

Effect of integrated nutrient management techniques on yield attributes and yield of sunflower (*Helianthus annuus*)

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ABSTRACT

An experiment was conducted during 1995–97 to develop integrated nutrient management package for sunflower (*Helianthus annuus* L.), with 2 types of organic sources, viz. farmyard manure (FYM) and P-enriched FYM, inorganic nutrients and biofertilizers. Integrated application of either FYM or P-enriched FYM combined with *Azospirillum* and phosphobacteria and borax spray in addition to recommended NPK alone gave the highest yield. On-farm experiment showed that integrated application gave 29% higher yield than recommended NPK. Integrated nutrition using P-enriched FYM was found to be effective, considering the benefit : cost ratio. Highest benefit : cost ratio was obtained with integrated application of P-enriched FYM, inorganic fertilizers and biofertilizers compared to application of NPK alone.

Key words : Sunflower, Integrated nutrient management, Enriched FYM, Biofertilizers

India, having the largest cultivated area under oilseeds in the world, has been chronically deficient in per caput supplies of fat and oils. One of the critical factors for low productivity of sunflower is injudicious use of plant nutrients. This calls for balanced use of fertilizers and adoption of appropriate agronomic practices. In view of the escalating prices and high demand-supply gap of chemical fertilizers, there is a strong need to adopt integrated nutrient supply system by judicious combination of organic manures, inorganic fertilizers and

biofertilizers to improve soil health and sunflower productivity. In this context, integrated nutrient management (INM) holds great promise in meeting the growing nutrient demands of intensive agriculture and maintaining the crop productivity at a fairly high level. Hence the present investigation was taken up to develop an INM package for sunflower.

MATERIALS AND METHODS

A field study was conducted during 1995–97 at Nagarjuna Agricultural

Research and Development Institute (NARDI), Hyderabad, to evaluate the integrated effect of organic manure, inorganic fertilizers and biofertilizers in sunflower. The soils of the experimental fields were sandy loam, low in available N (166 to 185 kg/ha) and medium in available P (10 to 12 kg/ha and K (207 to 221 kg/ha). The available zinc status of experimental soils was high (1.60 to 1.80 ppm). Trials in 1995 and 1996 were conducted adopting randomized block design with 4 replications. Based on the results, an on-farm trial was conducted in 1997 to demonstrate the INM package to the farmers.

In the first experiment, 8 treatments comprising soil application of FYM/P-enriched FYM with and without biofertilizers and zinc sulphate and borax were used. In the second trial, treatment schedule was slightly modified (Table 1). Based on the results of the first and second year trials, an on-farm trial was conducted with the best 2 treatments in comparison to recommended NPK alone.

The P-enriched FYM was prepared by incubating 750 kg FYM with the recommended level of phosphorus/ha (through single superphosphate) for 1 month. As per the treatment schedule, FYM @ 10 tonnes/ha and P-enriched FYM @ 750 kg/ha were applied basal, just before the sowing and thoroughly incorporated into the soil. Both the FYM and P-enriched FYM were analysed for their nutrient contents. The P-enriched FYM contained 1.39, 6.24 and 0.67% N, P_2O_5 and K_2O respectively, whereas FYM contained 1.38% N, 0.62% P_2O_5 and 0.68% K_2O . As

per the treatment schedule, zinc sulphate at 25 kg/ha was applied basally and borax at 0.2% was sprayed twice at weekly interval from seed floret stage.

Recommended level of NPK adopted was 80 kg N, 50 kg P_2O_5 and 30 kg K_2O /ha. Fertilizer N and K were applied in 3 equal splits at basal, 25 and 55 days after sowing through urea and muriate of potash respectively. Entire P was applied basal either through single superphosphate or P-enriched FYM. Biofertilizers, viz. *Azospirillum* and phosphobacteria, each at 2 kg/ha were applied at sowing as per the treatment schedule. Yield attributes such as head weight, head diameter and number of total and filled seeds/head were recorded from 10 random plants/plot. Grain yield was recorded after drying the seeds to 14% moisture.

RESULTS AND DISCUSSION

Yield attributes

Soil application of either FYM or P-enriched FYM integrated with recommended NPK, *Azospirillum*, phosphobacteria and borax spray increased the head weight and diameter over other treatments. Application of FYM and P-enriched FYM showed similar effect on weight and diameter. Inclusion of zinc sulphate in the integrated nutrition did not increase the weight, head diameter and number of filled and total seeds, since the soil DTPA-extractable zinc status was high (1.60 to 1.80 ppm).

Application of FYM or P-enriched FYM produced larger heads than application of recommended NPK alone. Irrespective of FYM or P-enriched FYM, addition of

Table 1. Effect of integrated nutrient management on yield attributes and yield of sunflower

Treatment	Head weight (cm)		Head diameter (cm)		Total grains/head		Filled grains/head		Seed yield (tonnes/ha)			Benefit : cost ratio		
	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996	1997*	1995	1996	1997*
Recommended NPK (control)	67	78	17.1	16.8	811	784	724	652	1.41	1.76	1.12	2.67	2.78	2.51
FYM @ 10 tonnes/ha	74	80	17.8	17.1	844	798	753	761	1.53	1.93		2.43	2.55	
FYM + <i>Azospirillum</i> + phosphobacteria	80	89	18.2	17.5	874	807	768	705	1.71	2.13		2.56	2.69	
FYM + <i>Azospirillum</i> + phosphobacteria + 0.2% borax spray	88	92	19.1	17.9	1092	975	974	862	1.77	2.24	1.44	2.71	2.80	2.53
FYM + <i>Azospirillum</i> + phosphobacteria + 0.2% borax spray + ZnSO ₄	83		17.9		1025		962		1.76			2.60		
P-enriched FYM @ 750 kg/ha	72	81	17.6	16.8	838	790	748	665	1.48	1.83		2.54	2.66	
P-enriched FYM + <i>Azospirillum</i> + phosphobacteria	81	87	18.4	17.4	861	811	745	718	1.55	1.97		2.77	2.86	
P-enriched FYM + <i>Azospirillum</i> + phosphobacteria + 0.2% borax	86	93	18.5	18.1	975	890	817	775	1.61	2.02	1.35	2.88	2.92	2.76
P-enriched FYM + <i>Azospirillum</i> + phosphobacteria + 0.2% borax spray + ZnSO ₄	82		18.2		984		827		1.66			2.71		
CD (P = 0.05)	3.7	5.1	1.3	NS	25.2	16.4	22.3	19.5	0.12					

*On-farm trial

biofertilizers to recommended NPK improved the head weight by 8–10% over the recommended NPK alone. Increased mineralization of N and P in addition to nutrient contribution of biofertilizers might have increased head weight significantly. Integrated application of FYM or P-enriched FYM with NPK, *Azospirillum*, phosphobacteria and borax spray gave the highest number of filled and total seeds compared to the rest of the treatments. Addition of borax spray in the integrated nutrition showed a significant improvement in number of total and filled seeds. Boron has many functions in the plant; it influences nitrogen and carbohydrate metabolism of the plants and facilitates synthesis of nucleic acids and hormones (Yadava *et al.*, 1999), which have enhanced the number of total and filled seeds in the head due to greater availability of nutrients and photosynthates.

Seed yield

Integrated application of FYM, recommended NPK, biofertilizers and borax spray registered the highest seed yield in 1995 and 1996, respectively, which was 25.5 and 27.3% higher than that obtained with recommended NPK alone (Table 1). Higher yield in INM treatment might be attributed to rapid mineralization of N from inorganic fertilizers and steady supply of N from FYM, which might have met the N requirement of crop at the critical stages. Borax spray increased the yield compared to no-spray treatment. Application of FYM resulted in higher yield than that of P-enriched FYM. This could be owing to higher quantity of

nutrients supplied through FYM at 10 tonnes/ha (N, 42.7 kg; P, 20.8 kg; K, 22.5 kg and traces of micronutrients) than in the enriched FYM applied at 750 kg/ha. Inclusion of biofertilizers in integrated nutrition increased the yield by 10.3–11.7% over no biofertilizer treatment.

In the on-farm trial (1997) integrated application of FYM, inorganic fertilizers and biofertilizers recorded the highest grain yield which was 28.6% higher than the yield obtained with recommended NPK alone. The treatment with enriched FYM with all other nutrients gave 20.5% higher yield than recommended NPK alone. Increased grain yield in these treatments might be due to the positive role of biofertilizers in the presence of organic manures. Supply of the required nutrients through organic and inorganic sources and biofertilizers facilitated balanced nutrition of the crop, which resulted in enhanced grain yield.

Benefit : cost ratio

Highest benefit : cost ratio was recorded with INM involving P-enriched FYM, inorganic fertilizers, biofertilizers and borax spray. The INM practice with FYM resulted in less benefit : cost ratio than with P-enriched FYM due to higher cost involved in the application of 10 tonnes/ha of FYM. The P-enriched FYM was applied only at 750 kg/ha. Hence benefit : cost ratio with P-enriched FYM was higher than that with FYM. Recommended NPK application through fertilizers recorded a benefit : cost ratio of 2.67 and 2.78 in trials 1 and 2 respectively. In the on-farm trial also, INM involving P-enriched FYM gave

higher benefit : cost ratio (2.76) than FYM (2.53) and recommended NPK (2.51).

Thus integrated nutrition with FYM, recommended NPK, biofertilizers and borax spray registered the highest sunflower yield. However, economically, application of P-enriched FYM at 750 kg/ha integrated with recommended level of inorganic nutrients, *Azospirillum* 2 kg/ha, phosphobacteria 2 kg/ha and spray of 0.2% borax holds is a viable method of fertilizing sunflower for sustaining high productivity.

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