

## Production potential of sunflower (*Helianthus annuus*) and groundnut (*Arachis hypogaea*) in intercropping system under different planting patterns, harvest schedules and genotypes of groundnut

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Received : February 2002

### ABSTRACT

An experiment was conducted during spring season of 1999 and 2000 at the Punjab Agricultural University, Ludhiana, to study the effect of intercropping groundnut (*Arachis hypogaea* L.) between the rows of sunflower (*Helianthus annuus* L.) on their productivity. Both sunflower and groundnut sown as sole crops and as intercrop in 1+1, 1+2 and 1+3 row patterns maintaining uniform plant population of sunflower in all the treatments. Sunflower and groundnut in intercrop system formed an economically viable combination if groundnut was allowed to continue up to mid-September after harvest of sunflower in June. It showed 64 to 85% higher productivity, depending on groundnut genotype than sole crop of sunflower and groundnut. The combined productivity of both the crops ranged from 35.7 to 42.9 q/ha when groundnut was harvested in September as compared to 23.9 – 28.9 q/ha when groundnut was harvested in June. Different planting patterns (i.e. 1+1, 1+2 and 1+3) did not significantly influence the total productivity of the intercrop system and were equally productive when groundnut was harvested in September. The 'M 522' genotype gave higher pod yield than 'SG 84'. The land-equivalent ratio of 1.81–1.89 also indicated the comparative high yield advantage of this intercrop system. Significantly higher sunflower-equivalent yield and gross income of the system over sole sunflower further established the economic advantage of this system.

**Key words :** Sunflower + groundnut intercropping, Planting patterns, Production potential, Harvest schedules.

Productivity of sunflower-based cropping system can be enhanced by growing groundnut in spring season between its rows which can form viable combination as both these crops can be planted during same time and may act as complimentary to each other, sunflower in providing shade to under-storey groundnut during summer months and groundnut by fixing biological nitrogen enriching the rhizosphere. Sunflower and groundnut form a compatible intercrop system and in general sunflower has no adverse affect and vice-versa (Birader *et al.*, 1988; Devidayal and Reddy, 1991; Simon *et al.*, 1993; Singh, 1994). Hence an experiment was conducted to study the growth and yield behaviour of sunflower and groundnut in an intercropping system and to define optimum planting pattern for maximizing total productivity of the system.

### MATERIALS AND METHODS

The experiment was conducted during spring season of 1999 and 2000. The soil was loamy sand, low in available nitrogen (75 kg/ha), medium in available phosphorus

(14.5 kg P<sub>2</sub>O<sub>5</sub>/ha) and potash (148 kg K<sub>2</sub>O/ha), with pH 7.8. The experiment was laid out in randomized block design with 13 treatments, comprising 3 planting patterns, viz. 1+1, 1+2 and 1+3 rows of sunflower (cv. 'MSFH 8') and 3 combinations of genotypes and harvesting dates of groundnut, i.e. 'SG 84' harvested in June and September, while 'M 522' harvested in September only, which were compared with their sole crops. Sunflower was sown in plant geometry of 60 cm × 30 cm, 90 cm × 20 cm and 120 cm × 15 cm to maintain uniform recommended plant population in each treatment and to adjust 1, 2 and 3 rows of groundnut in between as per treatment. Sowing of both the crops was done simultaneously in the second week of February and harvesting of sunflower was done in first week of June while groundnut in some treatments was harvested with sunflower in June and remaining second week of September. A uniform fertilizer dose of 60 kg N, 30 kg each of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O/ha was applied in all the treatments. Irrigations were applied as and when required by the sunflower crop. In all 8 irrigations were applied. Three

hoeings/weedings were performed to keep the crop weed free including one given after the harvesting of sunflower to loosen the soil for proper spread of groundnut crop in the vacated area during monsoon.

## RESULTS AND DISCUSSION

### Sunflower

**Yield attributes :** All the yield-attributing characters of sunflower, viz. seeds/head, total head area, filled head area, seed weight/head and 1,000-grain weight, were not influenced significantly by intercropping of groundnut and their planting patterns during both the years (Table 1). All these recorded statistically similar values between sole sunflower and sunflower intercropped at 1+1 or 1+2 or 1+3 planting pattern. It clearly brings out that intercropping of groundnut had no adverse effect on any of the growth and yield parameters of sunflower.

**Seed yield :** The seed yield of sunflower in sole as well in intercrop system (Table 2) did not differ significantly either due to various planting patterns or due to groundnut genotypes and their harvesting schedules. The average seed yield of sole sunflower in 1999 was 22.4 q/ha as compared to 19.5, 19.2 and 18.8 q/ha recorded in 1+1, 1+2 and 1+3 planting pattern respectively. Similarly, in 2000 these values were 23.3, 22.0, 21.4 and 20.8 q/ha, respectively, in sole and different planting patterns. Thus, on an average of 2 years 90.8, 89.0 and 86.8% of sole sunflower yield was obtained in 1+1, 1+2 and 1+3 planting pattern respectively. Non-significant difference in seed yield of sunflower may be due to 100% plant population of sunflower maintained in all the intercropping systems as compared to its sole crop. Further, it indicates that the

under-storey groundnut crop had no harmful effect on the growth and yield of sunflower. These results get support from yield attributes (Table 1) which also showed non-significant difference indicating that intercropping of groundnut as such did not adversely affect the yield of sunflower. Singh (1994) also reported 80-90% yield realization of sole sunflower when intercropped with groundnut in 1+3 row combination.

### Groundnut

**Yield attributes :** All the yield-attributing characters of groundnut except shelling (%) varied significantly due to planting patterns, harvesting dates and genotypes of groundnut only in genotype 'SG 84' when harvested in June (Table 3). Significantly higher number of pods/plant, matured pods, pod weight/plant and test weight were observed with sole crop of groundnut as compared to intercrop. The 3 planting patterns (i.e. 1+1, 1+2 and 1+3) also varied significantly among themselves but this effect was not seen when groundnut was harvested in September. In general, the pod weight/plant and test weight were higher in 'M 522' than that of 'SG 84' while matured pods (%) of both the genotypes were statistically similar.

**Pod yield :** The pod yield of groundnut (Table 2) in sole and intercrop varied significantly due to its harvest time. 'SG 84' when harvested in June produced very poor (3.9–6.7 q/ha) because of high percentage of immature pods. But, when harvested in September, it gave significantly higher yield (17.4–19.6 q/ha) in all planting patterns. 'M 522' was found better than 'SG 84' when harvested in September, as it produced pods 20.3–22.2 q/ha in different planting pattern. During initial stages, groundnut remained

Table 1. Yield attributes of sunflower as influenced by planting patterns, genotypes and harvesting dates of groundnut

Planting pattern	Seeds/head		Total head area (cm <sup>2</sup> )		Filled head area (cm <sup>2</sup> )		Seed weight/head (g)		Test weight (g)	
	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000
SF (Sole)	987	1,037	243	269	230	255	67.0	68.7	64.6	66.5
'SG 84' (June harvest)										
SF + GN (1+1)	978	1,036	238	266	231	249	63.5	67.7	70.8	65.7
SF + GN (1+2)	977	1,028	231	257	226	239	64.0	66.7	68.6	64.7
SF + GN (1+3)	982	1,023	184	211	171	198	57.0	65.3	64.5	63.3
'SG 84' (September harvest)										
SF + GN (1+1)	985	1,036	246	254	230	239	66.7	67.7	72.5	65.3
SF + GN (1+2)	987	1,026	211	249	199	235	65.0	66.0	68.2	64.8
SF + GN (1+3)	980	1,024	203	244	189	233	62.5	65.0	65.9	64.0
'M 522' (September harvest)										
SF + GN (1+1)	985	1,038	211	266	197	249	63.5	67.7	68.3	65.0
SF + GN (1+2)	980	1,027	206	246	189	234	64.5	65.7	68.2	64.7
SF + GN (1+3)	982	1,021	186	241	172	231	63.0	63.5	67.2	63.5
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

SF, Sunflower, GN, groundnut

suppressed due to shading by sunflower and led to poor yield when harvested along with sunflower in June. However, when it was allowed to grow in the field up to September, it gave 3.0–4.5 times more yield (17.5–19.1 q/ha) because of vigorous development due to conducive condition of temperature and moisture during monsoon. These results are in conformity with those reported by Singh (1994), who also found that groundnut genotypes when

harvested in June along with sunflower almost failed to yield. Similarly, 'M 522' when harvested in September gave average pod yield of 21.8, 20.9, 20.6 and 20.9 q/ha in sole, 1+1, 1+2 and 1+3 planting patterns, respectively, which was significantly higher than the pod yield of 'SG 84'. Further, pod yields under different planting patterns were statistically similar with the pod yield of sole groundnut when harvested in September. It was evident

**Table 2.** Individual and combined yield of sunflower and groundnut (q/ha), land-equivalent ratio, sunflower-equivalent yield (q/ha) and gross income ('000 Rs/ha) as influenced by planting patterns, genotypes and harvesting dates of groundnut

Treatment	1999						2000					
	SF	GN	Total yield	LER	Gross income	SEY	SF	GN	Total yield	LER	Gross income	SEY
SF (Sole)	22.4		22.4	1.00	19.0	22.4	23.3		23.3	1.00	19.8	23.3
'SG 84' (June harvest)												
GN (Sole)		6.3	6.3	1.00	8.60	10.1		6.7	6.7	1.00	9.20	10.8
SF + GN (1+1)	20.0	3.9	24.0	1.56	22.5	26.4	23.0	3.9	26.9	1.57	24.9	29.3
SF + GN (1+2)	19.2	4.7	23.9	1.64	22.8	26.9	22.0	5.2	27.2	1.72	25.9	30.4
SF + GN (1+3)	18.5	5.9	24.8	1.80	23.9	28.1	22.5	6.4	28.9	1.94	27.9	32.8
'SG 84' (September harvest)												
GN (Sole)		18.6	18.6	1.00	25.3	29.7		19.6	19.6	1.00	27.0	31.7
SF + GN (1+1)	19.3	17.4	36.7	1.81	40.4	47.5	21.7	17.6	39.3	1.83	42.6	50.2
SF + GN (1+2)	19.2	18.5	35.7	1.89	41.7	49.0	21.3	17.9	39.2	1.83	42.7	50.2
SF + GN (1+3)	19.1	17.4	36.5	1.83	40.2	47.3	20.4	18.1	38.5	1.80	42.4	49.7
'M 522' (September harvest)												
GN (Sole)		21.4	21.4	1.00	30.5	34.7		22.2	22.2	1.00	30.5	35.9
SF + GN (1+1)	19.3	20.3	39.6	1.83	44.4	52.2	21.3	21.6	42.9	1.89	47.8	56.2
SF + GN (1+2)	19.2	20.5	39.7	1.86	45.1	53.1	20.5	20.7	41.2	1.84	45.9	54.0
SF + GN (1+3)	18.5	20.5	39.0	1.81	46.9	51.7	20.5	21.4	41.9	1.88	46.9	55.0
CD (P=0.05)	NS	0.90	2.60	0.17	2.50	2.90	NS	1.30	2.10	0.15	2.20	2.60

LER, Land-equivalent ratio; SEY, sunflower-equivalent yield

**Table 3.** Yield attributes of groundnut as influenced by planting patterns, its genotype and harvesting date

Planting patterns	Pods/plant		Mature pods (%)		Pod weight/plant (g)		Test weight (g)		Shelling (%)	
	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000
'SG 84' (June harvest)										
GN (Sole)	29.0	33.0	60.4	56.7	16.6	18.8	38.7	37.2	63.1	64.5
SF + GN (1+1)	13.0	14.0	33.2	31.3	5.5	6.3	29.0	28.3	62.1	63.2
SF + GN (1+2)	16.0	17.0	41.9	38.0	8.3	9.3	31.5	32.7	63.4	64.0
SF + GN (1+3)	21.0	26.0	51.5	48.0	10.4	11.5	36.9	35.0	60.7	63.5
'SG 84' (September harvest)										
GN (Sole)	49.0	54.0	85.2	83.7	35.7	36.2	56.4	55.7	62.2	63.4
SF + GN (1+1)	46.0	52.0	80.2	83.7	34.5	35.3	53.0	54.3	61.4	63.8
SF + GN (1+2)	47.0	52.0	81.5	84.0	35.0	36.7	51.4	54.7	62.8	63.9
SF + GN (1+3)	46.4	53.0	81.0	84.0	35.7	37.3	53.1	55.0	63.4	63.8
'M 522' (September harvest)										
GN (Sole)	42.0	44.0	84.8	84.3	45.2	47.8	65.7	64.8	61.3	64.0
SF + GN (1+1)	39.5	42.0	80.6	83.3	45.1	46.2	61.0	63.3	61.9	63.3
SF + GN (1+2)	39.5	43.0	80.5	83.7	45.9	46.7	62.5	63.7	61.9	63.7
SF + GN (1+3)	38.0	44.0	81.9	84.3	44.2	47.7	64.1	64.0	62.0	63.8
CD (P=0.05)	2.7	2.3	5.5	3.1	3.2	2.9	4.7	1.6	NS	NS

that groundnut intercropped with sunflower when harvested in September resulted in 94–95% yield of sole groundnut.

### **Total productivity**

Total productivity of both the crops in all the intercrop combinations (Table 2) was significantly higher than that of sole sunflower or groundnut. The yield advantage is also evident from significantly higher land-equivalent ratio (Table 2) in the intercrop combination. Combined yield of sunflower and groundnut in different combinations was 64–67% higher with 'SG 84' and 84–85% higher with 'M 522' when harvested in September as compared to yield of both the sole crops. The different planting patterns did not influence the total productivity significantly. 'M 522' recorded about 15% higher pod yield than 'SG 84' genotype of groundnut. Simon *et al.* (1992) and Singh (1994) also reported the similar results.

### **Sunflower-equivalent yield**

Total yield of sunflower and groundnut in intercrop system expressed as sunflower-equivalent yield (Table 2) was significantly higher in all the planting patterns than sole sunflower. Sunflower intercropped with 'M 522' gave significantly higher (53.7 q/ha) sunflower-equivalent yield than that obtained by intercropping sunflower with September-harvested 'SG 84' (49.0 q/ha). Sunflower + 'SG 84' as an intercrop when harvested in September gave 49.0 q/ha which was significantly higher by 20.0 q/ha than sunflower + 'SG 84' harvested in June (29.0 q/ha). This indicated that 69% more sunflower-equivalent yield was obtained when sunflower was intercropped with 'SG 84' and harvested in September than the same was harvested in June.

### **Gross income**

Monetary advantage of intercropping sunflower with groundnut was observed over sole sunflower or sole groundnut. The average gross income (for 2 years) of sole sunflower was Rs 19,400/ha compared to Rs 24,620/ha, Rs 41,670/ha and Rs 45,650/ha obtained from sunflower + 'SG 84' harvested in June and 'SG 84' and 'M 522' harvested in September respectively. Monetary return from sunflower + June harvested 'SG 84' was significantly lower during both the years because of very poor yield of groundnut in this system, whereas monetary return from sunflower + 'M 522' was significantly higher than that of sunflower + 'SG 84' when both were harvested in Septem-

ber. The difference in monetary return due to planting patterns was non-significant. Simon *et al.* (1992) and Singh (1994) also recorded higher returns from sunflower and groundnut intercropping than their sole crop.

### **Land-equivalent ratio**

The land-equivalent ratios of all intercropping combinations were significantly higher than one, but did not vary among planting patterns except for the intercropping system with June harvested 'SG 84' (Table 2). Genotypes of groundnut did not influence the ratio significantly during both the years. Singh (1994) also reported higher land-equivalent ratio of 1.88–1.93 of this intercrop system when groundnut was harvested in September. Similarly, Devidayal and Reddy (1991) reported that intercropping resulted in higher productivity per unit area of land than monocultures of intercrop components.

It was concluded that growing of sunflower and groundnut in intercrop system formed an economically viable combination because 64–85% higher productivity than sole sunflower and groundnut was obtained when groundnut was allowed to continue up to mid-September after harvest of sunflower. All the planting patterns (i.e. 1+1, 1+2 and 1+3) in intercrop were equally productive when groundnut was harvested in mid-September. Intercropping sunflower with groundnut genotypes 'M 522' was more remunerative than 'SG 84' as the total productivity in this system was about 9% more than the latter.

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