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Effect of plant geometry on castor under conserved moisture condition at Ratia (Ghed), Gujarat

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Abstract
A field experiment was conducted on medium black soil to evaluate the different plant geometry for castor under conserved moisture condition for the effect of treatments on growth, yield attributes and maximization of economics under rain fed conditions at Dry Farming Research Station, Junagadh Agricultural University, ratia (Ghed), Gujarat during 4 consecutive *kharif* season of 2015-16 to 2018-19. The experiment comprising of nine treatments with three replications laid out in factorial randomized block design. In pooled results, effect of inter and intra raw distance remained significant for castor seed yield. While interaction effect of plant geometry remained non significant on castor seed yield. Among the different inter raw spacing S_3 (120 cm) recorded significantly higher seed yield of 969, 1093, 1196 and 1049 kg/ha during the year 2016-17, 2017-18, 2018-19 and pooled results, respectively, Whereas intra raw distance D_3 (60 cm) recorded significantly higher seed yield 924, 943, 1002 and 980 kg/ha during 2015-16, 2016-17, 2017-18 and pooled results, respectively. and effect of inter raw distance remained significant for castor stalk yield. While intra raw distance and interaction effect of plant geometry remained non significant on castor stalk yield. While interaction effect of plant geometry remained non significant on castor seed yield during 2017-18, 2018-19 and pooled results. The maximum net return ` 30459 /ha and B: C ratio 2.1 was recorded under treatment T_9 i.e. S_3D_3- 120 X 60 cm.

Keywords: Castor, plant geometry, growth and yield attributes

Introduction
Castor (*Ricinus Cummunis*) is also known as the "Palm of Christ". It belongs to the *Euphorbiaceae* family and is indigenous to the south-eastern Mediterranean Basin, Eastern Africa and India. The crop is cultivated around the world for its non-edible oilseed. Castor is a perennial crop but is grown as an annual for economic purpose. It is cultivated mostly in the arid and semi- arid regions of the world. The major castor producing States in India is Gujarat, Rajasthan and Andhra Pradesh. Together, these States account for more than 90 per cent of total domestic production with Gujarat being the largest castor oil seed producing State. The major districts where castor is cultivated in Gujarat are Banaskantha, Gandhinagar, Kutch, Mehsana, Patan, Rajkot and Surendranagar. India stands first position in area and production both. In India it is grown over an area of 900,000 hectares with production of 1198,000 tonne and productivity of 1331 kg/ha (FAOSTAT, 2018) [1]. Gujarat stands first position in area and production both in India. In Gujarat it is grown over an area of 534,000 hectares with production of 935,000 tonne and productivity of 1751 kg/ha (The solvent extractors' association of India, 2018) [2].

Crop geometry defines the arrangement of crops in different spacing levels that has a greater impact on physiological and yield attributes of castor crop. In determining plant population per hectare area, adoption wider or closer spacing, climatic condition, soil characteristics, cultivar selected, management practices are must be taken into consideration. Now, the recommendations on spacing of castor plants are generalized. Different crop geometry had been studied but the availability of scientific information is less for the support of technical recommendations to the farmers by adopting optimum crop geometry levels between rows and plants with ultimate aim of increasing yield. There is therefore a need for experiments that evaluate the spacing of castor crops under rain fed condition with lesser number of irrigations. The objective of this study is to different plant geometry for castor under conserved moisture condition for effect of treatments on growth, yield attributes and maximization of economics under rain fed conditions response of the cultivar GCH 7 to wider spacing's levels to increase the grain yield of castor. Castor plants which are prolific in growth produced a maximum seed yield of 3732 kg/ha at 90 x 60 cm spacing closely followed by 60 x 60 cm (3616 kg/ha)

geometry. At 60 x 30 cm spacing, castor produced its lowest seed yield of 3320 kg/ha (ARS 1992a) [4]. Crop geometry determines the area available to each plant and the competition for inputs mainly moisture, nutrients, light and space. In the arid region, particularly under rain fed conditions, a larger canopy may be disadvantageous as it may exhaust available soil moisture from the root zone in drought conditions (Singh 1977) [9]. Therefore, in drought-prone areas, a lot of consideration needs to be given to maintaining optimal plant stand and row spacing. It was observed that thinning or removing some plants to make room for the growth of others is a beneficial practice at the three-week stage, by keeping 15-20 cm intra-row spacing, at a recommended row spacing of 45 cm (ARS 1990a) [3]. One agricultural practice representing a very simple technology is the adoption of ideal spacing, defined as the distance between two rows, and which if correctly employed, can result in a significant increase in yield, better soil conservation, and better use of the water available to plants, and besides ensuring these benefits, also allows the use of agricultural machinery and a decrease in weed emergence (Beltrão and Vale, 2007; Magalhães *et al*., 2013) [5, 7]. Several studies focus on determining the best row spacing for various crops. As the spacing between rows in an area decreases, the competition between plants for water and nutrients intensifies; on the other hand, at smaller spacing's, there is greater light interception, and shading of the weeds occurs earlier, which hinders their growth, having a positive influence on crop yield. (Severino *et al*., 2006b; Magalhães *et al*., 2013) [8, 7].

Materials and Methods

The experiment was conducted on medium black soil of at Dry Farming Research Station, Junagadh Agricultural University, ratia (Ghed), Gujarat during *kharif*- 2015-16 to 2018-19 (Gujarat) during four consecutive *kharif* seasons of 2015-16 to 2018-19. The year wise total rainfall received during the crop growth seasons 2015 to 2018 were 180, 306.5, 270 and 149 mm, with 06, 12, 14 and 08 rainy days, respectively. The soil of the experimental field was medium black having poor drainage and low moisture retentive capacity. Some important characteristics of the soil were Ph 8.90, EC 0.64 dS/m, Organic carbon 0.38 %, available P, K and S were 12.0, and 751.9 kg/ha and 3.58 ppm, respectively and micronutrient Fe, Mn and Zn were 6.48, 7.22 and 0.58 ppm, respectively. The experiment comprises nine treatments combination.T_1- S_1D_1 (60 cm X 30 cm), T_2- S_1D_2 (60 cm X 45 cm), T_3- S_1D_3 (60 cm X 60 cm), T_4- S_2D_1 (90 cm X 30 cm), T_5- S_2D_2(90 cm X 45 cm), T_6- S_2D_3 (90 cm X 60 cm), T_7- S_3D_1 (120 cm X 30 cm), T_8- S_3D_2 (120 cm X 45 cm) and T_9- S_3D_3 (120 cm X 60 cm). The experiment was laid out in factorial randomized block design with three replications and individual plot size of 7.20 m x 5.40 m (gross) and 3.60 m x 3.60 m (net). Castor seed variety GCH-7 was sown at row to row and plant to plant distance based on treatments combination. The crops were fertilized with recommended dose of fertilizer (RDF) NPK kg/ha. All other recommended agricultural practices were followed throughout crop period. Main product yield and by product yield were recorded at the time of crop harvest and observations were made periodically. Economics of all the treatments was worked out. The B: C ratio was calculated by using following formula.

$$\text{B: C ratio} = \frac{\text{Gross monetary returns (Rs/ha)}}{\text{Cost of cultivation (Rs/ha)}}$$

Results and Discussion

Castor Seed Yield

The data presented in Table 1 revealed that effect of inter and intra raw distance remained significant for castor seed yield. While interaction effect of plant geometry remained non significant on castor seed yield. Among the different inter raw spacing S_3 (120 cm) recorded significantly higher seed yield of 969, 1093, 1196 and 1049 kg/ha during the year 2016-17, 2017-18, 2018-19 and pooled results, respectively, which remained at par with inter raw spacing 90 cm (S_2) in 2016-17, 2017-18, 2018-19 and pooled results, respectively. In 2015-16 significantly higher seed yield (960 kg/ha) recorded under S_2 (90 cm) which remained at par with inter raw spacing 120 cm (S_3). Whereas intra raw distance D_3 (60 cm) recorded significantly higher seed yield 924, 943, 1002 and 980 kg/ha during 2015-16, 2016-17, 2017-18 and pooled results, respectively and also remained at par with 45 cm (D_2). During 2018-19 intra raw distance remained non significant on castor seed yield. The response of castor variety, GCH-4 to varying levels of spacing under rain fed condition. Results indicated that wider spacing (120 x 60 cm) gave maximum length of main spike and number of spikes per plant as compared to narrow spacing (120 x 45 cm) result reported by Thadoda (1993) [12].

Table 1: Influenced of inter-raw and intra-raw spacing's on plant growth and castor seed and castor stalk yield attributes (mean data of 4 years)

Treatments	Pooled Yield (kg/ha)		Plant population	Plant height
	Castor seed yield	Castor stalk yield		
Inter raw spacing				
S_1: 60 cm	677	1201	47	55
S_2:90 cm	1017	1778	30	64
S_3:120 cm	1049	1919	23	76
S.Em.±	28.5	112.7	0.45	1.18
C.D. at 5%	98.5	389.8	1.56	4.10
Intra raw spacing				
D_1 :30 cm	854	1600	47	63
D_2 :45 cm	908	1605	30	65
D_3 :60 cm	980	1694	23	68
S.Em.±	14.8	46	0.40	0.36
C.D. at 5%	80.5	NS	1.56	3.35
Interaction (S X D)				
S.Em.±	31.8	74.4	4.6	1.05
C.D. at 5%	NS	NS	1.27	3.35
C.V.%	9.7	10.18	3.75	3.31

Castor Stalk Yield

The data presented in Table 1 revealed that effect of inter raw distance remained significant for castor stalk yield. While intra raw distance and interaction effect of plant geometry remained non significant on castor stalk yield. Among the different inter raw spacing S_3 (120 cm) recorded significantly higher stalk yield of 1209, 1237, 2497, 2733 and 1919 kg/ha during the year 2015-16, 2016-17, 2017-18, 2018-19 and pooled results, respectively which remained at par with inter raw spacing 90 cm (S_2) in 2017-18, 2018-19 and pooled results, respectively. Whereas intra raw distance D_3 (60 cm) remained non significant on castor stalk yield 2015-16, 2016-17, 2018-19 and pooled results. While interaction effect of plant geometry remained non significant on castor seed yield during 2017-18, 2018-19 and pooled results.

Effect of Treatment on Growth and Yield Attributes

The data presented in Table 1 revealed that effect of inter raw distance remained significant in growth and yield attributes. Among the both inter raw and intra raw spacing S_1 (60 cm) recorded maximum 47 plant population, whereas different inter raw spacing S_3 (120 cm) recorded maximum 76 cm plant height and intra raw spacing D_3 (60 cm) recorded maximum 68 cm plant height, which remained at par with intra raw spacing D_2 (45 cm) plant height 65 cm. The results indicated that there was a significant increase in number of branches, number of leaves, number of spikes, capsules and seed weight per plant while, decrease the plant height with increase in row spacing (90 cm) compared to narrow row spacing (60 cm) Vala *et al*. (2000) [13].

Economics

The data presented in Table 2 revealed that treatment T_9 (S_3D_3- 120 X 60 cm) recorded higher net returns of Rs. 30459 and B: C ratio of 2.1 followed by treatment T_6 (S_2D_3- 120 X 45 cm) with net returns of Rs. 27851 and B: C ratio of 2.0. The increase in net profit was attributed to large yield differences with very minute differences in cost of production under different intra-row spacing's. Closer intra-row spacing was found superior to wider ones. Singh (2003) [10] and Tank *et al*. (2007) [11] also reported similar pattern.

Table 2: Effect of different treatments on main product, by product yield, economics and RWUE of Castor

Sr. No.	Treatment combinations	Main product yield (kg/ha)	By product yield (kg/ha)	Gross income (Rs/ha)	Cost of cultivation (Rs/ha)	Net return (Rs/ha)	B:C Ratio	RWUE (kg/ha-mm)
T_1	S_1D_1	631	1165	32138	25426	6712	1.3	2.8
T_2	S_1D_2	693	1190	35269	25871	9398	1.4	3.1
T_3	S_1D_3	707	1249	35974	26316	9658	1.4	3.1
T_4	S_2D_1	954	1792	48607	25871	22736	1.9	4.2
T_5	S_2D_2	1015	1781	51624	26538	25086	1.9	4.5
T_6	S_2D_3	1083	1761	55054	27203	27851	2.0	4.8
T_7	S_3D_1	978	1842	49821	26316	23505	1.9	4.3
T_8	S_3D_2	1017	1845	51784	27203	24581	1.9	4.5
T_9	S_3D_3	1150	2071	58552	28093	30459	2.1	5.1

Rain Water Use Efficiency (kg/ha-mm)

The maximum rain water use efficiency 5.1 kg/ha-mm was recorded under treatment T_9 i.e. S_3D_3 (120 cm X 60 cm), which was followed by T_6- S_2D_3 (90 cm X 60 cm) 4.8 kg/ha-mm, T_5- S_2D_2(90 cm X 45 cm) 4.5 kg/ha-mm and T_8- S_3D_2 (120 cm X 45 cm) 4.5 kg/ha-mm, respectively. The minimum rain water use efficiency 2.8 kg/ha-mm was observed in T_1- S_1D_1 (60 cm X 30 cm).

Conclusion

The farmers of North Saurashtra Agro-climatic Zone growing castor in *Ghed* area under conserved soil moisture are recommended to sow the castor at 120 cm X 60 cm for obtaining higher yield and net return.

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