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Original Research Article

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

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.

Key words: Castor, intercropping, row ratio and sole crop

INTRODUCTION

Castor (*Ricinus communis* L.) is a non-edible oilseed having high industrial importance due to presence of unique fatty acid and ricinoleic acid. Castor is extensively cultivated in India, China, Brazil, Ethiopia, Thailand etc., In India total acreage, production and productivity of castor crop during 2011-12 were 11.20 lakh hectares, 15.80 lakh tonnes and 1240 kg/ha, respectively (SEA., 2013). The contribution of India in the world castor acreage and production are 56 and 84 per respectively. Area, production and productivity of

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castor in Gujarat were 4.22 lakh ha, 8.33 lakh tones and 1972 kg/ha, respectively (SEA, Annual report 2012-2013).

It is the major non-edible oil seed crop of India, which contributes 3-4 per cent to the total oilseeds production of the country. A significant future of mixed/intercropping is that it is biologically more dynamic than a pure crop and is therefore less likely to succumb to vagaries of weather for example reduction in yield of one compound may be compensated by the other component. Thus, a mixer is intrinsically more secure and dependable in providing some major of returns than sole cropping. Intercropping is growing subsidiary crops between two rows of widely spaced main crops. The main objective of intercropping is to utilize the space left between two rows of main crop and natural resources as well as to produce more grain per unit area by better use of resources. 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 in a given season.

The main principle involved in selecting intercrops is that they should not be competitive with main crop for soil moisture, nutrients and solar radiation. Considerable work has been done in selecting suitable crops like lucerne, chicory, fenugreek and carrot which were found suitable for intercropping in fennel but there is no any information available for taking these crops as intercrops in *rabi* castor. Shortages of fodder and vegetables in the country have focused the attention on including vegetables and fodder crops in intercropping systems which have 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 paired rows in which profitable short duration crop can be grown during early growth stages of crop as *rabi* intercrop which gives an additional income also.

MATERIALS AND METHODS

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

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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.

Among the intercrops, legumes and fodder crops were chosen because of being widely used in common diet of livestock. Lucerne and Chicory are the most important green forage crops by virtue of their excellent forage quality, flavor, taste and softness. Fenugreek and carrot are also eaten as raw vegetable and seed production. Full dose of P2O5 and half dose of N were applied as basal at the time of sowing of rabi castor and remaining half dose of N was applied in two equal splits at 40 and 70 days after sowing. In lucerne and fenugreek full dose of N and P2O5 was applied as basal. While in carrot and chicory full dose of P2O5 and half dose of N was applied as basal at the time of sowing and remaining half dose of nitrogen was applied in two equal split at 35 and 60 days after sowing. The castor, lucerne and chicory were given 10 irrigations each of 50 mm depth whereas five irrigations were applied to carrot and fenugreek crops. Two common light irrigations viz. first irrigation at the time of castor sowing and second irrigation at intercrop sowing were given to each crop for good germination and establishment of seedling. The recommended dose of fertilizer of rabi castor: 80-25-00, lucerne: 20-40-00, chicory: 150-30-00, fenugreek: 20-40-00 and carrot: 80-60-00 NPK kg/ha.

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).

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RESULTS AND DISCUSSION

Significantly higher seed and stalk yields (kg/ha) 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 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

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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.

CONCLUSION

On the basis of one year study, it can be concluded that the highest seed yields (2315 kg/ha) and stalk yield (2616 kg/ha) of castor were recorded when they were grown as sole crops as compared to intercrops, Oil content of castor seed did not showed significant difference due to different sole and intercropping treatments. Oil yield (kg/ha) of castor seed was significantly higher when it was grown as sole and significantly at par when it intercropped with lucerne and Fenugreek than rest of the treatments and castor grown in intercropped did not effect on nutrient status in soil after harvest of crop on loamy sand soil of North Gujarat Agro-climatic condition.

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

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 (%)
Castor sole	2315	2616	48.70	1127	-	-
Lucerne sole	19800	3400	-	-	18.65	20.6
Chicory sole	30300	5419	-	-	20.41	10.7
Fenugreek sole	816	1353	-	-	-	-
Carrot sole	16518	18704	-	-	12.60	2.35
Castor + Lucerne (1:2)	2267 (10900)	2539 (1879)	48.14	1091	18.13	20.4
Castor + Chicory (1:2)	1974 (18280)	2171 (3140)	47.85	945	20.22	10.5
Castor + Fenugreek (1:2)	2154 (534)	2391 (958)	48.05	1035	-	-
Castor + Carrot (1:2)	1761 (9783)	1919 (15163)	47.32	833	12.25	2.20
***S. Em.*±**	**-**	**-**	**1.55**	**51.61**	**-**	**-**
C. D. (0.05)	**-**	**-**	**NS**	**158.54**	**-**	**-**

*Data presented in parenthesis indicates intercrops values

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

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)
Castor sole	0.19	141.45	45.68	280.64	10.23
Lucerne sole	0.21	158.45	51.26	286.42	10.09
Chicory sole	0.20	151.60	48.50	279.68	9.94
Fenugreek sole	0.20	155.26	49.71	282.34	10.57
Carrot sole	0.19	142.30	46.35	280.12	9.85
Castor+ Lucerne (1:2)	0.23	152.56	48.62	286.40	9.88
Castor+ Chicory (1:2)	0.22	151.85	46.21	284.20	10.13
Castor+ Fenugreek (1:2)	0.21	148.62	46.89	283.61	9.95
Castor+ Carrot (1:2)	0.20	142.17	44.15	276.56	9.82
***S. Em.*±**	**0.008**	**4.13**	**1.60**	**7.57**	**0.35**
C. D. (0.05)	**NS**	**NS**	**NS**	**NS**	**NS**
Initial soil nutrient status	0.17	143.50	47.50	282.00	9.23