INTEGRATED NUTRIENT MANAGEMENT IN IRRIGATED SUNFLOWER

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Abstract: Field experiments were conducted at the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalainagar to study the effect of integrated nutrient management practices in irrigated sunflower. The experiments were laid out in randomized block design with three replications. The treatments consists of T_1 - Control, T_2 - Recommended dose of fertilizer (RDF – 50:60:40 kg NPK ha^{-1}), T_3 – RDF + FYM @ 12.5 t ha^{-1}, T_4 – RDF + $ZnSO_4$ @ 25 kg ha^{-1}, T_5 – RDF + Azospirillum seed treatment @ 600 g ha^{-1}, T_6 - RDF + Azospirillum soil application @ 2 kg ha^{-1}, T_7 – T_3 + $ZnSO_4$ @ 25 hg ha^{-1}, T_8 – T_3 + Azospirillum seed treatment @ 600 g ha^{-1}, T_9 – T_3 + Azospirillum seed treatment @ 600 g ha^{-1}, T_{10} – T_3 + $ZnSO_4$ @ 25 kg ha^{-1} + Azospirillum seed treatment @ 600 g ha^{-1}, T_{11} - T_3 + $ZnSO_4$ @ 25 kg ha^{-1} + Azospirillum soil application @ 2 kg ha^{-1}. Growth components *viz.*, plant height, DMP, LAI and yield components *viz.*, number of filled seeds capitulum^{-1}, seed yield and stalk yield were recorded. Net return and return rupee^{-1} invested were also calculated. Among the treatments, application of RDF + FYM @ 12.5 t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} + Azospirillum soil application @ 2 kg ha^{-1} (T_{11}) recorded higher values of growth and yield parameters and yield where as this treatment was statistically on par with RDF + FYM @ 12.5 t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} + Azospirillum seed treatment @ 600 g ha^{-1} (T_{10}). Application of RDF + FYM @ 12.5 t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} + Azospirillum soil application @ 2 kg ha^{-1} (T_{11}) recorded higher net return and return rupee^{-1} invested.

Keywords**: INM, RDF, FYM, Azospirillum, $ZnSO_4$, sunflower.**

Introduction

Sunflower (*Helianthus annuus* L.) is one of the most popular members of the family Asteraceae and is one of the world's most important sources of vegetable oil. The native of the sunflower is reported to be the Southern parts of United States of America and Mexico. Sunflower ranks third, next to groundnut and soybean in the total production of oilseeds in the world. Sunflower is cultivated on an area of 23.70 million hectares with an annual production and productivity of 31.33 million tones and 1322 kg ha^{-1}, respectively in the world. Though, sunflower crop has yield potential of around 2.3 to 2.5 tonnes per hectare under favourable conditions, mean productivity level in India is only 0.6 tonnes per hectare. In India it is cultivated in 1.48 million hectares with an annual production of 1.85 million tones and productivity of 576 kg ha^{-1}. Sunflower crop has been well accepted by the farming community because of its desirable attributes such as short duration, photoperiod insensitive, lower seed rate, high seed multiplication ratio, high quality of edible oil and high content of linolenic acid, which is a poly-unsaturated fatty acid.

Micronutrients have been reported to play a major role in increasing seed setting percentage in sunflower owing to their influence on growth and yield components (Sarkar and Mallick, 2009). However, the limitation on the realization of optimum yield from this valuable oil seed is poor germination of seeds and improper filling of seeds. These physiological disorders of sunflower can be set right through the balanced supply of nutrients as one of means by adopting the integrated nutrient management practices for the crop. There is a strong need to adopt integrated nutrient supply system with judicious combination of inorganic fertilizers, organic manure, micronutrients and biofertilizers to improve the soil health and sunflower productivity. In this context, the integrated nutrient management holds great promise in meeting the growing nutrient demands of intensive agriculture and maintaining the crop productivity.

Materials and methods

Field experiments were conducted at the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalainagar to study the effect of integrated nutrient management practices in irrigated sunflower. The experimental field is situated at 11° 24' N latitude and 79° 44' E longitude at an altitude of +5.79 m above mean sea level. The climate of Annamalai nagar is moderately warm with hot summer months. Soil is low in available nitrogen, medium in available phosphorus and high in available potassium.

The experiment was laid out in randomized block design with three replications. The treatments consists of T_1 - Control, T_2 - Recommended dose of fertilizer (RDF – 50:60:40 kg NPK ha^{-1}), T_3 – RDF + FYM @ 12.5 t ha^{-1}, T_4 – RDF + $ZnSO_4$ @ 25 kg ha^{-1}, T_5 – RDF + Azospirillum seed treatment @ 600 g ha^{-1}, T_6 - RDF + Azospirillum soil application @ 2 kg ha^{-1}, T_7 – T_3 + $ZnSO_4$ @ 25 kg ha^{-1}, T_8 – T_3 + Azospirillum seed treatment @ 600 g ha^{-1}, T_9 – T_3 + Azospirillum seed treatment @ 600 g ha^{-1}, T_{10} – T_3 + $ZnSO_4$ @ 25 kg ha^{-1} + Azospirillum seed treatment @ 600 g ha^{-1}, T_{11} - T_3 + $ZnSO_4$ @ 25 kg ha^{-1} + Azospirillum soil application @ 2 kg ha^{-1}. The inorganic nutrients NPK were supplied in the form of urea, single super phosphate and muriate of potash, respectively.

The biometric observations recorded in the sunflower crop were plant height, dry matter production, leaf area index, number of seeds capitulum^{-1}, seed yield and stalk yield. Net return and return rupee^{-1} invested also calculated. The data presented was subjected to statistical analysis following the methods suggested by Panse and Sukhatme (1978).

Results and discussion

Growth characters (Table 1)

The data pertaining to the growth attributes are given in table 1. The results of the experiments showed that significant variation on the plant height, dry matter production at harvest stage and leaf area index at flowering stage of the crop. Among the treatments, application of RDF + FYM @ 12.5 t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} + Azospirillum soil application @ 2 kg ha^{-1} (T_{11}) recorded higher plant height (152.42 cm), dry matter production (4720 kg ha^{-1}) and higher values of leaf area index (5.65) at flowering stage of the crop. This was statistically on par with RDF + FYM @ 12.5 t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} + Azospirillum seed treatment @ 600 g ha^{-1}. An increase in the plant height and other growth parameters with an increase in the dose of nitrogen may be attributed to the fact that nitrogen increases cell elongation as it is a constituent of many important compounds of plant (Singh, 2007). Azospirillum increased the plant height, number of leaves, leaf area, stem girth etc., by virtue of fixing atmospheric nitrogen it secretes growth promoting substances and polysaccharides. Similar finding was reported by Nirmala Devi *et al.* (1995).

Application of inorganic fertilizers in combination with $ZnSO_4$ and Azospirillum had increased the LAI which could be attributed to the increase in metabolic process of plant in turn promotes meristematic activities causing apical growth. The increased LAI could be also due to increased number of leaves. Higher LAI in sunflower due to the application of fertilizers was also reported by Mishra *et al.* (1995). Application of RDF + FYM @ 12.5 t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} + Azospirillum soil application @ 2 kg ha^{-1} (T_{11}) registered increased dry matter production and this was on par with RDF + FYM @ 12.5 t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} + Azospirillum seed treatment @ 600 g ha^{-1}. This might be due to the higher uptake of NPK nutrients. N is a major constituent of chlorophyll and proteins and its adequate supply through fertilizer encouraged the photosynthesis. This resulted in an increased total dry matter accumulation. Potassium with its prime role in activating many enzymes in carbohydrates and protein metabolism and also in cell expansion which significantly enhanced the dry matter accumulation. Similar findings have been reported on sunflower by Nandagopal *et al.* (2003).

Table 1. Effect of integrated nutrient management practices growth parameters of sunflower

Treatments	Plant height at harvest (cm)	Dry matter production at harvest (kg ha^{-1})	Leaf area index at flowering stage
T_1 - Control	116.41	2216	2.36
T_2 – RDF (50:60:40 kg NPK ha^{-1})	126.56	2391	2.82
T_3- RDF + FYM @ 12.5 t ha^{-1}	134.64	2620	3.68
T_4 – RDF + $ZnSO_4$ @ 25 kg ha^{-1}	137.33	3272	4.19
T_5 – RDF + Azospirillum seed treatment @ 600 g ha^{-1}	136.85	3175	4.08
T_6 – RDF + Azospirillum soil application @ 2 kg ha^{-1}	136.99	3200	4.12
T_7 – T_3 + $ZnSO_4$ @ 25 kg ha^{-1}	145.78	4155	4.65
T_8 – T_3 + Azospirillum seed treatment @ 600 g ha^{-1}	142.88	3789	4.35
T_9 – T_3 + Azospirillum seed treatment @ 600 g ha^{-1}	143.43	3858	4.40
T_{10} – T_3 + $ZnSO_4$ @ 25 kg ha^{-1} + Azospirillum seed treatment @ 600 g ha^{-1}	151.12	4682	5.62
T_{11} - T_3 + $ZnSO_4$ @ 25 kg ha^{-1} + Azospirillum seed treatment @ 600 g ha^{-1}	151.20	4720	5.65
S. Ed	1.02	55.07	0.06
CD (p=0.05)	2.11	113.67	0.13

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Yield attributes, yield and economics (Table 2)

Integrated nutrient management practices positively influenced the yield attributes, yield and economics (Table. 2). Application of RDF + FYM @ 12.5 t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} + Azospirillum soil application @ 2 kg ha^{-1} (T_{11}) recorded higher mean number of filled seeds $capitulum^{-1}$ (930.0), seed yield (1953 kg ha^{-1}) and stalk yield (4235.3 kg ha^{-1}). This was statistically on par with RDF + FYM @ 12.5 t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} + Azospirillum seed treatment @ 600 g ha^{-1} (T_{10}). This could be due to synergistic and cumulative effect of the integration of inorganic nutrients and biofertilizers on sunflower. The increased leaf number, LAI, higher nutrient uptake and translocation of photosynthates from source to sink might be contributed to greater number of seeds $capitulum^{-1}$. This might be due to the combined effect of $ZnSO_4$ and Azospirillum along with readily available chemical fertilizers. Many workers earlier reported the beneficial advantage of chemical fertilizers and $ZnSO_4$ in augmenting the yield components of sunflower (Venkatakrishnan and Balasubramanian, 1996; Sarkar and Mallick, 2009). The treatment control (T_1) registered lower values of growth and yield components and yield.

Higher crop productivity resulted in better economic parameters like net return and return $rupee^{-1}$ invested. Among the treatments, application of RDF + FYM @ 12.5 t ha^{-1} + $ZnSO_4$ @ 25 hg ha^{-1} + Azospirillum soil application @ 2 kg ha^{-1} (T_{11}) recorded higher net return of Rs. 45537 and return per rupee invested of Rs. 3.16. This was comparable with RDF + FYM @ 12.5 t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} + Azospirillum seed treatment @ 600 g ha^{-1} (T_{10}). This could be attributed the fact that, the treatments involving combined application of RDF with FYM, $ZnSO_4$ and Azospirillum produced higher seed and stalk yield. These results evidently indicated that integration of inorganic fertilizer with $ZnSO_4$ and biofertilizer is necessary to augment higher yields than recommended dose of fertilizer alone.

Table 2. Effect of integrated nutrient management practices yield attributes, yield and economics of sunflower

Treatments	Number of filled seeds capitulum^{-1}	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Net return (Rs. ha^{-1})	Return rupee^{-1} invested
T_1 - Control	246.0	548.32	1431.00	4941	1.37
T_2 – RDF (50:60:40 kg NPK ha^{-1})	318.0	889.57	2225.31	8582	1.54
T_3- RDF + FYM @ 12.5 t ha^{-1}	385.0	1210.14	2896.08	20262	2.01
T_4 – RDF + $ZnSO_4$ @ 25 kg ha^{-1}	688.0	1562.33	3573.33	29667	2.78
T_5 – RDF + Azospirillum seed treatment @ 600 g ha^{-1}	650.0	1549.00	3550.33	26572	2.66
T_6 – RDF + Azospirillum soil application @ 2 kg ha^{-1}	663.0	1550.32	3531.00	28702	2.76
T_7 – T_3 + $ZnSO_4$ @ 25 kg ha^{-1}	859.3	1838.36	3958.12	41417	2.99
T_8 – T_3 + Azospirillum seed treatment @ 600 g ha^{-1}	794.0	1703.33	3803.66	36202	2.80
T_9 – T_3 + Azospirillum soil application @ 2 kg ha^{-1}	805.0	1716.12	3825.33	37482	2.85
T_{10} – T_3 + $ZnSO_4$ @ 25 kg ha^{-1} + Azospirillum seed treatment @ 600 g ha^{-1}	923.3	1943.38	4231.00	44357	3.12
T_{11} - T_3 + $ZnSO_4$ @ 25 kg ha^{-1} + Azospirillum soil application @ 2 kg ha^{-1}	930.0	1953.00	4235.33	45537	3.16
S. Ed	21.85	20.91	54.11	-	-
CD (p=0.05)	45.10	43.17	108.26	-	-

Conclusion

Based on the result of the experiment, it was concluded that application of RDF + FYM @ 12.5 t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} + Azospirillum soil application @ 2 kg ha^{-1} (T_{11}) will be economical in sunflower in addition to improvement in soil fertility. Thus, it is agronomically feasible, ecologically desirable, practically applicable and economically viable technology paves the way for higher return rupee^{-1} invested in sunflower.

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