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Yield, equivalent yield and economics of castor as influenced by different castor (*Ricinus communis* L.) based cropping systems in North Gujarat agro-climatic condition

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Abstract
A field experiment was conducted during the years 2011-12 and 2012-13 to study the effect of different castor-based cropping systems on yield, castor equivalent yield and economics of castor in North Gujarat Agro-climatic condition on loamy sand soils of Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. The experiment was laid out in randomised block design with four replications comprising ten treatments *viz.*, T_1 : Castor sole, T_2 : Greengram + castor (2:1), T_3 : Cowpea + castor (2:1), T_4 : Groundnut + castor (2:1), T_5 : Sesamum + castor (2:1), T_6 : Greengram-*rabi* castor, T_7 : Castor-summer pearl millet, T_8 : Castor-summer greengram, T_9 : Castor-summer sesamum and T_{10} : Castor-summer mothbean. Number of spikes per plant and capsules per spike were recorded statistically equal number in all the cropping systems except, T_2 [Greengram + castor (2:1)], T_3 [Cowpea + castor (2:1)], T_5 [Sesamum + castor (2:1)] and T_6 (Greengram-*rabi* castor). Among all the cropping sequences castor sole and groundnut + castor inter cropping system produced significantly higher seed and stalk yield of castor. Inter cropping system groundnut + castor (2:1) recorded significantly maximum CEY (5141 kg/ha). Maximum net realization of ₹ 1,13,595/ha was obtained with groundnut + castor (2:1) system but benefit: cost ratio registered higher with sole castor (2.87). Growing of groundnut + castor (2:1) as intercropping system produced higher castor equivalent yield and secured maximum net realization under North Gujarat Agro-climatic condition.

Keywords: Crop production, cropping systems, growth parameters, net return, yield attributes and yield

Introduction
Castor (*Ricinus communis* L.) is one of the most important oilseed crops of India as its oil has a diversified uses and great value in foreign trade. It is a non-edible oil seed crop (45 to 50 % oil) having high industrial importance due to presence of unique fatty acid and ricinoleic acid. It belongs to family *Euphorbiaceae*, and originated from Ethiopia. Castor is extensively cultivated in India, China, Brazil, Ethiopia and Thailand. The contribution of India in the world is 56 per cent in area and 84 per cent in production of castor. Thus, India is a leading country in the world not only in area and production, but also in productivity of castor. Gujarat is the leading producer of castor in India with nearly 85 per cent of the output followed by Andhra Pradesh and Rajasthan. Further, the castor oil is differing from other vegetable oil due to its non-freezing nature up to temperature of -18 ^{0}C. It is therefore, considered to be the best lubricating agent particularly for both high speed engines and aeroplanes. Castor oil has many medicinal uses, *viz.*, curing in constipation (when taken internally), relief from pain, inflammation and stomach problems. It has also cosmetic uses and has been said to restore a youthful glow and maintain smooth and supple skin. It is also been used in the manufacturing of dyes, detergents, plaster of paris, soaps, polishes, greases, rubber, hydraulic brake fluids, polymers, wetting agents, surfactants, surface coatings *etc.* To reduce the duration and increase cropping intensity along with saving of irrigation water, cultivation of castor during *rabi* season is a suitable option. Intercropping is a common practice followed by farmers of semi-arid and arid tropics. A significant feature of intercropping is that, it is biologically more dynamic than a sole crop and is therefore, less likely to succumb to vagaries of weather Thus, intercropping is intrinsically more secure and dependable in providing some returns than sole cropping (Chetty and Rao, 1979) [2].
Shortage of pulse and oil seeds in our country have focused the attention on their inclusion in intercropping systems which have a capacity to get more return per unit area as well as to

improve the physical, biological and chemical properties of soil. As the wide space is available between two rows of main crop in which profitable short duration crop can be grown during early growth stage of the crop as intercrop which gives an additional income also (Chetterjee and Mandal, 1992) [1]. Sequence crop is also used to control pests and diseases that can become established in the soil over time. Sequence cropping could also help in maintaining soil fertility provided suitable crops such as legumes may be included in the cropping system. An important aspect of sequence cropping is the utilisation of nutrients more efficiently as the crops growing on the same piece of land would have different nutritional requirements.

Materials and Methods

The experiment was laid out during years 2011-12 and 2012-13 at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, District: Banaskantha, Sardarkrushinagar. It is situated in the North Gujarat Agro-climatic Zone of the Gujarat State. This zone is characterised by arid and semi-arid climate with extreme cold winter and hot and dry windy summer. The soil of the experimental plot was low in organic carbon (0.18 %) and available nitrogen (148 kg/ha), medium in phosphorus (47 kg/ha) and available potash (284 kg/ha). The experiment was laid out in randomised block design with four replications comprising ten treatments *viz.*, T_1 : Castor sole, T_2 : Greengram + castor (2:1), T_3 : Cowpea + castor (2:1), T_4 : Groundnut + castor (2:1), T_5 : Sesamum + castor (2:1), T_6 : Greengram-*rabi* castor, T_7 : Castor-summer pearl millet, T_8 : Castor-summer greengram, T_9 : Castor-summer sesamum and T_{10} : Castor-summer mothbean. Castor: GCH 7, greengram: GM 4, cowpea: GC 5, groundnut: GG2, sesamum: GT 2, pearl millet: GHB 558, mothbean: GMo 2 were taken for experiment. The RDF of castor, mungbean, cowpea, groundnut, sesamum, pearl millet and mothbean 180-37.5-00-20, 20-40-00-00, 20-40-00-00, 25-50-00-00, 50-25-00-20, 80-40-00-00 and 20-40-00-00 N-P-K-S kg/ha, respectively. The total rainfall received during July-October, November –March and April- June was 916.1, 0 and 0 mm during 2011-12 and 590.6, 2.0 and 199.5 mm during 2012-13 respectively. The average monthly air temperature, relative humidity and sunshine hours were almost similar during both the years.

Castor was sown in the first fortnight of August during both the years and harvested in the last week of January to first week of March (2012) while during 2013 castor was harvested in the first week of February to first week of March. *Rabi* casor was sown in the first fortnight of October and harvested in the third week of February to second week of March during both the years. Greengram, groundnut, cowpea and sesamum were sown on second fortnight of July during 2011 and 2012 as an intercrop. Greengram and cowpea were harvested in the last week of the September while sesamum was harvested in the first fortnight of October and groundnut was harvested in first fortnight of November. Sowing of summer greengram, pearl millet, sesamum and mothbean on last week of march during both the years as sequence crops. Greengram and mothbean were harvested in the first week of june while peal millet and sesamum were harvested on third and fourth week of June, respectively. The number of irrigations applied in the *kharif* castor was 7 and in intercrop greengram, groundnut, cowpea and sesamum were 3 and in *rabi* castor was 5 while in summer sequence crop 7 irrigations were applied in pearl millet and sesamum while 5 irrigations were applied in greengram and mothbean. Economic yields of the component crops were converted to castor equivalent yield (CEY), taking into account the prevailing minimum support price (MSP)/market prices of the crops. The statistical analysis of data of various characters was done using analysis of variance techniques as suggested by Panse and Sukhatme (1985) [12].

Results and Discussion

Growth parameters

Plant height (cm): In pooled results (Table 1) taller plant (151.3 cm) at harvest was recorded under castor-summer greengram cropping system as compared to other systems. Significantly higher plant height of castor was obtained in those treatments where castor crop was sown as sole crop during *kharif* as compared to castor crop sown as intercrop. This might be due to non-existence competition for sunlight, space, nutrient and water. The results are confirmed with the results reported by Kumar *et al.* (2010) [6] and Singh *et al*. (2012).

Table 1: Growth attributes of castor as influenced by different castor-based cropping systems

Treatment	Plant height at harvest (cm)			Number of primary branches			Number of internodes per plant at main spike maturity		
	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled
Castor sole	140.9	154.4	147.7	4.9	7.8	6.4	17.9	18.9	18.4
Greengram + castor (2:1)	121.4	147.0	134.2	5.8	6.8	6.3	19.1	18.6	18.8
Cowpea + castor (2:1)	115.2	143.7	129.4	4.6	6.5	5.5	19.0	20.7	19.8
Groundnut + castor (2:1)	124.1	147.3	135.7	4.2	6.3	5.2	20.1	21.4	20.7
Sesamum + castor (2:1)	110.6	135.7	123.2	5.4	5.4	5.4	17.7	18.1	17.9
* Greengram-*rabi* castor	104.2	105.1	104.6	6.1	4.7	5.4	16.6	17.5	17.0
Castor-summer pearl millet	144.3	152.9	148.6	5.6	9.4	7.5	18.8	20.0	19.4
Castor–summer greengram	146.2	156.5	151.3	6.0	8.1	7.0	18.8	21.0	19.9
Castor–summer sesamum	142.7	155.5	149.1	5.4	7.8	6.6	17.4	20.6	19.0
Castor–summer mothbean	142.1	152.5	147.3	5.2	9.4	7.3	18.4	19.2	18.8
S.Em.±	3.1	3.3	3.2	0.4	0.7	0.5	0.6	1.1	0.9
C.D.at 5 %	8.9	9.6	9.3	NS	2.0	1.6	1.8	NS	2.5
C.V %	4.6	4.4	4.5	16.2	18.1	17.2	6.9	11.1	9.0

* *Kharif* castor was sown on 18th and 13th August while *rabi* castor was sown on 15th and 12th October, 2011 and 2012, respectively.

Number of branches

Significantly higher number of primary branches per plant of castor (7.5 and 7.8) were recorded under castor-summer pearl millet system (Table 1). More number of branches per plant in these treatments might be due to appropriate time of sowing, availability of proper climatic conditions and day length.

Though a smaller number of branches per plant was recorded by *rabi* sown castor crop. This might be due to unavailability of proper day length and climatic conditions. These results are confirmed with the results reported by Kumar *et al.* (2010) [6].

Internode per plant: Significantly higher number of internodes per plant of castor (20.7) was recorded (Table 1) under groundnut + castor (2:1) cropping system. T_5 [sesamum + castor (2:1)] recorded a smaller number of internodes per plant which might be due to shading effect and some allelopathic effects of sesamum on castor crop during growth period. Castor crop grown during *rabi* season also recorded similar number of internodes (17.0) per plant as a result of poor growth of castor during *rabi* season.

Yield attributes and yield

Number of spikes per plant of castor: Higher number of spikes per plant of castor was recorded in those systems where castor was sown as sole during *kharif* season (Table 2). This might be due to relatively less inter row competition in sole castor and better use of non-renewable resources like water, nutrients, space and incoming solar radiation which resulted into higher dry matter accumulation in reproductive parts. Srilatha *et al.* (2002) [17] and Mudalagiriyappa *et al.* (2011) [7] also reported that number of spikes per plant was higher when castor was sown as sole.

Table 2. Yield attributes of castor as influenced by different caasor based cropping systems

Treatment	Number of spikes per plant			Number of capsules per main spike			100 seed weight (g)		
	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled
Castor sole	10.5	11.3	10.9	56.0	56.3	56.1	33.1	31.2	32.1
Greengram + castor (2:1)	9.0	8.5	8.8	50.0	49.1	49.5	31.5	32.4	32.0
Cowpea + castor (2:1)	8.3	8.0	8.1	48.9	52.6	50.7	30.9	31.0	31.0
Groundnut + castor (2:1)	9.5	10.0	9.8	51.4	54.6	53.0	31.1	32.7	31.9
Sesamum + castor (2:1)	7.3	6.8	7.0	43.3	47.8	45.5	31.0	31.2	31.1
* Greengram-*rabi* castor	9.0	8.0	8.5	47.5	50.1	48.8	29.8	30.6	30.2
Castor-summer pearl millet	9.8	10.8	10.3	53.3	55.7	54.5	32.1	31.1	31.6
Castor–summer greengram	10.0	10.5	10.3	55.7	56.0	55.8	31.5	31.9	31.7
Castor–summer sesamum	9.5	10.0	9.8	55.1	51.9	53.5	32.1	32.0	32.0
Castor–summer mothbean	9.0	10.8	9.9	54.3	54.6	54.5	30.9	32.9	31.9
S.Em.±	0.5	0.6	0.5	2.0	1.9	1.9	0.8	0.7	0.8
C.D.at 5 %	1.3	1.7	1.5	5.8	5.7	5.7	NS	NS	NS
C.V %	9.9	12.2	11.0	7.7	7.3	7.5	4.9	4.7	4.8

*Kharif castor was sown on 18th and 13th August while rabi castor was sown on 15th and 12th October, 2011 and 2012, respectively.

Number of capsules on main spike of castor: Among intercropping systems, groundnut + castor (2:1) recorded significantly higher number of capsules per main spike (Table 2) than that of other intercropping systems might be due to supply of nitrogen by fixing atmospheric N in soil to the associated castor, better moisture conservation by working as cover crop, suppression of weeds and higher sunshine availability. The findings are in agreement with the results reported by Srinivas *et al.* (2005) [18], Dhimmar (2009) [3] and Singh (2009) [16].

100-seed weight (g): Among different intercropping systems treatment T_2 [greengram + castor (2:1)] recorded maximum 100-seed weight during 2011-12 and in pooled result, while during 2012-13 treatment T_4 [groundnut + castor (2:1)] recorded maximum 100-seed weight (Table 2). Among cropping sequence system treatment T_9 (castor-summer sesamum) recorded maximum 100-seed weight during 2011-12 and in pooled results, while during 2012-13 treatment T_{10} (castor-summer mothbean) recorded maximum 100-seed weight.

Seed and stalk yield (kg/ha): Among all the cropping systems when castor crop sown during *kharif* season as a sole crop produced higher seed yield as compared to its own as inter crop (Table 3). This might be due to relatively less inter row competition in sole castor and better use of resources like water, nutrients, space and sunlight ultimately resulted into higher number of spikes per plant and number of capsules per spike which showed positive correlation with seed yield. These finding are in close conformity with the findings of Hegde and Reddy (1987) [5], Mudalagiriyappa *et al.* (2011) [10], Neginhal *et al.* (2011) [11], Kumar *et al.* (2011) [7] and Kumavat *et al.* (2016) [9]. On the other hand, among intercropping systems, groundnut + castor (2:1) recorded significantly higher castor seed yield than that of other intercropping systems.

Table 3: Castor yield, component crop yield as influenced by different castor (*Ricinus communis* L.) based cropping systems

Treatment	Castor yield (kg/ha)			Intercrop/sequence crop yield (kg/ha)		
	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled
Castor sole	3665^{a}	3772^{a}	3718^{a}	-	-	
Greengram + castor (2:1)	2645^{bc}	2946^{ab}	2796^{bc}	696	756	726
Cowpea + castor (2:1)	2316^{c}	2463^{b}	2390^{c}	664	711	688
Groundnut + castor (2:1)	3307^{ab}	3684^{a}	3495^{ab}	1034	965	999
Sesamum + castor (2:1)	2253^{c}	2227^{b}	2240^{c}	360	335	347
Greengram-*rabi* castor	1975^{c}	2048^{b}	2012^{c}	728	789	758
Castor-summer pearl millet	3711^{a}	3747^{a}	3729^{a}	1336	1202	1269
astor–summer greengram	3785^{a}	3806^{a}	3796^{a}	671	633	652
Castor–summer sesamum	3622^{a}	3718^{a}	3670^{ab}	341	377	359
Castor–summer mothbean	3733^{a}	3770^{a}	3752^{a}	323	349	336
S.Em.±	255.4	290.1	272.8	-	-	-
C.D.at 5 %	16.5	18.0	17.3	-	-	-

Note: Treatment means with the letter/letters in common are not significant by DNMRT
at 5 % level of significance

Castor equivalent yield (kg/ha): Among the different intercropping systems under study (Table 4) groundnut + castor (2:1) found better (5141 kg/ha) than rest of the intercropping systems with respect to castor equivalent yield during both the years as well as in pooled results. Higher castor equivalent yield obtained in this system might be due higher yield potentiality of groundnut crop as compared to other crops alongwith higher market price of groundnut. This result is in accordance with the findings of Gupta and Rathore

(1993) [4], Srilatha *et al*. (2002) [17], Mudalagiriyappa *et al*. (2011) [10] and Neginhal *et al*. (2011) [11]. On the other hand, all the cropping sequence under study was at par in term of producing castor equivalent yield. However, castor-summer greengram recorded maximum CEY (4991, 4672 and 4681 kg/ha). This might be only due to higher yield of castor because, it grown as sole during *kharif* season as compared to castor sown as intercrop and better yield of greengram. This result is in conformity with the findings of Singh (2009) [16] and Patel *et al*. (2009) [14].

Table 4: Castor-equivalent yield and economics (average 2 years) as influenced by different castor (*Ricinus communis* L.) based cropping systems

Treatment	Castor equivalent yield (kg/ha)			Gross income (₹/ha)	Net income (₹/ha)	Benefit cost ratio (₹/ha)
	2011-12	2012-13	Pooled			
Castor sole	3723^{bcd}	3832^{bcde}	3777^{bc}	1,39,760	91,102	2.87
Greengram + castor (2:1)	3583^{cd}	3954^{bcd}	3769^{bc}	1,39,437	66,877	1.92
Cowpea + castor (2:1)	3209^{d}	3411^{cde}	3310^{c}	1,22,459	49,899	1.69
Groundnut + castor (2:1)	4955^{a}	5327^{a}	5141^{a}	1,90,215	1,13,595	2.48
Sesamum + castor (2:1)	3026^{d}	2948^{e}	2987^{c}	1,10,523	41,301	1.60
Greengram-*rabi* castor	2928^{d}	3078de	3003^{c}	1,11,098	48,771	1.78
Castor-summer pearl millet	4573^{ab}	4564^{ab}	4569^{ab}	1,69,036	90,005	2.14
Castor–summer greengram	4691^{a}	4672^{ab}	4681^{ab}	1,73,201	97,421	2.29
Castor–summer sesamum	4375^{abc}	4547^{ab}	4461^{ab}	1,65,044	85,578	2.08
Castor–summer mothbean	4271^{abc}	4340^{abc}	4306^{ab}	1,59,305	83,003	2.09
S.Em. ±	263.5	300.3	281.9	-	-	-
C.D.at 5 %	13.4	14.8	14.1	-	-	-

Note: Treatment means with the letter/letters in common are not significant by DNMRT at 5 % level of significance

Castor	:	₹37/kg	Greengram	:	₹40/kg	Groundnut	:	₹48/kg
Sesamum	:	₹75/kg kg	Pearl millet	:	₹14/kg g	Mothbean	:	₹45/kg g

Economics

Among different intercropping systems groundnut + castor (2:1) (₹ 1,13,595/ha) proved better in respect of obtaining net realization (Table 4). This might be due to higher yield of groundnut and castor which turned into maximum CEY. Results are in conformity with Patel *et al.* (1989) [13] and Prasad and Verma (1986) [15]. While castor-summer greengram recorded maximum (₹ 97,421/ha) net profit among the different cropping sequences under study. This might be due to higher CEY owing to more net realization. Maximum value of benefit : cost ratio (2.87) recorded with sole castor might be due to lowest cost of cultivation (₹ 48,658/ha) while minimum value of benefit : cost ratio (1.60) obtained with sesamum + castor (2:1) might be due to the lowest CEY (2987 kg/ha) turned into lower net realization (₹ 41,301) with high cost of cultivation (₹ 69,222/ha). The results are inconformity with the findings of Singh (2009) [16]. With respect to net return, sole crop recorded higher net realization (₹ 91,102/ha) than all the treatments except T_4 [groundnut + castor (2:1)] and T_8 (castor-summer greengram). This might be due to sowing of sole castor having lower cost of cultivation with higher castor seed production than other systems. More or less lower net realization recorded under the sequential cropping systems, eventhough higher CEY in these systems might be due to more cost of cultivation in these systems.

References

1. Chatterjee BN, Mandal BK. Indian Journal of Agricultural Science. 1992; 62:507-518.
2. Chetty CKR, Rao UMB. Experimental design for intercropping systems and analysis of data. In: Proceedings of international Intercropping Workshop. International Crop Research Institute of Semi-Arid Tropics, Hyderabad, India held during 10th to 13th January. 1979; 277-281.
3. Dhimmar SK. Effect on growth and yield of rabi castor on pulses intercropping under varying planting geometry. American-European Journal of Scientific Research. 2009; 4(3):165-168.
4. Gupta IN, Rathore SS. Intercropping in castor (*Ricinus communis* L.) under dryland condition in Rajasthan. Indian Journal of Agronomy. 1993; 38(2):182-186.
5. Hegde MR, Reddy BN. Performance of castor based intercropping systems as influenced by nipping. Indian Journal of Agronomy. 1987; 32(1):18-20.
6. Kumar HCS, Mudalagiriyappa, Nanjappa HV, Ramachandrappa BK, Humanthappa HC. Productive performance of castor based intercropping system under rainfed conditions of central dry land zone in Karnataka. Mysore Journal of Agricultural Sciences. 2010; 44(3): 481-484.
7. Kumar HCS, Mudalagiriyappa, Nanjappa HV, Ramachandrappa BK, Humanthappa HC. Effect of castor-based intercropping on yield of post-harvest nutrient status of soil. Mysore Journal of Agricultural Sciences. 2011; 45(1):39-41.
8. Kumar M, Shivran AC, Chouhan R., Meena KS, Verma KC. Effect of row ratio and sulphur levels on yield attributes, seed yield and quality in castor-mungbean intercropping systems under dryland condition. Environment and Ecology. 2013; 31(2C):1061-1064.
9. Kumavat AK, Ardesna RB, Kumar D, Chouhan M. Yield, quality, nutrient uptake, soil fertility and weed dry weight as influenced by castor (*Ricinus communis* L.) intercropped with mungbean (*Vigna radiata* L.) under different row ratios and spacing during rabi season. The Bioscan. 2016; 11(1):607-610.
10. Mudalagiriyappa, Nanjappa HV, Ramachandrappa BK, Kumar HCS. Productivity and economics of castor (*Ricinus communis* L.) based intercropping systems in vertisols under rainfed conditions. Indian Journal of Dryland Agriculture Research and Development. 2011; 26(2):77-81.
11. Neginhal MP, Ramachandrappa BK, Dhanapal GN, Nanjappa HV. Productive performance of intercrops in

nipped castor (*Ricinus communis* L.) in Alfisols of dryland. Mysore Journal of Agricultural Sciences. 2011; 45(2):322-325.
12. Panse VG, Sukhatme PV. Statistical methods for Agricultural Workers, Indian Council of Agricultural Research, New Delhi. 1985.
13. Patel PG, Patel LD, Patel MK, Patel JV. Studies on intercropping in castor. Journal of Oilseeds Research. 1989; 6:113-117.
14. Patel RM, Patel MM, Patel GN. Effect of spacing and nitrogen levels on rabi castor, *Ricinus communis* Linn. Grown under different cropping sequences in North Gujarat Agroclimatic Conditions. Journal of Oilseeds Research. 2009; 26(2):123-125.
15. Prasad SN, Verma B. Effect of intercropping on castor with greengram, blackgram, sesame and sorghum on yield and net returns. Indian Journal of Agronomy. 1986; 3(1):21-25.
16. Singh I. Study on intercropping of castor, *Ricinus communis* L. under irrigated condition. Journal of Oilseeds Research. 2009; 26(2):170-171.
17. Srilatha AN, Masthan SC, Mohammed S. Production potential of castor intercropping with legumes under rainfed conditions. Journal of Oilseeds Research. 2002; 19(1):127-128.
18. Srinivas M, Mohammed S, Sairam A. Yield components and yield of castor (*Ricinus communis* L.) as influenced by different planting geometries and row proportions of intercropped groundnut or pearl millet. Crop Research. 2005; 30(3):349-354.