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Yield, quality and soil fertility as influenced by *rabi* castor (*Ricinus communis* L.) based intercropping system

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ABSTRACT

An experiment comprising nine treatments of sole crops and intercropping systems viz., castor sole, lucerne sole, chicory sole, fenugreek sole, carrot sole, castor + lucerne (1:2), castor + chicory (1:2), castor + fenugreek (1:2), and castor + carrot (1:2) was conducted in a randomized block design with three replications. Sole castor, castor + lucerne and castor + fenugreek (1:2) found equally effective with respect to seed yield of castor. These treatments were found significantly superior than rest of the treatments. With regards to intercrops viz- lucerne, chicory, fenugreek and carrot the maximum green forage yield of lucerne / chicory, seed yield of fenugreek and root yield of carrot were obtained when they were sown as sole crop. Similar trend was also observed in stalk / dry fodder / straw / green fodder yield of castor and intercrops. Oil content in castor / crude protein and crude fiber content in lucerne and chicory / total soluble salts in carrot were found higher in their sole crop treatments as compared to when they were grown as intercrop. Oil yield was found significantly higher in sole castor than other treatments but it was statistically at par with castor + lucerne and castor + fenugreek at 1:2 ratio. Nutrient status of soil viz: organic carbon, available N, P, K and S after harvest of crops did not differ significantly due to different treatments.

***Keywords*: Castor, intercropping, row ratio and sole crop**

Castor (*Ricinus communis* L.) is a non-edible oilseed crop having high industrial importance due to presence of unique fatty acid and ricinoleic acid. Castor is extensively cultivated in India, China, Brazil, Ethiopia and Thailand etc in the world. In general castor is grown in *kharif* season but after taking short duration *kharif* legume crop for getting maximum income per unit area, *rabi* castor can be sown with intercrops This practices leads to some benefits like yield advantages as compared to sole cropping, greater stability of yield over different seasons, insurance against aberrant weather conditions, build-up or maintenance of soil fertility, economy of land, production of higher yield and higher economic returns per unit area. Keeping this in view, present experiment on "Feasibility of intercropping in *rabi* castor under North Gujarat agro climatic conditions" was planned.

A field experiment was conducted during *rabi* season of the year 2013 at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, District Banaskantha (North Gujarat). The field experiment was laid out in a Randomized Block Design with four replications. An experiment consists of nine treatments including sole crops and intercropping systems *viz.*, T_1 : castor sole, T_2 : lucerne sole, T_3 : chicory sole, T_4 : fenugreek sole, T_5 : carrot sole, T_6 : castor + lucerne (1:2), T_7 : castor + chicory (1:2), T_8 : castor + fenugreek (1:2), and T_9 : castor + carrot (1:2) were allotted to each plot by random method. The soil of experimental plot was loamy sand in texture, low in organic carbon and available nitrogen, medium in available phosphorus and potassium. Organic carbon (%), available N (kg ha^{-1}), available P_2O_5 (kg ha^{-1}), available K_2O (kg ha^{-1}) and available sulphur (ppm ha^{-1}) were estimated by Walkley and Black's rapid titration method (Jackson, 1973), Alkaline permanganate method (Jackson, 1973), Olsen's method (Jackson, 1954), Flame photometer method (Jackson, 1973) and Extraction with l % NaCl (William and Steinbergs, 1959), respectively.

Random seed samples were drawn from the produce of each net plot to estimate the oil content of castor seed. The oil content in castor seed samples was determined by IBM DC/20 series, NMR (Nuclear Magnetic Resonance) analyzer. Oil yield (kg ha^{-1}) was worked out by using following formula

$$\text{Oil yield (kg ha}^{-1}) = \frac{\text{Oil (\%)} \times \text{seed yield (kg ha}^{-1})}{100}$$

The crude protein content and crude fiber content were measured with the help of INSTALAB 600 NIR product analyzer and it was expressed as percentage on dry weight basis (Nortvedt *et al*., 1998).

Significantly higher seed and stalk yields (kg ha^{-1}) were recorded by sole castor than rest of the intercropping treatments, but it remained statistically at par with castor + lucerne and castor + fenugreek with row ratio of 1:2, which could be attributed to higher and optimum plant densities in sole cropping system. Among the intercropping treatments, castor + lucerne (1:2) and

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Table 1: Yield and quality of castor and inter crops as influence by different treatments

Sr. No	Treatments	Seed yield / green forage yield/root yield (kg ha^{-1})	Stalk yield /dry or green fodder yield / straw yield (kg ha^{-1})	Oil content (%) in castor seed	Oil yield (kg ha^{-1})	Crude protein content/ total soluble salts (%) in carrot root	Crude fibre content (%)
T_1	Castor sole	2315	2616	48.70	1127	-	-
T_2	Lucerne sole	19800	3400	-	-	18.65	20.6
T_3	Chicory sole	30300	5419	-	-	20.41	10.7
T_4	Fenugreek sole	816	1353	-	-	-	-
T_5	Carrot sole	16518	18704	-	-	12.60	2.35
T_6	Castor + Lucerne (1:2)	2267 (10900)	2539 (1879)	48.14	1091	18.13	20.4
T_7	Castor + Chicory (1:2)	1974 (18280)	2171 (3140)	47.85	945	20.22	10.5
T_8	Castor + Fenugreek (1:2)	2154 (534)	2391 (958)	48.05	1035	-	-
T_9	Castor + Carrot (1:2)	1761 (9783)	1919 (15163)	47.32	833	12.25	2.20
SEm (±)		-	-	**1.55**	**51.61**	-	-
LSD (0.05)		-	-	**NS**	**158.54**	-	-

*Note: *Data presented in parenthesis indicates intercrops values*

Table 2: Effect of different treatments on residual soil fertility after harvest of the crops

Sr. No	Treatments	Nutrient status in soil after harvest				
		Organic carbon (%)	Available nitrogen (kg ha^{-1})	Available phosphorus (kg ha^{-1})	Available potash (kg ha^{-1})	Available sulpher (ppm)
T_1	Castor sole	0.19	141.45	45.68	280.64	10.23
T_2	Lucerne sole	0.21	158.45	51.26	286.42	10.09
T_3	Chicory sole	0.20	151.60	48.50	279.68	9.94
T_4	Fenugreek sole	0.20	155.26	49.71	282.34	10.57
T_5	Carrot sole	0.19	142.30	46.35	280.12	9.85
T_6	Castor+ Lucerne (1:2)	0.23	152.56	48.62	286.40	9.88
T_7	Castor+ Chicory (1:2)	0.22	151.85	46.21	284.20	10.13
T_8	Castor+ Fenugreek (1:2)	0.21	148.62	46.89	283.61	9.95
T_9	Castor+ Carrot (1:2)	0.20	142.17	44.15	276.56	9.82
SEm (±)		**0.008**	**4.13**	**1.60**	**7.57**	**0.35**
LSD (0.05)		**NS**	**NS**	**NS**	**NS**	**NS**
Initial soil nutrient status		**0.17**	**143.50**	**47.50**	**282.00**	**9.23**

castor + fenugreek were found equally efficient to castor sole as lucerne and fenugreek crops have ability to fix atmospheric N and supply it to the associated castor crop and suppressed the weeds and higher sunshine availability to castor. Lower seed and stalk yields were noticed under castor intercropping with carrot and chicory at 1:2 row ratios (Table 1). This might be due to higher competition offered by intercrops for natural resources like space, plant nutrients, moisture and incoming sun radiation. The findings are in agreement with the results reported by Dhimmer (2009) and Singh (2009).

Green forage and dry fodder yields of lucerne and chicory, seed and straw yield of fenugreek and root and green forage yields of carrot were reduced in intercropping systems as compared to their respective sole cropping (Table1). Such variation could be ascribed due to increase in plant densities since these were grown as intercrops with castor and higher competition for natural resources like soil moisture, plant nutrients, space and sunlight which are responsible for less photosynthesis rate resulted in lower accumulation of photosynthates in seed and dry matter per plant in comparison to sole crop. These findings are in close vicinity with the results of Srilatha *et al.* (2002).

The sole crop and intercropping systems exerted their non-significant effect on oil content of castor (Table 1), but marginally higher oil content was recorded with castor grown as sole crop as compared to different intercropping systems. The decrease in oil content of castor grown in intercropping system might be due to higher competition offered by intercrops for natural resources like space, plant nutrient, moisture and incoming sun radiation. Similar findings were recorded by Singh (2009) and Singh *et al*. (2013).

Further, the intercropping systems could not exert their significant effect on crude protein content of lucerne and chicory fodder and total soluble salts in carrot. While lower values of crude protein content in lucerne and chicory and total soluble salts in carrot were recorded when they were grown as intercrop with castor at 1:2 row ratio (Table 1). Moreover, higher crude fibre content of sole crops (lucerne and chicory) was ascribed as compared to their respective intercropping systems *i.e.* lucerne, chicory and carrot (Table 1). This might be due to higher competition offered by intra row spacing for natural resources like space, plant nutrients, moisture and incoming solar radiation.

The sole crop and intercropping systems exerted did not exert their significant effect on soil available organic carbon, nitrogen, phosphorus, potassium and sulpher after harvest of the crops (Table 2). However, improvement in organic carbon of soil was found in castor + lucerne intercropping (1:2 row ratio) at the end of cropping as compared to initial nutrients status of soil. This might be due to the nitrogen fixing behavior of lucerne (leguminous crop). Similar results for intercropping systems in mustard + lucerne were also reported by Patel *et al.* (2007) and Singh *et al*. (2013) in sandy loam soils of north Gujarat. Further, higher available nitrogen, phosphorus and potassium were observed in lucerne grown as sole, whereas, fenugreek sole established its superiority by recording higher available sulphur after harvest of the crop (Table 2). Available N, P and K content increased in soil after harvest of crops might be due to the complementary effect of lucerne and fenugreek throughout the crop growth period. These results are in conformity with findings of Patel *et al.* (2007) and Singh *et al*. (2013). However, growing of castor as a sole crop as well as castor + carrot as intercropping reduced the nutrient status of available N, P_2O_5 and K over the initial fertility status of the soil.

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