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Influence of intercropping and nitrogen on growth and yield of sunflower (*Helianthus annuus*) and groundnut (*Arachis hypogaea*)

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ABSTRACT

An experiment was conducted during rainy season (*kharif*) of 1989 and 1990 to study the effect of intercropping and nitrogen on growth and yield of sunflower (*Helianthus annuus* L.). and groundnut (*Arachis hypogaea* L.) at New Delhi. The intercropping had detrimental effect on growth, yield attributes and pod yield of groundnut. Growth and yield attributes of sunflower were not affected due to intercropping. However, yield was affected due to varying plant density. N application boosted the growth and yield of sunflower, while groundnut did not respond.

In the present-day agriculture a scientific approach of intercropping is being adopted under irrigated areas with a view to enhance productivity. It has been recommended to intercrop sunflower (*Helianthus annuus* L.) with groundnut (*Arachis hypogaea* L.) in varying row ratios, depending on the duration of sunflower and growth habit of groundnut (Sindagi, 1982). This prompted to study the effect of intercropping of Valencia groundnut on growth and yield of short-duration sunflower variety 'Morden' (70–75 days) and vis-a-vis. Sunflower responds up to 80 kg N/ha under irrigated conditions (Rao and Gangasaran, 1991). In intercropping, groundnut being a legume may deviate the N requirement of sunflower. Keeping this aspect in view levels of N were also included in the study.

MATERIALS AND METHODS

An experiment was conducted during the rainy season (*kharif*) of 1989 and 1990 on sunflower and groundnut intercropping at the institute's farm, New Delhi. A 3-time replicated split-plot design was adopted, with cropping systems in main plots and N levels in subplots. Cropping system comprised sole crops of sunflower and groundnut, intercropping sunflower with groundnut at 50 cm in 1 : 1, at 75 cm in 1 : 1, at 100 cm in 1 : 2 at 100 cm in 1 : 3 row ratios. These systems were supplied with 3 levels of nitrogen (0, 30 and 60 kg/ha). Details of the treatments are given in Table 1.

Soil of the experimental site was sandy loam in texture, low in total N (0.03%) and available P (8.0 kg/ha) and medium in available K (249.5 kg/ha), with pH 7.6 (1 : 2 soil water suspension).

Both the years (1989 and 1990) had distinct rainfall pattern. Rainfall in 1989 (184 mm) was below normal (550 mm from July–October), while in 1990 an excess of

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Table 1. Density adjustment and row ratios

System	Population density (%)		
	Sun-flower	Ground-nut	Total
Sole sunflower at 50 cm (SF)	100		100
Sole groundnut at 25 cm		100	100
Sunflower at 50 cm + 1 row of groundnut (1 : 1)	100	50	150
Sunflower at 75 cm + 1 row of groundnut (1 : 1)	66.6	33.3	100
Sunflower at 100 cm + 2 rows of groundnut (1 : 2)	50	50	100
Sunflower at 100 cm + 3 rows of groundnut (1 : 3)	50	75	125

93 mm over normal was received.

RESULTS AND DISCUSSION

Seasonal effect

Both seasons were distinct in respect of rainfall. The crop season was more humid during 1990 compared with the previous year (1989). Because of this reason both the crops were infested by diseases and pests in 1990. Rainfall in 1989 was so low that crops had to be irrigated. This dry season was considered to be more favourable for growth and development of both the oilseed crops. Due to this reason yields of both sunflower and groundnut were higher in 1989 than those of both crops in 1990.

Sunflower–dry matter

Dry-matter accumulation in sunflower was not significantly affected by intercropping of groundnut in any combination in either of the seasons (Table 2). Nitrogen improved the dry-matter accumulation of sunflower in both the seasons; however, differences were significant at 30 days in both the seasons and 60 days in 1990. Dry matter increased with increase in N level up to 60 kg/ha at 30 days in 1989, while in 1990 significant increase was noted only up to 30 kg N/ha both at 30 and 60 days after sowing.

Sunflower–yield attributes

The intercropping of groundnut did not have significant influence on yield attributes of sunflower in any year. Application of N influenced the seed filling in 1989 only and test weight and seed weight/plant in both the years (Table 3). Seed-filling and test weight in 1989 increased significantly only up to 30 kg N/ha, while test weight in 1990 and seed weight/plant in both seasons increased up to 60 kg N/ha.

Sunflower–seed yield

Seed yield of sunflower was influenced due to intercropping of groundnut; however, differences were significant in 1989 and in pooled data (Table 4). All the ratios of groundnut as intercrop suppressed the yield of sunflower against sole crop. As regards the influence of N, significant improvement in seed yield of sunflower was observed up to 60 kg N/ha in 2 seasons, whereas in pooled data response was recorded only up to 30 kg N/ha.

Groundnut–dry matter

Dry-matter accumulation (Table 2) of groundnut was suppressed when intercropped with sunflower at 30 days and at harvest in 1989 and at 60 days and at harvest in 1990. Degree of suppression was more when groundnut was grown between the closer row spacing of sunflower.

Nitrogen application did not have significant influence on dry-matter accumula-

Table 2. Dry-matter accumulation (g) in sunflower and groundnut as influenced by intercropping and levels of nitrogen

Treatment	Sunflower at days*						Groundnut at days*					
	30		60		At harvest		30		60		At harvest	
	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990
Cropping system												
Sole sunflower (SF)	5.92	2.96	53.6	35.8	87.5	40.7						
SF + GN at 50 cm 1 : 1 ratio	6.37	2.94	47.3	33.0	89.4	46.4	2.49	4.25	9.07	11.0	17.7	13.6
SF + GN at 75 cm 1 : 1 ratio	6.07	3.28	52.4	38.0	81.5	38.4	2.24	4.21	9.04	13.2	18.6	15.4
SF + GN at 100 cm 1 : 2 ratio	6.50	2.64	46.7	35.2	91.5	40.6	2.40	4.26	9.42	16.8	23.6	19.2
SF + GN at 100 cm 1 : 3 ratio	5.63	2.34	47.9	36.7	72.1	48.2	2.90	3.63	8.24	14.0	22.2	15.8
Sole groundnut							2.88	4.24	9.67	15.5	25.5	18.6
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	0.46	NS	NS	2.8	5.05	3.0
Nitrogen (kg/ha)												
0	4.82	2.50	44.5	31.7	75.3	41.5	2.51	4.40	8.68	13.3	20.7	15.6
30	5.92	3.26	51.1	39.4	89.1	42.3	2.50	4.21	9.20	13.6	21.9	17.6
60	7.55	2.73	52.8	36.3	88.8	44.8	2.74	3.74	9.57	13.5	21.9	16.3
CD (P = 0.05)	0.96	0.56	NS	5.2	NS	NS	NS	NS	NS	NS	NS	NS

SF, Sunflower; GN, groundnut

* Days after sowing

Table 3. Yield attributes of sunflower and groundnut as affected by intercropping and levels of nitrogen

Treatment	Sunflower (SF)						Groundnut (GN)					
	Head (filled) diameter (%)		1,000-seed weight (g)		Seed weight/ plant (g)		Pods/ plant		Pod weight/ plant (g)		100-kernel weight (g)	
	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990
Cropping system												
Sole sunflower (SF)	81.5	68.3	45.7	38.3	24.4	17.3						
SF + groundnut (GN) at 50 cm 1 : 1 ratio	83.7	67.4	44.6	38.8	23.4	18.7	13.4	13.2	10.7	7.2	28.0	23.5
SF + GN at 75 cm 1 : 1 ratio	82.2	67.9	43.6	41.6	22.5	19.0	8.0	8.0	5.1	4.6	27.2	23.0
SF + GN at 100 cm 1 : 2 ratio	83.4	74.4	47.2	40.1	25.3	21.1	8.7	9.0	5.8	4.8	27.6	21.6
SF + GN at 100 cm 1 : 3 ratio	82.5	71.6	44.0	38.2	22.3	20.5	10.6	13.3	6.9	6.6	26.5	21.5
Sole groundnut							10.6	10.2	7.2	5.3	28.0	23.5
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	2.6	2.8	1.8	2.0	NS	NS
Nitrogen (kg/ha)												
0	77.4	67.0	40.9	36.8	19.2	16.5	10.1	11.2	7.6	6.3	27.1	23.3
30	83.7	71.7	47.5	38.4	23.8	19.4	10.9	9.9	6.9	5.2	28.7	22.5
60	85.8	71.1	46.6	42.0	27.7	22.1	9.9	10.9	6.9	5.4	27.0	22.7
CD (P = 0.05)	3.5	NS	3.9	3.5	3.7	1.8	NS	NS	NS	NS	NS	NS

tion of groundnut.

Groundnut–yield attributes

Yield attributes except 100-kernel weight of groundnut were significantly reduced in intercropping against sole crop (Table 3). Maximum reduction in pods and pod weight/plant was recorded when groundnut was grown in the narrow row spacing of groundnut. Yield attributes remained unchanged due to N application in both the years.

Groundnut–pod yield

Intercropping systems had significant influence on pod yield of groundnut in both the years (Table 4). In 2 seasons and also in the pooled data maximum yield was recorded from sole crops of groundnut while under all the intercropping systems yield was drastically reduced (Table 4.). Maximum reduction was recorded in the system where groundnut was grown in the 1 : 1 row ratio at 50 cm spacing. N doses did not influence the pod yield of groundnut in either of the seasons and also in pooled data.

Dry-matter accumulation and yield attributes of sunflower remained unchanged due to intercropping of groundnut. Narwal and Malik (1986) reported similar results. However, significant reduction in seed yield was recorded due to intercropping. Reduction in sunflower population under 75 cm and 100 cm row spacings and competition due to higher population (150%) of sunflower and groundnut under 50 cm spacing was responsible for reduction in sunflower yield against sole crops.

Higher dry-matter accumulation in sunflower due to N application was because of the increase in plant vigour which

Table 4. Yield of sunflower and groundnut under different cropping systems and nitrogen doses

Treatment	Seed yield of sunflower (q/ha)				Pod yield of ground (q/ha)			
	1989	1990	Pooled	Expected	1989	1990	Pooled	Expected
Cropping system								
Sole sunflower (SF)	13.6	7.9	10.7	10.7				
SF + GN at 50 cm 1 : 1 ratio	11.0	7.5	9.1	10.7	5.3	2.0	3.5	7.2
SF + GN at 75 cm 1 : 1 ratio	9.1	6.6	7.9	7.0	5.0	2.2	3.5	4.8
SF + GN at 100 cm 1 : 2 ratio	9.2	6.8	8.0	5.3	9.5	3.2	5.7	7.2
SF + GN at 100 cm 1 : 3 ratio	9.2	6.8	8.0	5.3	13.0	4.4	8.4	10.9
Sole groundnut (GN)					24.6	6.5	14.5	14.5
CD (P = 0.05)	2.0	NS	1.1		2.2	1.0	1.0	
Nitrogen (kg/ha)								
0	8.7	6.2	7.4		11.7	3.9	7.3	
30	10.9	7.4	9.2		11.2	3.6	7.1	
60	11.7	7.7	9.6		11.4	3.5	6.9	
CD (P = 0.05)	0.6	0.3	1.0		NS	NS	NS	

resulted in more seed- filling and better seed development. This caused higher seed weight/plant and finally significantly higher seed yield of sunflower.

Dry-matter accumulation of groundnut was suppressed in intercropping due to shading effect of sunflower. This effect was more pronounced when groundnut was intercropped between the narrow row spacing of sunflower.

Shading of sunflower proved more detrimental to yield attributes of groundnut which suppressed the pod formation and seed development. This finally caused reduction in pod weight/plant of groundnut. The results corroborate the findings of Narwal and Malik (1986). Pod yield, being a product of plant density and yield attributes, was higher under the higher row ratios of groundnut compared with 1 : 1 row ratio.

Groundnut being a legume did not respond to applied N which indicated that N fixed through root nodules might have met its N requirement.

Proper adjustment of rows at 100 cm with 1 : 3 ratio, where 125% density was maintained, made these crops more compatible. In this system sunflower had the advantage as 74.7% of the yield could be harvested from 50% density of sole sunflower. Under this system yield reduction in groundnut was only 22.9% compared with 52.0 and 26.8% in 50 and 75 cm row spacing of sunflower. This indicated an efficient utilization of resources and complimentarity of sunflower and groundnut when intercropped in wider rows of sunflower.

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