International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(2): 1834-1836

Received: 18-01-2018
Accepted: 22-02-2018

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Effect of spacing and spike maintenance for yield maximization in castor (*Ricinus communis* L.)

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Abstract
A field experiment was conducted at Tapioca and Castor Research Station, Yethapur, Salem district, Tamil Nadu during the year 2012-2014, to study the effect of spacing and spike maintenance for yield maximization in castor. This study was initiated with castor hybrid YRCH1 and the following treatments were imposed. In main plot, different spacing *viz.*, 60 x 60 cm (M_1), 90 x 60 cm (M_2), 90 x 90 cm (M_3), 120 x 90 cm (M_4), 120 x 120 cm (M_5). In sub plot, spike maintenance *viz.*, maintaining primary spike alone (S_1), maintaining secondary spike alone (S_2), maintaining primary and secondary spikes alone (S_3), allowing all the orders of spike (S_4). The field trial was laid out in split plot design with three replications. The results revealed that, spacing of 120 x 120 cm along with allowing all the orders of spikes recorded higher seed yield which was on par with the spacing of 120 x 90 cm along with allowing all the orders of spikes.

Keywords: castor, spacing, spike maintenance, number of spike, yield

Introduction
Castor (*Ricinus communis* L.) is one of the industrially important oilseed crop. It is cultivated in various parts of the world. The second green revolution is expected to emerge from rainfed or dryland agriculture system where oilseeds and pulses are important components. In India, castor has gained commercial significance as the country is the pioneer in development and cultivation of hybrids both under irrigated and rainfed situations. India accounts for nearly 68 per cent of the world castor area and 76 per cent of the world castor production and ranks first in both area and production in the world (Hegde, 2010) [2]. India is the world leader in castor seed production and meets about 90 per cent of the world's requirement of castor oil earning about Rs. 2000 crores of foreign exchange (Pathak, 2009) [3].
Castor being a non edible crop, its integration with food crops in the cropping system varies depending on the agro - climatic situation and the farmers' requirement. Castor is a long duration crop. Castor also exhibits considerable plasticity to spacing variation (Venkattakumar *et al.*, 2012) [7]. It has profound compensatory mechanism for loss of plant stand through putting forth more branches. Studies on the effect of different spacing and maintaining primary or secondary spikes on the yield of hybrid castor are meager. Hence, the present experiment is initiated to study the effect of spacing and spike maintenance in castor.

Materials and Methods
A field experiment was conducted at Tapioca and Castor Research Station, Yethapur, Salem district, Tamil Nadu during the year 2012 – 2014. The experimental soil was red loamy soil with a pH of 7.18, low in organic carbon (0.27%), medium in available N (192 kg ha^{-1}), low in available P (8 kg ha^{-1}) and high in available K (338 kg ha^{-1}). This study was initiated with castor hybrid YRCH 1 was sown in first week of July during *Kharif* season 2012 and 2013. The field trial was laid out in split plot design with three replications. The gross plot size for individual treatment is 7.2 x 7.2 m. In main plot, different spacing intervals *viz.*, 60 x 60 cm (M_1), 90 x 60 cm (M_2), 90 x 90 cm (M_3), 120 x 90 cm (M_4), 120 x 120 cm (M_5). In sub plot, spike maintenance *viz.*, maintaining primary spike alone (S_1), maintaining secondary spike alone (S_2), maintaining primary and secondary spikes alone (S_3), allowing all the order of spikes (S_4). YRCH 1 hybrid is well suited for both pure and mixed cropping system with duration of 150-160 days. Recommended dose of fertilizer was applied for hybrid castor as N, P, K 60:30:30 kg/ha, respectively. Rainfall received during the cropping period is 493 mm and 426 mm and mean average temperature is 37^0 C and 37.5^0 C during 2012 and 2013,

respectively. All the recorded data were analysed statistically as per the method suggested by Gomez and Gomez (1984) [1].

Results and Discussion

Growth attributes

Plant height was higher in closer spacing than wider spacing. Among the closer spacing, 60 x 60 cm and 90 x 60 cm recorded higher plant height than wider spacing of 120 x 90 cm and 120 x 120 cm. (Table 1). This may be due to inter competition between the plants for obtaining high solar energy. Such findings were earlier reported by Patel and Patel (2012) [4].

Yield attributes

Among the spacing intervals, wider spacing recorded more number of spikes per plant. Wider spacing of 120 x 120 cm with allowing all the order of spikes recorded more number of spikes per plant (23 Nos.) than closer spacing (Table 2). Wider planting produces more number of branches due to lesser competition between the plants. The results are in accordance with a finding of Vala *et al.*, (2000) [6].

Seed yield

In general, seed yield was recorded higher in wider spacing than closer spacing. Castor crop sown with a spacing of 120 x 120 cm and 120 x 90 cm recorded higher seed yield which was on par with each other. For maintenance of spike, allowing all the order of spikes recorded higher seed yield which was followed by maintaining primary and secondary spikes alone. In combination, spacing of 120 x 120 cm along with allowing all the order of spikes recorded higher seed yield of 2675 kg ha^{-1} which was on par with a spacing of 120 x 90 cm along with allowing all the orders of spikes recorded the seed yield of 2552 kg ha^{-1} (Table 3). Growing castor in wider spacing resulted more number of branches and it also produces more number of spikes per plant. This might be the reason for adopting wider spacing recorded higher seed yield than closer spacing (Rana *et al.* 2006) [5].

Table 1: Effect of treatments on plant height (cm) in castor (Mean of two years)

Treatments	60 x 60 cm	90 x 60 cm	90 x 90 cm	120 x 90 cm	120 x 120 cm	Mean
Primary spike alone	158	148	138	126	117	137
Secondary spike alone	156	145	139	128	116	138
Primary and Secondary spike alone	154	149	139	129	118	138
All order of spikes	154	148	138	127	118	136
Mean	156	148	139	128	117	
	Spacing (M)	Spike maintain(S)	M x S			
S.Ed	5.4	4.3	10.1			
CD(0.05)	10.9	NS	NS			

Table 2: Effect of treatments on number of spikes / plant of castor (Mean of two years)

Treatments	60 x 60 cm	90 x 60 cm	90 x 90 cm	120 x 90 cm	120 x 120 cm	Mean
Primary spike alone	1	1	1	1	1	1
Secondary spike alone	3	3	3	4	4	3
Primary and Secondary spike alone	4	4	5	5	5	5
All order of spikes	8	13	16	19	23	16
Mean	4	5	6	7	8	
	Spacing (M)	Spike maintain(S)	M x S			
S. Ed	0.5	0.6	1.1			
CD(0.05)	1.1	1.2	2.4			

Table 3: Effect of treatments on seed yield (kg ha^{-1}) of castor (Mean of two years)

Treatments	60 x 60 cm	90 x 60 cm	90 x 90 cm	120 x 90 cm	120 x 120 cm	Mean
Primary spike alone	1386	1372	1335	1287	1274	1331
Secondary spike alone	1563	1547	1526	1494	1479	1522
Primary and Secondary spike alone	1582	1628	1854	2058	2046	1834
All order of spikes	1616	1726	2169	2552	2675	2168
Mean	1537	1568	1721	1848	1869	
	Spacing (M)	Spike maintain(S)	M x S			
S. Ed	63	82	155			
CD(0.05)	122	166	331			

Table 4: Effect of spacing and spike maintenance on Economics (Rs/ha) of castor

Treatments	Cost of cultivation (Rs)	Gross return (Rs)	Net return (Rs)	B:C ratio
60 x 60 cm spacing with all the order of spikes	25426	48480	23054	1.90
90 x 60 cm spacing with all the order of spikes	25278	51780	26502	2.05
90 x 90 cm spacing with all the order of spikes	25237	65070	39833	2.58
120 x 90 cm spacing with all the order of spikes	25185	76560	51375	3.04
120 x 120 cm spacing with all the order of spikes	25076	80250	55174	3.21

Economics

Economic analysis revealed that, spacing of 120 x 120 cm along with allowing all the order of spikes recorded maximum net returns (Rs.55,174/-) and benefit: cost ratio of 3.21. This is mainly due to yield increment under adopting 120 x 120 cm

spacing along with allowing all the order of spikes when compared to closer spacing of 90 x 60 cm.

It could be concluded that adopting the spacing of 120 x 120 cm along with allowing all the order of spikes can be recommended for YRCH 1 hybrid castor cultivation in Tamil Nadu.

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