Indian Journal of Agronomy 46 (1) : 50–55 (March 2001)

Influence of intercropping and weed-control measures on dry-matter accumulation and nutrient uptake by sunflower (*Helianthus annuus*) and groundnut (*Arachis hypogaea*) and their effect on succeeding maize (*Zea mays*)

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Received: March 2000

ABSTRACT

An experiment conducted during the spring seasons of 1996 and 1997 revealed that sunflower (*Helianthus annuus* L.) grown in 1:2 ratio of intercropping recorded significantly higher dry matter. However highest N and P uptake was recorded from the sole crop. Intercropping suppressed the dry-matter accumulation and N and P uptake of groundnut. Weed-control measures enhanced the dry-matter accumulation of both sunflower and groundnut (*Arachis hypogaea* L.). Combined application of pendimethalin and 1 hand-weeding recorded the highest dry matter of both component crops. On an average, combined application of both weed-control measures showed 30.5 and 46.0% higher uptake of N and P by sunflower and 222 and 370% by groundnut respectively. Productivity and N uptake of maize (*Zea mays* L.) was significantly higher when it was preceded by intercropping of sunflower and groundnut. Weeds controlled by both pendimethalin and 1 hand-weeding also enhanced the productivity and N uptake by succeeding maize.

Key words : Dry-matter accumulation, Nutrients uptake, Sunflower, Groundnut, Maize

The productivity of the cropping system is not only governed by the inputs applied to the crop but also by the harmony between the crops grown in association or in sequence. Inclusion of legumes in these systems helps in utilizing natural resources efficiently and maintaining the fertility status of soil which may contribute to the productivity of the succeeding crop. Sunflower–groundnut intercropping boosts the total productivity (Giri and Blaize, 1994). However, information on the nutrients uptake by these crops in association and their effect on the succeeding crop is lacking. Therefore, this experiment was intiated to study the effect of intercropping and weed-control measures on dry-matter accumulation

pattern by sunflower and groundnut and nutrients uptake by 2 crops and to study their effect on the productivity of succeeding maize crop.

MATERIALS AND METHODS

An experiment was conducted during spring and rainy (*kharif*) seasons of 1996 and 1997 at Indian Agricultural Research Institute, New Delhi. The treatments consisting of 4 cropping systems (sole sunflower, sunflower at 100 cm + 2 rows of groundnut, sunflower in paired rows at 40/160 cm + 4 rows of groundnut and sole groundnut) were assigned to main plots and 4 weed-control measures (weedy check, pendimethalin 1 kg a.i./ha as pre-emergence, 1 hand-weeding at 35 days, and pendimethalin + 1 hand-weeding at 35 days) formed the subplots. The soil of the site was sandy loam, low in organic carbon (0.42%) and medium in available P (13.0 kg/ha) and K (218 kg/ha) with pH 7.4. Groundnut 'S.G. 84' and sunflower hybrid 'MSFH 8' were sown on 6 and 5 March in respective seasons. A basal dose of 25 kg N + 50 kg P_2O_5/ha to groundnut and 80 kg N + 40 kg P_2O_5 + 40 kg K_2O/ha to sunflower was applied to various systems as per the density of 2 crops. In subsequent seasons maize composite 'Navjot' was sown on 18 and 21 July in respective years without fertilizer. Sunflower and groundnut were harvested on 4 June and 5 July in 1996 and 5 June and 2 July in 1997 respectively. Succeeding maize crop was harvested on 21 and 17 October in 2 years respectively.

RESULTS AND DISCUSSION

Effect of intercropping

Sunflower: Sunflower grown in 1:2 ratio of intercropping recorded significantly higher dry-matter/plant than that of sole sunflower at 60 days and at harvest (Table

Table 1. Dry-matter accumulation at various growth stages and at harvest of sunflower as influenced by intercropping and weed-control measures

Treatment	Dry-matter accumulation (g/plant)					
	1996			1997		
	30 days	60 days	at harvest	30 days	60 days	at harvest
Intercropping						
Sole sunflower	3.58	25.75	94.24	2.54	19.48	76.01
SF + GN (1:2)	3.41	29.75	101.16	2.31	22.79	84.72
SF + GN (2:4)	3.76	27.61	95.63	2.55	21.90	77.51
CD (P = 0.05)	NS	2.51	5.01	NS	2.27	5.27
Weed-control measure						
Weedy check	3.41	22.97	87.12	2.16	16.34	65.74
Pendimethalin (P)	3.72	28.26	97.74	2.71	21.76	80.50
Hand-weeding (HW)	3.42	27.50	95.53	2.24	21.08	75.84
P + HW	3.76	32.08	107.64	2.76	26.37	95.58
CD (P = 0.05)	0.29	1.71	3.47	0.22	1.50	3.55

SF, Sunflower; GN, groundnut

1). This was because wider spacing of sunflower in 1:2 ratio of intercropping might have made more resources available to the individual plant which leads to more accumulation of photosynthates. However, biological productivity of sunflower in intercropping was significantly lower than sole crop. This was due to lower plant density of sunflower in intercropping. Sunflower grown in 1:2 ratio gave more biomass and seed yields over that in paired rows of sunflower at 40/160 cm with 4 rows of groundnut. This was owing to less competition in uniform planting in 1:2 ratio. The N and P uptake by sunflower was significantly suppressed by intercropping. The highest reduction in N and P uptake was recorded in paired row planting of sunflower at 40/160 cm (Table 3). Suppression in N and P uptake of sunflower by intercropping was due to reduction in total biological yield (Table 3), as N and P content in sunflower plant parts remained unchanged due to intercropping (Singh, 1998).

Groundnut : The highest dry matter was accumulated by sole groundnut which was significantly suppressed by intercropping at all the stages in 2 years except at 30 days after sowing. Lowest dry mater was recorded in 1:2 ratio of intercropping. This remained significantly lower than that recorded from sunflower + groundnut in 2:4 ratio of intercropping. Reduction in dry-matter of groundnut due to intercropping was because of shading and competition for natural resources offered by sunflower. More suppression in dry-matter accumulation of groundnut in 1 : 2 ratio of intercropping was because sunflower sown at 160 cm in 2:4 ratio caused less shading due to wider spacing in sunflower. Similarly, sole

Table 2. Effect of intercropping and weed-control measures on dry-matter accumulation of groundnut at different growth stages

Treatment	Dry-matter accumulation (g/plant)							
	1996				1997			
	30 days	60 days	90 days	Harvest	30 days	60 days	90 days	Harvest
Intercropping								
SF + GN (1:2)	2.29	4.08	7.16	9.32	2.36	3.86	6.71	8.75
SF + GN (2:4)	2.45	4.59	9.01	12.13	2.55	4.48	8.82	12.29
Sole groundnut (GN)	2.54	5.60	12.80	17.85	2.40	5.34	12.10	17.51
CD (P = 0.05)	NS	0.45	1.41	1.72	NS	0.47	1.56	1.88
Weed-control measure								
Weedy check	2.00	3.35	5.96	8.11	2.07	3.28	5.78	7.49
Pendimethalin (P)	2.76	4.72	9.91	13.01	2.73	4.46	9.10	12.76
Hand-weeding (HW)	2.07	4.47	9.37	13.59	2.09	4.27	9.00	13.71
P + HW	2.86	6.49	13.37	17.68	2.74	6.23	12.95	17.45
CD (P = 0.05)	0.24	0.31	1.01	1.29	0.25	0.33	1.34	1.37

groundnut gave the highest biomass and pod yields, which were significantly reduced by the intercropping in both years (Table 3). The groundnut grown in 2:4 ratio with sunflower gave more biomass and pod yields than 1:2 ratio. Sole groundnut removed highest amount of N and P, which were significantly reduced in intercropping, lowest being in 1:2 ratio of sunflower : groundnut (Table 3). Suppression in N and P uptake of groundnut in intercropping was due to reduction in total biomass and pod yields of groundnut, as N and P content in groundnut plant parts was not significantly affected in intercropping (Singh, 1998).

Succeeding maize: Intercropping of sunflower and groundnut in 1:2 ratio being at par with 2:4 ratio recorded significantly higher dry matter of succeeding maize compared with sole sunflower at all stages in 2 years and over sole groundnut at 30 days in 2 years (Table 4). This tended to show similar effect of sunflower and groundnut intercropping on grain and biomass yields of succeeding maize (Table 4).

Both the intercropping systems of sunflower and groundnut recorded significantly higher uptake of N over sole component crops (Table 4). Higher dry-matter accumulation, total biomass and seed yields and N uptake of succeeding maize due to inclusion of groundnut in the system were because of the fact that groundnut being a legume enriches the soil, whereas sunflower being a heavy feeder might have exhaused the soil.

Effect of weed control

Sunflower: Weed-control measures significantly increased the dry-matter accumulation at all the stages of sunflower

Table 3. Effect of intercropping and weed-control measures on productivity and nutrients uptake by sunflower and groundnut

Treatment	Sunflower				Groundnut			
	Seed yield (q/ha)	Biomass yield (q/ha)	N uptake (kg/ha)	P uptake (kg/ha)	Pod yield (q/ha)	Biomass yield (q/ha)	N uptake (kg/ha)	P uptake (kg/ha)
Intercropping								
Sole sunflower	15.08	50.87	83.75	22.76				
SF + GN (1:2)	12.18	40.57	67.00	18.64	6.56	19.68	45.0	4.48
SF + GN (2:4)	10.01	33.97	55.5	15.05	7.94	22.58	53.6	5.53
Sole groundnut (GN)					17.85	43.08	110.1	12.29
CD (P = 0.05)	2.16	4.11	7.1	1.90	1.10	3.45	7.9	0.86
Weed-control measure								
Weed check	11.08	35.76	58.7	15.20	4.43	13.83	30.5	2.48
Pendimethalin (P)	12.39	42.46	69.8	18.68	11.64	31.06	75.3	7.66
Hand-weeding (H.W.)	12.70	35.65	69.9	19.20	11.50	30.67	74.2	7.79
P + H.W.	13.51	46.64	76.6	22.20	15.57	38.22	98.3	11.68
CD (P = 0.05)	0.65	3.11	5.3	1.41	1.19	3.42	7.7	0.80

SF, Sunflower; GN, groundnut

Table 4. Effect of preceding season cropping system and weed-control measures on dry-matter accumulation, productivity and N uptake of maize

Treatment	Dry-matter accumulation (g/plant) at			Grain yield (q/ha)	Biomass yield (q/ha)	N uptake (kg/ha)
	30 days	60 days	Harvest			
Intercropping						
Sole sunflower (SF)	3.74	42.06	54.62	15.24	47.84	39.7
SF + GN (1:2)	5.83	45.73	59.40	18.95	59.53	51.9
SF + GN (2:4)	5.06	46.23	58.90	19.15	60.40	51.7
Sole groundnut (G.N.)	4.65	44.56	57.41	17.09	54.43	45.8
CD (P = 0.05)	0.76	4.07	3.33	4.86	5.34	4.9
Weed-control measure						
Weedy check	3.59	34.97	47.46	14.07	46.10	37.8
Pendimethalin (P)	4.98	44.76	60.51	18.16	56.77	48.0
Hand-weeding (HW)	4.83	44.40	58.02	17.29	54.61	46.9
P + HW	5.89	54.46	64.34	20.90	63.74	56.5
CD (P = 0.05)	0.53	3.07	2.43	1.31	3.79	3.8

except hand-weeding which showed its influence at 60 days and harvest because hand-weeding was done at 35 days (Table 1). Combined application of pendimethalin and 1 hand-weeding recorded the highest dry matter, which was significantly superior to their individual application. Both these treatments remained at par for dry-matter accumulation at 60 days in both years and at harvest in 1996. However, in 1997 pendimethalin proved to be signifiantly better than hand-weeding. As indicated by dry-matter accumulation, weed-control measures significantly increased the seed and biomass yields of sunflower (Table 3). Combined application of 2 weed-control measures significantly improved seed and biomass yields over their individual application. Weeds suppressed by pendimethalin or and hand-weeding as indicated by their dry-matter accumulation (Singh, 1998) offered less competition for natural resources which resulted in the higher dry matter and productivity of sunflower.

Weed-control measures significantly boosted the uptake of N and P by sunflower over weedy check (Table 3). The highest uptake of N and P was recorded with the combined application of pendimethalin and 1 hand-weeding which was significantly higher than their individual application. Higher N and P uptake by sunflower under weed-control measures was due to increase in dry matter and higher productivity of total biomass.

Groundnut: Dry-matter accumulation of groundnut was significantly increased due to weed-control measures at all the stages (Table 2) except at 30 days where hand-weeding remained on a par with weedy check. This was because hand-weeding was done 5 days after recording dry matter. Both the weed-control measures remained

equally effective, but their combined application further brought significant improvement over their individual application. Reduction in weed competition for natural resources due to weed-control measures favoured higher dry-matter accumulation of groundnut. As a result of better growth and proper partitioning of photosynthates, groundnut recorded significantly higher pod and biomass yields owing to weed-control measures, highest being with combined application of pendimethalin and hand-weeding. The N and P uptake of groundnut was also significantly enhanced by weed-control measures (Table 3). Highest N and P uptake was recorded with combined application of both weed-control measures. This was because of increase in pod and biomass yields of groundnut (Table 3) coupled with higher P content in groundnut plant parts (Singh, 1998).

Succeeding maize: The weed-control measures imposed in preceding season also significantly increased the dry-matter accumulation of succeeding maize at all the stages (Table 4). Combined application of pendimethalin and hand-weeding recorded the highest dry matter of maize which was significantly superior to their individual application. Both of them remained at par for dry-matter accumulation in maize. As indicated by dry-matter accumulation, combined application of pendimethalin + 1 hand-weeding also recorded the highest grain and biomass yields of succeeding maize which was also significantly superior to their individual application. On an average, combined application of 2 weed-control measures in preceding season enhanced the grain and biomass yields of maize by 49 and 38% respectively (Table 4).

Weed-control measures also increased the N uptake by succeeding maize, highest being under combined application of pendimethalin and 1 hand-weeding (Table 4). Both these treatments remained at par for N uptake by succeeding maize.

The favourable effect of weed-control measures on succeeding maize was due to the fact that these treatments suppressed weeds growth in preceding season (Singh, 1998), which in turn might have made more nutrients available to following maize crop.

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