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Comparative performance of different maize based intercropping systems and planting patterns under rainfed situation

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Abstract: Field experiments were conducted at Tamil Nadu Agricultural University, Central Farm, Coimbatore during Northeast monsoon seasons of 1997-98 and 1998-99 to study the influence of cropping systems, intercrops and row proportions on growth parameters, yield components and yield of maize under rainfed situation. Maize as sole crop recorded significantly higher grain yield, maize grain equivalent yield as compared to intercropped maize. Among the intercrops studied, greengram did not affect the growth and yield components and yield of the base crop of maize and it made complementary effect to maize. Among the intercropping systems, growth parameters, yield components and yield are higher under 4:2 row proportion than under 3:3 row proportion of maize and greengram.

Key words : Rainfed maize, Intercropping, Growth and yield attributes and yield.

Introduction

Intercropping is an age-old practices being followed by subsistence farmers to achieve their domestic needs. The main advantage of intercropping is that the component crops are able to use growth resources differently and make better overall use of growth resources than grown separately. The success of any intercropping system depends mainly on selection of component crops. The component crops should invariably have different maturity periods, growth rhythms and rooting patterns. Maize is a tall growing, wide spaced crop which can accommodate rapidly growing short duration and short statured crops like greengram, soybean and gingelly. Under rainfed conditions, introducing additional population of intercrops without reducing the base crop population gives rise to severe competition between crop plants for soil moisture and nutrients. Replacing certain rows of base crop population with intercrops is ideal for reducing the competition for resources. The proportion of intercrop to the base crop is an important factor in minimizing the risk to the base crop during adverse weather conditions like low rainfall. This approach will also optimize the yield recovery of such system; hence the investigation was undertaken to study the performance of different maize based intercropping systems and planting patterns at Coimbatore under rainfed situation.

Materials and Methods

Field experiments were conducted during Northeast monsoon season of 1997-98 and 1998-1999 at Tamil Nadu Agricultural University Farm, Coimbatore on vertisols. The soil was neutral in pH (7.6) with 0.58 per cent in organic carbon, 198 kg ha^{-1} of available N, 17.2 kg ha^{-1} of available phosphorus and 578 kg ha^{-1} of available potassium. There were nine treatment combinations comprising of greengram, redgram, sunflower and gingelly as intercrops and two row proportions (3:3 and 4:2) with maize as sole crop and intercrop combinations. The experiment was laid out in a randomized block design with three replications. The gross plot size was 6.25 x 4.0 m and the net plot size varied under different row proportions. The varieties used were CO 1 (maize), CO 2 (sunflower), CO 4 (greengram), CO 1 (gingelly) and ICPL 87 (redgram). The population of intercrops varied under 3:3 (50%), 4:2 (66.5:33.5) row proportions of maize and intercrops. Sole maize and sunflower were sown at a spacing of 45 x 15 cm, sole redgram at a spacing of 30 x 10 cm. The recommended dose of fertilizer (N, P_2O_5, K_2O for maize 40:20:0; 12.5:25:0 for redgram and greengram, 40:20:0 for sunflower and 23:13:13 kg ha^{-1} for gingelly) in the form of urea, single super phosphate and potash were applied as basal dose. Incase

Table 1. Effect of treatments on growth and yield parameters of rainfed maize

Treatments		Plant height (cm)		LAI		Total dry matter (kg ha⁻¹)		Cob length (cm)	Cob girth (cm)	No. of grains per row	No. of grain rows per cob	Shelling percentage
		60 DAS	At harvest	60 DAS	At harvest	60 DAS	At harvest					
T_1	Sole Maize	224.8	253.1	6.80	2.50	10059	16910	18.17	14.10	32.01	14.1	77.91
T_2	Maize + Redgram (3:3)	229.8	258.7	6.95	2.56	5640	8888	17.20	13.62	31.54	13.5	75.41
T_3	Maize + Sunflower (3:3)	221.1	248.9	6.69	2.46	6533	7879	16.32	13.21	31.02	13.0	74.54
T_4	Maize + Greengram (3:3)	232.9	262.2	7.05	2.59	7019	9627	17.61	13.74	31.75	13.6	76.01
T_5	Maize + Gingelly (3:3)	230.9	260.0	6.99	2.57	6021	8967	17.22	13.69	31.64	13.7	75.21
T_6	Maize + Redgram (4:2)	227.8	256.5	6.89	2.53	5754	9154	17.36	13.74	31.61	13.6	75.76
T_7	Maize + Sunflower (4:2)	204.0	229.7	6.17	2.27	5688	7580	16.49	13.34	30.90	13.2	74.93
T_8	Maize + Greengram (4:2)	231.7	260.9	7.01	2.58	6420	9834	17.97	13.82	31.89	13.8	78.89
T_9	Maize + Gingelly (4:2)	228.1	256.8	6.90	2.54	5686	9231	17.45	13.7	31.82	13.7	79.95
SEd		0.70	2.23	0.02	0.01	92.8	138.0	0.118	0.066	0.280	0.280	0.320
CD (P=0.05)		1.50	4.70	0.05	0.02	197.0	293.0	0.250	0.140	0.590	0.60	1.110

of intercropping treatments the fertilizers were applied in proportionate to the sole optimum population for maincrop and intercrop separately. Bold and healthy seeds were selected and were treated with thiram @ 2.0 g per kg of seed. Later the seeds were inoculated with suitable rhizobium strains and dried in shade before sowing. The crops were sown on 9.9.1997 and 17.9.98 respectively. The seeds were dibbled in each spot and the seedlings were thinned at 15 DAS to maintain required plant population. Possible care was taken to keep the plots free from weeds and pests by taking up timely weeding and plant protection measures. The rainfall received during crop growth period was adequate and well distributed. The crops were harvested at their physiological maturity. The two years data were pooled and subject to statistical scrutiny.

Results and Discussion

Growth parameters (Table 1)

At all the stages of observation, there was drastic reduction in maize plant height, leaf area index in association with sunflower in 4:2 ratio. Among the treatment combinations, maize + greengram in 4:2 ratio recorded higher plant height and leaf area index. This is mainly due to complementary effect between base crop and intercrop, the greengram was a short statured crop and grew about 1/3 of the plant height of base crop maize and offered lesser resistance for maize growth. Being a leguminous plant with shorter duration as compared to redgram, maize might have utilised the residual nitrogen left by greengram after its harvest. The reduction in plant height and leaf area index of maize in association with sunflower was mainly due to the competition offered by sunflower under rainfed situation for scarce resources like soil moistue and nutrients. Such depressing effect of sunflower on base crop maize was reported by Jehan Bakht *et al.* (1989). The solid stand of maize produced the highest dry matter over other intercropping systems and it was due to cent per cent population of

Table 2. Effect of treatments on grain and stover yield, percentage of recovery, equivalent yield and return per rupee invested

Treatments		Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Maize grain equivalent yield (kg ha^{-1})	Return per rupee invested	LER	Solar energy conversion efficiency (%)	Relative crowding coefficient (K value)
T_1	Sole Maize	5345	13095	5345	2.21	-	1.14	-
T_2	Maize + Redgram (3:3)	3187 (59.6)*	7882 (60.2)*	3884	1.52	-	0.72	1.26
T_3	Maize + Sunflower (3:3)	2718 (50.9)	6699 (51.2)	2961	1.35	1.06	0.63	0.81
T_4	Maize + Greengram (3:3)	3416 (63.9)	8482 (64.8)	4013	1.62	0.95	0.81	2.00
T_5	Maize + Gingelly (3:3)	3215 (60.1)	7932 (60.6)	3888	1.45	1.17	0.75	3.32
T_6	Maize + Redgram (4:2)	3282 (61.4)	8121 (62.0)	3822	1.41	1.29	0.73	0.89
T_7	Maize + Sunflower (4:2)	2825 (52.9)	6921 (52.9)	3016	1.25	0.97	0.64	0.59
T_8	Maize + Greengram (4:2)	3526 (66.0)	8754 (66.8)	3899	1.50	0.87	0.80	0.96
T_9	Maize + Gingelly (4:2)	3310 (61.9)	8191 (62.6)	3743	1.48	0.99	0.75	1.48
SEd		49 (0.89)	126.9 (0.94)	51.9	-	1.10	0.019	Not analysed
CD (P=0.05)		104 (1.90)	269 (2.00)	110.0	-	0.154	0.040	

Percentage recovery of maize under intercropping system given in parentheses for both grain and stover yields

maize maintained with sole maize treatment. Among the intercropping systems, the dry matter production of maize was higher with maize + greengram in 4:2 and 3:3 ratio, next to sole maize owing to increased plant height and LAI of maize, whereas exhaustive nature of sunflower resulting in reduced plant height, leaf area index and nutrient uptake in maize.

Yield components and yield (Table 2)

Significantly higher values of cob length, cob girth, number of rows per cob, shelling percentage were recorded by the sole maize crop treatment and was comparable with the values of these parameters recorded for maize crop when it was grown with intercrops except sunflower. Better source to sink operation, might have contributed for such an increase with the intercrops like greengram, gingelly and redgram. The highest maize grain yield was recorded under sole maize over maize grown in association with other intercrops due to the maintenance of cent per cent population (100%) as warranted by the treatments, while in the intercropping systems, due to 3:3 and 4:2 row arrangement of maize and intercrops, comparatively, lesser base maize crop population was maintained.

In the case of intercropping systems, the maize grain yield was significantly higher with greengram (4:2 and 3:3 ratio) and between greengram and maize as reflected in the increased growth and yield components. This result is in conformity with the findings of Gangwar and Kalra (1983). Sunflower when grown in association with maize had exerted depressing effect on maize grain and stover yield. This result is in consonance with the results reported by Jehan Bakht *et al.* (1989). The highest percentage of recovery of maize grain yield was recorded under treatment maize + greengram system at 4:2 ratio followed by maize + greengram at 3:3 ratio due to higher population of maize (66.5% of sole maize) and the complementary effect exerted by the greengram to maize. The lowest percentage recovery of grain and stover yields in maize + sunflower intercropping system was mainly due to competitiveness of sunflower on the base crop of the maize as reported earlier.

The total solar energy conversion efficiency of maize + greengram (3:3 and 4:2 ratio) was next to solar energy conversion efficiency of sole maize crop and superior among intercropping systems studied (Khola *et al.* 1997). This indicated the suitability of greengram as intercrop to maize. The treatments T_2 (maize + redgram in 3:3 ratio), T4 (maize + greengram in 3:3 ratio), T_5 (maize + gingelly in 3:3 ratio) and T_9 (maize + gingelly in 4:2 ratio) recorded LER value of more than one.

The highest Land Equivalent Ratio (LER) was recorded in maize + gingelly intercropping system than other intercrops studied. These higher values indicate the greater biological efficiency of these intercropping systems. This result is in accordance with the findings of Francis *et al.* (1978) who reported that land utilization efficiency increased with intercropping system. Lower LER values of less than one observed for other intercropping combinations might be due to lower efficiency of these intercropping systems probably due to competitive factors. Relative crowding coefficient is judged through 'K' values of different yield advantage of the proposed intercropping system because of compatible nature of component crops (Pandey *et al.* 1999). The highest K value was observed with maize + gingelly and maize + greengram under 3:3 ratio row arrangement.

The return per rupee invested was higher in sole maize due to its higher grain yield of maize and reduced economic returns in the intercropping system was due to reduction in maize yield as a result of proportionate replacement with intercrops.

The results of the present study revealed that sole maize was superior over other intercropping systems with reference to production and monetary returns and this was followed by maize + greengram intercropping system at 3:3 ratio and served as an alternate system for crop diversification.

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