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Effect of Different Nutrient Management on the Yield and Economics of *Kharif* Sunflower (*Helianthus annuus* L.)

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Abstract

A field experiment was carried out during *kharif* season (June–September, 2023), at Experimental Farm of Agronomy Section, College of Agriculture, Latur, Maharashtra, India to assess the yield and economic of *kharif* sunflower (*Helianthus annuus* L.) under different nutrient management. The experiment was laid out in Randomized Block Design (RBD) with seven treatments replicated thrice. The treatments were T_1-RDF (80:40:40 kg NPK ha^{-1}), T_2-RDF+FYM 5 t ha^{-1}, T_3-RDF+Multimicronutrient Grade-I @ 25 kg ha^{-1}, T_4-RDF+FYM 5 t ha^{-1}+Multimicronutrient Grade-I @ 25 kg ha^{-1}, T_5-RDF+Spraying of Multimicronutrient Grade-II @ 0.2% at 25 DAS and 45 DAS, T_6-RDF+FYM 5 t ha^{-1}+Spraying of Multimicronutrient Grade-II @ 0.2% at 25 DAS and 45 DAS and T_7-Control. The results showed that the application of RDF+FYM 5 t ha^{-1}+Multimicronutrient Grade-I @25 kg ha^{-1} (T_4) recorded maximum Plant height (198.85 cm), Number of functional $plant^{-1}$ (35.04), Head diameter $plant^{-1}$ (20.21 cm), Weight of head $plant^{-1}$ (92.76 g), Number of filled seeds $plant^{-1}$ (1074), Total number of seeds $plant^{-1}$ (1237), Seed yield $plant^{-1}$ (73.65 g), yield (1942 kg ha^{-1}), biological yield (7187 kg ha^{-1}), GMR (₹ 131279 ha^{-1}), and NMR (₹ 81740 ha^{-1}) being at par with RDF+Multimicronutrient Grade-I @ 25 kg ha^{-1} (T_3) and RDF+Spraying of Multimicronutrient Grade-II @ 0.2% at 25 DAS and 45 DAS (T_6) and found significantly superior over rest of the treatments. The highest B:C ratio (2.65) was recorded with the application of RDF+FYM 5 t ha^{-1}+Multimicronitrient Grade-I @ 25 kg ha^{-1} (T_4).

Keywords: Sunflower, RDF, FYM, multimicronutrient grades, nutrient management, yield

1. Introduction

Sunflower (*Helianthus annuus* L.,) is a day-neutral, short duration oil seed crop that exhibits remarkable tolerance to drought and salinity. Belonging to the family compositae and it is one of the most significant annual crops globally, playing a vital role in edible oil production (Mukherjee et al., 2019). Sunflower thrives in fertile soil with adequate rainfall (500–600 mm annually) or irrigation. The crop requires a cool-dry climate and proper water management to achieve optimal productivity and quality (Alipatra et al., 2019). It is native of North America. The total area under sunflower crop in world is 29.80 m ha with the production of 55.23 mt and productivity of 1.85 mt ha^{-1} (Anonymous, 2023a). Sunflower offers remarkable adaptability to diverse environmental conditions, making it an ideal crop to bridge the demand-supply gap in the current oil crisis (Sheoran et al., 2016). The area under sunflower cultivation in India is 0.36 M ha, with the production of 0.36 mt and productivity of 996 kg ha^{-1} in 2022–23 In India, (Anonymous, 2023b). Sunflower has gained immense popularity due to its exceptional oil quality and high market value for both oil and seeds (Singh and Kumar, 2017). Additionally, sunflower has numerous industrial and pharmaceutical applications (Kumar et al., 2019). Sunflower oil is used to prevent heart diseases, as it is rich in polyunsaturated fatty acids and vitamins (Vijayakumar et al., 2016; Anushree et al., 2017). Nitrogen, phosphorus and potassium plays an important role in the growth and development of sunflower. Among micronutrients, boron is known to play an important role in seed setting and yield of sunflower. It also stimulates germination of pollen tubes which results in better fertilization and higher seed set in sunflower

(Ameen et al., 2024). Iron (Fe) is involved in the biosynthesis of chlorophyll molecules and the regulation of different enzyme functions (Gunsu et al., 2024, Khobra et al., 2014 and Poonia et al., 2022). Moreover, Fe also plays a very important role in plant growth due to the basic component in physico-chemical cells (Tripathi et al., 2018). Manganese (Mn) has a wide impact on plant growth and development. Copper (Cu) is an essential metal micronutrient in the metabolism of plants. . Zinc (Zn) has emerged as an indispensable nutrient for plant growth (Kaleri et al., 2024 and Kundu et al., 2023). It plays an important role in nucleic acid and protein synthesis and helps in utilization of phosphorous and nitrogen as well as seed formation and development (Ahmad et al., 2020, Immanuel at al., 2020, Patel et al., 2023). Molybdenum (Mo) is involved in several enzyme systems, particularly nitrate reductase which is needed for the reduction of nitrate and nitrogenase. FYM is the most common source of organic manure increases the crop yield and cause improvement in soil quality of vertisols (Bhusari et al., 2018, Kalaiyarasan et al., 2019, Pattanayak et al., 2016 and Suryavanshi et al., 2015). By incorporating FYM into fertilizer management plans, farmers can promote healthy soil conditions, reduce reliance on synthetic fertilizers and cultivate more resilient and productive crops (Dambale et al., 2018). Integrated nutrient management aims at a judicious combination of inorganic and organic sources for meeting the nutrient needs of crop and cropping system and is of great interest for sustaining high productivity in today's agriculture (Mohamed et al., 2018). In view of limited information available on nutrient management in sunflower, a field experiment was conducted to assess the yield and economic of sunflower under different nutrient management.

2. Materials and Methods

The field experiment was carried out during *kharif* season (June–September, 2023) at the College of Agriculture, Latur, Maharashtra, India Experimental Farm of the Agronomy Section. The experimental area was located between 18° 05' to 18° 75' North latitude and between 76° 25' to 77° 36' East latitude. The soil at the experimental location had clayey in texture, slightly saline in reaction (pH 7.6), low in available nitrogen (239 kg ha^{-1}), medium levels of phosphorus (18.47 kg ha^{-1}) and high levels of potassium (468.16 kg ha^{-1}). The rainfall received during the experiment was 335.6 mm and distribution was erratic. The maximum and minimum temperature was 29.2°C and 20.16°C, respectively. The maximum and minimum relative humidity was 77.54% and 38.94%, respectively. The seven treatments in the experiment are arranged in a randomized block design and replicated three times. The treatments were T_1-RDF (80:40:40 kg NPK ha^{-1}), T_2-RDF+FYM 5 t ha^{-1}, T_3-RDF+Multimicronutrient Grade-I @ 25 kg ha^{-1}, T_4-RDF+FYM 5 t ha^{-1}+Multimicronutrient Grade-I @ 25 kg ha^{-1}, T_5-RDF+Spraying of Multimicronutrient Grade-II @ 0.2% at 25 DAS and 45 DAS, T_6-RDF+FYM 5 t ha^{-1}+Spraying of Multimicronutrient Grade-II @ 0.2% at 25 DAS and 45 DAS and T_7-Control. The truthful seed of sunflower hybrid LSFH-171 was used for sowing with the seed rate of 5 kg ha^{-1}. Seeds are sown at a spacing of 60×30 cm^2 using the dibbling method. The recommended fertilizer dose of 80:40:40 NPK kg ha^{-1} was applied. The 50% of N and full dose of P and K were applied as basal and remaining 50% of N is applied as top dressing on 30 days after sowing. The statistical technique of analysis of variance was employed to analyse the recorded data (Panse and Sukhatme, 1967).

3. Results and Discussion

3.1. Growth and yield attributes

Results showed in Table 1 reveal that yield attributing characters viz., plant height $plant^{-1}$, number of functional leaves $plant^{-1}$, head diameter $plant^{1}$ (20.21 cm), Weight of head $plant^{-1}$ (92.76 g), Number of filled seeds $plant^{-1}$ (1074), Total number of seeds $plant^{-1}$ (1237), Seed yield $plant^{-1}$ (73.65 g) of sunflower were influenced significantly due to different treatments.The application of RDF+FYM 5 t ha^{-1}+Multimicronutrient Grade-I @ 25 kg ha^{-1} (T_4) recorded higher values of these growth and yield attributing characters which were at par with the application of RDF+Multimicronutrient Grade-I @ 25 kg ha^{-1} (T_3) and RDF+FYM 5 t ha^{1}+Spraying of Multimicronutrient Grade-II @ 0.2% at 25 DAS and 45 DAS (T_6) and found significantly superior over rest of the treatments. The increase in head diameter might be due to the balance nutrition which enhanced the efficient metabolism and translocation of carbohydrates. Micronutrients like iron which helps in cell wall synthesis and absorption of anions, pollen viability and carbohydrates and fats metabolism. Multimicronutrient Grade, which is a composite of six micronutrients viz., Fe, Mn, Cu, Zn, B and Mo, might be attributed to the improvement in the fertilizing capacity of pollen and adequate nutrition resulted in higher number of filled seed in sunflower. Kalaiyarasan et al. (2019) also revealed improvement in yield attribute and yield of sunflower with integrated nutrient management.

3.1.1. Seed yield (kg ha^{-1})

The mean seed yield and biological yield was significantly influenced by different treatments (Table 2). Application of RDF+FYM 5 t ha^{-1}+Multimicronutrient Grade-I @ 25 kg ha^{-1} (T_4) was found to record maximum seed yield (1942 kg ha^{-1}) which was at par with the application of RDF+Multimicronutrient Grade-I @ 25 kg ha^{-1} (T_3) and RDF+FYM 5 t ha^{1}+Spraying of Multimicronutrient Grade-II @ 0.2% at 25 DAS and 45 DAS (T_6) and found significantly superior over rest of the treatments. It might be due to balanced nutrition with addition of RDF, FYM along with micronutrients which improved the yield attributing character and resulted in higher seed yield. Application of micronutrients (Fe, Mn, Cu, Zn, Mo and B) accelerate in better translocation of assimilates from source to the reproductive sink which showed an increase in yield of the crop. Swetha et al. (2024), also confirmed significant

Table 1: Effect of different treatments on growth and yield contributing characters of sunflower

Treatments	Plant height (cm)	No. of functional leaves plant^{-1}	Head diameter plant^{-1} (cm)	Weight of head plant^{-1} (g)	Number of filled seeds plant^{-1}	Total number of seeds plant^{-1}	Seed yield plant^{-1} (g)
T_1: RDF	166.59	21.73	16.11	63.13	722.67	928.00	41.46
T_2: RDF+FYM 5 t ha^{-1}	170.11	25.07	17.20	69.54	813.00	1012.33	47.30
T_3: RDF+Multimicronutrient Grade-I @ 25 kg ha^{-1}	190.13	33.53	19.42	86.64	990.33	1168.00	67.15
T_4: RDF+FYM 5 t ha^{-1}+Multimicronutrient Grade-I @25 kg ha^{-1}	198.85	35.04	20.21	92.76	1074.00	1237.00	73.65
T_5: RDF+Spraying of Multimicronutrient Grade-II @ 0.2% at 25 DAS and 45 DAS	173.25	28.85	17.85	74.49	793.33	989.33	51.38
T_6: RDF+FYM 5 t ha^{-1}+Spraying of Multimicronutrient Grade-II @ 0.2% at 25 DAS and 45 DAS	183.76	31.33	18.74	81.63	924.33	1108.67	63.54
T_7: Control	140.75	17.80	12.17	53.49	641.00	860.67	35.58
SEm±	8.06	1.44	0.715	4.05	52.33	55.15	3.57
CD (*p*=0.05)	24.83	4.44	2.202	12.49	161.22	169.91	11.00

Table 2: Yield and economics of sunflower as influenced by different treatments

Treatments	Seed yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Gross monetary returns (₹ ha^{-1})	Net monetary returns (₹ ha^{-1})	B:C ratio
T_1: RDF	1460	5618	98696	56870	2.36
T_2: RDF+FYM 5 t ha^{-1}	1522	5832	102887	56061	2.20
T_3: RDF+Multimicronutrient Grade-I @ 25 kg ha^{-1}	1739	6524	117556	73017	2.64
T_4: RDF+FYM 5 t ha^{-1}+Multimicronutrient Grade-I @ 25 kg ha^{-1}	1942	7187	131279	81740	2.65
T_5: RDF+Spraying of Multimicronutrient Grade-II @ 0.2% at 25 DAS and 45 DAS	1612	6124	108971	64765	2.47
T_6: RDF+FYM 5 t ha^{-1}+Spraying of Multimicronutrient Grade-II @ 0.2% at 25 DAS and 45 DAS	1714	6426	115866	66660	2.35
T_7: Control	1239	5231	83756	49856	2.47
SEm±	77	256	5432	5432	-
CD (*p*=0.05)	236	789	16737	16737	-

effect of Integrated use of nutrients along with soil and foliar application on seed yield of sunflower.

3.2. Economics

Data concerned with the economics viz. gross monetary returns (₹ ha^{-1}), net monetary returns (₹ ha^{-1}) and benefit: cost ratio of sunflower as influenced by different treatments are presented in Table 2.

The maximum gross monetary returns (₹ ha^{-1}) and net monetary returns (₹ ha^{-1}) were obtained with the application of RDF+FYM 5 t ha^{-1}+Multimicronutrient Grade-I @ 25 kg ha^{-1} (T_4) (₹ 1,31,279 ha^{-1}) which was at par with the application of RDF+Multimicronutrient grade-I @ 25 kg ha^{-1} (T_3) and RDF+FYM 5 t ha^{1}+Spraying of Multimicronutrient grade-II @ 0.2% at 25 DAS and 45 DAS (T_6) and found significantly superior over rest of the treatments. Highest seed yield is the factor that influences gross monetary returns. These results are in confirmative with the findings of Bellaki et al. (2013), and Poonia et al. (2022). Highest B:C ratio was recorded with the application of RDF+FYM 5 t ha^{-1}+Multimicronutrient Grade-I

@ 25 kg ha^{-1} (T_4)

4. Conclusion

Application of RDF+FYM @ 5 t ha^{-1}+Multimicronutrient Grade-I @25 kg ha^{-1} (T_4) had recorded significantly higher yield attributes, yield, GMR and NMR of sunflower and it was followed by application of RDF+Multimicronutrient Grade-I @ 25 kg ha^{-1} (T_3) and RDF+FYM 5 t ha^{-1}+Spraying of Multimicronutrient Grade-II @0.2% at 25 DAS and 45 DAS (T_6). Highest B:C ratio (2.65) was recorded with the application of RDF+FYM 5 t ha^{-1}+Multimicronutrient Grade-I @ 25 kg ha^{-1} (T_4).

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