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Growth and Productivity of Castor as Influenced by Millet Based Intercropping Systems

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during summer season of 2022 at Tamil Nadu Agricultural University, Coimbatore to study the influence of millet based intercropping systems on growth and productivity of castor under irrigated situation. The experiment was laid out in randomized block design and replicated thrice. The treatment consist of nine cropping systems *viz*., castor + foxtail millet (1:3), castor + proso millet (1:3), castor + little millet (1:3), castor + kodo millet (1:3), paired row castor + foxtail millet (2:4), paired row castor + proso millet (2:4), paired row castor + little millet (2:4), paired row castor + kodo millet (2:4), sole castor. Experimental results revealed that the different millet based cropping systems significantly influenced growth and productivity of castor. Sole castor was recorded the highest growth, yield parameters and seed yield (20.98 q/ha). Among the millet based intercropping systems, maximum values of growth parameters *viz*., plant height

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(170.20 cm), number of branches/plant (7.90), stem girth (8.70 cm) and dry matter production (29.83 q/ha) were recorded in the paired row castor + proso millet (2:4) and it was on par with paired row castor + foxtail millet (2:4). Similarly, yield and yield attributing characters *viz*., number of spike/plant (28.2), number of capsule/ spike (55.8), highest length of primary branch (40.1 cm) and seed yield (20.03 q/ha) was obtained in paired row castor + proso millet (2:4) and it was comparable paired row castor + foxtail millet (2:4). The economic study revealed that the higher net return and benefit cost ratio was obtained from paired row castor + foxtail millet (2:4) (₹. 74,842.00 and 2.30) and paired row castor + proso millet (2:4) ((₹. 72,702.00 and 2.26). From this study, it was concluded that proso millet and foxtail millet were indentified to be compatible intercrops with castor for improved productivity.

Keywords: Castor; growth; millets; productivity.

1. INTRODUCTION

Castor (*Ricinus communis L.*) is a non-edible oilseed crop of India with significant commercial value. India is the world's largest producer of castor with the production of 7.7 lakh tonnes sharing 68 and 76 per cent castor area and output and generates over rupees 40000 million in export revenue each year. India outperforms the global average for castor productivity followed by other big producers like China and Brazil. In India castor is cultivated in an area of 887.50 thousand hectares with a production of 1646.96 thousand tonnes and productivity of 1856 kg/ha [1]. Castor contains 85–90% naturally occurring ricinoleic acid. Due to its strong root structure, it thrives well in dry conditions as well as with minimal irrigation. Cultivation of castor is popular due to its strong export potential and medical benefits.

Farmers are developing different crop production systems to increase productivity and sustainability since ancient times. This includes crop rotation, relay cropping and intercropping of major crops with other crops. However, several factors like cultivar, seeding ratios, planting pattern and competition between mixture components affect the growth of species in intercropping. The major objective of intercropping is to produce an additional crop, to optimize the use of natural resources and to stabilize the yield of crops and to overcome the risk. The intercropping systems involve smart risk protection combinations [2].

Consumption of minor millets has showed good health effects among diabetes patients. Castor is grown as a mixed or intercrop and as a solitary crop. Because the inter- and intra-row spacing is larger, it is perfect for intercropping systems. Hence, the present study was undertaken to identify the best millet based intercropping systems to increase productivity of castor.

2. MATERIALS AND METHODS

2.1 Site Selection

The field experiment was conducted during summer 2022 at Eastern Block Farm, Tamil Nadu Agricultural University, Coimbatore located in Western Agro Climatic Zone of Tamil Nadu with 11°N latitude, 76°E longitude and at an altitude of 427 m above the mean sea level. The maximum and minimum temperatures recorded were 32.9^{o}C and 22.6^{o}C, respectively. The relative humidity was 82.7% in the forenoon (07:22 hrs.) and 47.2% in the afternoon (14:22 hrs.). The average annual rainfall of the area was 695.8 mm.The bright sunshine of 6.9 hours day^{-1} and the mean solar radiation of 355.7 cal cm^{-2} day^{-1} were recorded. The wind speed of 5.8 km hr^{-1}. The soil was sandy clay loam has low available nitrogen (174 kg ha^{-1}), medium available phosphorus (22.3 kg ha^{-1}) and high available potassium (800 kg ha^{-1}).

2.2 Experimental Description

The study was conducted in randomized complete block design and replicated thrice with following treatments *viz*., T_1 - castor + foxtail millet (1:3), T_2 - castor + proso millet (1:3), T_3 - castor + little millet (1:3), T_4 - castor + kodo millet (1:3), T_5 - paired row castor + foxtail millet (2:4), T_6 - paired row castor + proso millet (2:4), T_7 - paired row castor + little millet (2:4), T_8 - paired row castor + kodo millet (2:4), T_9 - sole castor. The hybrid castor YRCH 1 was sown at the depth of 4-6 cm with the seed rate of 5 kg /ha with spacing for intercropping (150 x 120 cm) and for paired row spacing was carried out of about 90 x 120 cm. Three rows of nutri cereals were sown in between two rows of castor (1:3). Four rows of nutri cereals were sown in between two paired rows of castor (2:4). As per the blanket recommendation, 196:281:75 NPK kg/ha were supplied through urea, single super phosphate and muriate of potash. In irrigated situations apply 100% P and 50% N and K as basal and remaining quantity of N and K may be applied in two equal splits at 30 and 60 DAS. $ZnSO_4$ was applied @ 12.5 kg/ha. Observations on growth parameters *viz*., plant height (cm), number of effective branches/plant, stem girth (cm), dry matter production (kg/ha) and yield attributes *viz*., number of spike/plant**,** length of primary spike (cm), number of capsule/spike,100 seed weight (g) and seed yield (q/ha) were recorded by selecting 5 plants randomly in each plot. The data analysed statistically under the randomised block design. If the treatment differences were found to be significant, then the critical difference (CD) was worked out at 5% probability level (P=0.05). If no significant differences observed between any treatments, then it was considered as non-significant and indicated as NS [3].

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

Experimental results revealed that the growth parameters showed significant improvement such as plant height, number of branches/plant, stem girth and dry matter production which are direct indices to measure plant growth and vigour. All the growth components were influenced due to different intercropping systems at harvest stage of castor (Table 1). At harvest, sole castor recorded highest plant height (175.36 cm), which was on par with paired row castor + proso millet (2:4) (170.20 cm) and was followed by paired row castor + foxtail millet (2:4) (155.61 cm). This could be due to less competition environment prevailed in proso millet and foxtail millet inctercropped systems. In sole castor wider spacing leads to taller plants. Similar findings were also observed by [4] and [5]. Among the treatments, sole castor recorded more number of branches/plant (9.20) and stem girth (9.50 cm) at harvest and was followed by paired row castor + proso millet (2:4), paired row castor + foxtail millet (2:4). A crop's biological and economic yield directly correlates with the number of branches per plant. Having more branches means producing a higher yield, hence branches per plant are an important characteristic [6]. Sole castor recorded higher dry matter production (3545 kg/ha) which was closely followed by paired row castor + proso millet (2:4) (2983 kg/ha) and paired row castor + foxtail millet (2:4) (2925 kg/ha). Paired row castor with kodo millet (2:4) had most competitive effect for least dry matter production of 2050 kg/ha. Similarly castor + kodo millet (1:3) also showed inhibitive effect among all. The higher dry matter production under paired row sowing may be attributable to the higher leaf area index, which received more photosynthetically active radiation, leading to an increase in photosynthetic efficiency. In addition, paired row sowing was associated with higher nutrient uptake than regular row sowing [7] and [8].

3.2 Yield Attributes and Yield

Yield attributes and yield were significantly influenced by intercropping systems (Table 2.). Sole castor recorded significantly a greater number of spike/plant (28.2), number of capsule/spike (55.8) and highest length of primary branch (40.1 cm) and was comparable to paired row castor + proso millet and paired row castor + foxtail millet (2:4) in all pickings. The yield parameters were not significantly affected by the number of castor plants cultivated in intercrops (1:3) and paired rows (2:4). This was brought about by an increase in light absorption, more available space and reduced competition for nutrients, water and light. Similar findings were observed by [9] and [10]. In castor with leguminous intercropping systems, [11] showed similar results where the intra-specific competition was not increased by the pairing of rows as compared to castor that was sown in evenly spaced rows, this gave space for additional rows of intercrops. Castor + kodo millet (1:3) intercropping and castor + kodo millet grown in paired rows both had significantly less spike/plants, primary spike length and capsule per plants (2:4) due to competitive effect and less use efficiency of space, light, nutrients and more weed density in kodo millet intercropped castor systems. The various treatments showed no significant influence on the weight of 100 castor seeds. Similar findings were observed by [12]. The highest castor seed yield (20.98 q/ha) was recorded in sole castor which was found on par with paired row castor + proso millet (2:4) (20.03 q/ha) and paired row castor + foxtail millet (2:4) (19.14 q/ha). This was primarily caused by a significant increase in yield components, such as the number of spike /plant, the number of capsule/plant and the length of the primary spike, as a result of improved light distribution up to lower leaves, adequate soil moisture availability and higher nutrient uptake in paired row systems. Similar findings were observed by [13].

Table 1. Effect of millet based intercropping on growth parameters of castor

Treatment	Plant height (cm)	No. of effective branches/ plant	Stem girth (cm)	Dry matter production (kg/ha)
Castor + foxtail millet (1:3)	138.61	6.80	6.40	2656
Castor + proso millet (1:3)	148.20	7.00	6.60	2802
Castor + little millet (1:3)	134.25	6.50	6.50	2425
Castor + kodo millet (1:3)	124.12	6.25	7.00	2116
Paired row castor + foxtail millet (2:4)	155.61	7.20	7.00	2925
Paired row castor + proso millet (2:4)	170.20	7.90	8.70	2983
Paired row castor + little millet (2:4)	131.24	6.50	6.80	2216
Paired row castor + kodo millet (2:4)	120.41	6.23	6.40	2050
Sole castor	175.36	9.20	9.50	3545
SE(m)+	**7.7**	**0.47**	**0.43**	**156.1**
CD (P=0.05)	**16.51**	**1.01**	**1.00**	**331.1**

Table 2. Effect of millet based intercropping on yield and economics of castor

Treatment	No. of spike /plant	Length of primary spike (cm)	No. of capsule /spike	100 seed weight (g)	Seed yield (q/ha)	Net Retrun Rs/ha	B:C ratio
Castor + foxtail millet (1:3)	23.1	30.2	45.4	29.0	17.28	66361	2.15
Castor + proso millet (1:3)	25.2	31.4	48.1	29.2	18.18	67246	2.17
Castor + little millet (1:3)	21.8	29.0	42.2	29.3	16.33	43731	1.76
Castor + kodo millet (1:3)	19.0	28.3	38.7	30.2	12.40	31527	1.55
Paired row castor + foxtail millet (2:4)	26.1	32.2	50.4	30.1	19.14	74842	2.30
Paired row castor + proso millet (2:4)	27.2	34.5	52.3	30.6	20.03	72702	2.26
Paired row castor + little millet (2:4)	20.0	29.7	40.1	30.6	16.12	44107	1.77
Paired row castor + kodo millet (2:4)	18.1	25.5	37.3	30.1	11.65	28520	1.50
Sole castor	28.2	40.1	55.8	31.6	20.98	51665	1.97
SE(m)+	**1.24**	**1.67**	**3.42**	**1.11**	**98.19**		
CD (P=0.05)	**2.64**	**3.55**	**7.25**	**NS**	**208.15**		

3.3 Economics

Net return and benefit cost ratio was significantly influenced by different intercropping system in castor (Table 2.). Higher net return and benefit cost ratio was obtained from paired row castor + foxtail millet (2:4) (₹. 74,842.00 and 2.30), paired row castor + proso millet (2:4) (₹. 72,702.00 and 2.26) followed by castor intercropped with proso millet (1:3) and foxtail millet (1:3). Sole castor obtained lesser net return (₹. 51,665.00) and benefit cost ratio (1.97) when compared to castor intercropped with nutri cereals. This might be due to higher yield in castor intercropped with foxtail millet and proso millet leads to higher net returns and B:C ratio. Similar results were obtained by [14] with castor + green gram intercropping system.

4. CONCLUSION

Based on one season field experiment, it may be concluded that highest growth and yield were recorded in sole castor which was significantly on par with nutri cereal intercropping systems *viz*., paired row castor + proso millet and paired row castor + foxtail millet systems. Whereas, highest net return and benefit cost ratio was obtained in paired row castor + foxtail millet (2:4) and paired row castor + proso millet. Thus, proso millet and foxtail millet were indentified to be compatible intercrops with castor under paired row system which may be recommended for enhancing productivity.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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