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Effect of nitrogen fertilization on growth, productivity and economic feasibility of sunflower and groundnut under different cropping systems

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Abstract

An experiment was conducted during spring season of 2000 and 2001 to study the effect of different cropping systems and levels of nitrogen on growth, yield and yield attributes of spring sunflower and groundnut. Growth parameters *i.e*. plant height, leaf area and dry matter of sunflower and groundnut, both as well as sunflower yield attributes *i.e*. head diameter, number of filled achenes per head, 1000 achenes weight and groundnut yield attributes *viz.* pods/plant, kernels/pod, and 100 kernel weight were not affected due to different cropping systems except the number of filled achenes/head and seed yield /plant in sunflower. Significantly higher sunflower seed yield was obtained with normal sunflower treatment as compared to remaining cropping systems. The intercropping had detrimental effect on the yield of sunflower. Nitrogen application boosted the yield and yield attributes of sunflower up to 90 kg N level. However, groundnut yield and yield attributes responded up to 60 kg N/ha only. Highest system productivity was observed under Paired SF + two row GN, which was 12.17% higher over sole sunflower. The system productivity observed under 90 kg N/ha was 47.77% higher over 0 kg N/ha. Similarly application of 90 kg N/ha to sunflower yielded 52.78 and application of 60 kg N/ha yielded 35.11% higher sunflower and groundnut yield over 0 kg N/ha, respectively. Highest cost (₹ 17850/ha), gross return (₹ 35702/ha), net return (₹ 17852/ha), out: input (2.0) and B:C ratio (1.0) was incurred with paired SF+ two row groundnut. The net return with paired SF+ two row groundnut was, 23.98% higher than sole sunflower. Similarly the net return with 90 kg N/ha was 126 per cent higher over 0 kg N /ha.

Key Words: Groundnut, Intercropping system, Nitrogen levels, Spring Sunflower, Yield

Introduction

Recent studies affirmed the utility of intercropping system as one of the crop contingency strategies against any mono cultured crop failures and by now acclaimed the most reliable approach of harnessing available natural resources *i.e*. light, moisture as well as nutrients effectively. Sunflower grown with groundnut in varying row ratios would be a suitable choice for improving production **(**Sindagi 1982). Since, the differential nitrogen need of a crop is attributed to their differential growth nature, quality and production potential, which is largely associated of its genetic makeup. Nitrogen mutually benefits both the crops when applied keeping the demand of the system as a whole in the intercropping system. Hence, a field trial was carried out to study the effect of cropping systems and nitrogen levels on crop growth, yield, yield attribute and economic feasibility on spring sunflower and groundnut.

Materials and Methods

The field experiment was conducted at Crop Research Centre of G. B. Pant University of Agriculture and Technology, Pantnagar. The soil was silty loam in texture, high in organic carbon (0.95%), available P (40 kg P_2O_5/ha) with pH 7.2. The experiment consisted of 4 cropping systems as main plot *viz*. Normal sunflower (60 x 25 cm), Normal sunflower +1 alternate row of groundnut, Paired sunflower (30/90 x 25cm) and Paired sunflower +2 row of groundnut and 4 levels of Nitrogen (0, 30, 60 and 90 kg N/ha) as sub plot treatments, was laid out in split plot design with 3 replications. The crop was fertilized uniformly with 60 kg P_2O_5 and 30 kg K_2O/ha. The nitrogen application was done as per treatments. Full dose of P_2O_5, K_2O whereas, half dose of nitrogen was applied as basal and rest half N was top dressed at flower bud initiation stage of sunflower. Other cultural practices were followed as per approved package of practices of sunflower. Plant

protection measures were applied as and when required for keeping both the components of system pest free. The cost of production, gross return, net return, out put: in put ratio and B:C ratio were worked out on the basis of unit cost of inputs and outputs during the year 2001. The system productivity was calculated as sunflower equivalent (kg/ha) yield using following formula;

$$\text{Sunflower equivalent yield} = \text{Sunflower yield}\ (\text{kg/ha}) + \frac{\text{Groundnut yield}\ (\text{kg/ha}) \times \text{MSP for groundnut}\ (\text{Rs./kg.})}{\text{MSP for sunflower}\ (\text{Rs./kg})}$$

Where MSP= Minimum support price (₹ /kg)

Result and Discussion

Growth, yield attributes and yield of sunflower

Data (Table 1) reveals that plant height, leaf area, dry matter per plant, head diameter and test weight of sunflower were not influenced significantly by different cropping systems. Though highest value of above listed parameters in sunflower were observed under normal sunflower. However, highest plant height (69.1 and 64.8 cm), leaf area (2322 and 2128 cm^2/plant) and dry matter yield (54.36 and 54.28 g/plant) of groundnut was noticed with paired SF + two row GN during 2000 and 2001, respectively. Blaise & Giri (1996**)** also reported similar trend of result.

Maximum head diameter (18.5cm), no. of filled achenes (800.5 achenes/ head), 1000 achenes weight (53.7 g) and sunflower seed yield (2584 kg/ha) was recorded under normal SF which was significantly higher over the rest of the cropping systems (Table 2). The higher seed yield in normal sown sunflower, shows that inter crop suppressed the yield of sunflower due to completion for growth limiting factors. Highest system productivity was recorded with Paired SF + two row GN (3141 kg sunflower equivalent yield kg/ha) which registered its significant superiority over normal sunflower (2801 kg SF equivalent yield/ha) and paired sunflower (2491 kg SF equivalent yield/ha). Sarkar *et al***.** (1997) also reported analogous findings. The system productivity with Paired SF + two row GN, was 12.13% higher over normal sunflower.

The value of all the growth as well as yield parameters increased significantly with increasing levels of nitrogen. Besides, cropping systems nitrogen levels also markedly varied for different growth and yield parameters and recorded highest plant height (201.6 and 201 cm), leaf area (5034 and 5025 cm^2 plant) during 2000 and 2001, respectively. Similarly the head diameter (21.8 cm), No. of filled achenes (995.2 achenes/head) 1000- achenes (55.7 g) sunflower seed yield (2906 kg/ha) also were noticed maximum with paired sunflower + two row GN (Table 2 and Table 3). Application of 90 kg N resulted 52.22% higher sunflower seed yield over 0 kg N/ha. Increasing trend of these growth and yield attributes with increasing levels of nitrogen might was due to the fact that nitrogen increased protein synthesis thus resulted over all enhanced cell division and elongation (Devlin 1972). Higher seed yield of sunflower with 90 kg N/ha was due to favorable effect of nitrogen on different yield parameters. The result confirms finding of Megure *et al*. (1983).

Growth, yield attributes and yields of groundnut

Groundnut also not responded significantly for different growth parameters *i.e*. plant height, leaf area, dry matter/plant. Though, highest value of these parameters was observed under paired SF + two row GN (Table 1). Contrary to growth parameters the yield parameters and yield of ground was significantly influenced with cropping systems except kernels/pod and 100 kernel weight (Table 1 and 2). Highest value of pod yield was observed with Paired sunflower +

two row GN (624 kg/ha), which was significantly higher and stood 11.83% additional over paired SF + one row GN.

Plant height, leaf area, dry matter /plant increased with increasing levels of nitrogen up to 90 kg N/ha. Significantly higher plant height (71 and 60 cm) leaf area /plant (2574 and 2228 cm^2/ plant) and dry matter (54.85 and 57.16 g/plant) was recorded with 90 kg N/ha. The differences in dry matter accumulation between 60 and 90 kg N/ha was not significant (Table 1). Increasing N levels (0 to 90 kg N/ha) increased pods / plant only up to 60 kg N /ha and thereafter, reduction in pod number was observed with increased rates of 90 kg N /ha during both the years. Maximum no. of pods/plant was recorded with 60kg N (12.7 pods), being at par with 90 kg N (12.3 pods) and stood significantly higher to 30 kg N /ha (11.1 pods). Thus, nitrogen application registered significant increase in pods/ plant over control during both the years. Nitrogen application could not exhibit significant influence on number of kernels/ pod and 100 kernel weights. In general increasing N increased the of kernels/pod and 100-kernel weight only up to 60kg N/ ha (Table 2). Nitrogen application recorded significant impact on pod yield of groundnut only up to 60kg N/ ha. .The plots fertilized with 60 kg N/ha had 35.1 and 11.9% higher groundnut pod yield over 0 kg and 30 kg N/ha, respectively. Groundnut being a legume crop did not respond to applied N beyond 60 kg N/ ha indicating that N fixed through root nodules might have met its N requirement. The results are in accordance of findings of Patra *et al*. (1990).

Table 1: Effect of cropping systems and nitrogen rates on growth parameters of sunflower and groundnut

Treatment	Plant height at maturity (cm)				Leaf area (cm^2/plant)				Dry matter at maturity (g/plant)			
	Sunflower		Groundnut		Sunflower (90 DAS)		Groundnut (Maturity)		Sunflower		Groundnut	
	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
Cropping System												
Normal SF	179.4	177.2	-	-	4577	4322	-	-	180.93	166.03	-	-
Normal SF + one row GN	181.5	183.9	69.1	64.8	4320	4148	2252	2179	176.30	163.21	52.17	53.64
Paired SF	187.6	187.6	-	-	4174	4227	-	-	177.87	164.9	-	-
Paired SF + two row GN	189.1	186.3	69.9	64.8	4123	4146	2322	2128	176.91	164.23	54.36	54.28
S.Em +_	6.3	4.7	1.0	1.5	121.2	78.1	49.1	43.9	4.54	4.24	1.26	1.28
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen (level Kg /ha)												
0	168.6	164.2	67.1	61.0	3332	3079	1917	2063	142.37	127.04	50.89	49.56
30	178.1	179.6	69.1	64.3	4265	4065	2324	2140	173.47	159.87	52.85	53.44
60	189.4	190.0	70.7	65.9	4564	4675	2332	2185	190.22	178.84	54.48	55.70
90	201.6	201.0	71.1	68.0	5034	5025	2574	2228	205.95	193.61	54.85	57.16
S.Em +_	4.3	3.9	1.3	1.6	63.9	39.8	50.9	37.0	2.85	3.26	0.93	0.79
CD (P=0.05)	12.4	11.2	NS	NS	186	116	156.8	114.1	8.32	9.52	2.86	2.42

* SF= Sunflower, GN= Groundnut, NS= Non significant

Table 2 : Effect of cropping systems and nitrogen levels on yield attributes and yield of sunflower and groundnut (Mean of two years data)

Treatment	Sunflower			Groundnut			Sun-flower seed yield (kg/ha)	Ground-nut pod yield (kg/ha)	System yield (Sun-flower seed equivalent yield kg/ha)
	Head diameter (cm)	No..of filled achenes/ head	1000-achenes weight (g)	No. of pods / plant	No.of kernels /pod	100-kernel weights (g)			
Cropping System									
Normal SF	18.5	800.5	53.1	-	-	-	2584	-	2801
Normal SF + one row GN	17.4	693.9	51.4	10.5	1.9	26.2	2443	558	3136
Paired SF	17.1	730.3	54.9	-	-	-	2396	-	2491
Paired SF + two row GN	17.4	731.3	53.6	11.7	1.9	27.2	2467	624	3141
S.Em +_	0.4	14.5	0.7	0.2	0.4	0.6	54	13	64.1
CD (P=0.05)	NS	49.9	NS	NS	NS	NS	NS	NS	18.6
Nitrogen (level Kg /ha)									
0	13.7	501.1	49.3	10.2	1.8	26.1	1902	487	2476
30	16.7	665.9	52.8	11.1	1.9	26.4	2379	588	3101
60	18.3	793.8	55.2	11.7	2.0	27.2	2702	658	3462
90	21.8	995.2	55.7	11.3	2.0	27.1	2906	632	3659
S.Em +_	0.3	12.6	0.4	0.3	0.1	0.5	38	15	42.3
CD (P=0.05)	0.8	36.8	1.1	0.8	NS	NS	111	46	14.5

- SF= Sunflower,1GN= Groundnut, NS= Non significant

Table 3 Effect of cropping systems and nitrogen levels on economic parameters (mean from two years data).

Treatments	**Cost of cultivation (₹ /ha)**	**Gross return (₹ /ha)**	**Net return (₹ /ha)**	**Output : input ratio (₹ : ₹)**	**B:C ratio (₹ : ₹)**
Cropping Systems					
Normal SF	15447	29845	14398	1.93	0.93
Normal SF + one row GN	17850	34654	16804	1.94	0.94
Paired SF	15447	26675	11228	1.73	0.72
Paired SF + two row GN	17850	35702	17852	2.00	1.00
Nitrogen Rates Kg /ha					
0	16194	24780	8886	1.53	0.54
30	16528	29873	13345	1.81	0.80
60	16800	35010	18210	2.08	1.08
90	17073	37213	20140	2.18	1.17

- SF= Sunflower, GN= Groundnut, NS= Non significant

System productivity (sunflower seed-equivalent yield)

On the basis of two years data on crop yields it was inferred that intercropping system *i.e*. normal SF + 1 alternate row of GN (31.36 kg /ha) or paired SF + 2 rows of GN (3141 kg/ha) gave more or less equal total productivity (Table 2) in terms of sunflower seed equivalent yield, which was significantly higher over normal SF (2801 kg/ha) and paired SF (2491 kg/ha) showed an efficient utilization of resources and better productivity. Paired SF + 2 rows of GN cropping system resulted 12.13% higher sunflower seed equivalent yield over normal sunflower. The results are in accordance to findings of Sarkar *et al*. (1997) and Olowe & Adebimpe (2009).

The system productivity also was influenced with nitrogen fertilization and recorded maximum with90 kg N (3659 kg SF equivalent yield) followed by 60 kg N (3463 kg SF equivalent yield). The mean data on total productivity showed that the highest dose of 90 kg N/ ha which produced 48.0, 17.9 and 6% higher productivity over 0 , 30 and 60 kg N/ ha, respectively. The result corroborate with the findings of Blaise & Giri (1996)**.**

Economics

Although highest cost of production was registered with paired SF + two row GN (₹ 17850/ha) but highest gross return (₹ 35702/ha) net return (₹ 17852/ha) as well as B:C ratio (1.0) also were associated with paired SF + two row GN. Paired SF + two row GN cropping system fetched 23.9% higher net return compared to normal SF. This was owing to additional return obtained due to raising groundnut as intercropping with sunflower. In spite of higher net return, highest output: input ratio also was incurred under paired SF + two row GN (2.0). The results are in accordance with that of Sarkar *et al*. (1997), Barik *et al.* (1998), Sarkar *et al*. (1998) Sarkar & Chakraborty (1999). Amongst Nitrogen levels highest gross return (₹ 37213/ha) net return (₹ 20140/ha) as well as B:C ratio (1.17) were obtained with 90 g /ha. Application of 90 kg N /ha to the system resulted 126, 50.9 and 10% high net return over 0, 30 and 60 kg N /ha, respectively. The highest mean net return and in put: out put ratio with 90 kg N/ ha was due to conspicuously higher seed yields of both the component crops of the system. The findings are in agreement with Blaise & Giri (1996) and Barik *et al*. (1998).

Conclusions

On the basis of two years experimentation it can be concluded that one may adopt paired planting of sunflower in combination with two rows of groundnut fertilized with 90 kg N /ha or normal planting of sunflower with alternate row of groundnut fertilized with 90 kg N /ha for getting higher productivity per unit area from the system as a whole without any adverse effect of groundnut on sunflower yield.

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