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Original Research Article

Effect of Plant Spacing and Fertilizer Levels on Yield and Yield Attributes of Castor (*Ricinus communis* L.)

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Keywords

Plant spacing, Fertilizer, Attributes, Castor (*Ricinus communis* L.)

A B S T R A C T

A field experiment was conducted during *kharif* season of 2016 at Experiment Farm, Department of Agronomy, College of Agriculture, Latur, to study the effect of plant to plant spacing and fertilizer levels on castor. The results indicated that growth and yield attributing characters of castor viz. plant height, number of functional leaves, number of capsules plant^{-1}, total dry matter, seed yield per plant were appreciably improved with the spacing of 75 cm (P_3). The plant to plant spacing of 45 cm (P_1) was found to be significantly effective in producing higher seed yield (kg ha^{-1}), oil yield (kg ha^{-1}), gross monetary returns, net monetary returns and B: C ratio which was at a par with the spacing of 60 cm (P_2) and significantly superior over 75 cm spacing. Among different fertilizer levels, the application of 80:50:40 NPK kg ha^{-1} (F_3) produced significantly higher growth and yield attributing characters, higher seed yield and oil yield (kg ha^{-1}), gross and net monetary returns with higher B: C ratio as compared to 40:30:20 NPK kg ha^{-1} (F_1) and it was at par with 60:40:30 NPK kg ha^{-1} (F_2).

Introduction

Castor (*Ricinus commuunis* L.) is one of the oilseed crop and plays an important role in country's vegetable oil economy. It is indigenous to Eastern Africa and originated in Ethiopia. Red and white seeded variety of castor were described in the ancient book of Indian "Susrut Samhita" written nearly 2000 years ago, which indicates familiarity of the crop to Indians since ancient time. Castor seed contain 50-55 per cent oil and occupies second position in the production of non-edible oil in the world. It is sticky, dissolved slowly in petrol and other organic solvents and does not freeze at very low temperature (-12 to -18°C) which makes it superb lubricating material.

India is the world's largest producer of castor contributing to around 80 per cent of total world production and dominating the global trade with a share of more than 10 lakh tonnes of castor seed and around 5.5 lakh tonnes of castor oil, India meets more than 80 per cent demand of castor oil, thereby enjoying a dominant position in the world castor scenario. The production in India has been with standing an increasing trend in the 2001-2014 decade due to rising usage of castor oil in different industries. Moreover, strong export demand for castor oil was also one of the reasons for rise in production. Gujarat, Rajasthan and Andhra Pradesh contribute 96 per cent of the total castor seed production in India. Gujarat is the chief producing state, having a share of 75 per cent of domestic production, followed by Rajasthan and Andhra Pradesh. Total area under castor crop in India for year 2013-14 was 9.84 lakh ha and production of castor seed was 12.03 lakh tonnes. Average yield for 2013-14 was 1223 kg ha^{-1} (Anonymous, 1995).

In Maharashtra, castor is grown on an area of 10132 ha with the production of 3036 tonnes of castor seed and average productivity of 310 kg ha^{-1} (Anonymous, 2003). Thus, the statistics on area, production and productivity of castor in Maharashtra are not encouraging when compared with Gujarat and India. In castor plant with an important aspect of its nutrition that will help in taking decision to improve its production and management. It will also help in adoption of proper package and practices for castor crop and reduce the cost of fertilization and know requirement of fertilizer and appropriate plant spacing of castor plant. In view of above consideration the present investigation was carried out entitled "Effect of plant spacing and fertilizer levels on castor (*Ricinus communis* L.)" was planned with objectives to find out appropriate plant spacing of castor crop and to assess the fertilizer requirement under variable plant spacing.

Materials and Methods

The experiment was conducted during *kharif* season of 2016-17 at Experimental Farm, Department of Agronomy, College of Agriculture, Latur. The topography of experimental field was uniform and leveled. The soil of the experimental site was deep, black in colour with good drainage. The soil of experimental plots was clayey in texture. The chemical composition of experimental plots indicated that the soil was low in available nitrogen (159.6kg ha^{-1}), medium in available phosphorus (18.00 kg ha^{-1}), very high in available potassium (454.06 kg ha^{1}) content and alkaline in reaction having pH of 7.90.The mean annual precipitation was about 735 mm. Most of the monsoon rains (72 per cent) received from June to September. The present experiment was laid out by using Factorial Randomized block design with three replications. There were nine combinations of two factors i.e plant spacing (45, 60 and 75 cm) and fertilizer doses (40:30:20, 60:40:30, 80:50:40 kg N, P and K per ha) each three levels. The seeds of hybrid DCH 177 were sown at the depth of 5 cm. Sowing was done by dibbling by using seed rate as per different treatment according to plant spacing kg ha^{-1}. The gross and net plot size was 6.3 x 4.5 m and 2.7 m x variable respectively. The total rainfall received during growth period of cowpea was 1096 mm with 38 rainy days. The recommended dose of fertilizer was 60:40:30 kg NPK ha^{-1} applied as per treatments through Urea, single super phosphate and murate of potash. Weed control was done by hand weeding. Statistical analysis of the data was carried out using standard analysis of variance.

Results and Discussion

Effect of plant spacing and fertilizer levels on castor- Results shows that at harvest the closer plant to plant spacing (45 cm) was recorded higher plant height (133.87 cm).and at harvest the maximum plant height was recorded with the application of 80:50:40 Kg NPK ha^{-1}. This treatment significantly superior over 40:30:20 Kg NPK ha^{-1}. The narrow inter row and intra row plant spacing might have provided insufficient space for spread or low plant canopy area and energy diverted upward increasing height instant of spreading due to lower area available to each plant and increased in height at narrow spacing 90 x 45 cm. This is in agreement with the findings Ivanov *et al.,* (1996), Virendersardana *et al.,* (2008). Among the plant to plant spacing, 75 cm (P_3) was significantly superior over 60 cm (P_2) and 45 cm (P_1) at harvest. This might be due to sufficient availability of nutrients, space, sunlight and soil moisture leads to more number of leaves and broader leaves resulted in higher leaf area under wider plant to plant spacing (75 cm). The closer plant to plant spacing (45 cm) was recorded lower number of nodes plant^{-1}. This might be due to lower production of photosynthesis and more competition for nutrient, light and moisture. Due to reduced nutritional area per plant resulted in low supply of nutrients which might have decreased growth rate of crop under narrow spacing. Such type of advantage of wider spacing in castor was also reported from Talod (Anonymous, 1996).

Thus the increased total dry matter per plant at wider plant spacing which usually associated with increased leaf area per plant has led to greater accumulation of photosynthates due to wider plant to plant spacing (75 cm) better availability of light, nutrient and moisture. Similar findings reported by Rao and Venkateswarlu (1988) from Hyderabad narrow spacing 90 x 45 cm. This is in agreement with the findings Ivanov *et al.,* (1996), Virendersardana *et al.,* (2008). Among the plant to plant spacing, 75 cm (P_3) was significantly superior over 60 cm (P_2) and 45 cm (P_1) at harvest. This might be due to sufficient availability of nutrients, space, sunlight and soil moisture leads to more number of leaves and broader leaves resulted in higher leaf area under wider plant to plant spacing (75 cm).The closer plant to plant spacing (45 cm) was recorded lower number of nodes plant^{-1}. This might be due to lower production of photosynthesis and more competition for nutrient, light and moisture. Due to reduced nutritional area per plant resulted in low supply of nutrients which might have decreased growth rate of crop under narrow spacing. Such type of advantage of wider spacing in castor was also reported from Talod (Anonymous, 1996). Mean stem girth is the result of amount of total dry matter accumulation in stem and subsequent development of stem tissue. The mean stem girth was increasing substantially as the plant to plant spacing was increasing from 45 cm to 75 cm. thereby resulting in total dry matter accumulation and subsequently increase in mean stem girth of the castor crop plant. Wider plant to plant spacing and significantly higher total dry matter per plant and at par with the narrow plant to plant spacing (60 cm) and found significantly superior over 45 cm. Thus the increased total dry matter per plant at wider plant spacing which usually associated with increased leaf area per plant has led to greater accumulation of photosynthates due to wider plant to plant spacing (75 cm) better availability of light, nutrient and moisture. Similar findings reported by Rao and Venkateswarlu (1988) from Hyderabad.

Application of 80:50:40 NPK kg ha^{-1} (F_3) was found significantly effective than 40:30:20 NPK kg ha^{-1} and 60:40:30 NPK kg ha^{-1} in increasing in all growth and yield parameter. This might be due to enhanced mostly all the growth and yield parameters with higher levels of balanced fertilizer (NPK). The nitrogen promotes leaf, stem and other vegetative growth, produce rapid and early growth. Phosphorus stimulate early root development, flowering and aids in seed formation. Adequate supply of phosphorus in early stage helps in increasing number of branches for the reproductive plant parts.

Table.1 Growth attributes of castor as influenced by plant spacing's and fertilizer levels

Treatment	Plant height (cm)	Leaf area(dm^2)	Dry matterplant^{-1}(g)
A. Plant to plant spacing			
P_1 - 45 cm	133.87	11.60	129.67
P_2 - 60 cm	126.94	13.25	142.91
P_3 - 75 cm	126.18	14.61	143.90
SEm±	2.35	0.40	2.83
CD at 5 %	NS	1.23	8.48
B. Fertilizer Levels (NPK kg/ha)			
F_1 - 40:30:20	125.38	12.36	132.64
F_2 - 60:40:30	127.86	13.07	140.38
F_3 - 80:50: 40	133.76	14.03	143.46
SE m±	2.35	0.40	2.83
CD at 5 %	NS	1.23	8.48
Interaction (P x F)			
SE m±	4.08	6.70	4.90
C.D. at 5 %	NS	NS	NS
General Mean	**133.87**	**13.25**	**139**

Table.2 Yield and yield attributes of castor as influenced by plant spacing's and fertilizer levels

Treatments	Number of Spike plant^{-1}	Number of capsule plant^{-1}	Seed yield plant^{-1} (g)	Seed index (g)	Seed yield (kg ha^{-1})
A. Plant to plant spacing					
P_1 - 45 cm	5.30	131	82	23.47	1205
P_2 - 60 cm	5.68	141	87	23.76	1120
P_3 - 75 cm	6.40	169	97	24.90	957
SEm±	0.29	3.00	2.36	0.37	37.61
CD at 5 %	0.87	9.48	7.07	1.13	113
B. Fertilizer Levels (NPK kg/ha)					
F_1 - 40:30:20	4.97	135	80	22.81	983
F_2 - 60:40:30	5.97	146	86	24.36	1113
F_3 - 80:50: 40	6.44	161	99.39	24.96	1187
SE m±	0.29	3.16	2.36	0.37	37.61
CD at 5 %	0.87	9.48	7.07	1.13	113
Interaction (P x F)					
SE m±	0.50	5.48	4.08	0.65	65
C.D. at 5 %	NS	NS	NS	NS	NS
General Mean	**3.79**	**147**	**88**	**24**	**1094**

Whereas potassium helps in seed development, improves the quality of final products. These activities of nitrogen, phosphorus and potassium are responsible for better growth and yield attributes. Similar results for P and K were reported by Kathmale *et al.,* (2008), Virendarsardana *et al.,* (2008) also found higher growth attributes with higher levels of fertilizers.

Among the different plant to plant spacings, 75 cm (P_3) produced significantly highest number of spikes per plant (6.40) and number of capsules per plan over rest of spacings and lowest produced due to 45 cm (P_1). This happens may be due to the wider plant to plant spacing (75 cm) provides the better nutrients, light and moisture in adequate amount resulted in higher dry matter production alternatively it converts in higher number of spikes and capsuls plant^{-1}.

The mean seed index (100 seed weight) of castor was significantly influenced due to different spacing. The spacing 75 cm (P_3) was recorded significantly highest seed index (24.90 g) than closer spacing might be due to lower competition among plant for nutrient, light and moisture which increase dry matter accumulation per plant and resulted in better development of seed due to increased test weight under wider spacing. Such wider spacing was reported by Thadoda *et al.,* (1996). Thus, the increased number of spikes per plant at wider plant densities which usually associated with increased number of capsule per plant has led to greater seed yield per plant. This resulted in relatively better yield per plant at wider plant spacing than at lower plant spacing.

The mean seed yield per plant was influenced significantly due to different spacings. The spacing of 75 cm (P_3) was recorded highest mean seed yield per plant over rest of the spacings this might be due to higher photosynthesis and higher dry matter production converted into seed yield by the availability of sufficient space for growth.

The yield attributing character viz. number of spikes plant^{-1}, number of capsule plant^{-1}, seed yield plant^{-1} and seed index (g) were influenced significantly due to different fertilizer levels.

The application of fertilizer @ 80:50:40 NPK kg ha^{-1} (F_3) recorded higher yield attributes. It might be due to higher fertilizers levels (80:50:40 NPK kg ha^{-1}) enhanced the growth attributes through increasing photosynthetic efficiency which ultimately contributes to higher yield attributes of the plant. Similar result also reported by M.S. Jakasaniya *et al.,* (2009), Singh I. (2009).

Application of 80:50:40 NPK kg ha^{-1} (F_3) recorded significantly higher seed yield (kg ha^{-1}) over the 40:30:20 NPK kg ha^{-1} (F_1) and found to be at par with 60:40:30 (F_2). This might be due to higher growth and yield contributing characters with higher levels of fertilizers which results in increasing the final yield. The similar results were obtained by Singh I (2009), Shrivastava S.K. and Singh N.D. (2009).

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