Indian Agriculturist, Vol. 64, No. 3 & 4, pp. 123-131, 2020

Integrated Nutrient Management For Productivity, Quality, Nutrient Uptake and Economics of Sunflower (*Helianthus annuus* L.) After Rice in Gangetic Alluvial Soil

Chakradhar Pal, Debasis Sahoo and R.K. Sarkar

Department of Agronomy, Institute of Agricultural Science, University of Calcutta, 51/2, Hazra Road, Kolkata – 700 019

Email- palchakra@gmail.com

Received : 09.09.2022 **Accepted : 05.10.2022** **Published : 28.10.2022**

Abstract

A field experiment was conducted at the Agricultural Experimental Station of Calcutta University, Baruipur in two consecutive winter (*Rabi*) seasons of 2017-18 and 2018-19 to evaluate the effect of integrated nutrient management on productivity, profitability, nutrient uptake and economics in sunflower (*Helianthus annuus* L.). Application of 75% RDF+FYM 10t/ha + PSB proved significantly and appreciably higher mean plant height (188.3 cm), dry matter (779 g/ Plant), head diameter (20.6 cm), number of filled seed/head (1263), test weight (39.7 g), seed yield (4.18 t/ha), Biological yield (8.96t/ha), harvest index (46.60), net return (Rs 24117/ha) and B:C ratio (8.20), N,P and K uptake compared to Control. Oil content (43.20 %), oil yield (1806 kg) and protein content (18.39%) increased with the application of 75% RDF+FYM 10t/ha and PSB over the control and 100% RDF.

Introduction

Recently Sunflower (*Helianthus annuus* L.) has been recognized as an important oil seed crop in gangatic alluvial land after harvest of rice (Sarkar *et al.* 2007). There are several factors, which influence the yielding capacity and quality of crop. Out of these, plant nutrient is very important in deciding the ultimate yield of the crop. The availability of plant nutrients in sufficient quantity is important for successful production of sunflower. Required amount of nutrients may be supplied through organic manures and inorganic fertilizers to grow the crop and maintain soil fertility on a sustained manner. Farm Yard Manure (FYM) although not useful as a sole source of nutrients, is a good complimentary and supplementary source to mineral fertilizers (Choudhary *et al*. 2004).

Biofertilizers are also available and could be alternative of chemical fertilizers for improving both productivity and sustainability of crop production. Integrated Plant nutrient system, therefore appears to be choice for sunflower production. A study was therefore conducted to evolve a viable nutrient management option for sunflower production in Gangetic plains of eastern India.

Materials and Methods

The experiments was conducted during the winter (*Rabi*) seasons of 2017-18 and 2018-19 on clay loam soil at the Agricultural Experimental Station of Calcutta University, Baruipur (88.26^0 E longitude and 12.22^0N latitude with 1.3 m altitude. The soil had average value of organic carbon 0.62%, 0.078% total N 36 kg available P and 262 kg available K/ ha with pH 6.3 before planting of sunflower.

The FYM was applied 15 days before crop sowing. The total rainfall received during *rabi* season of 2017-18 and 2018-19 was 530mm and 470mm respectively. The field experiment consisting of 12 treatments, i.e. T1 Control with no manures or fertilizers, T2 Recommended dose of Fertilizers (RDF) i.e. 80:60:60: N, P_2O_5, K_2O /ha, T3 75% of RDF + FYM 10t/ha, T4 75% of RDF + Azotobacter 50g/kg seed, T5 75% of RDF + PSB 5kg/ha, T6 75% of RDF + FYM 10t/ha + Azotobacter 50g/kg seed, T7 75% of

RDF + FYM 10t/ha + PSB 5kg/ha, T8 50% of RDF + FYM 10t/ha, T9 50% of RDF + Azotobacter 50g/kg seed, T10 50% of RDF + FYM 10t/ha + PSB 5kg/ha, T11 50% of RDF + Azotobacter 50g/kg seed, T12 50% of RDF + PSB 5kg/ha were arranged in a randomized block design with three replications during both the years. Sunflower variety *chitra* was sown in second forth night of October in both the years. The crop was sown with residual moisture and two protective irrigations were given when required. The crop was sown with spacing of 60cm X 20cm. The crop was harvested during first fourth-night of February in both the year. For biometric observation seemed row of each plot was used for destructive sampling. Economics were computed considering the prevailing market prices of input market rates of outputs.

Results and Discussion

Growth and yield attributes

Application of 100% RDF enhanced plant height, dry matter /plant and yield attributes over the control treatments in sunflower due to increased availability of nutrients. However, 75% of RDF + FYM 10t/ha + PSB 5kg/ha was statistically and appreciably superior to almost all the integrated nutrient management treatments for most of the character studied (TABLE I). Plant height and dry mater/plant on pooled data was registered to the tune of 11.61 and 94.18 percent over the control respectively.

The higher values of diameter of head, seeds/ head and test weight of seeds were obtained with 75% of RDF + FYM 10t/ha + PSB 5kg/ha possibly due to better nutrition. Increased mineralization of N and P in addition to contribution of biofertilizers might have improved the yield attributes. Solubilization of inorganic P through the secretion of soil organic acid by inoculation of PSB might have influenced favorable the yield attributes (Dubey, 1997). Integrated nutrient management with 75% of RDF + FYM 10t/ha + PSB 5kg/ha significantly and appreciably improved yield attributes over control and 100% RDF. Lowest values for growth parameters and yield attributes were recorded in control treatments.

Yield

Adequate nutrient management in sunflower either with inorganic sources or with organic and biofertilizer sources in combination significantly enhanced seed and biological yield of sunflower compared to no nutrient (TABLE-3). Application of 100% RDF produced higher seed and biological yields to the tune of 104.2 and 94% over the control. Among the treatments, integrated use of 75% of RDF + FYM 10t/ha + PSB 5kg/ha recorded higher seed and biological yields over rest of treatments. Seed inoculation with PSB along with 75% of RDF + FYM 10t/ha produced remarkable seed and biological yields of sunflower compared to application of RDF alone. The increase in seed and biological yields might be due to increased growth and yield attributes owing to increased availability of essential nutrients from integration of fertilizers, organic manure and biofertilizer. The results corroborate the findings of Jeyabal *et al.* (2000). Increasing biological yield, corresponding to increasing economic is proportional to harvest index (Donald and Hamblin,1976) . Higher harvest index in 75% of RDF + FYM 10t/ha + PSB 5kg/ha was mainly due to higher economic yield.

Seed quality parameter

Integrated use of 75% of RDF + FYM 10t/ha + PSB 5kg/ha showed accelerating effect on oil content, oil yield and protein content in sunflower. This treatment added more phosphorus which played a role in enhancing the glucoside content in seed which upon hydrolysis and esterification resulted in higher oil content in seed (Krishnamurthy and Mathan, 1996). The more availability of nitrogen at 75% of RDF + FYM 10t/ha + PSB 5kg/ha must have increased the proportion of protein substance in seed by way of high proportion of photosynthates diverted to protein formation. The increased protein content might be due to more protein synthesis in presence of P supplied through FYM and solubilization of P by PSB and the formation of some stable phosphor-protein compounds (Verma and Khera, 1973). Oil yield increased due to integrated fertilization of 75% of RDF + FYM 10t/ha + PSB 5kg/ha in both the years because of increased seed yield.

TABLE 1. Effect on Growth attributes of Sunflower due to Integrated Nutrient Management

Treatments	Plant Height (cm)			Dry Matter/Plant (g)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Recommended dose of Fertilizers (RDF)						
Absolute Control	173.9	175.3	174.1	387.0	415.3	401.2
100% (RDF) 80:60:60::N:P_2O_5:K_2O /ha	183.0	185.4	184.2	687.0	806.3	746.7
75% RDF + FYM 10t/ha	185.6	188	186.8	577.0	823.7	700.4
75% RDF + FYM10t/ha + Azotobacter 50g/kg seeds	188.8	190.0	189.4	530.0	802.7	666.4
75% RDF + Azotobacter 50g/kg seed	187.1	189.5	188.3	519.7	812.0	665.9
75% RDF + FYM 10t/ha + PSB 5kg/ha	194.7	193.9	194.3	869.3	868.7	869.0
75% RDF + PSB 5kg/ha	187.6	190.0	188.8	648.0	848.3	748.2
50% RDF + FYM 10t/ha	185.4	187.8	186.6	643.0	815.0	729.0
50% RDF + FYM 10t/ha+ Azotobacter 50g/kg seed	185.4	187.8	186.6	677.0	746.7	711.9
50% RDF + Azotobacter 50g/kg seed	182.9	185.3	184.1	676.4	737.8	707.1
50% RDF + FYM 10t/ha + PSB 5kg/ha	181.3	190.6	185.9	666.0	731.7	698.8
50% RDF + PSB 5kg/ha	181.2	183.6	182.4	664.7	753.3	709.0
Sem+/-	4.1	4.8	4.9	13.3	21.6	12.5
CD(P=0.05)	8.7	10.2	9.8	28.0	45.4	26.2

Nutrient Uptake

The nutrients N,P and K was increased with increasing level of fertilizers and maximum uptake of N,P and K was recorded with 75% of RDF + FYM 10t/ha + PSB 5kg/ha. NPK uptake followed a similar trend of seed and biological yield in respective treatments. Higher uptake of NPK at 75% of RDF + FYM 10t/ha + PSB 5kg/ha might be due to more nutrients availability from soil (Sing and Sing, 2006)

Economics

Application of 75% of RDF + FYM 10t/ha + PSB 5kg/ha fetched higher net returns and benefit cost ratio. Over the rest of the nutrient management practices and control (TABLE - 6). Nutrient management practice of 75% of RDF + FYM 10t/ha + PSB 5kg/ha was recorded maximum return over 100% RDF alone. This might be due to achieved higher productivity as well as lower cost of cultivation owing to increase economic returns in sunflower production.

Literature Cited

Choudhary, O. P., A. S. Josan, M. S. Bajwa, and M. L. Kapur. "Effect of sustained sodic and saline-sodic irrigation and application of gypsum and farmyard manure on yield and quality of sugarcane under semi-arid conditions." *Field crops research* 87, no. 2-3 (2004): 103-116.

Donald, C.M. and Hamblin, J. (1976) The Biological Yield and Harvest Index of Cereals as Agronomic and Plant Breeding Criteria. Advances in Agronomy, 28, 361-405.

http://dx.doi.org/10.1016/S0065-2113(08)60559-3.

Dubey, S.K. 1997. Co-inoculation of phosphorus-solubilizing bacteria with Bradyrhizobium japonicum to increase phosphate availability to rainfed soybean on vertisol. Journal of Indian Society of Soil Science 45(3): 506–509

Table 2. Effect on Yield attributes of Sunflower due to Integrated Nutrient Management

Treatments	Diameter of head (cm)			Seeds/ head			Test Weight of seeds (g)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Recommended dose of Fertilizers (RDF)									
Absolute Control	12.98	14.70	13.84	568	744	656	34.0	34.7	34.4
100% (RDF) 80:60:60::N:P_2O_5:K_2O /ha	17.80	20.07	18.94	1085	1282	1184	38.7	39.2	39.0
75% RDF + FYM 10t/ha	17.80	19.58	18.69	1072	1211	1142	38.7	38.4	38.6
75% RDF + FYM10t/ha + Azotobacter 50g/kg seeds	17.74	19.85	18.80	1030	1326	1178	37.7	38.2	38.0
75% RDF + Azotobacter 50g/kg seed	17.00	18.86	17.93	1038	1321	1180	38.8	37.9	38.4
75% RDF + FYM 10t/ha + PSB 5kg/ha	19.82	21.38	20.60	1141	1385	1263	39.4	39.9	39.7
75% RDF + PSB 5kg/ha	17.38	20.41	18.90	934	1174	1054	38.4	39.2	38.8
50% RDF + FYM 10t/ha	18.00	19.67	18.84	892	1163	1028	38.8	39.1	39.0
50% RDF + FYM 10t/ha+ Azotobacter 50g/kg seed	18.76	18.70	18.73	963	1145	1054	38.5	38.1	38.3
50% RDF + Azotobacter 50g/kg seed	18.44	18.39	18.42	944	1113	1029	38.0	37.9	38.0
50% RDF + FYM 10t/ha + PSB 5kg/ha	17.81	18.31	18.06	863	1102	983	38.6	37.4	38.0
50% RDF + PSB 5kg/ha	18.70	19.67	19.18	809	1021	915	38.7	39.1	38.9
Sem+/-	0.213	0.279	0.194	18	20	14	0.200	0.227	0.270
CD(P=0.05)	0.622	0.817	0.566	54	57	42	0.560	0.670	0.740

Table 3. Effect on Yields of Sunflower due to Integrated Nutrient Management

Treatments	Yield(t/ha)			Biological Yield (t/ha)			HI		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Recommended dose of Fertilizers (RDF)									
Absolute Control	1.61	2.15	1.88	3.89	4.84	4.37	41.38	44.44	43.07
100% (RDF) 80:60:60::N:P_2O_5:K_2O /ha	3.50	4.19	3.84	7.62	9.35	8.48	45.99	44.80	45.33
75% RDF + FYM 10t/ha	3.46	3.88	3.67	7.22	9.08	8.15	47.90	42.70	45.00
75% RDF + FYM10t/ha + Azotobacter 50g/kg seeds	3.33	4.22	3.78	7.43	9.41	8.42	44.82	44.85	44.84
75% RDF + Azotobacter 50g/kg seed	3.36	4.30	3.83	7.34	9.39	8.37	45.75	45.82	45.79
75% RDF + FYM 10t/ha + PSB 5kg/ha	3.75	4.61	4.18	7.96	9.97	8.96	47.09	46.21	46.65
75% RDF + PSB 5kg/ha	2.99	3.84	3.42	6.77	8.97	7.87	44.16	42.78	43.37
50% RDF + FYM 10t/ha	2.80	3.67	3.24	6.61	8.79	7.70	42.38	41.77	42.08
50% RDF + FYM 10t/ha+ Azotobacter 50g/kg seed	3.00	3.64	3.32	6.3	8.39	7.34	47.77	43.35	45.25
50% RDF + Azotobacter 50g/kg seed	2.92	3.52	3.22	6.2	8.04	7.12	47.08	43.75	45.20
50% RDF + FYM 10t/ha + PSB 5kg/ha	2.67	3.43	3.05	6.08	7.94	7.01	43.90	43.23	43.52
50% RDF + PSB 5kg/ha	2.61	3.33	2.97	5.82	7.65	6.73	44.84	43.51	44.08
Sem+/-	0.05	0.04	0.06	0.04	0.05	0.04	0.34	0.46	0.52
CD(P=0.05)	0.15	0.23	0.22	0.14	0.17	0.15	1.27	1.78	1.48

Table 4. Effect on Oil and Protein of Sunflower due to Integrated Nutrient Management

Treatments	Oil Concentration (%)			Oil Yield (kg/ha)			Protein content (%)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Recommended dose of Fertilizers (RDF)									
Absolute Control	39.8	40.0	39.9	641	860.6	750.8	11.3	12.4	11.9
100% (RDF) 80:60:60::N:P_2O_5:K_2O /ha	41.2	42.3	41.8	1439.9	1770.2	1695.0	15.6	14.6	15.1
75% RDF + FYM 10t/ha	41.4	42.5	42.0	1432.3	1645.8	1539.1	14.6	14.8	14.7
75% RDF + FYM10t/ha + Azotobacter 50g/kg seeds	41.6	42.6	42.1	1384.4	1796.1	1590.3	15	14.9	15.0
75% RDF + Azotobacter 50g/kg seed	41.4	41.8	41.6	1388.5	1797.9	1593.2	14.6	14.5	14.6
75% RDF + FYM 10t/ha + PSB 5kg/ha	42.7	43.7	43.2	1598.5	2013.8	1806.2	15.2	15.6	15.4
75% RDF + PSB 5kg/ha	41.2	40.6	40.9	1229.9	1557.4	1393.7	13.8	14.4	14.1
50% RDF + FYM 10t/ha	41.4	41.8	41.6	1160.7	1533.9	1347.3	13.8	14	13.9
50% RDF + FYM 10t/ha+ Azotobacter 50g/kg seed	41.0	41.8	41.4	1234.7	1518.5	1376.6	13.3	13.8	13.6
50% RDF + Azotobacter 50g/kg seed	40.7	41.5	41.1	1187.8	1457.8	1322.8	12.1	13.9	13.0
50% RDF + FYM 10t/ha + PSB 5kg/ha	40.4	41.1	40.8	1078.2	1412.6	1245.4	13.9	13.9	13.9
50% RDF + PSB 5kg/ha	40.3	41.1	40.7	1052.2	1366.3	1209.3	13.8	13.8	13.8
Sem+/-	0.7	0.8	0.7	118.8	90.6	88.5	0.5	0.5	0.3
CD(P=0.05)	1.6	1.6	1.4	249.5	190.3	161.6	1	0.9	0.8

Table 5. Effect on Nutrients Uptake of Sunflower due to Integrated Nutrient Management

Treatments	N			P_2O_5			K_2O		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Recommended dose of Fertilizers (RDF)									
Absolute Control	36.52	40.10	38.31	11.61	14.59	13.10	19.01	26.52	22.77
100% (RDF) 80:60:60::N:P_2O_5:K_2O /ha	91.34	100.50	95.92	30.01	33.77	31.89	56.27	75.32	65.80
75% RDF + FYM 10t/ha	81.29	104.70	93.00	25.85	36.85	31.35	53.29	73.61	63.45
75% RDF + FYM10t/ha + Azotobacter 50g/kg seeds	66.14	97.90	82.02	21.07	36.27	28.67	51.17	71.85	61.51
75% RDF + Azotobacter 50g/kg seed	59.93	93.30	76.62	20.27	33.23	26.75	45.69	71.67	58.68
75% RDF + FYM 10t/ha + PSB 5kg/ha	101.84	128.50	115.17	34.66	44.92	39.79	60.62	91.72	76.17
75% RDF + PSB 5kg/ha	81.37	118.80	100.09	25.81	42.94	34.38	54.17	76.40	65.29
50% RDF + FYM 10t/ha	79.37	112.20	95.79	24.02	41.88	32.95	43.71	67.39	55.55
50% RDF + FYM 10t/ha+ Azotobacter 50g/kg seed	83.20	107.80	95.50	32.28	35.57	33.93	36.47	62.49	49.48
50% RDF + Azotobacter 50g/kg seed	77.69	97.30	87.50	31.24	32.74	31.99	33.19	58.76	45.98
50% RDF + FYM 10t/ha + PSB 5kg/ha	83.27	97.20	90.24	28.46	30.59	29.53	33.07	58.17	45.62
50% RDF + PSB 5kg/ha	75.85	109.30	92.58	27.28	33.04	30.16	29.67	54.88	42.28
Sem+/-	4.9	6.4	4.7	2.0	2.2	2.0	4.7	3.5	3.5
CD(P=0.05)	10.3	13.5	12.9	4.2	3.6	4.3	5.9	5.1	4.4

TABLE 6. Effect on Economics of Sunflower due to Integrated Nutrient Management

Treatments	Yield (t/ha)	Increase in yield (t/ha)	Gross return (Rs./ha) (Rs./ha)	Value of increased produces	Cost of Treatments (Rs./ha)	Net Profit (Rs./ha)	Benefit : Cost ratio
Recommended dose of Fertilizers (RDF)							
Absolute Control	1.88	-	**20680**	-	-	-	-
100% (RDF) 80:60:60::N:P_2O_5:K_2O /ha	3.84	1.96	**42240**	21560	2790	18770	6.7
75% RDF + FYM 10t/ha	3.67	1.79	**40370**	19690	2843	16847	5.9
75% RDF + FYM10t/ha + Azotobacter 50g/kg seeds	3.78	1.9	**41580**	20900	3143	17757	5.6
75% RDF + Azotobacter 50g/kg seed	3.83	1.95	**42130**	21450	3090	18360	5.9
75% RDF + FYM 10t/ha + PSB 5kg/ha	4.18	2.3	**45980**	25300	2943	22357	7.6
75% RDF + PSB 5kg/ha	3.42	1.54	**37620**	16940	2193	14747	6.7
50% RDF + FYM 10t/ha	3.24	1.36	**35640**	14960	2145	12815	6.0
50% RDF + FYM 10t/ha+ Azotobacter 50g/kg seed	3.32	1.44	**36520**	15840	2445	13395	5.5
50% RDF + Azotobacter 50g/kg seed	3.22	1.34	**35420**	14740	1695	13045	7.7
50% RDF + FYM 10t/ha + PSB 5kg/ha	3.05	1.17	**33550**	12870	2245	10625	4.7
50% RDF + PSB 5kg/ha	2.97	1.09	**32670**	11990	1495	10495	7.0

Jeyabal Appavu, & Palaniappan, Sp & Chelliah, Subbiah. (2000). Effect of integrated nutrient management techniques on yield attributes and yield of sunflower (Helianthus annuus). Indian Journal of Agronomy. 45. 384-388.

Krishnamurthy, V. V., and K. K. Mathan. "Influence of Sulphur and magnesium on Growth and yield of Sunflower (Helianthus annus L.)." Indian Journal of Agronomy 41, no. 4 (1996): 627-629.

Sarkar RK, Deb N, Parya MK. Effect of seed treatment and foliar nutrition on growth and productivity of spring sunflower (Helianthus annuus). Indian Journal of Agricultural Sciences. 2007; 77(3):191-194.

Sing A and Sing NP2006 Direct and residual effects of organic and inorganic sources of nutrients under urdbean - wheat cropping sequence in foot hills of Uttaranchal Indian Journal of Agronomy 51(2)97_99.

Verma .MM and Khera PH 1973 Influence of phosphate on catbon and nitrogen of oata and barley plants Indian Agriculturist 17 :153-140.