81) and was on par with December 15th sown crop (S_1) (4.80). The field bean crop sown on January 15th (S_3) recorded the lowest number of buds per node (4.25).The highest number of buds per node in January 1st sown crop could be attributed to the presence of congenial climatic factors for formation of buds when compared with other dates of sowing.

The effect of growth regulators on number of buds per node was significant. The plants sprayed with Triacontanol 2 ppm (G_2) recorded the highest number of buds per node (4.87), followed by NAA 25 ppm spray (4.55) and control (4.44). The growth regulators significantly influenced the number of buds per node. It might be due to an increased photo assimilates and improved translocation of food assimilates to the meristematic tissue at nodal region and differentiation of meristematic tissue into flower buds.

The effect of VxS interaction was significant for number of buds per node. The highest number of buds per node were observed in Arka Sowmya sown on January 15th (V_4S_3) (5.33) and was on par with Arka Sowmya sown on January 1st (5.18) Arka Sambhram (5.10) sown on December 15th (V_3S_1). The effect of VxG interaction was significant for number of buds per node. The highest number of buds per node (5.34) was observed in Arka Sowmya in combination with Triacontanol 2 ppm spray (V_4G_2). The lowest number of buds per node (4.15) was observed in Arka Sambhram without spray (V_3G_3).The effect of SxG interaction was non-significant for number of buds per node. The effect of VxSxG was found significant for number of buds per node. The highest number of buds per node were observed in Arka Sowmya sown on January 15th in combination with Triacontanol 2 ppm spray ($V_4S_3G_2$) (5.71).

The varieties differed significantly for days to 50 per cent flowering. Arka Jay took less number of days to 50 per cent flowering (41.62 days) whereas, Arka Sowmya took more number of days to 50 per cent flowering (43.10 days). The variety, Arka Jay flowered earlier in the present study. The earliness in Arka Jay could be due to earlier morphological differentiation due to its inherent genetic factor and better adaptability to growing environmental conditions. Similar variation in days to 50 per cent flowering has been earlier reported by Rana and Kumar (2008) in french bean and Prakash and Ram (2014) in french bean and Kharbamon *et al.,* (2016) in Indian bean.The influence of dates of sowing on days to 50 per cent flowering was significant. January 1st sowing took less number of days for 50 per cent flowering (41.02), followed by January 15th sowing (41.99 days) and December 15th sowing (43.54).

Table.1 Effect of varieties, dates of sowing, growth regulators and their interaction on plant height in field bean at 90 DAS and at harvest in open field

Varieties (V)	**Plant Height (cm) at harvest**				**Leaf area par plant at harvest (cm^2)**				
	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	67.27	67.08	67.33	**67.23**	V_1	854.4	1013.4	862.9	**910.2**
V_2	67.16	67.71	67.30	**67.39**	V_2	1055.2	1104.1	1016.7	**1058.7**
V_3	65.55	68.31	67.80	**67.22**	V_3	1068.6	995.9	909.3	**991.3**
V_4	66.27	66.99	66.80	**67.02**	V_4	1083.9	999.9	1113.8	**1065.9**
Mean	**66.56**	**67.77**	**67.31**	--	**Mean**	**1015.5**	**1028.3**	**975.7**	--
Varieties (V)	**Growth Regulators (G)**			**Mean**	**Varieties (V)**	**Growth Regulators (G)**			**Mean**
	G_1	**G_2**	**G_3**			**G_1**	**G_2**	**G_3**	
V_1	67.27	68.34	66.08	**67.23**	V_1	940.2	1011.0	779.5	**910.2**
V_2	67.47	68.72	65.99	**67.39**	V_2	1066.7	1102.7	1006.5	**1058.7**
V_3	67.29	68.43	65.94	**67.22**	V_3	983.0	1049.9	940.9	**991.3**
V_4	67.33	68.13	65.60	**67.02**	V_4	1049.5	1142.6	1005.5	**1065.9**
Mean	**67.34**	**68.41**	**65.90**	--	**Mean**	**1010.0**	**1077.0**	**933.0**	--
Dates of sowing(S)	**Growth Regulators (G)**			**Mean**	**Dates of sowing (S)**	**Growth Regulators (G)**			**Mean**
	G_1	**G_2**	**G_3**			**G_1**	**G_2**	**G_3**	
S_1	66.71	67.51	65.47	**66.56**	S_1	1013.0	1083.0	951.0	**1015.5**
S_2	67.76	69.26	66.31	**67.77**	S_2	1024.0	1106.0	955.0	**1028.3**
S_3	67.56	68.45	65.92	**67.31**	S_3	992.0	1041.0	893.0	**975.7**
Mean	**67.34**	**68.41**	**65.90**	--	**Mean**	**1010.0**	**1077.0**	**933.0**	--
Interaction (VxSxG)	**Growth Regulators (G)**				**Interaction (VxSxG)**	**Growth Regulators (G)**			
	G_1	**G_2**	**G_3**			**G_1**	**G_2**	**G_3**	
V_1 **S_1**	67.55	68.66	65.60	--	V_1 S_1	881.29	971.16	710.85	--
S_2	66.51	68.86	65.89	--	**S_2**	1060.74	1121.39	858.04	--
S_3	67.76	67.51	66.74	--	**S_3**	878.65	940.53	769.55	--
V_2 **S_1**	67.09	68.11	66.28	--	V_2 **S_1**	1056.52	1076.97	1032.01	--
S_2	67.99	69.64	65.50	--	**S_2**	1099.93	1132.27	1080.07	--
S_3	67.31	68.41	66.18	--	**S_3**	1043.72	1098.99	907.41	--
V_3 **S_1**	65.76	66.05	64.84	--	V_3 **S_1**	1034.88	1051.63	1019.15	--
S_2	68.06	69.74	67.14	--	**S_2**	982.5	1021.81	983.30	--
S_3	68.06	69.49	65.84	--	**S_3**	931.72	976.20	820.10	--
V_4 **S_1**	66.44	67.22	65.16	--	V_4 **S_1**	1078.16	1131.74	1041.86	--
S_2	68.46	68.81	66.70	--	**S_2**	954.52	1147.38	897.83	--
S_3	67.09	68.37	64.94	--	**S_3**	1115.90	1148.71	1076.92	--
Source	**SE.m ±**		**C.D at 5 %**		**SE.m ±**			**C.D at 5 %**	
V	0.19		NS		10.49			29.28	
S	0.16		0.46		9.08			25.36	
G	0.16		0.46		9.08			25.36	
VxS	0.32		0.92		18.17			50.72	
VxG	0.32		NS		18.17			50.72	
SxG	0.28		NS		15.74			NS	
VxSxG	0.57		NS		31.48			87.86	

Varieties (V)
V_1 - Arka Jay
V_2 - Arka Amog
V_3 - Arka Sambhram
V_4 - Arka Sowmya

Dates of sowing (S)
S_1 - December 15th
S_2 - January 1st
S_3 - January 15th

Growth Regulators (G)
G_1 - NAA 25 ppm
G_2 - Triacontanol 2 ppm
G_3 - Control

Table.2 Effect of varieties, dates of sowing, growth regulators and their interaction on number of buds/node and days to 50% flowering in field bean in open field

Varieties (V)	Number of buds/node				Days to 50% flowering				
	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	5.06	5.07	3.25	**4.46**	V_1	43.16	40.60	41.10	**41.62**
V_2	4.34	4.53	4.80	**4.56**	V_2	43.86	40.92	41.50	**42.09**
V_3	5.10	4.43	3.61	**4.38**	V_3	41.97	41.55	42.22	**41.91**
V_4	4.70	5.18	5.33	**5.07**	V_4	45.16	41.01	43.13	**43.10**
Mean	**4.80**	**4.81**	**4.25**		**Mean**	**43.54**	**41.02**	**41.99**	--
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	4.50	4.51	4.37	**4.46**	V_1	41.56	41.01	42.29	**41.62**
V_2	4.43	4.96	4.28	**4.56**	V_2	42.01	41.57	42.70	**42.09**
V_3	4.31	4.68	4.15	**4.38**	V_3	41.86	41.39	42.49	**41.91**
V_4	4.94	5.34	4.94	**5.07**	V_4	42.99	42.60	43.71	**43.10**
Mean	**4.55**	**4.87**	**4.44**		**Mean**	**42.10**	**41.64**	**42.80**	--
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	4.74	5.07	4.60	**4.80**	S_1	43.53	43.16	43.93	**43.54**
S_2	4.66	5.06	4.67	**4.81**	S_2	40.97	40.23	41.85	**41.02**
S_3	4.23	4.47	4.04	**4.25**	S_3	42.10	41.64	42.80	**41.99**
Mean	**4.55**	**4.87**	**4.44**		**Mean**	**42.10**	**41.64**	**42.80**	--
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	5.57	5.10	4.54	--	V_1 S_1	43.34	42.28	43.85	--
V_1 S_2	4.57	5.10	5.55	--	S_2	40.33	40.13	41.34	--
V_1 S_3	3.38	3.57	3.02	--	S_3	41.00	40.60	41.68	--
V_2 S_1	4.06	4.69	4.28	--	V_2 S_1	43.61	43.70	44.25	--
V_2 S_2	4.46	5.10	4.04	--	S_2	41.20	39.92	41.61	--
V_2 S_3	4.77	5.10	4.54	--	S_3	41.20	41.07	42.22	--
V_3 S_1	4.67	5.61	5.05	--	V_3 S_1	41.73	41.74	41.42	--
V_3 S_2	4.57	4.69	4.04	--	S_2	41.41	40.60	42.62	--
V_3 S_3	3.71	3.73	3.36	--	S_3	42.42	41.80	42.42	--
V_4 S_1	4.69	4.89	4.54	--	V_4 S_1	45.40	44.89	45.17	--
V_4 S_2	5.07	5.43	5.05	--	S_2	40.93	40.26	41.81	--
V_4 S_3	5.07	5.71	5.25	--	S_3	42.63	42.63	44.13	--

Source	SE.m ±	C.D at 5 %	SE.m ±	C.D at 5 %
V	0.04	0.12	0.30	0.84
S	0.03	0.10	0.26	0.73
G	0.03	0.10	0.26	0.73
VxS	0.07	0.21	0.52	1.46
VxG	0.07	0.21	0.52	NS
SxG	0.06	NS	0.45	NS
VxSxG	0.13	0.37	0.90	NS

Varieties (V)
V_1 - Arka Jay
V_2 - Arka Amog
V_3 - Arka Sambhram
V_4 - Arka Sowmya

Dates of sowing (S)
S_1 - December 15th
S_2 - January 1st
S_3 - January 15th

Growth Regulators (G)
G_1 - NAA 25 ppm
G_2 - Triacontanol 2 ppm
G_3 - Control

Table.3 Effect of varieties, dates of sowing, growth regulators and their interaction on pod weight and pod yield per hectare in field bean in open field

Varieties (V)	Pod weight (g)				Pod yield (q/ha)				
	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	4.01	3.96	3.94	**3.97**	V_1	131.53	169.90	132.53	**144.66**
V_2	4.59	4.16	4.73	**4.49**	V_2	155.04	203.34	182.94	**180.44**
V_3	4.47	4.43	4.72	**4.54**	V_3	169.18	217.14	168.02	**184.78**
V_4	4.45	4.48	4.68	**4.54**	V_4	153.46	227.36	211.25	**197.36**
Mean	**4.38**	**4.26**	**4.52**	--	**Mean**	**152.30**	**204.43**	**173.69**	
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	3.95	4.10	3.87	**3.97**	V_1	145.43	158.12	130.42	**144.66**
V_2	4.53	4.60	4.35	**4.49**	V_2	181.68	191.57	168.06	**180.44**
V_3	4.45	4.55	4.62	**4.54**	V_3	186.77	189.36	178.21	**184.78**
V_4	4.55	4.61	4.45	**4.54**	V_4	192.77	221.34	177.96	**197.36**
Mean	**4.37**	**4.46**	**4.32**	--	**Mean**	**176.66**	**190.10**	**163.66**	
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	4.29	4.50	4.35	**4.38**	S_1	151.22	164.33	141.35	**152.30**
S_2	4.22	4.26	4.29	**4.26**	S_2	204.52	216.78	192.01	**204.43**
S_3	4.59	4.64	4.32	**4.32**	S_3	174.24	189.19	157.62	**173.69**
Mean	**4.37**	**4.46**	**4.32**	--	**Mean**	**176.66**	**190.10**	**163.66**	--
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	3.98	4.22	3.82	--	V_1 S_1	128.35	153.99	112.26	--
V_1 S_2	3.91	3.95	4.02	--	S_2	168.87	174.17	166.66	--
V_1 S_3	3.95	4.12	3.76	--	S_3	139.06	146.20	112.34	--
V_2 S_1	4.43	4.71	4.64	--	V_2 S_1	154.80	166.31	143.99	--
V_2 S_2	4.27	4.14	4.08	--	S_2	207.83	209.41	192.77	--
V_2 S_3	4.90	4.96	4.32	--	S_3	182.41	198.98	167.41	--
V_3 S_1	4.46	4.49	4.46	--	V_3 S_1	170.74	173.06	163.74	--
V_3 S_2	4.30	4.49	4.48	--	S_2	226.46	221.40	203.55	--
V_3 S_3	4.59	4.67	4.91	--	S_3	163.11	173.63	167.32	--
V_4 S_1	4.31	4.56	4.48	--	V_4 S_1	151.00	163.97	145.41	--
V_4 S_2	4.41	4.47	4.56	--	S_2	214.90	262.12	205.06	--
V_4 S_3	4.93	4.80	4.30	--	S_3	212.40	237.94	183.41	--

Source	SE.m ±	C.D at 5 %	SE.m ±	C.D at 5 %
V	0.06	0.16	2.45	6.83
S	0.05	0.14	2.12	5.92
G	0.05	NS	2.12	5.92
VxS	0.10	NS	4.24	11.84
VxG	0.10	NS	4.24	NS
SxG	0.09	NS	3.67	NS
VxSxG	0.18	NS	7.35	20.51

Varieties (V)
V_1 - Arka Jay
V_2 - Arka Amog
V_3 - Arka Sambhram
V_4 - Arka Sowmya

Dates of sowing (S)
S_1 - December 15th
S_2 - January 1st
S_3 - January 15th

Growth Regulators (G)
G_1 - NAA 25 ppm
G_2 - Triacontanol 2 ppm
G_3 - Control

The reason for variation in days to 50 per cent flowering might be due to varied weather conditions prevailed during different sowing times as reported by Hussain (2005) and Surekha (2006) in french bean.The influence of growth regulators on days to 50 per cent flowering was significant. The plants sprayed with Triacontanol 2 ppm spray took the lowest number of days to 50 per cent flowering (41.64 days) and it was on par with NAA 25 ppm (42.10 days) whereas, G_3 (control) took the highest number of days (42.80). This can be attributed to the higher rate of photosynthesis and reduced respiration due to Triacontanol application which might have resulted in the early flowering. The results are in agreement with findings of Sharma (1995) in tomato.The interaction effect of VxS was significant for days to 50 per cent flowering Arka Jay when sown on January 1st took less number of days to 50% flowering (V_1S_2)(40.60). The interactions effect of VxG, SxG and VxSxG was non-significant for days to 50 per cent flowering.

Varieties and dates of sowing showed significant effect on pod weight. Growth regulators, interaction of varieties and sowing dates, sowing dates and growth regulators and varieties, sowing dates and growth regulators showed non significant effect on pod weight and the results are depicted in Table 3.

The highest pod weight (4.54 g) was noticed in Arka Sowmya (V_4) and Arka Sambhram (V_3). Pod weight was lowest in Arka Jay (V_1) (3.97 g). It might be due to the genotypic variation among the varieties and their interaction with environmental factors reaction which might have accelerated the vegetative and reproductive growth phases ultimately promoted pod weight. The present findings are in agreement with the findings of Patel *et al.*, (2011), Ravinaik *et al.*, (2012) in dolichos bean.

Dates of sowing showed significant effect on pod weight. The highest pod weight was noticed with January 15th sowing (S_3) (4.52 g), followed by December 15th sowing (S_1) (4.38 g). January 1st sowing (S_1) recorded the lowest pod weight (4.26 g). The variation in pod weight might be due to variation in climatic factors owing to different sowing times. The present results are in consonance with the findings of Abido and Seadh (2014) in dolichos bean.

Growth regulators showed non-significant effect on pod weight. The interactions of varieties and sowing dates, varieties and growth regulators, sowing dates and growth regulators and varieties, sowing dates and growth regulators also showed non-significant effect on pod weight.

The results on pod yield per hectare in field bean as influenced by varieties, dates of sowing and growth regulators are presented in Table 3. The varieties recorded significant differences for pod yield per hectare. Arka Sowmya (V_4) recorded significantly the highest pod yield per ha (197.36 q) followed by Arka Sambhram (V_3) (184.78 q).The increase in pod yield per hectare may be ascribed to the results of the present study which showed more leaf area and pod weight. Further, yield also depends on the genetic constitution of the variety. The findings are in corroborate with the results obtained by Sharma *et al.*, (2014) and Prakash *et al.*, (2015) in dolichos bean.

Dates of sowing showed significant influence on pod yield per hectare. The crop sown on January 1st (S_2) recorded significantly the highest pod yield per hectare (204.43 q) followed by crop sown on January 15th (S_3) (173.69 q). Spraying of growth regulators showed significant influence on pod yield per hectare. Triacontanol 2 ppm as foliar spray (G_2) recorded the highest pod yield per

hectare (190.1 q), followed by spraying of NAA 25 ppm (G_1) (176.66 q). The positive influence of Triacontanol on plant yield might be due to its impact on the carbon cycle in plant *i.e.*, higher CO_2 fixation and their efficient translocation to the sink (Menon and Srivastava, 1984). Similar results were reported by Singh (2010) in fenugreek and Palakshi *et al.*, (2012) in tomato The interaction of varieties and sowing dates showed significant effect on pod yield per ha. Arka Sowmya recorded the highest pod yield per ha (227.36 q) when sown on January 1st (V_4S_2) followed by Arka Sambhram with same date of sowing (V_3S_2) (217.14 q). Arka Jay recorded the lowest yield per ha (131.53 q) when sown on December 15th (V_1S_1). The interaction of varieties and growth regulators and interaction of sowing dates and growth regulators showed non significant influence on pod yield per hectare. The interaction of varieties, dates of sowing and growth regulators influenced the pod yield per ha significantly. Arka Sowmya recorded the highest pod yield per ha (262.12 q) 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 sowing and the plants were sprayed with Triacontanol 2 ppm ($V_4S_3G_2$) (237.94 q).

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How to cite this article:

Padma, E., K. Uma Jyothi, G. Ramanandam, P. Subbaramamma and Uma Krishna, K. 2020. Effect of Varieties, Dates of Sowing, Growth Regulators and their Interaction on Growth and Yield of Dolichos Bean (*Lablab purpureus* L.) During off Season under Coastal Andhra Pradesh Conditions. *Int.J.Curr.Microbiol.App.Sci.* 9(09): 933-942.
doi: https://doi.org/10.20546/ijcmas.2020.909.115