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Productivity and Economics of Groundnut-Sunflower Intercropping System as Influenced by Nutrient Management Practices under Irrigated Condition

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Field experiment was conducted during *kharif* 2003-04 at Tamil Nadu Agriculture University Farm, Coimbatore to find out optimum nutrient requirement for groundnut +sunflower intercropping (3:1) system under irrigated conditions with replacement series. Treatments were consisted of recommended dose of fertilizers (RDF) to main crop alone, both main and intercrop separately, 50% reduction in RDF to intercrop and split application of nitrogen to intercrop and no fertilizer application to entire system. Results revealed that the growth, yield attributes and nutrient uptake of groundnut and the intercrop sunflower were improved when groundnut (17:34:54 kg ha^{-1}) and sunflower (40:20:20: kg ha^{-1}) were supplied with their recommended does of NPK and split application of nitrogen as 50% basal and 50% as top dressing on 21 DAS to sunflower. Significantly higher pod yield of groundnut and seed yield of sunflower were recorded with the application of recommended dose of fertilizer to both the crops separately with split application of nitrogen to sunflower on area basis compared to 50% reduction in the recommended dose of NPK to sunflower and unfertilized plots. Land equivalent ratio, crop equivalent yield and benefit cost ratio were higher under intercropping situation with the application of recommended dose of fertilizer to groundnut and split application of nitrogen with basal application of P and K to sunflower on area basis.

Key words: Groundnut, nutrient management, sunflower, productivity

Groundnut is an important commercial crop in India, being the main raw material for production of edible oil of mass consumption. It is cultivated in an area of 68.68 lakh ha with a productivity of 770 kg ha^{-1}. Even with the availability of different new crop production technologies, the total oil seed production is low in India compared to other oilseeds growing countries which leads to increasing trend in import of oilseeds. To overcome this problem, bunch type groundnut can be grown with a short stature one more oilseed crop as intercrop in the interspaces. Among crops, sunflower can suit well with groundnut in the intercropping programmes because of its shorter duration. Samui and Roy (1990) reported that the yield advantage ranged from 81% and 57% by introducing sunflower in groundnut as intercrop at 2:1 and 1:2 row ratios respectively.

The most important factor affecting the growth and yield of oilseed crop is mineral nutrition, especially nitrogen, phosphorus and potassium. In intercropping system the present day recommendation is based on the maincrop requirement. The fertilizer recommended for base crop is applied to the entire system without considering the requirement of the intercrop. Quantity of nutrient requirement and time of application varies with the crop which resulted in indiscriminate application of fertilizer in the inter cropping situation may create a negative imbalance and reflect on the productivity of component crops as well as soil fertility status. Increased crop management practices and balanced fertilization based on their requirement in the groundnut + sunflower intercropping system assume importance in oilseed production. This situation warrants the need to find appropriate nutrient management practices in groundnut based intercropping system. Hence, a field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore during 2003-04 to evaluate judicial nutrient requirement for groundnut + sunflower intercropping system under irrigated condition.

Materials and Methods

Field experiment was conducted during *kharif* 2003-04 at Tamil Nadu Agriculture University Farm, Coimbatore to find out optimum nutrient requirement for groundnut+sunflower intercropping (3:1) system under irrigated condition with replacement series. The experiment was laid out in randomized block design replicated thrice. Groundnut (CO3) and sunflower (var.Morden) was sown in ridges and furrow at 3:1 ratio. Irrespective of the treatment, except control, the base crop of groundnut was applied with the recommended does of NPK

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(17:34:54 kg ha^{-1}) as basal on area basis. The sunflower raised as intercrop received 100% recommended NPK(40:20:20: kg ha^{-1}), 50% recommended dose of NPK and 50% recommended N alone as basal. Along with this the sunflower was also applied with 100% recommended NPK and N was applied as two equal splits as basal and 21 days after sowing as top dressing. Another plot was applied with 50% recommended NPK with two equal split application of N as basal and top on 21 days after sowing. These treatments were compared with no fertilizer application to entire system as well as fertilizer recommended for groundnut applied to entire system. Sole crop of groundnut and sunflower was raised separately with the recommended dose of fertilizer for comparison purpose. Nutrient requirement for each crop in the intercropping system was calculated based on the area occupied by that crop. Growth, yield attributes and yields of both the crops and intercropping evaluating parameters like crop equivalent yield, LER and economics were studied.

Results and Discussion

In general, the growth and yield attributes of groundnut and the intercrop sunflower was influenced by nutrient management practices under intercropping system.

Groundnut

The growth characters such as plant height, leaf area index and dry matter production and yield attributes *viz*., matured pods per plant and test weight were higher when groundnut and sunflower were supplied with their RDF and two equal split application of nitrogen to sunflower (Table 1).Under intercropping situation, higher nutrient uptake of groundnut was obtained with the application of recommended dose of fertilizer to groundnut with split application of recommended dose of nitrogen and basal application of P and K to sunflower on area basis. However the NPK uptake of groundnut was higher under pure crop situation. The higher

Table 1. Effect of nutrient management practices on growth, yield parameters and nutrient uptake of groundnut in groundnut + sunflower intercropping system

Treatment	Plant height (cm)	LAI at 60 DAS	DMP at Harvest (kg/ha)	Matured pods/ plant	100 kernal weight (g)	Nutrient uptake (kg ha^{-1})		
						N	P	K
T_1- No fertilizer	33.0	3.38	3380	14.5	36.5	42.0	3.22	40.5
T_2- RDF of GN to entire system	37.6	3.89	3900	20.3	38.5	55.0	6.31	68.5
T_3- RDF to GN+ No RDF to SF	37.1	3.99	3500	18.3	38.0	52.0	6.14	56.0
T_4- T_3+100% RDF to SF	40.0	4.20	4087	21.0	38.7	56.5	7.23	66.4
T_5- T_3+50% RDF to SF	37.3	3.78	3461	20.7	38.4	55.2	6.70	64.2
T_6- T_3+50% RDF to SF+50% N top	37.9	3.71	3495	22.3	38.6	54.8	6.92	61.2
T_7- T_3+50% N to SF basal	37.0	3.68	3500	21.3	38.0	53.2	6.61	59.0
T_8- T_3+100%PK+50%N to SF basal+50%N top	42.2	4.22	4127	23.0	38.9	58.3	7.34	71.1
T_9- Sole Sunflower	39.3	4.62	4453	25.3	39.8	61.3	7.41	72.0
SEd	1.5	0.14	164	0.9	1.80	2.4	0.28	2.7
CD (p=0.05)	3.3	0.31	348	1.8	NS	5.0	0.60	5.8

RDF -Recommended dose of fertilizer; GN-Groundnut; SF-Sunflower; LAI - Leaf Area Index; DMP - Dry Matter Production

nutrient uptake in sole crop may be attributed to lesser competition among the plant species. This was in accordance with the observations of Pawar *et al.* (1985).

In intercropping situation, higher pod yield of 1539 kg ha^{-1} was recorded with 100% of RDF to both the crops and split application of nitrogen with basal application of P and K to sunflower compared to 50% reduction in the recommended dose of NPK to sunflower and unfertilized plots. This was closely followed by application of recommended dose of fertilizer as basal to both the crops separately. This might be due to higher level of NPK application to intercropping system than the conventional method of fertilizer application only to main crop alone. Similar results were reported by AICRP (2002).

Sunflower

The growth and yield characters of sunflower were influenced by the nutrient management practices under intercropping situation (Table 2). Application of 100% RDF separately to sunflower recorded significantly higher growth and yield characters than the 100% RDF of main crop rows

Table 2. Effect of nutrient management practices on growth, yield parameters and nutrient uptake of sunflower in groundnut + sunflower intercropping system

Treatment	Plant height (cm)	LAI at 60 DAS	DMP at Harvest (kg/ha)	Seed filling %	100 kernal weight (g)	Nutrient uptake (kg ha^{-1})		
						N	P	K
T_1- No fertilizer	75.9	0.51	2000	79.5	3.6	45	6.2	64.0
T_2- RDF of GN to entire system	81.0	0.60	2210	89.4	3.9	52	7.5	74.5
T_3- RDF to GN+ No RDF to SF	76.2	0.53	2100	80.8	3.7	49	6.7	67.5
T_4- T_3+100% RDF to SF	83.2	0.70	2315	90.5	3.9	57	7.0	70.5
T_5- T_3+50% RDF to SF	82.0	0.60	2019	89.6	3.8	54	6.9	69.8
T_6- T_3+50% RDF to SF+50% N top	81.5	0.62	2300	90.0	3.9	56	6.9	70.2
T_7- T_3+50% N to SF basal	81.0	0.60	2169	82.9	3.7	53	6.8	68.8
T_8- T_3+100% PK+50% N to SF basal+50% N top	84.0	0.81	2380	90.6	4.0	58	7.2	71.1
T_{10}- Sole GN	85.0	3.41	5100	90.0	3.8	61.0	7.4	72.0
SEd	2.7	0.39	229	3.9	0.14	5.0	0.3	3.0
CD (p=0.05)	5.6	0.08	108	8.1	NS	2.0	0.6	6.3

RDF –Recommended dose of fertilizer; GN-Groundnut; SF-Sunflower; LAI - Leaf Area Index; DMP - Dry Matter Production

only. Among the treatments imposed to the intercrop, higher growth character viz., plant height, LAI and DMP of sunflower were noticed with basal application of P and K with split application of nitrogen as 50% basal and 50% as top dressing on 21 DAS than 100% basal application. Application of required nutrient at right time to the intercrop of sunflower favoured the leaf area expansion, increased synthesis of food leads to increased accumulation of dry matter. Whereas, under normal intercrop situation, the intercrop does not receive any fertilizers and it has to share the fertilizer applied to the base crop. This led to starvation of intercrop and resulted in the lesser accumulation of dry matter compared to the fertilized intercrop (Tisdale *et al*., 1985).

Nutrient uptake of sunflower was higher with the application of recommended dose of fertilizer to component crops separately with split application of recommended dose of nitrogen and basal application of P and K to sunflower on area basis. This is because of application of nutrients to both main crop and intercrop separately. However the NPK uptake of sunflower was higher under pure crop situation. Higher nutrient uptake in sole crop may be attributed due to reduction in competition among the plant species (Pawar *et al*., 1985).

Nutrient management practices had significant influence on the seed yield of sunflower in intercropping system (Table 3). Split application of recommended dose of nitrogen as 50% basal and 50% as top dressing on 21 DAS with basal application of 100% P and K produced higher seed yield (564 kg ha^{-1}) than the other nutrient management practices. The increase in seed yield is due to the application of higher level of NPK to intercropping system on area basis. The seed filling percentage is also higher in intercropping system. These results confirmed the findings of AICRP (2002).

Evaluation of intercropping system

Land equivalent ratio, crop equivalent yield and benefit cost ratio were higher under intercropping situation with the application of recommended dose of fertilizer to groundnut and split application of nitrogen with basal application of P and K to sunflower on area basis (Table 3). Application of recommended dose of fertilizer to groundnut with split application of recommended dose of nitrogen with basal application of P and K to component crop recorded higher groundnut equivalent yield of 2244 kg ha^{-1}. Higher crop equivalent yield under intercropping system showed an efficient utilization of recourses and better productivity (Chakravarthy *et al.*, 2003). This finding indicated that the base crop yield reduction was well compensated with the intercrop yield.

The LER of groundnut + sunflower intercropping system was more than one. Under intercropping situation, split application of recommended dose of nitrogen with basal application of P and K to component crop gave higher LER of 1.29. The increase in LER under intercropping system is due to higher productivity per unit area of land under intercropping than monocultures of intercrop components (Devidayal and Reddy, 1991).

Table 3. Effect of nutrient management practices on yield and intercrop evaluating parameters in groundnut + sunflower intercropping system

Treatment	Groundnut Pod yield (kg ha^{-1})	Sunflower seed yield (kg ha^{-1})	Groundnut Equivalent yield (kg ha^{-1})	LER	Net income (Rs. ha^{-1})	BCR
T_1- No fertilizer	999	347	1433	0.83	6439	1.66
T_2- RDF of GN to entire system	1308	486	1916	1.11	7474	1.63
T_3- RDF to GN+ No RDF to SF	1393	366	1851	1.05	9926	1.88
T_4- T_3+100% RDF to SF	1467	518	2068	1.20	11957	1.96
T_5- T_3+50% RDF to SF	1413	405	1616	1.09	10545	1.89
T_6- T_3+50% RDF to SF+50% N top	1420	429	2003	1.14	10912	1.90
T_7- T_3+50% N to SF basal	1406	388	1891	1.07	10637	1.92
T_8- T_3+100%PK+50%N to SFbasal+50%N top	1539	564	2244	1.29	13779	2.10
T_9- Sole SF	-	1417	1771	1.00	11482	1.75
T_{10}- Sole GN	1950	-	1950	1.00	10400	1.80
SEd	81	21	-	-		
CD (p=0.05)	172	44	-	-		

RDF -Recommended dose of fertilizer; GN-Groundnut; SF-Sunflower; Groundnut pod Rs12 kg-1 and Sunflower seed Rs15 kg-1

The higher net return and benefit cost ratio were noted under intercropping system. Reddy and Singh (1987) also concluded that intercropping system were highly profitable as compared to sole cropping. Among the nutrient management practices, split application of recommended dose of nitrogen with basal application of P and K to component crop gave higher BCR of 2.1 under groundnut + sunflower intercropping system. This results confirmed the findings of AICRP (2001) that the seed yield of sunflower was significantly higher when fertilized with 150% of recommended NPK with or without supplementation of secondary and micronutrients, as compared to use of N alone or 50% reduction in NPK or unmanured treatments causes nutrient imbalance in the intercropping system resulted in lower seed yield and economic return.

Finally, it could be concluded that basal application of 100% recommended fertilizer dose (17:34:54 kg NPK ha^{-1}) to groundnut (base crop) rows and basal application of 50% recommended N (20 kg ha^{-1}) with 100 % P (20 kg ha^{-1}) and K (20 kg ha^{-1}) and top dressing of 50% N (20 kg ha^{-1}) at 21 DAS to sunflower rows separately found superior in increasing the productivity and economics of the system.

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