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Effect of planting methods and intercrops on productivity and economics of castor *(Ricinus communis)*-based intercropping systems

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ABSTRACT

An experiment was conducted during the rainy season of 2001 and 2002 at Udaipur, to evaluate productivity and economics from intercropping greengram (*Vigna radiata* L.), blackgram (*Vigna mungo* L.), clusterbean [*Cymopsis tetragonoloba* (L.) Taub.] and sesame (*Sesamum indicum* L.) with castor (*Ricinus communis* L.) in uniform and paired rows systems of planting. Paired row planting (60/120 cm) gave the maximum seed yield (41.84 q/ha), castor-equivalent yield (47.50 q/ha), land-equivalent ratio (1.52) and monetary advantage, followed by paired row planting at 80/160 cm and uniform row planting at 90 cm × 60 cm. Castor intercropped with greengram recorded higher values of yield attributes and yielded maximum castor-equivalent yield, land-equivalent ratio, net returns and benefit : cost ratio over sole castor, castor + sesame and castor + clusterbean intercropping systems, but remained at par with castor + blackgram intercropping system.

Key words : Castor, Planting methods, Intercropping, Production efficiency, Castor-equivalent yield, Land-equivalent ratio, Land equivalent coefficient

Castor is a long-duration, widely spaced, hardy crop having deep root system with initial slow growth. Under the prevailing agro-climatic conditions of south-western Rajasthan which experiences droughts now and then resulting in wide variations in yearly rainfall, the cultivation of castor may stabilize crop productivity and uplift the economic status of the farmer. The large unutilized area between inter-row spaces of castor can be utilized efficiently by growing short-duration intercrops. Intercropping provides substantial yield advantage over sole crop owing to temporal and spatial complemenarity and minimizing inter-or intra-specific competition (Chatterjee and Mandal, 1992). Therefore, a strong need was felt to evaluate different methods of castor planting and to select suitable non-competitive crop to enhance intercropping advantage by improving production efficiency and monetary benefits.

MATERIALS AND METHODS

The experiment was conducted at Instructional Farm, Rajasthan College of Agriculture, Udaipur, during the rainy seasons of 2001 and 2002 on clay-loam soil having pH 7.9, organic carbon 0.72%, available nitrogen 279.3 kg/ha, phosphorus 23.6 kg P_2O_5/ha and available potassium 298.3 kg K_2O/ha. The experimental treatments comprised 4 methods of castor planting, viz. uniform row systems (90 cm × 60 cm and 120 cm × 45 cm) and paired row systems (60/120 × cm 60 cm and 80/160 cm × 45 cm) and 4 intercrops, viz. greengram, blackgram, clusterbean and sesame, as well as their sole crops. The experiment was laid out in a randomized block design with 3 replications using castor cv. 'GCH' 4, greengram cv. 'K 851', blackgram cv. 'T 9', clusterbean cv. 'RGC 936' and sesame cv. 'RT 46'. All the crops were sown on 18 July 2001 and 19 July 2002 with the castor seed rate of 12 kg/ha, greengram15 kg/ha, blackgram 15 kg/ha, clusterbean 20 kg/ha and sesame 3 kg/ha. Inter- and intra-row spacings were kept as per treatment. The recommended plant population of castor (18.5 thousand plants/ha) was maintained both in sole and intercropped castor by adjusting inter- or intra-row spacing, whereas for intercrops, plant population was not uniform in all plots and differed as per treatment. Plant population of greengram, blackgram, clusterbean, sesame in sole crop was 3.22, 3.22, 3.21 and 3.21 lakh/ha, whereas their population in intercropping system were 1.90, 1.90, 1.88 and 1.86 lakh/ha, respectively. Fertilizer application was done only for castor crop, while intercrops were not fertilized separately. Fifty per cent of recommended dose of N (40 kg/ha) and full dose of P_2O_5 (50 kg/ha) was drilled below castor seed while sowing. Remaining 50% N (40 kg/ha) was top-dressed in 2 equal splits at 120 days of crop growth, and 30 days thereafter. Picking of castor was done 5 times, i.e. 120, 150, 180, 210 and 240 days after sowing. Intercrops, i.e. greengram, blackgram, clusterbean and sesame were harvested 73, 77, 86 and 94 days after sowing.

The error variance for seed yield of castor and those of individual inercrops were found homogeneous during the 2 years and therefore these data were subjected to pooled analysis. The pooled data were further computed for different production efficiency parameters [land equivalent ratio (LER) land-equivalent coefficient (LEC)] and monetary advantage in terms of net returns, benefit : cost ratio. Land-equivalent ratio and monetary advantage were calculated as per Willey (1979).

RESULTS AND DISCUSSION

Planting methods

Methods of castor planting had significant effect on yield attributes of castor. The maximum number of branches/plant, length of primary spike, capsules/plant and seed index of castor were recorded in paired row planting (60/120 × 60 cm) and found at par with those under paired row of planting at 80/160 cm × 45 cm (Table 1). Such significant increase in yield attributes of castor under paired row planting (60/120 cm) was ascribed to the significant increase in growth parameters and least competition offered by the intercrops to the castor (Chauhan and Singh, 1994). The seed yield of castor and intercrops

Table 1. Effect of planting methods and intercropping on yield attributes of castor

Treatment	Branches/ plant		Length of primary spike (cm)		Capsules/ plant		Capsules weight/plant (g)		Seed index (g)	
	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03
Method of castor planting										
90 cm × 60 cm	7.8	7.6	37.9	36.0	280.3	255.3	368.7	324.2	30.7	29.9
120 cm × 45 cm	7.1	7.1	35.3	33.7	244.2	240.4	335.7	298.4	28.1	27.8
60/120 cm × 60 cm	8.4	8.0	41.8	37.8	303.8	263.9	377.7	329.3	32.4	31.9
80/160 cm × 45 cm	7.9	7.8	41.0	37.3	296.5	255.9	370.7	326.1	31.2	30.9
CD (P=0.05)	0.5	0.5	2.1	2.1	14.9	13.9	18.8	17.3	2.0	2.0
Intercropping										
Sole castor	7.7	7.5	38.8	35.8	284.9	256.2	370.4	312.8	30.8	29.9
Castor + greengram	8.2	8.0	40.7	37.9	295.8	261.8	381.7	334.2	31.7	31.6
Castor + blackgram	8.0	7.8	39.8	37.3	289.5	258.3	376.3	332.4	31.3	31.4
Castor + clusterbean	8.0	7.9	39.3	37.1	289.0	256.9	371.7	329.6	31.4	30.3
Castor + sesame	7.1	6.7	36.5	32.9	246.9	236.2	315.8	288.5	27.9	27.5
CD (P=0.05)	0.6	0.5	2.3	2.4	16.4	15.6	21.0	19.3	2.3	2.2

Table 2. Effect of planting methods and intercropping on production efficiency of castor-based intercropping systems

Treatment	Castor-seed yield (q/ha)		Intercrop seed yield (q/ha)								Castor-equivalent yield (q/ha)		Mean LER	Mean LEC	Mean Benefit: cost ratio
			Greengram		Blackgram		Clusterbean		Sesame						
	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03			
Method of castor planting															
90 cm × 60 cm	42.5	40.6	4.8	4.4	4.6	4.3	6.2	5.7	2.6	2.3	47.3	45.2	1.37	0.39	4.01
120 cm × 45 cm	38.5	37.1	4.1	3.8	3.9	3.6	5.5	5.6	2.2	2.1	43.0	41.4	1.32	0.35	3.54
60/120 cm × 60 cm	42.9	40.8	5.7	5.2	5.6	5.1	7.1	6.4	3.3	2.9	48.7	46.3	1.52	0.52	4.22
80/60 cm × 45 cm	42.3	40.5	5.1	4.7	5.0	4.5	6.6	5.9	3.0	2.7	47.2	45.1	1.51	0.47	4.16
CD (P=0.05)	2.1	1.6	0.96	0.87	1.0	0.9	1.1	NS	0.7	0.6	2.3	1.8	0.04	0.03	0.15
Intercropping															
Sole castor	41.8	40.0	8.6	7.9	8.2	7.7	12.0	11.3	5.5	5.3	41.8	40.0	1.00	0.00	3.87
Castor + greengram	43.7	41.2	4.9	4.5							51.5	47.6	1.61	0.60	4.29
Castor + blackgram	42.5	40.7			4.8	4.4					50.3	46.5	1.60	0.59	4.18
Castor + clusterbean	42.1	40.3					6.6	5.9			47.6	48.0	1.54	0.53	4.20
Castor + sesame	37.6	36.6							2.8	2.5	41.4	40.5	1.40	0.44	3.36
CD (P=0.05)	2.4	1.8									2.6	2.0	0.04	0.03	0.17
'F' test			Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.					

were significantly higher in paired row planting of castor (60/120 cm) over planting at 90 cm x 60 cm, paired planting at 80/160 cm and planting at 120 cm x 45 cm. However, total productivity measured in terms of castor-equivalent yield under paired row planting (60/120 cm) was significantly higher over uniform row planting at 120 cm x 45 cm. (Table 2). It appears that paired row planting of castor at 60/120 cm could intercept more solar radiation and utilize it more efficiently thereby improving its growth parameters, i.e. LER, LEC, and ultimately the seed yield. Paired row planting of castor resulted in significantly higher LER while higher castor-equivalent yield could be attributed to additive effects of seed yield of castor and intercrops. These results are in close conformity to those reported by Sharma (2002).

Intercropping

The yield components of castor showed significant improvement owing to intercropping with greengram, blackgram and clusterbean. Further, castor intercropped with greengram showed higher values of yield attributes compared with blackgram and clusterbean. However, yield components of castor showed declining trend when intercropped with sesame. Castor intercropped with legumes might have improved nitrogen status of the soil on account of atmospheric N-fixation which was made available to the castor to utilize N more efficiently 90 days after sowing to harvest of castor. These results are in agreement with those of Gupta and Rathore (1993). Castor seed yield was increased owing to intercropping of castor with greengram, blackgram and clusterbean, but castor seed

Table 3. Interaction effect of planting methods and intercropping on yield, net returns and benefit : cost ratio (pooled data of 2 years)

Intercropping	Methods of castor planting				
	90 cm x 60 cm	120 cm x 95 cm	60/120 cm x 60 cm	80/160 cm x 45 cm	Mean
Seed yield (q/ha)					
Sole castor	43.4	40.8	41.4	37.9	40.9
Castor + greengram	43.4	35.7	47.0	43.6	42.5
Castor + blackgram	41.7	37.7	43.0	44.1	41.6
Castor + clusterbean	41.3	39.6	40.9	43.0	41.2
Casor + sesame	38.0	35.4	36.9	39.2	37.0
Mean	41.6	37.8	41.8	41.4	
CD (P=0.05)		2.97			
Castor-equivalent yield (q/ha)					
Sole castor	43.4	40.8	41.4	37.9	40.9
Castor + greengram	50.3	41.9	55.3	50.7	49.6
Castor + blackgram	48.2	43.6	51.0	50.8	48.4
Castor + clusterbean	47.8	45.8	48.2	49.5	47.8
Castor + sesame	41.5	38.9	41.6	41.8	40.9
Mean	46.2	42.2	47.5	46.1	
CD (P=0.05)		3.24			
Net returns (Rs/ha)					
Sole castor	43,007	39,766	40,503	36,364	39,910
Castor + greengram	50,906	40,200	57,334	52,383	50,206
Castor + blackgram	48,318	42,385	51,862	52,475	48,760
Castor + clusterbean	48,778	46,238	49,907	51,806	49,182
Castor + sesame	39,573	35,429	39,309	40,343	38,664
Mean	46,116	40,804	47,783	46,674	
CD (P=0.05)		3,965			
Benefit : cost ratio					
Sole castor	4.15	3.88	3.91	3.55	3.87
Castor + greengram	4.30	3.36	4.95	4.57	4.29
Castor + blackgram	4.09	3.56	4.49	4.59	4.18
Castor + clusterbean	4.11	3.86	4.30	4.51	4.20
Castor + sesame	3.41	3.03	3.44	3.57	3.36
Mean	4.01	3.54	4.22	4.16	
CD (P=0.05)		0.347			

Selling price (Rs/q) : in 2001-02 and 2002-03 respectively
castor seed, 1,100 and 1,275; castor stalk, 20 and 20; greengram seed, 1,750 and 1,800; greengram stover, 100 and 120; blackgram seed, 1,800 and 1,675; blackgram stover, 100 and 120; clusterbean seed, 950 and 1,670; clusterbean stover, 100 and 130; and sesame seed, 1,500 and 2,000

yield decreased due to intercropping with sesame. Of the intercropping systems, castor + greengram recorded significantly higher seed yield of castor (43.7 and 41.2 q/ha) than sole castor (40.9 q/ha) and castor + sesame (37.1 q/ha) respectively. This clearly indicates that there was more intra-specific competition than that of inter-specific competition of sole stand. Castor + greengram recorded the maximum castor-equivalent yield (49.6 q/ha) which was 21.2, 2.5, 3.6 and 21.0% higher over sole castor, castor + blackgram, castor + clusertbean and castor + sesame respectively. Maximum land-equivalent ratio (1.4 and 1.6) and land-equivalent coefficient (0.6) recorded in castor + greengram intercropping system showed more efficient use of land than sole castor and other intercropping systems.

Further, maximum benefit : cost ratio (4.29) was also recorded when castor intercropped with greengram which was significantly higher over sole castor (3.87) and castor + sesame (3.36) but was at par with castor + blackgram (4.18) and castor + clusterbean (4.20) intercropping systems. This could be owing to higher yield of castor as well as intercrop in intercropping systems. The findings support the results reported by Prasad and Verma (1986).

Interaction of planting methods and intercropping

Planting methods and intercropping systems significantly affected the seed yield, castor-equivalent yield, net returns and benefit : cost ratio. When castor was intercropped with greengram in paired row planting systems (60/120 cm), the maximum seed yield of castor (47.0/ha) was recorded which was at par with castor + blackgram in paired row planting system (80/160 cm). Further, castor grown as sole crop in uniform row planting methods (90 cm × 60 cm) as well as when intercropped with greengram, blackgram and clusterbean remained at par but gave significantly higher seed yield than castor + sesame by 14.3, 14.3, 9.7 and 8.8% respectively (Table 3).

Sole castor in uniform row planting system (90 cm × 60 cm) recorded significantly higher seed yield (43.4 q/ha) over paired row planting at 80/160 cm, but remained at par with planting at 120 cm × 45 cm and paired row planting at 60/120 cm. The interaction effect of planting methods and intercropping systems on CEY revealed that planting castor with greengram in paired row system (60/120 cm) gave the higher CEY (55.3 q/ha) over all other planting methods of intercropping system. Castor + greengram, castor + blackgram, castor + clusterbean in uniform row planting (90 cm 60 cm) and paired row planting (80/160 cm) systems were found at par in terms of CEY, but significantly higher than sole castor and castor + sesame in all the methods of castor planting. Maximum CEY (55.3 q/ha) was recorded when castor was intercropped with greengram in paired row planting system (60/120 cm), followed by castor + blackgram (51.0 q/ha) in the same planting method. Further, analysis of the interaction effect revealed that castor + greengram if planted at 60/120 cm not only gives the significantly higher net returns (Rs 57, 334/ha), but also benefit : cost ratio (4.95) over castor + blackgram (Rs 52,475/ha and 4.59) and castor + greengram (Rs 52,383/ha and 4.57) planted in paired row system at 80/160 cm as well as over other interactions.

Thus an intercropping of castor (paired row planting at 60/120 cm × 60 cm) with 3 rows of greengram is highly productive and beneficial, as it yielded maximum castor-equivelent yield (55.3 q/ha) and returns (Rs 57,334/ha) and benefit : cost ratio (4.95).

REFERENCES

Chatterjee, B. N. and Mandal, B.K. 1992. Present trends in research on intercropping. *Indian Journal of Agricultural Sciences* **62**: 507–518.

Chauhan, G.S. and Singh, I. 1994. Studies on stand geometry and intercropping of castor under irrigated and rainfed conditions of Rajasthan. *Crop Research* **7** : 201–206.

Gupta, I.N. and Rahore, S.S. 1993. Intercropping in castor *(Ricinus communis* L.) under dryland condition in Rajasthan. *Indian Journal of Agronomy* **38** : 182–186.

Prasad, S.N. and Verma, B. 1986. Effect of intercropping castor with greengram, blackgram, sesame and sorghum on yield and net returns. *Indian Journal of Agronomy* **31** : 21–25.

Sharma, S.L. 2002. 'Studies on castor *(Ricinus communis* L.)-based intercropping of legumes at varying fertility levels under rainfed conditions of semi-arid region.' Ph.D. thesis, Rajasthan Agricultural University, Bikanar, Rajasthan.

Willey, R.W. 1979. Intercropping–its importance and research needs. I. Competition and yield advantages. *Field Crops Abstracts* **32** : 1–10.