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INFLUENCE OF SOIL DEPTH ON PRODUCTIVITY OF RAINFED CASTOR AND CLUSTERBEAN IN SOLE AND INTERCROPPING SYSTEMS

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ABSTRACT

The studies on influence of soil depth on productivity of rainfed castor and clusterbean in sole and intercropping systems were conducted in semi arid Alfisol watershed area during *kharif* season from 1992 to 1995. The results indicated that castor and clusterbean in different intercropping systems showed positive response with increment in soil depth in all the years. Among the crops, castor was found highly sensitive than clusterbean in terms of yield and growth components. The intercropping of castor and clusterbean recorded higher yield and monetary advantages than respective sole crops at all soil depths due to efficient utilization of rainwater and nutrients. However, the yield advantages in intercropping systems increased with increment of soil depth upto 30 cm and decreased from 30-45 cm. Among the systems intercropping of castor + clusterbean (1:2) recorded the highest castor seed equivalents at 30-45 cm followed by sole castor. The increase in seed yields, growth and yield components with increased soil depth is attributed to efficient use of rainwater and nutrients.

INTRODUCTION

Castor is one of the important non-edible oilseed crop grown widely in rainfed alfisols of India. The productivity of the crop often fluctuates due to variation in rainfall, both in terms of quantity and distribution. The productivity of castor can be stabilized through intercropping with short duration legumes (Subba Reddy and Venkateswarlu, 1989). But the yield gains through the system are dependent on available rainwater and nutrients, which are further, determined by effective soil depth (Vittal *et al.*, 1990). Hence a study was conducted to study the interactive effects between soil depth, rainfall, crop growth in castor and clusterbean intercropping systems in alfisols under rainfed environment.

MATERIAL AND METHODS

The experiment was conducted on an Alfisol watershed at Hayatnagar Research Farm of CRIDA, Hyderabad, India (17^0-20'-02" N latitude and 78^0-35'-08" longitude). The general physiography of watershed it found to be gentle in slope (2-5%) with highest elevation of 520 msl. The watershed covering an area of 5 ha has three pediments consisting of upper, middle and lower portions. Inter bunded area of each pediment has been covered with 0.5m^2 graded bund. The topsoil (A1) found to be loose grained and sub soil structure compact, weakly sub angular blocky. The soil belonged to an Alfisol according to the soil taxonomy and Levisol according to FAO legend. A topsoil survey was made by making pits upto 60 cm depth, at 20 sites in each strip on watershed line in small grid fashion (10 x 50 m). The average soil depth in upper, middle and lower basins of micro- catchment was 8.0 cm + 4.3 cm (D1), 15.0 cm + 4.5 cm (D2) and 30 cm + 12 cm (D3) respectively. Sole crops of castor (SHB-18) and clusterbean (Pusa Navbahar) and intercrop of Castor + clusterbean (1:2) were grown in upper, middle and lower portions of the watershed area from 1992-95 during *kharif*. Castor in sole and intercropping systems was grown at 90 x 20 cm apart white clusterbean was grown at 45 x 20 cm. An amount of 10 kg N and 30 kg P_2O_5 was applied uniformly to both the component crops in different systems as basal. Castor in sole and intercropping system received 40 kg N/ha as top dressing in two equal installments at 30-

45 and 60-75 days after sowing. These treatments were tested in randomized block design with four replications. Interculture and plant protection measures were undertaken as required. The rainfall and potential evapotranspiration were recorded daily and rainfall use efficiency (RUE) and moisture adequacy index (MAI) was calculated according to Mahandra Singh and Joshi (1997). Drymatter, leaf area index (LAI) and nitrogen uptake were recorded at different phonological stages of component crops. Seed yields of castor and clusterbean were recorded in all four years. The yield and economic advantages were estimated through grain equivalents (Mead and Willey, 1980). The total nutrient contents in soil were nitrogen 140, phosphorus 10 and potassium 220 kg ha^{-1}, respectively.

Rainfall Pattern

Castor in sole and intercropping systems received total amount of 602, 640, 718 and 750 mm of rainfall in 1992, 93, 94 and 95 respectively during its growth while component crop clusterbean in sole and intercropping system received rainfall of 456, 604, 319 and 518 mm respectively during its growth period in 1992, 93, 94 and 95.

In 1992, castor in different cropping systems experienced moderate moisture stress (Fig. 1) at all soil depths during formation of tertiaries i.e. 20-21 weeks after sowing (WAS). Clusterbean component in different cropping systems experienced severe moisture stress during early vegetative phase i.e. 2-3 WAS in shallow soil depth and during flowering stage in medium and deep soils. In 1993, castor component in the system experienced moderate stress at all soil depths 20-21 WAS and severe stress in shallow and medium soil depths from 23 WAS. Clusterbean suffered moderate stress at all soil depths 7-8 WAS.

During 1994, castor experienced moderate stress 21 WAS at shallow soil depth. In medium and deep soils castor experienced moderate moisture stress in medium and deep soils 16-17 WAS. Clusterbean experienced moderate stress during early vegetative stage at all soil depths and severe moisture stress during flowering stage in medium and deep soils. In 1995,castor experienced moderate moisture stress at shallow soil depth 23 WAS. Clusterbean component in the system experienced moderate stress during vegetative phase in shallow depth and severe stress at deeper depth (Fig. 1).

RESULTS AND DISCUSSION

Soil depth in relation to crop growth and yields

The growth components *viz.*, LAI and drymatter in castor and Clusterbean in sole and intercropping systems increased significantly with increment in soil depth. In castor, in different cropping systems LAI increased upto 75 days after sowing (DAS); while in clusterbean LAI increased upto 60DAS and later decreased at soil depths. At D3 (30-45cm), total drymatter in sole castor increased by 58,62,39 and 18 percent compared to soil depths of <15 cm at 45,60,75 and 120 DAS respectively in 1993. Similar trends of results were noticed in 1994 and 1995. Sole clusterbean at D3 (30-45 cm) recorded higher drymatter production by 62, 220, 81 and 63 per cent compared to soil depth < 15 cm at 45, 60, 75 and 120 DAS respectively in 1993. Similar increment in drymatter production in sole clusterbean was observed in 1994 and 1995. Castor and clusterbean in intercropping system produced higher combined LAI and drymatter as compared to the respective sole crops at different growth stages in all years. This indicates efficient use of rainfall and light interception by component crops leading to the production of photosynthates necessary for higher biomass production (Fig. 2). Soil depth significantly influenced the growth and development through variation in soil moisture content. Deep soils retained more soil moisture throughout the growth period and resulted in

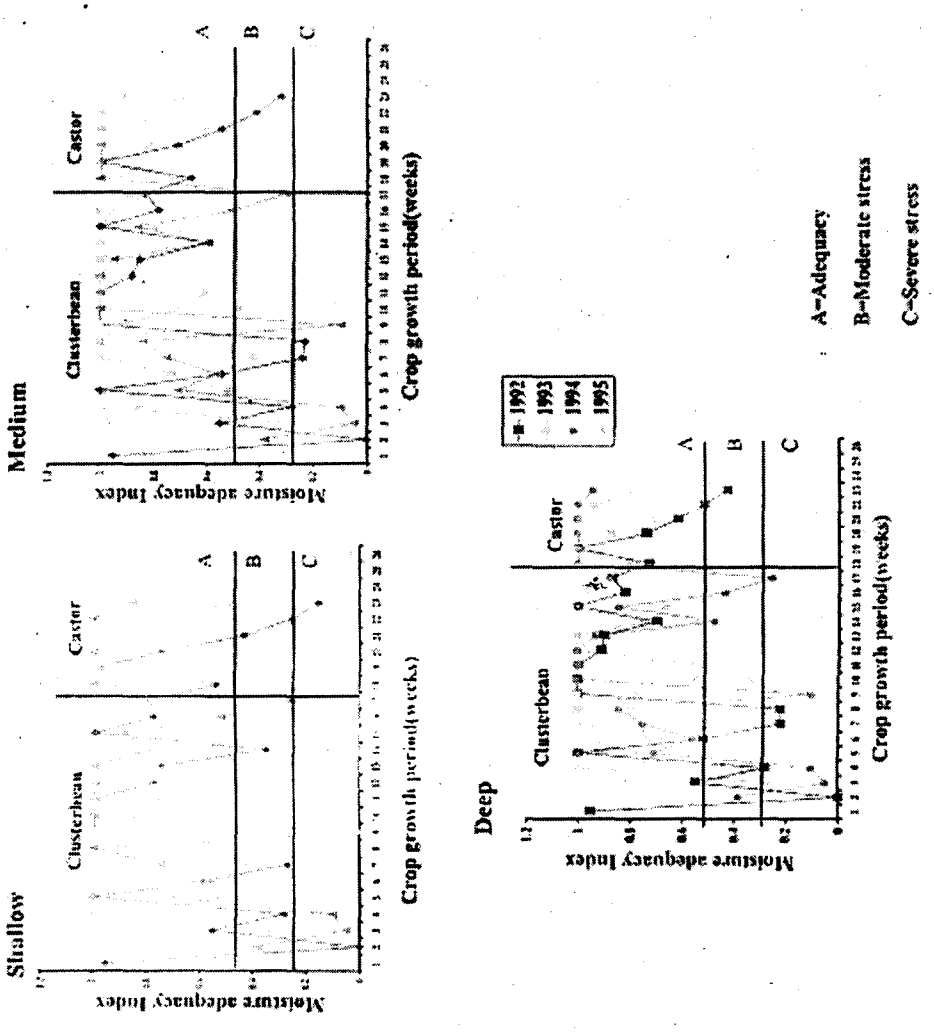

Fig. 1. Influence of soil depth on moisture availability in castor and clusterbean

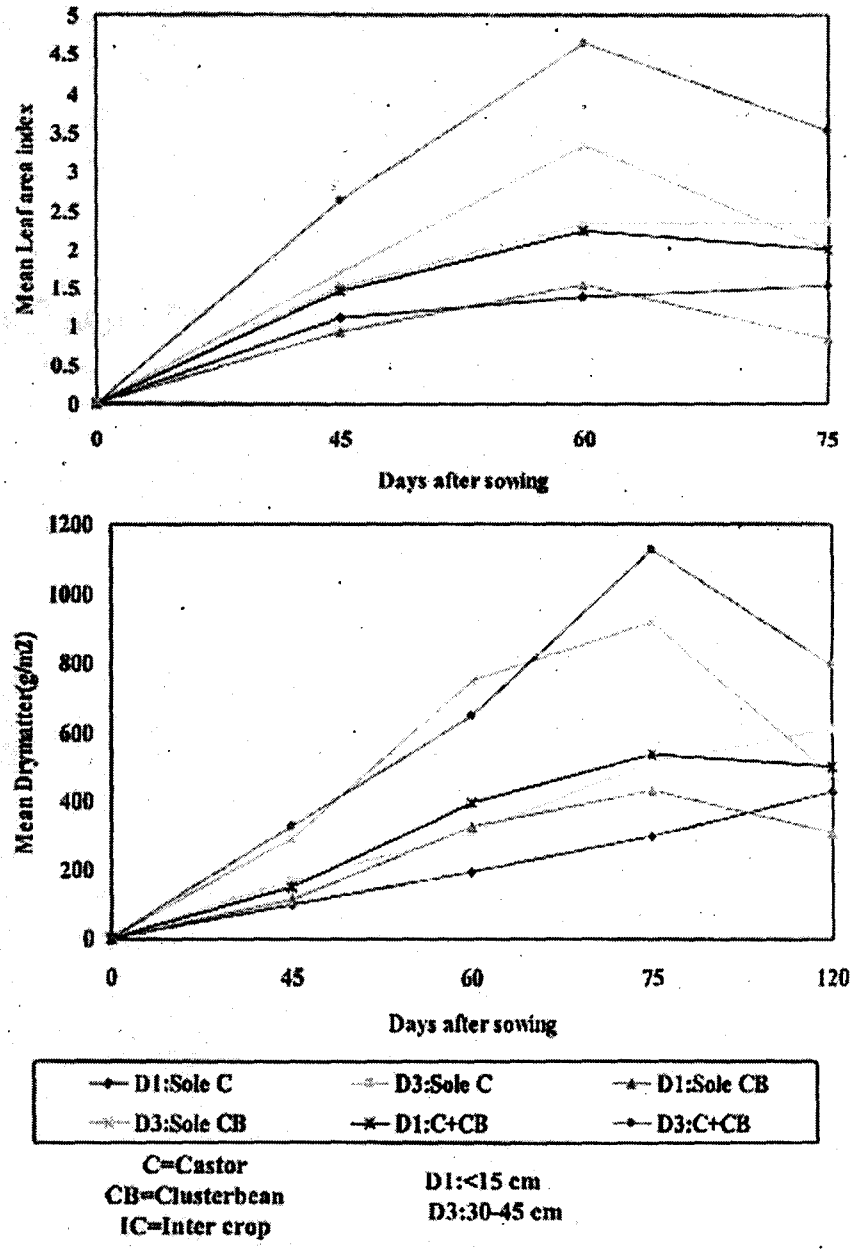

Fig. 2. Mean growth parameters of castor and clusterbean as influenced by soil depth in different cropping systems

higher drymatter and seed cotton yield compared to medium deep soils (Pundarikakshudu *et al.*, 1992 and Katkar *et al.*, 1999).

The seed yield of sole castor in sole and intercropping systems significantly increased with increase in soil depth (15-45 cm) in the watershed. The seed yield of castor was higher by 47 and 102 per cent in 15-30 and 30-45 cm soil depth, respectively over the soil depth of 15 cm. The influence of soil depth on seed yield of sole castor was highest in 1993 followed by 1994 due to better distribution of rainfall for castor. The influence of soil depth on productivity of clusterbean was slightly less when compared to castor. On an average, the seed yield of sole clusterbean was enhanced by 1981 and 3360 kg/ha in soils having depth ranging 15-30 and 30-45 cm respectively compared to < 15 cm depth. The influence of soil depth on clusterbean was highest in 1994 and 1995 due to better distribution of rainfall for clusterbean. Medium and deeper soil depth significantly influenced the seed yields of castor and clusterbean in intercropping system. (Table 1). Significant increase in seed yields of chickpea; soybean and sorghum, pearlmillet and castor were noticed due to variation of soil depth due to higher moisture and nutrient use efficiencies (Vittal *et al.*, 1990; Jadhav *et al.*, 1996 and Paira Singh *et al.*, 1999).

Intercropping of castor and clusterbean recorded higher castor seed equivalents at all soil depths compared to sole crops over the years. At shallow soil depth (<15 cm) castor and clusterbean intercropping systems produced higher castor seed equivalents of 22 and 127 per cent, 30 and 44 per cent in medium soil depths (15-30 cm) and 31 and 40 per cent in deeper soils (30-45 cm) than sole crops of castor and clusterbean respectively.

Yield and monetary advantages

Gross returns: The results indicated that castor + clusterbean (1:2) in sole and intercropping systems increased gross returns per hectare with increment in soil depth over the years. Sole castor at 30-45 cm soil depth (D3) increased the gross returns per hectare by 102 and 36 per cent as compared to the crop raised at < 15 cm (D1) and 15-30 cm (D2) respectively while sole clusterbean at D3 (30-45 cm) soil depth enhanced gross returns per hectare by 251 and 40 percent at D1 and D2 respectively. On an average intercropping of Castor + Clusterbean (1:2) recorded higher gross returns by 30 and 52 percent as compared to sole crops of castor (Rs. 7111/ha) and clusterbean (Rs. 6080/ha) (Table 2). Among the intercropping systems, castor + clusterbean (1:2) grown at D3 (30-45 cm) gave the higher gross returns per hectare by 115 and 37 per cent as compared to the intercropping system raised within 15 cm and

Table 1. Influence of soil depth on yield of castor and clusterbean in sole and intercropping systems

		Castor bean yield (kg/ha)					Clusterbean green pod yield (kg/ha)				
		1992	1993	1994	1995	Mean	1992	1993	1994	1995	Mean
Sole Crops	D1	668	789	381	778	654	666	2040	1600	1058	1341
	D2	783	1222	768	1079	963	1044	6117	2437	3691	3322
	D3	1022	1798	1229	1253	1325	2203	6933	3210	6458	4701
Intercrops	D1	420	750	361	548	520	392	1930	1072	946	1085
	D2	524	902	533	723	671	623	4048	1425	2823	2230
	D3	705	1448	818	870	960	1682	4439	2194	3600	2979
CD (0.05)	Crops	52	62	36	36	107	46	161	92	242	742
	Depths	63	75	44	44	131	57	197	113	297	909
Crops x Depths		NS	107	62	62	NS	80	279	160	420	NS

Table 2. Influence of soil depth on castor seed equivalents, gross returns and RUE in sole and intercropping systems

		Castor seed equivalents (kg/ha)					Gross returns (Rs./ha)					RUE (kg/ha/mm)				
		1992	1993	1994	1995	Mean	1992	1993	1994	1995	Mean	1992	1993	1994	1995	Mean
Sole Castor	D1	2224	2367	1524	3890	2501	3340	4734	3048	7780	4725	1.11	1.23	0.53	1.04	0.97
	D2	2607	3666	3072	5395	3685	3915	7332	6144	10790	7045	1.30	1.91	1.07	1.44	2.97
	D3	3403	5394	4916	6265	4995	5110	10788	9832	12530	9565	1.70	2.81	1.71	1.67	3.08
Sole Clusterbean	D1	666	2040	1600	1058	1341	999	4080	3200	2116	2599	1.46	3.38	5.01	2.04	1.43
	D2	1044	6117	2437	3691	3322	1566	12234	4874	7382	6514	2.29	10.13	7.64	7.12	6.79
	D3	2203	6933	3210	6458	4701	3305	13866	6420	12916	9127	4.83	11.48	10.06	12.47	5.49
Castor+Clusterbean (1:2)	D1	1791	4180	2516	3686	3043	2688	8361	5032	7372	5863	1.54	4.36	3.86	2.56	1.97
	D2	2368	6754	3557	6438	4779	3555	13417	6864	12876	9178	2.24	8.11	5.21	6.41	9.71
	D3	4030	8790	5466	7975	6565	6048	17566	10932	15900	12611	4.86	9.61	8.01	8.20	7.67
CD (0.05)	Crops	147	207	147	188	800	221	421	326	383	1660	0.11	0.24	0.24	0.29	1.23
	Depths	147	207	147	188	800	221	421	326	383	1660	0.11	0.24	0.24	0.29	1.23
Crops x Depths		255	360	255	326	NS	383	729	565	664	NS	0.19	0.41	0.42	0.50	2.14

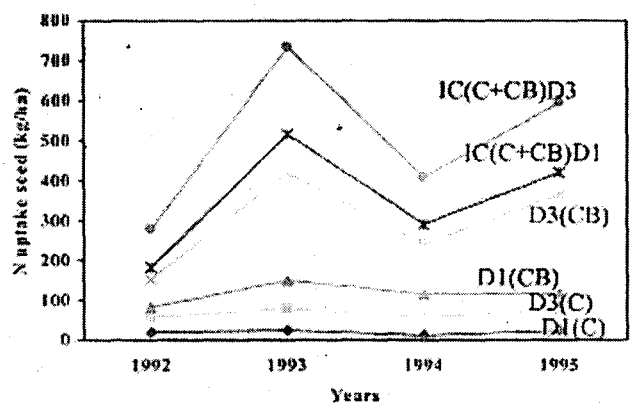

Fig. 3. Effect of soil depth on nitrogen uptake in castor and clusterbean in sole and intercropping systems

15-30 cm soil depth, respectively. Thus, clusterbean showed profound influence in enhancing the gross returns compared to castor. However, the intercropping system of castor + clusterbean showed higher returns than that of sole clusterbean.

Nitrogen uptake

The nutrient uptake in different intercropping systems showed that nitrogen uptake in seed of castor and clusterbean in sole and intercropping system increased with increase in soil depth. Sole castor grown at D3 (30-45 cm) recorded higher nitrogen uptake by 123 and 47 per cent compared to sole castor at D1 and D2 soil depths respectively, while sole clusterbean recorded higher nitrogen uptake by 274 and 40 per cent compared to sole clusterbean grown at soil depth ranging < 15 cm and 15-30 cm respectively. Among the intercropping systems, castor + clusterbean (1:2) raised at D3 (30-45 cm) recorded 166 and 39 per cent more nitrogen uptake than that of system raised at shallow (D1) and medium soil depth (D2) respectively (Fig. 3) (Pundarikakshudu *et al.*, 1991).

Rainfall Use Efficiency

The rainfall use efficiency (RUE) of seed in castor and clusterbean in sole and intercropping systems increased with increase in soil depth in all the years. Among the sole crops clusterbean recorded higher RUE than castor on an average. Intercropping of castor + clusterbean (1:2) at shallow soil depth increased RUE of seed by 103 and 38 percent compared to sole castor and clusterbean. At medium soil depth, intercropping system (Castor + clusterbean at 1: 2) recorded higher RUE of seed by 226 and 43 percent compared to respective sole crops of castor and clusterbean. At deeper soil depth, increment of RUE of seed was noticed by 149 and 40 per cent in intercropping system when compared to sole crops of castor and clusterbean (Table 2) (Nam *et al.*, 1993).

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