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EFFECT OF DIFFERENT NUTRIENT MANAGEMENT ON GROWTH AND YIELD OF *KHARIF* SUNFLOWER (*HELIANTHUS ANNUUS* L.)

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ABSTRACT

A field experiment was carried out during *kharif*, 2023 at Experimental Farm of Agronomy Section, College of Agriculture, Latur to study the nutrient management in *kharif* sunflower (*Helianthus annuus* L.). 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 growth and yield attributes of sunflower were influenced significantly due to the different treatments. Application of RDF + FYM 5 t ha^{-1} + Multimicronutrient Grade-I @ 25 kg ha^{-1} (T_4) recorded significantly highest plant height (198.85 cm), number of functional leaves plant^{-1} (35.04), leaf area plant^{-1} (74.85 dm^2), stem girth (7.93 cm), dry matter accumulation plant^{-1} (208.25 g), seed yield (1942 kg ha^{-1}), biological yield (7187 kg ha^{-1}) and oil yield (636 kg ha^{-1}) being at par with application of 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) over rest of the treatments.
***Keywords*: Sunflower, RDF, FYM, Multimicronutrient grades**

Introduction

Sunflower is a member of the Asteraceae (Compositae) family, genus *Helianthus* and species *annuus* and popularly known as 'Surajmukhi'. It is native of North America. It was introduced to India in 1969 as an addition to the introduction of oilseed crops to fill the gap left by the nation's ongoing edible oil scarcity (Shankergoud *et al*., 2006). The kernel oil content ranges from 48 to 53% and for seed it ranges from 28 to 35%. The protein content ranges from 14 to 19%. Sunflower's protein score is 63 (Sosulski and Sarware, 1973). The major sunflower producing countries are Russia, Ukraine, European Union, Argentina, China, Turkey, United States and South Africa. The total area under sunflower crop in world is 29.80 million hectares with the production of 55.23 MT and productivity of 1.85 MT ha^{-1} (Anonymous, 2023 a). 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, Karnataka is the largest producer of sunflower with 0.23 MT followed by Haryana and Odisha with the production of 0.02 and 0.02 MT, respectively. In Maharashtra, sunflower is grown on 0.30 Lakh hectare area with a production of 0.15 Lakh tonnes and productivity of 498 kg ha^{-1} (Anonymous, 2023 b). Due to the impact of green revolution, Indian soils became deficient in micronutrients. Micronutrients *i.e.,* boron (B), copper (Cu), manganese (Mn), zinc (Zn), iron (Fe) and molybdenum (Mo) though required by plants in lesser amounts but they have a significant effect in enhancing the use efficiency of macronutrients (NPK) (Katyal *et al*., 2004; Singh, 2009; Shukla *et al*., 2009). Hence, a need arises to develop appropriate management systems of micronutrients among researchers to curtail the declining input use efficiency of NPK. In accordance with this, the current investigation was conducted.

Materials and Methods

Experimental site and treatment details

The field experiment was carried out at the College of Agriculture, Latur, Experimental Farm of the Agronomy Section during *kharif* 2023. 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 ºC and 20.16 ºC, 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 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 experimental unit's gross and net plot sizes were, respectively, 4.8 m x 4.5 m and 3.6 m x 3.9 m. 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 cm x 30 cm 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 crop was harvested on 29th October 2023. The statistical technique of analysis of variance was employed to analyse the recorded data (Panse and Sukhatme, 1967).

Methodology

Plant height (cm)

The height of plant was measured in cm from base of the plant to the base of fully opened top leaf of sunflower.

Number of functional leaves plant^{-1}

Total number of functional leaves of sunflower crop born on sample plants were counted and recorded at different stages of crop growth up to harvest. Leaves were dried more than half of its area were excluded while counting the functional leaves.

Leaf area plant^{-1} (dm^2)

Leaf area plant^{-1} (dm^2) of sunflower was measured by leaf area meter.

$$LA = L \times B \times N \times K$$

Where, LA= Leaf area (dm^2)

L = Maximum length of leaf (cm)

B = Maximum breadth of leaf (cm)

N = Number of leaves under particular group

K = Leaf area constant (0.64) (Priya Sharma *et al*., 2024)

Stem girth plant^{-1} (cm)

Stem girth of sunflower was measured by vernier scale at different growth stages up to harvest and means were worked out. Stem girth about 20 cm from base of sampled plants was measured in cm by vernier scale at various scale at various stages of crop growth.

Dry matter accumulation plant^{-1} (g)

The weight of dry matter of sunflower is an index of productive capacity of the plant. Hence, one representative plant from each plot was randomly uprooted. The roots of plant uprooted for dry matter study from each net plot were removed. After removal of roots, the plant parts were divided into leaves, stem and head. These separated plant parts were collected in separate brown paper bag, properly labelled, sun dried in the first istance and oven dried at 65 ± 2ºC temperature for 48 hours. The constant weight was recorded as total dry matter weight (g) plant^{-1} for each treatment.

Seed yield (kg ha^{-1})

Sunflower heads from net plot were cut, against ground and seeds were separated and cleaned by winnowing. Weight of sun-dried seed kg net plot^{-1} was recorded and presented in kg ha^{-1}.

Biological yield (kg ha^{-1})

The biological yield per plot was calculated by adding stalk yield per plot and head weight per plot and converted into hectare basis and expressed in kg ha^{-1}.

Biological yield = head weight + stalk yield

Harvest Index

Harvest index indicates the effieciency of plant materials to convert the photosynthesis into the economic yield and it is worked out as

$$\text{Harvest index } (\%) = \frac{\text{Seed yield } (\text{kg ha}^{-1})}{\text{Total biological yield } (\text{kg ha}^{-1})} \times 100$$

Where, biological yield = head weight + stalk yield

Stalk yield= Stalks + leaves

Oil yield (kg ha^{-1})

The oil yield (kg ha^{-1}) was calculated as a product of per cent oil content in seed and seed yield (kg ha^{-1}) of respective treatments.

Statistical analysis and interpretation of data

Data obtained on various variables were analysed by Analysis of Variance Method (Panse and Sukhatme, 1967). The total variance (S^2) and degree of freedom (n-1) were partitioned into different possible sources. The variance of treatments and replications were calculated and compared with error variance for finding out 'F' value and ultimately for testing of significance at P = 0.05. Wherever the results were found significant, critical differences were calculated for comparison of treatment mean at 5% level of significance.

Results and Discussion

Growth attributes

Results presented in Table 1 reveal that growth attributes of sunflower *viz*., plant height plant^{-1}, No. of functional leaves plant^{-1}, leaf area plant^{-1}, stem girth and dry matter accumulation plant^{-1} of sunflower were influenced significantly due to different treatments. Application of RDF + FYM 5 t ha^{-1} + Multimicronutrient Grade-I @ 25 kg ha^{-1} (T_4) recorded significantly higher plant height plant^{-1}, No. of functional leaves plant^{-1}, leaf area plant^{-1}, stem girth and dry matter accumulation plant^{-1} of sunflower 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 and adequate supply of nutrients (micro and macronutrients) which ultimately increased the vegetative growth and photosynthetic activity of the crop. The application FYM, RDF and Multimicronutrient Grade enhanced the photosynthetic activities and metabolic functions in plants. Dry matter production is a function of leaf area and its activity. Increased leaf area per plant would contribute to higher dry matter production and seed yield. The results are confirmative with the findings of Chowdhary *et al.* (2010), Jayewar *et al.* (2016) Elankavi (2017), Dambale *et al.* (2018), Ramesh *et al.* (2019) and Gawande *et al.* (2022) and Swetha *et al.* (2024).

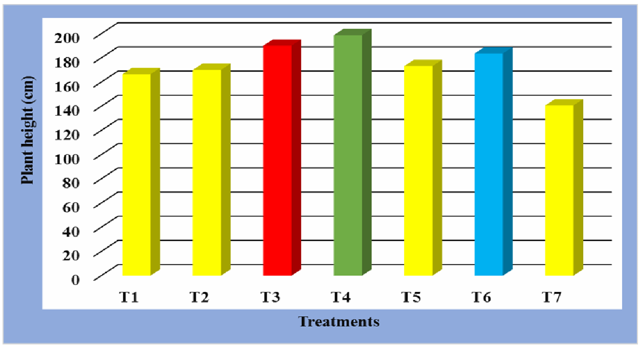

Fig. 1: Mean plant height (cm) of sunflower as influenced by different treatments at harvest

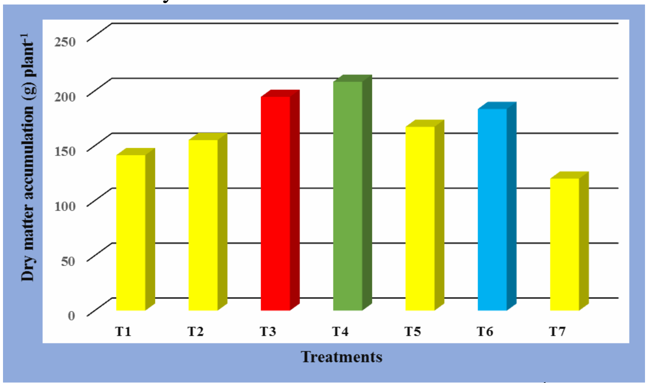

Fig. 2: Mean total dry matter accumulation plant^{-1} (g) as influenced by different treatments at harvest.

Yield

The mean seed yield (kg ha^{-1}), biological yield (kg ha^{-1}) and oil yield (kg ha^{-1}) were 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}), biological yield (7187 kg ha^{-1}) and oil yield (636 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. The improved vegetative growth due to balanced application of macronutrients (NPK) and micronutrients (Fe, Mn, Cu, Zn, Mo and B) throughout the crop period helps in better translocation of assimilates from source to the reproductive sink which showed an increase in yield of the crop. An increase in seed yield might be due to increase in yield components (especially seed weight and higher seed setting). Micronutrients like Manganese plays an important role in carbohydrate metabolism, synthesis of some proteins and nitrates, which increase seed yield. These findings are confirmative with the Ramulu *et al.* (2011), Elankavi (2017), Ramesh *et al.* (2019), Gawande *et al.* (2022) and Swetha *et al.* (2024). Highest harvest index as observed with the application of RDF + FYM 5 t ha^{-1} + Multimicronutrient Grade-I @ 25 kg ha^{-1} (T_4), closely 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).

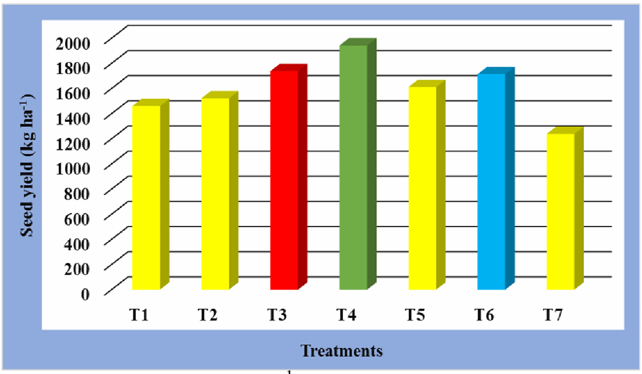

Fig. 3: Seed yield (kg ha^{-1}) of sunflower as influenced by different treatments

Conclusion

Application of RDF + FYM @ 5 t ha^{-1} + Multimicronutrient Grade-I @ 25 kg ha^{-1} (T_4) has recorded significantly higher growth attributes and seed yield of sunflower and it was followed by 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).

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Table 1: Plant height, number of functional leaves plant, leaf area plant, stem girth, head diameter plant and dry matter accumulation per plant of sunflower as influenced by different treatments

Treatments	Plant height (cm)	No. of functional leaves plant^{-1}	Leaf area plant^{-1} (dm^2)	Stem girth plant^{-1} (cm)	Dry matter accumulation plant^{-1} (g)
T_1: RDF	166.59	21.73	60.51	6.64	141.49
T_2: RDF + FYM 5 t ha^{-1}	170.11	25.07	64.12	6.91	155.26
T_3: RDF + Multimicronutrient Grade-I @ 25 kg ha^{-1}	190.13	33.53	72.32	7.69	194.57
T_4: RDF + FYM 5 t ha^{-1} + Multimicronutrient Grade-I @ 25 kg ha^{-1}	198.85	35.04	74.85	7.93	208.25
T_5: RDF + Spraying of Multimicronutrient Grade-II @ 0.2% at 25 DAS and 45 DAS	173.25	28.85	65.89	6.96	167.28
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	68.88	7.57	183.51
T_7: Control	140.75	17.80	58.48	5.74	120.11
SE(m)±	8.06	1.44	2.77	0.30	8.60
C.D. at 5%	24.83	4.44	8.54	0.92	26.49

Table 2: Seed yield, biological yield harvest index and oil yield of sunflower as influenced by different treatments

Treatments	Seed yield (kg ha^{-1})	Biological yield (kg ha^{-1})	HI (%)	Oil yield (kg ha^{-1})
T_1: RDF	1460	5618	25.99	448
T_2: RDF + FYM 5 t ha^{-1}	1522	5832	26.10	470
T_3: RDF + Multimicronutrient Grade-I @ 25 kg ha^{-1}	1739	6524	26.66	563
T_4: RDF + FYM 5 t ha^{-1} + Multimicronutrient Grade-I @ 25 kg ha^{-1}	1942	7187	27.02	636
T_5: RDF + Spraying of Multimicronutrient Grade-II @ 0.2% at 25 DAS and 45 DAS	1612	6124	26.32	511
T_6: RDF + FYM 5 t ha^{-1} + Spraying of Multimicronutrient Grade-II @ 0.2% at 25 DAS and 45 DAS	1714	6426	26.67	550
T_7: Control	1239	5231	23.68	371
SE(m)±	77	256	-	29
C.D. at 5%	236	789	-	91

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