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Growth and Yield of Castor Hybrids at Varying Nitrogen Levels in Andhra Pradesh, India

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A B S T R A C T

The present study was conducted to evaluate the response of three castor hybrids (PCH 111, GCH 4, Western Maruthi) to varying nitrogen levels (60, 80, 100 and 120 kg N ha^{-1}) under rainfed conditions at Agricultural College Farm, Bapatla during *kharif*, 2017. The growth characters *viz.*, plant height and dry matter accumulation at harvest, days to maturity and SPAD chlorophyll meter reading as well as yield attributing parameters *viz.*, number of capsules per primary spike and test weight as well as bean yield were significantly higher with PCH 111 hybrid and it was closely followed by hybrid GCH 4. Application of 120 kg N ha^{-1} recorded the highest growth and yield parameters.

Introduction

Castor is one of the important non-edible oil seed cash crop grown widely in rainfed areas of India. The productivity of this crop in rainfed environment quite often fluctuates due to vagaries of monsoon. The low productivity of rainfed castor is attributed to its cultivation under marginal soils having low available nitrogen. It is also attributed to the erratic rainfall distribution, use of non-descriptive cultivars and poor management practices.

Castor is exhaustive crop and responds well to the added fertilizers. Keeping these facts in view an experiment was conducted to study growth and yield of on different hybrids response to nitrogen doses.

Materials and Methods

A field trial was carried out during *kharif* 2017 on clay soil at Agricultural College Farm, Bapatla. It is situated at an altitude of 5.49 m above mean sea level, 15º 54' N latitude, 80º 25'E longitude. The soil was clayey in texture, slightly alkaline in reaction, low in organic carbon (0.3%), low in available nitrogen (200 kg ha^{-1}), high in available phosphorus (28.7 kg ha^{-1}) and available potassium (307 kg ha^{-1}). The mean maximum and minimum temperatures during crop growth period ranged from 37.6 °C and 26.1°C respectively. A total of 686.6 mm rainfall was received during crop growth period in 28 rainy days. The experiment was replicated thrice where in twelve treatment combinations comprising of

three hybrids and four levels of nitrogen were tested in randomized block design with factorial concept. The crop was sown on 3rd August, 2017. Nitrogen was applied in the form of urea (46% N) as per the treatments in 3 splits i.e., ½ at the time of sowing, ¼ at 30-35 DAS and ¼ at 60-65 DAS. A common dose of 40 kg P_2O_5 and 30 kg K_2O ha^{-1} was applied in the form of single superphosphate (16% P_2O_5) and muriate of potash (60% K_2O), respectively, as basal. Standard procedures were adopted for recording data on various growth and yield parameters. Necessary plant protection measures were taken. The data were analyzed statistically by adopting the standard procedure described by Gomez and Gomez (1984).

Results and Discussion

Growth parameters

The data on growth parameters of different castor hybrids as influenced by nitrogen levels are presented in Table 1. There was no significant variation in plant height recorded at 30 DAS in different hybrids. Castor hybrid GCH 4 recorded maximum plant height (67.2 cm) at 60 DAS which was significantly superior to the other two hybrids tested *viz.*., PCH 111 and Western Maruthi.

At 90 DAS and at harvest significantly taller plants were obtained with PCH 111 compared to GCH 4. The differences in plant height observed among the castor hybrids might be due to their differences in genetic makeup. Significantly higher plant height of 121.4 cm was noticed with 120 kg N ha^{-1} than lower nutrient levels and the lowest was recorded with application of 60 kgNha^{-1}.

This, increasing trend in plant height might be due to the reason that nitrogen hastens the metabolic activity in the plant body by synthesizing tryptophan, a precursor for the auxins, which in turn resulted in increased plant height. But under limited availability of nitrogen reduced cell divison and elongation occurs which ultimately reduced the plant height. The results obtained in present study are in close agreement with Torres *et al.,* (2016) and Hanumanthappa *et al.,* (2011).

Drymatter accumulation is one of the important parameter which influences the crop growth. Drymattter accumulation with GCH 4 at 60 DAS was highest with 694 kg ha^{-1} which was significantly superior to Western Maruthi (581 kg ha^{-1}). At 90 DAS and harvest, the drymatter accumulation with PCH 111 with (4234, 6663 kg ha^{-1}) was significantly higher when compared with GCH 4(3018, 5419 kg ha^{-1}) and Western Maruthi (3558, 5892 kg ha^{-1}), respectively. The increase in drymatter accumulation with PCH 111 was 40.2 per cent and 22.9 per cent, over GCH 4 while it was 18.9 per cent and 13.0 per cent, higher with Western Maruthi at 90 DAS and at harvest, respectively. Nitrogen levels had a significant influence on drymatter accumulation from 60 DAS to maturity.

Application of nitrogen @ 120 kg N ha^{-1} resulted in maximum accumulation of drymatter which was significantly superior to 60 kg N ha^{-1} and on a par with 80 kg N ha^{-1} and 100 kg N ha^{-1} at 60 DAS. At 90 DAS and at harvest, 120 kg N ha^{-1} recorded significantly highest drymatter over 60 kg N ha^{-1} and 80 kg N ha^{-1} levels. At 90 DAS, the drymatter accumulation was significantly influenced by the interaction between hybrids and nitrogen levels. The highest drymatter accumulation (4596 kg ha^{-1}) was with combination of PCH 111 and 120 kg N ha^{-1} which was on a par with PCH 111 and 100 kg N ha^{-1} and Western Maruthi and 120 kg N ha^{-1} where the drymatter production was 4203 kg ha^{-1} and 4370 kg $ha,^{-1}$ respectively and were significantly superior to all other treatment combinations (Table 2).

Table.1 Growth parameters of castor as influenced by hybrids and nitrogen levels

Treatment	Plant height (cm)				Drymatter accumulation				(Days to maturity)	SPAD chlorophyll meter
	30	60	90	At harvest	30	60	90	At harvest		
Hybrids										
V_1 - PCH 111	28.3	59.4	110.6	111.3	57	607	4234	6663	158	44.9
V_2 - GCH 4	30.2	67.2	96.4	95.9	58	694	3018	5419	145	46.7
V_3 - Western Maruthi	28.2	60.4	109.3	110.8	56	581	3558	5892	170	46.1
S.Em±	0.72	1.99	3.10	2.43	2.5	29.8	115.9	141.4	0.54	0.61
CD (p = 0.05)	NS	5.8	9.0	7.1	NS	87.5	340.1	417.4	1.5	NS
Nitrogen levels (kg ha^{-1})										
N_1 - 60	28.4	57.0	92.4	93.1	54	545	3202	5543	157	43.3
N_2 - 80	29.0	61.9	93.3	93.9	57	608	3536	5808	157	45.1
N_3 - 100	28.9	63.6	115.9	115.7	58	659	3711	6105	158	47.0
N_4 - 120	29.2	66.8	120.1	121.4	59	699	3965	6508	160	48.2
S.Em±	0.83	2.30	3.58	2.81	2.9	34.4	133.9	163.2	0.62	0.70
CD (p = 0.05)	NS	6.7	10.5	8.26	NS	101.0	392.7	478.8	1.8	2.0
Interaction (VX N)										
S.Em±	1.44	3.99	6.20	4.87	5.0	59.70	231.9	282.8	NS	1.2
CD (p = 0.05)	NS	NS	NS	NS	NS	NS	680.2	NS	1.1	NS
CV (%)	8.61	11.0	10.1	7.9	15.1	16.4	11.1	8.1		4.6

Table.2 Interaction between castor hybrids and nitrogen on drymatter production at 90 DAS (kg ha^{-1})

Hybrids	N levels (kg ha^{-1})				Mean
	N_1 -60	N_2 -80	N_3 -100	N_4 -120	
V_1 – PCH 111	4083	4060	4203	4596	4234
V_2 - GCH 4	2632	3500	3005	2937	3018
V_3 - Wesern Maruthi	2890	3049	3925	4370	3558
Mean	3202	3536	3711	3965	
S.Em±	231.9				
CD (p = 0.05)	680.2				

Table.3 Yield attributes and bean yield of castor as influenced by hybrids and nitrogen levels

Treatment	No. of capsules primary spike^{-1}	Test weight (g/100 beans)	Bean yield (kg ha^{-1})
Hybrids			
V_1 - PCH 111	90	26.5	2703
V_2 - GCH 4	72	26.4	2494
V_3 - Western Maruthi	67	26.7	1899
S.Em±	1.99	0.24	84.9
CD (p = 0.05)	5.8	NS	249.2
Nitrogen levels			
N_1 - 60	67	26.1	2015
N_2 - 80	71	26.2	2159
N_3 - 100	79	26.9	2505
N_4 - 120	88	27.0	2781
S.Em±	2.30	0.28	98.1
CD (p = 0.05)	6.7	NS	287.8
Interaction (V X N)			
S.Em±	3.99	0.48	169.9
CD (p = 0.05)	NS	NS	498.5
CV (%)	9.0	3.2	12.4

Table.4 Interaction between hybrids and nitrogen in castor (kg ha^{-1})

Hybrids	N levels (kg ha^{-1})				Mean
	N_1 -60	N_2 -80	N_3 -100	N_4 -120	
V_1 – PCH 111	2035	2140	3242	3396	2703
V_2 - GCH 4	2156	2406	2498	2914	2494
V_3 - Western Maruthi	1854	1932	1775	2034	1899
Mean	2015	2159	2505	2781	
S.Em±	169.9				
CD (p = 0.05)	498.5				

The probable reason for such a positive response upto 120 kg N ha^{-1} was availability of nitrogen in synchrony with crop need which has resulted in good vegetative growth, better root development and efficient photosynthesis and finally accumulated more drymatter. Such increase in drymatter with the application of nitrogen was also reported by Sarada Devi *et al.,* (2002) and Lakshmi and Sambasiva Reddy (2006).

Castor hybrid, Western Maruthi took maximum number of days (170) to attain maturity and it was significantly superior to the other two hybrids. Earliness in GCH 4 hybrid is due to early set of reproductive activity. The delay to reach maturity in PCH 111 and Western Maruthi might be due to highest plant height, more number of branches which resulted in luxurious growth of the crop and took more number of days before the crop transformed from vegetative to reproductive phase, leading to delay in harvest. Application of maximum dose of nitrogen 120 kg N ha^{-1} took highest number of days to mature and was significantly superior to other doses of nitrogen applied. The present results corroborate with the findings of Venugopal *et al.,* (2006) and Mishra and Tewari (2014). The hybrids of castor could not reach the level of significance for SPAD chlorophyll meter reading. Nitrogen @ 120 kg N ha^{-1} resulted in maximum chlorophyll content which was significantly superior to that of 60 kg N ha^{-1} and 80 kg N ha^{-1} and was on a par with that of 100 kg N ha^{-1}. Increase in nitrogen dose might have contributed to chlorophyll content of castor with incremental doses of nitrogen.

Yield attributes and yield

There was a significant difference in the yield components *viz.,* number of capsules per spike and test weight (Table 3). Castor hybrid, PCH 111 recorded significantly higher number of capsules per primary spike (90) whereas Western Maruthi recorded significantly lowest number of capsules per primary spike (67). More plant height, higher drymatter accumulation and a better source-sink relationship established in PCH 111 hybrid might have resulted in greater number of capsules primary $spike^{-1}$ than Western Maruthi which might be due to inefficient drymatter partitioning. Among levels of nitrogen, maximum number of capsules per primary spike were recorded when 120 kg N ha^{-1} was applied and it was significantly superior to other rates of nitrogen application. Similarly, 100 kg N ha^{-1} recorded 79 capsules per primary spike which was significantly superior to that of 80 kg N ha^{-1} and 60 kg N ha^{-1}. The increase in number of capsules primary $spike^{-1}$ was in the order of 31.9, 23.9, 11.3 per cent, with 120, 80 and 100 kg N ha^{-1}, respectively over 60 kg N ha^{-1}. This shows that increased availability of nitrogen in sufficient quantities increased the drymatter accumulation of plants, which might have acted as a source to supply nutrients to reproductive parts i.e. flowers and capsules which might have increased the number of capsules primary $spike^{-1}$. The data on test weight recorded indicated that hybrids and nitrogen levels could not reach the level of significance However, numerically increase in nitrogen levels from 60 - 120 kg N ha^{-1} improved the test weight (g) in increasing trend. These findings are in consonance with those of and Vijay Bhaskar Reddy *et al.,* (2007) and Hanumantahappa *et al.,* (2011).

Castor hybrid PCH 111 recorded maximum bean yield of 2703 kg ha^{-1} which was significantly superior to Western Maruthi with 1899 kg ha^{-1}. There was 42.3 per cent increase in bean yield with PCH 111 over Western Maruthi. In PCH 111 and GCH 4 more number of total spikes $plant^{-1}$ and capsules $spike^{-1}$ have contributed the maximum bean yield when compared with other hybrid. These are physiologically important yield attributes, which have a positive correlation with bean yield of castor and also due to delayed senescence of leaves which helped these hybrids to produce more photosynthates, thus increasing the assimilatory efficiency. The lowest seed yield recorded in Western Maruthi might be due to poor source- sink relationship and lower yield attributes. Application of 120

kg N ha^{-1} significantly enhanced the bean yield (2781 kg ha^{-1}) over rest of the nitrogen levels but it remained on par with 100 kg N ha^{-1} and it was 38.0 per cent higher than that of 60 kg N ha^{-1}. The interaction effect between hybrids and nitrogen levels on total castor bean yield presented in Table 4 showed that maximum bean yield 3396 kg ha^{-1} was attained with the treatment PCH 111 at 120 kg N ha^{-1}. However, it was statistically on par with PCH 111 at 100 kg N ha^{-1} with 3342 kg ha^{-1} and GCH 4 at 120 kg N ha^{-1} with 2914 kg ha^{-1}.

The increase in bean yield of castor due to more synchronous availability of 'N' as per crop need with the application of 120 kg N ha^{-1} might have tended to put more vegetative growth, better root development, more drymatter accumulation and yield attributing characters which resulted in efficient photosynthesis and finally produced more bean yield. The present results are in conformity with those of Torres *et al.,* (2016) and Man *et al.,* (2017). Based on this study, it can be concluded that cultivation of castor variety PCH 111 and GCH 4 with 120 kg N ha^{-1} has recorded higher growth and yield parameters and bean yield in Andhra Pradesh under rainfed condition.

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