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Profitable Intercropping Systems for Rainfed Arid Region of Andhra Pradesh

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ABSTRACT

A field experiment was conducted to study profitable groundnut based intercropping systems for rainfed arid region of Andhra Pradesh in alfisols for three years during kharif, 2013-14, 2014-15 and 2015-16 at Agricultural Research Station, Ananthapuram of Andhra Pradesh.Experiment results revealed that groundnut + redgram intercropping system recorded higher groundnut equivalent yield (1041 kg/ha)which was significantly on par with groundnut +castor intercropping system (975 kg/ha) and sole groundnut (960 kg/ha). Higher land equivalent ratio of 1.14 was recorded with groundnut +redgram intercropping system followed by groundnut +castor intercropping system compared to other intercropping systems. Groundnut +redgram intercropping system recorded higher net returns (31280 Rs/ha)followed by groundnut +castor intercropping system (28292 Rs/ha) and sole groundnut (27057 Rs/ha). Groundnut +redgram intercropping system recorded higher BC ratio (1.46)followed by sole redgram (1.34) and groundnut+castor intercropping system (1.32). Groundnut intercropping with redgram or castor are the most profitable systems to achieve high yields during kharif season over sole cropping.

Key words: *Groundnut, Rainfed alfisols, Redgram*

Ananthapuramu district of Andhra Pradesh comes under arid zone and isone of thedrought-pronedistrictsinthe rainshadow areaof Andhra Pradesh.Ananthapuramuis the southern-most district of the Rayalaseema region of Andhra Pradesh, India. Agriculture remains the most important economic activity of the district, which is characterized by high levels of instability and uncertainty, being located in the scarce rainfall zone of Andhra Pradesh with normal annual rainfall of 542 mm.The district is drought-prone as it does not get the full benefit of either the south west or north east monsoons. Alfisols are predominant which are characterized by hills and ridges and undulating and gently –sloping lands. In terms of the cultivable area, 70% of the district comes under classes III and IV of land capability classification, which are suitable for arable cropping with certain limitations. Groundnut is the principal crop of the district being mostly grown as a mono crop in an area of 7.52 lakh ha, with highly unstable productivity due to erratic rainfall, leading to partial and total crop failure.

Intercropping and sequence cropping systems can make better use of space and the entire rainy season, respectively, compared with monoculture systems. These systems have a greatpotential in enhancing income of farmers in rainfed alfisols, provided there is good rainfall and proper timely agro-techniques.The intensification of resource use both spatially and temporally is one of the ultimate principles of crop intensification (Willey, 1979).

Although there has been little detailed work on the intercropping of groundnut with the long season annuals like redgramand castor,there is good agronomic evidence that these systems can give very substantial yield advantages.Castor can be successfully intercropped with groundnut, blackgram, greengram (Pooran Chand and Sujatha, 2000). Rao, 1996 reported that castor yields were greater when intercropped with greengram, clusterbean and declined with sesame.Castor was found to be compatible with blackgram, greengram, groundnut giving higher land equivalent ratio (LER) of more than 1.5 (DOR, 1996). Higher groundnut pod equivalent yield in groundnut + redgram(7:1) intercropping system was reported by Reddy and Jagannatham (1996), Jayaprada (1998), Sampath Kumar *et al.,* (2001) and Ravindranatha Reddy *et al.,* (2010)while groundnut + castor was found to achieve a higher groundnut pod equivalent yield by several earlier researchers (Guggari *et al.,* 1994 and Jayaprada, 1998). Srinivasa Rao *et al*., (2012) found that equivalent yields of castor were significantly higher in castor with cluster bean followed by black gram as intercrops. Lower equivalent yields were recorded in castor + sorghum and castor + redgram compared to castor as monocrop. Hence this study was undertaken to develop a viable, profitable intercropping system for efficient resource use and profitable crop production in rainfed alfisols.

MATERIAL AND METHODS

A field experiment was conducted to study profitability of intercropping system with clusterbean in alfisols of scarce rainfall zone under rainfed conditions for three consecutive years (2013 – 15) during *kharif* at Agricultural Research Station, Ananthapuramu of

Andhra Pradesh. Crop seasonal rainfall of 415, 299 and 460 mm was received in19, 20 and 36 rainy days during 2013-14, 2014-15 and 2015-16 respectively.The soil of the experimental site was red sandy loam with shallow depth, low in organic carbon (0.34%) and low in available nitrogen (138 kg ha^{-1}), medium in available phosphorous (28 kg ha^{-1}) and potassium (215 kg ha^{-1}). Randomized block design was adopted with three replications. The experiment consisted of eight treatments viz., T_1: Sole crop of Clusterbean, T_2: Sole crop of Redgram, T_3: Sole crop of Groundnut, T_4: Sole crop of Castor, T_5: Clusterbean + Redgram (15:1), T_6: Clusterbean + Castor (15:1), T_7: Groundnut + Redgram (15:1) and T_8: Groundnut + Castor (15:1). In sole crop treatments, for groundnut and clusterbean, row to row spacing of 30 cm and plant to plant spacing of 10 cm (30x10cm) was maintained to get a plant density of 3,33,333plants ha^{-1}.Redgramwas sown at a spacing of 90x20 cm to get a plant density of 55,555plants ha^{-1}.For castor sowing was done at 60x45cm spacing to obtain a plant population of 37,037plants ha^{-1}. In groundnut intercropping treatments, after every fifteen rows of groundnutone row of redgram was sown (15:1) at a distance of 30 cm. Similarly one row of redgram was sown at a distance of 30 cmafter every fifteen rows of clusterbean inclusterbean intercropping treatments. This way, intercrop to intercrop row distance in intercropping was 4.8 m. All the treatments were tried in replacement series of intercropping.As per the treatments N, P_2O_5 and K_2O was applied at the time of sowing in the form of urea, single super phosphate and muriate of potash respectively. Thinning and gap filling was done wherever necessary, weeding and hoeing were taken up depending on the intensity of weeds at critical stages of crop weed competition. Groundnut, clusterbean, redgram and castor were harvested manually at 117,85,222 and 162 days after sowing (DAS). Labour charges, cost of inputs were worked out to compute the cost of cultivation. Gross returns were calculated based on local market prices of groundnut, clusterbean, redgram and castor and net returns by subtracting the total cost of cultivation from gross returns. Since the yield of different sole crops and intercrops cannot be statistically compared, because of difference in nature of yield of different crops tried, the absolute yields of different sole crops and intercrops were converted into groundnut equivalent yield. The groundnut equivalent yield of sole and intercrops were summed up and groundnut equivalent yield of each system was arrived. Groundnut equivalent yield (GEY) was calculated using formula given below.

GEYof sole crops =

$$\frac{\text{yield of sole crop x price of sole crop}}{\text{price of groundnut}}$$

GEYof intercrops =

$$\frac{\text{yield of intercrop x price of intercrop}}{\text{price of groundnut}}$$

GEYof intercropping system =

GEYof solecrop + GEYof intercrop.

RESULTS AND DISCUSSION

Among sole crops castor, clusterbean and groundnut recorded higher yields during 2013-14, 2014-15 and 2015-16 respectively (Table 1). Groundnut followed by castor obtained higher mean yield among sole crops. In 2013-14, yield of clusterbean was reduced in cluster bean + redgram intercropping system compared to its sole crop yield. Where as in 2014-15 and 2015-16, both in clusterbean + redgram and clusterbean + castor intercropping systems yield reduction in clusterbean was recorded compared to its sole crop yield.Pod yield of groundnut was reduced both in groundnut + redgram and groundnut + castor intercropping systems compared to its sole crop yield during entire period of study except with groundnut + redgram intercropping system in 2013-14. Mean yield of clusterbean and groundnut was reduced in both intercropping systems with Redgram and castor.

In 2013-14, among different intercropping systems tried, the reduction in yield of clusterbean was 34.2 % due to intercropping with redgram, groundnut pod yield reduced to 9.8 % in groundnut + castor intercropping system. During 2014-15, yield of clusterbean was reduced due to intercropping with redgram (37.5 %), castor (63.1 %), whereas pod yield of groundnut was reduced in intercropping system with redgram (42.1 %), castor (17.3 %). In 2015-16, yield of clusterbean was less due to intercropping with redgram (13.2 %), castor (14.7 %), whereas pod yield of groundnut was reduced in intercropping system with redgram (17.1 %), castor (11.7 %). Mean yield of clusterbean was reduced due to intercropping with redgram (29.1 %), castor (39.5 %), whereas pod yield of groundnut was less in intercropping with redgram (14.9 %), castor (12.4 %). Yield reduction in clusterbean might be due to moisture stress during pod development stage resulting in less yields. Clusterbean being a fast growing crop was harvestedwhen the associated redgram/castor attained 80-85 days.Groundnut was harvested when the associated redgram/castor attained its grand growth period (110–120 DAS) and competition with associated redgram or castor was not considerable. Groundnut utilized resources, particularly the soil water due to rainfall received during pegging and pod development stage. Redgram/castor utilized resources later in the season and continued to grow by extracting residual moisture from deeper soil layers. The duration of a crop in an

intercropping system plays a useful role in achieving yield advantage. Higher yield advantage can be expected when the maturity period of the component crops are different. In groundnut + redgram, groundnut + castor intercropping system, associated crops had different maturity periods and hence competition was less (Nambiar *et al*., 1983).

During first year of study, sole crop of castor recorded higher groundnut equivalent yield which was comparable with groundnut + redgram, groundnut + castor intercropping systems, sole crop of groundnut and significantly superior to other cropping systems (Table 2). Lowest groundnut equivalent yield was obtained with clusterbean + redgram intercropping system. This was due to higher pod and seed yield of the component crops in these systems. While during the second year of study, maximum groundnut equivalent yield was obtained with sole crop of clusterbean which was on par with groundnut + castor intercropping system and significantly superior to other cropping systems. Lowest groundnut equivalent yield was recorded with sole crop of redgram. In third year of study, groundnut + redgram intercropping system recorded higher groundnut equivalent yield which inturn was comparable with sole crop of groundnut, groundnut + castor intercropping system and significantly superior to other cropping systems. Lowest groundnut equivalent yield was obtained with clusterbean + castor intercropping systems and sole crop of clusterbean. Higher mean groundnut equivalent yield was obtained with groundnut + redgram intercropping system which inturn was comparable with groundnut + castor intercropping system.Higher groundnut equivalent yield in groundnut + redgram intercropping system was also reported by Itnal *et al*., (1992), Sankaranarayana Rao *et al.* (1992), Reddy and Jagannatham (1996), Jayaprada (1998) and Sampath Kumar *et al*., (2010), while groundnut + castor was found to realize higher groundnut equivalent yield by several earlier researches (Bhon dave *et al*., 1994, Guggari *et al*., 1994 and Jayaprada, 1998).

Lowest mean groundnut equivalent yield was obtained with clusterbean + castor, clusterbean + redgram intercropping systems and sole crop of clusterbean. Mean groundnut equivalent yield with groundnut + redgram intercropping system was 5.5, 9.1, 63.8, 70.5, 130.1, 148.7 and 167.1 percent higher than the groundnut equivalent yield obtained due to groundnut + castor intercropping system, sole crop of groundnut, sole crop of castor, sole crop of redgram, sole crop of clusterbean, clusterbean + redgram intercropping system and clusterbean + castor intercropping system respectively indicating that groundnut + redgram, groundnut + castor intercropping system and sole crop of groundnut would be best suited during kharif for scarce rainfall zone.

Land Equivalent Ratio (LER) was calculated to evaluate the efficiency and advantages of intercropping over sole crops (Table 2). The LER was highest with clusterbean + castor (1.41), groundnut + castor (1.16) and groundnut + redgram intercropping system (1.42) in 2013-14, 2014-15 and 2015-16, respectively. In groundnut + redgram and groundnut + castor intercropping system mean value of LER was more than 1.0. Mean LER was highest with groundnut + redgram intercropping system (1.14) followed by groundnut + castor intercropping system (1.09) indicating an yield advantage of 14 and 10 percent with groundnut + redgram and groundnut + castor intercropping systems, respectively. Higher yield advantage in these intercropping systems was due to higher yield of component crops as a result of minimum competition between the base and intercrops, due to differential growth habits. Higher LER with groundnut + castor system was also reported in the experiments conducted at Dharwad (AICRPO, 1987). Itnal *et al*. (1992) reported higher LER with groundnut + redgram intercropping. Crop complementarities or supplementarities determine the magnitude of competition. In the present study, though there was a reduction yield of intercrops, a higher GEY and LER value in intercropping system indicated a definite advantage compared to monocrop yields apparently because of crop complementarities.

Gross returns were higher with groundnut + redgram, groundnut + castor and groundnut + redgram intercropping system during 2013-14, 2014-15 and 2015-16 respectively (Table 3), whereas mean gross returns were higher with groundnut + redgram and groundnut + castor intercropping systems. Net returns were higher with groundnut + redgram intercropping system, sole crop of clusterbean and groundnut + redgram intercropping system in 2013-14, 2014-15 and 2015-16 respectively. While, mean netreturns were higher with groundnut + redgram intercropping system followed by groundnut + castor intercropping system and sole crop of groundnut. Higher B:C ratio was obtained with sole crop of redgram, sole crop of clusterbean and groundnut + redgram intercropping system during 2013-14, 2014-15 and 2015-16 respectively. Mean B:C ratio was higher with groundnut + redgram intercropping system followed by sole crop of redgram, groundnut + castor intercropping system and sole crop of groundnut.Higher yields of both the component crops in groundnut + redgramand groundnut + castor systems coupled with the higher price of saleable produce of intercrops resulted in production of the highest groundnut pod equivalent yield in these intercropping systems. This

Table 1. Profitability of groundnut based intercropping systems for rainfed arid regions

Treatments	Pod/seed yield (kg/ha)							
	2013-14		2014-15		2015-16		Mean	
	Sole crop	Inter crop	Sole crop	Inter crop	Sole crop	Inter crop	Sole crop	Inter crop
T1: Sole crop of Clusterbean	155	-	878	-	515	-	516	-
T2: Sole crop of Redgram	627	-	326	-	487	-	480	-
T3: Sole crop of Groundnut	607	-	573	-	1701	-	960	-
T4: Sole crop of Castor	786	-	581	-	948	-	772	-
T5: Clusterbean + Redgram (15:1)	102	46	549	42	447	121	366	70
T6: Clusterbean + Castor (15:1)	174	233	324	85	439	175	312	164
T7: Groundnut + Redgram (15:1)	707	56	332	55	1411	290	817	134
T8: Groundnut + Castor (15:1)	547	161	474	193	1501	151	841	168

Table 2. Profitability of groundnut based intercropping systems for rainfed arid regions

Treatments	Groundnut Equivalent Yield (kg/ha)				LER			
	2013-14	2014-15	2015-16	Mean	2013-14	2014-15	2015-16	Mean
T1: Sole crop of Clusterbean	186	817	335	446	1	1	1	1
T2: Sole crop of Redgram	477	326	968	590	1	1	1	1
T3: Sole crop of Groundnut	607	573	1701	960	1	1	1	1
T4: Sole crop of Castor	683	527	604	605	1	1	1	1
T5: Clusterbean + Redgram (15:1)	157	554	529	413	0.74	0.75	1.12	0.87
T6: Clusterbean + Castor (15:1)	410	379	324	371	1.41	0.52	0.92	0.95
T7: Groundnut + Redgram (15:1)	750	387	1987	1041	1.26	0.75	1.42	1.14
T8: Groundnut + Castor (15:1)	687	649	1586	975	1.1	1.16	1.02	1.09
S. Em ±	62.1	56.5	167	97.6	-	-	-	-
CD at 5 %	188	173	512	279	-	-	-	-

Table 3: Profitability of groundnut based intercropping systems for rainfed arid regions

Treatments	Gross returns(Rs/ha)				Net returns(Rs/ha)				B:CRatio			
	2013-14	2014-15	2015-16	Mean	2013-14	2014-15	2015-16	Mean	2013-14	2014-15	2015-16	Mean
T1:	8525	35098	14054	19226	-4803	23960	2916	7358	-0.36	2.15	0.26	0.68
T2:	22373	18323	44015	28237	10327	6277	31969	16191	0.86	0.52	2.65	1.34
T3:	32172	34215	80307	48898	8776	13152	59244	27057	0.38	0.62	2.81	1.27
T4:	31440	22659	23870	25990	14294	6619	7830	9581	0.83	0.41	0.49	0.58
T5:	7135	23728	22528	17797	-6193	12590	11390	5929	-0.46	1.13	1.02	0.56
T6:	18810	15991	13635	16145	5482	4853	2497	4277	0.41	0.44	0.22	0.36
T7:	40750	27015	91596	53120	17354	5952	70533	31280	0.74	0.28	3.35	1.46
T8:	37190	37157	76050	50132	13794	16094	54987	28292	0.59	0.76	2.61	1.32

suggests that intercropping redgram or castor with groundnut are the most appropriate systems to achieve high yield during rainy season. Lower prices of clusterbean resulted in the lowest groundnut pod equivalent yield of clusterbean + redgram and clusterbean + castor systems, though the yield of clusterbeanwas still fairly high compared to other intercrops tried.

CONCLUSION

Our results clearly indicated that under uneven and deficit rainfall situation, groundnut + redgram intercropping is superior to conventional groundnut monocropping, and minimizes the risk of failure of groundnut and provides maximum profit. Thus, higher profit in the intercropping system may be attributed to high yield and high market price of redgram.

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