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Performance of sunflower (*Helianthus annuus*) with intercrops under various planting pattern

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Abstract : A two year field study on sunflower (*Helianthus annuus* L.) based inter cropping systems conducted at Regional Research Station, Aruppukottai revealed that planting of component crops at 3:1 ratio under replacement series was optimum for better growth, increased sunflower grain yield equivalent (1019 kg ha^{-1}) and higher net income (Rs. 6392 kg ha^{-1}) with higher benefit cost ratio (2.69). The yield of sunflower component increased from 718.7 to 805.9 kg ha^{-1} as planting row ratio gets widened from 2:1 to 4:1 ratio. The yield of intercrops reduced by 17.7 and 33.8 per cent in 3:1 ratio and 4:1 ratio as compared to 2:1 ratio. Among the intercropping systems, sunflower + sesame had recorded the highest mean grain yield equivalent (1082.6 kg ha^{-1}), mean net income (Rs. 6942 kg ha^{-1}) coupled with maximum benefit cost ratio (2.87) compared to other intercropping systems. The yield advantage in sunflower + sesame intercropping system was mainly due to efficient utilizaiton of water under rainfed situation. *(Keywords : Sunflower, Red gram, Sesame, Bengal gram, Intercropping system)*

Importing large quantity of edible oils is mainly because the productivity of oilseeds is largely determined by the moonsoons since bulk of their area is under rainfed condition. One of the ways to achieve higher yields of oilseeds would be intercropping. Higher productivity and returns in intercropping systems depend on the selection of compatible, complementary crops and their planting density and geometry. Intercropping sunflower with pigeon pea brings stability in yield and improves total productivity. It also ensures adequate yields of one of the component crops (Rao and Willey, 1983 ; Subba

Reddy and Havanagim 1986) under aberrant weather conditions. With these points in view, the present study was undertaken to find out the performance of sunflower (*Helianthus annuus*. L.) and various intercrops (i.e. red gram, sesame and bengal gram) in an intercropping system at various row ratio of component crops under replacement series.

Materials and Methods

The field experiment was carried out under rainfed condition during rainy seasons of 1997-98 and 1998-99 at Regional Research Station, Aruppukottai. The soil of the experimental field was clay loam in texture with low available N, medium available P and high available K. The Available Water Holding Capacity (AWHC) of the soil was 64.0 mm. During the cropping seasons of 1997-98 and 1998-99 (October - December),, 542.8 and 560.0 mm rainfall respectively was received. Fertilizer was applied to sunflower rows only as basal application.

The experiment during 1997-98 and 1998-99 season consisted of nine treatments with three planting patterns (2:1, 3:1 and 4:1 ratio under replacement series) and three intercrops (red gram, sesame and bengal gram). The experiment was laid out in split-plot design, replicated four times, taking planting patterns in main plots and intercrops in sub-plots. Yield attributes of sunflower were studied from random samples and yield attributes and yield of component crops were statistically analysed during both seasons.

Results and Discussion

Performance of planting pattern

Row proportions of component crops recorded significant variations in number of filled seeds, seed weight (g plant^{-1}), intercrop yield and sunflower grain yield (Table 1). Among the planting patterns, 4:1 ratio registered the highest sunflower grain yield of 805.9 kg/ha compared to 2:1 and 3:1 ratio. However, bigger sunlfower ear heads, more number of filled seeds with increased seed weight were recorded in 2:1 ratio of sunflower and intercrops mainly due to lower sunflower population pressure per unit are compared to others (Table 1). Higher sunflower grain yields in 3:1 and 4:1 ratio, therefore, were mainly due to higher population of sunflower component (75 and 80 per cent in 3:1 and 4:1 ratio respectively against 66.3 per cent sunflower population in 2:1 ratio) which surpassed the superiority of per plant characters of sunflower in 2:1 ratio. Similar trends were reported by Shivaramu and Shivashankar (1992) in an sunflower - soybean intercropping system. The sunflower grain yield gets lowered when the number of sunflower rows get reduced and the yield reduction of sunflower was 10.82 and 3.59 per cent in the treatments having one inter crop row for every two and three rows of sunflower respectively. The yield of intercrop gets reduced as ratio widened. Increase in sunflower population from 66.3 to 80 per cent decreased the yield of inter crop, 177.6 to 117.5 kg ha^{-1}. It was mainly due to lesser intercrop population per unit area besides the adverse effect of sunflower on growth and yield attributes of intercrops. Robinson(1984) reported similar yield reduction in soybean due to adverse effect of increased sunflower population. The yields of intercrops were improved with increasing its population from 20 to 33.3 per cent.

Performance of base crop, inter crop and intercropping systems

Inter cropping of various crops i.e., red gram sesame and bengal gram with sunflower influence the grain yield of sunflower. The yield of intercroppe sunflower depends mainly on the nature of intercrop ground covering area, type of crop, total dry matte production and moisture and nutrient requirement c intercrops. During 1997-98 higher sunflower grai yield (811.1 kg ha^{-1}) was recorded in sunflower bengal gram inter cropping system, while durin 1998-99 more sunflower yield (747.6 kg ha^{-1}) was in sunflower + red gram intercropping system. Higher yield in these systems was mainly because of improved availability of N through atmospheric N fixation by legume crops. The extent of increase in yield during 1997-98 was 3.36 to 3.99 per cent compared to other intercropping systems while during 1998-99 it was 0.69 to 1.40 per cent. This increase in yield was attributed to increased flower head diameter, more number of filled seeds with maximum per plant seed weight (Table 1). Performance of sesame with sunflower was better during both the seasons compared to red gram and bengal gram.

The extent of reduction in red gram and bengal gram grain yield was 26.49 and 53.30 per cent at an average of two years compared to sesame grain yield. This reduction in yield of intercropped red gram and bengal gram was mainly due to the shading effect of tall growing crop, the sunflower. Similar reduction in yield of intercropped soybean due to sunflower was reported by Srivastava *et al.* (1980).

Intercropping advantage

Sunflower and inter crops with 3:1 ratio under replacement series provided higher mean net income of Rs. 6392 kg ha^{-1} with a maximum benefit cost ratio

Table 1. Growth, yield parameters and yield of sunflower (SF) as influenced by intercropping of crops and row ratio

Treat-ment	Head diameter (cm)			Filled seeds (No.)			Seed weight (g/pl.)			Seed yield (kg/ha)					
										Intercrop			Sunflower		
	1997-98	1998-99	Mean	1997-98	1998-99	Mean	1997-98	1998-99	Mean	1997-98	1998-99	Mean	1997-98	1998-99	Mean
Planting pattern															
P1	9.90	9.60	9.75	610.2	602.4	606.3	20.09	20.02	20.06	180.3	174.8	177.6	744.5	692.8	718.7
P2	9.52	9.20	9.36	595.2	588.9	592.1	19.62	19.65	19.64	148.6	143.7	146.2	797.5	756.5	777.0
P3	9.43	8.88	9.16	578.9	572.1	575.5	18.96	18.50	18.73	124.6	110.4	117.5	833.7	778.1	805.9
CD (P=0.05)	1.43	0.19	0.42	9.27	2.78	3.57	0.40	0.15	0.79	8.98	4.92	15.68	49.78	10.04	23.07
Intercropping system															
I1	9.48	9.37	9.43	593.7	591.6	592.7	19.55	19.45	19.50	151.1	143.1	147.1	780.0	747.6	763.8
I2	9.61	9.10	9.36	593.6	585.0	589.3	19.44	19.35	19.40	206.6	194.3	200.5	784.7	737.3	761.0
I3	9.77	9.22	9.50	597.1	586.7	591.9	19.68	19.37	19.53	95.7	91.5	93.6	611.1	742.5	776.8
CD (P=0.05)	0.69	0.30	0.52	7.40	5.33	5.86	0.29	0.29	0.17	11.71	8.22	4.89	51.33	13.72	30.43

P1 - 2:1 ratio in Replacement series ; I1 - Sunflower + redgram

P2 - 3:1 ratio in Replacement series ; I2 - Sunflower + sesame

P3 - 4:1 ratio in Replacement series ; I3 - Sunflower + bengalgram

Table 2. Grain yield equivalent, net income and benefit cost ratio of sunflower intercropping system

	Grain yield equivalent (kg ha^{-1})			Net Income (Rs. ha^{-1})			BCR		
	1997-98	1998-99	Mean	1997-98	1998-99	Mean	1997-98	1998-99	Mean
Planting pattern									
P_1 - 2:1 ratio in R.S	1042.4	982.7	1012.2	6374	5767	6071	2.58	2.43	2.51
P_2 - 3:1 ratio in R.S	1042.8	995.5	1019.2	6628	6155	6392	2.75	2.62	2.69
P_3 - 4:1 ratio in R.S	1039.0	960.4	99.7	6590	5804	6197	2.74	2.53	2.64
CD (P=0.05)	60.81	16.20	47.83	-	-	-	-	-	-
Intercropping system									
I_1 - S.F + redgram	1006.6	962.3	984.5	6200	5757	5979	2.61	2.49	2.55
I_2 - S.F + sesame	1115.3	1049.3	1082.6	7370	6513	6942	2.95	2.78	2.87
I_3 - S.F + bengalgram	1002.2	925.5	963.9	6022	5255	5639	2.51	2.32	2.42
CD (P=0.05)	61.12	16.18	30.90	-	-	-	-	-	-

of 2.69 as compared to 2:1 ratio (Rs. 6197 kg ha^{-1} and 2.51 respectively) and 3:1 ratio (Rs. 6197 kg ha^{-1} and 2.51 respectively). Sunflower + sesame intercropping system has recorded the highest mean net income (Rs. 6942 kg ha^{-1}). The advantage of this planting system was also seen from benefit cost ratio (2.87) compared to 2.55 and 2.42 in sunflower + red gram and sunflower + bengal gram intercropping system respectively. Higher sunflower grain yield equivalent in sunflower + sesame intercropping system with higher mean net income and mean benefit cost ratio might be due to better performance of sesame intercrop which gave the highest yields (206.6 and 194.3 kg ha^{-1} during 1997-98 and 1998-99 respectively) compared to red gram and bengal gram (Table 1 and 2). There was instability in the performance of sunflower + legume intercropping systems during the experimental years. This was mainly because of late sowing of red gram with sunflower. Normally pulse crops are being sown under pre-monsoon sowing condition. Moisture constraint during the cropping season of pulse crop might have affected the growth of the crop.

It can be concluded that sun flower and sesame based intercropping system at 3:1 ratio was highly profitable in rainfed vertisol under late sowing situation.

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