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Influence of Nitrogen and Foliar Spray of Iron on Growth and yield of Safflower (*Carthamus tinctorius* L.)

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ABSTRACT: To study the impact of nitrogen and iron on growth and yield attributes of *rabi* safflower, an experiment was carried out in 2020-21 Crop Research Form of SHUATS. The treatments consist of three levels of nitrogen soil application and three levels of iron foliar spray, experiment was laid out in randomized block design with nine treatments each replicated thrice. The result showed that *viz.,* plant height (108.43 cm) and was recorded significantly higher with application of 50 kg/ha N + 0.3% iron foliar spray. Whereas, number of branches per plant (21.88), was recorded significantly higher with application of 50 kg/ha N + 0.6% iron foliar spray. The significantly higher dry weight (35.37 g/plant) and crop growth rate at 40-60 DAS (9.26 g/m^2/day) was observed in 50 kg/ha N + 0.5% iron foliar spray treatment. Number of seeds per capitulum (22.18), seed yield (1427.7 kg/ha), stalk yield (3695.2 kg/ha) was recorded significantly higher with the application of 50 kg/ha N + 0.6% iron foliar spray.

Keywords: Nitrogen, iron foliar spray, safflower growth and yield attributes.

INTRODUCTION

Safflower (*Carthamus tinctorius* L.) is one of humanity's oldest crops cultivated in India mainly for oil from the seeds and a reddish dye from the flowers. Nonetheless, it has mainly remained a minor crop grown on small plots for the grower's personal use. It is a *rabi* oil seed crop mainly grown in semi-arid regions for use as vegetable and industrial oil, medicinal purpose and for its colourful petals used as food coloring, flavoring agent and preparing textile dyes (Dordas and Sioulos, 2008). It contains about 36 percent of oil, which accounted for about 8percent of the value of total agriculture produce (Ravi and Channal, 2010). India is the largest producer of safflower (2.0 lakh tonnes) in the world with highest acreage (4.3 lakh hectares) but with an average productivity of only 465 kg/ha. Poor crop management under input-starved conditions is the most important reason for such low per hectare yields. It is mainly grown in Maharashtra, Karnataka and parts of Andhra Pradesh, Madhya Pradesh, Orissa, Bihar, etc. Maharashtra and Karnataka are the two most important safflower growing states accounting for 72 and 23 per cent of area and 63 and 35 per cent of production, respectively (Nimbkar, 2021). The deficiency of macro and micronutrients is wide spread in many parts of the country due to cultivation of high yielding varieties, intensive agriculture has been increased using of over dosage of N, P and K fertilizers, concomitantly the balance should have maintained between macro and micronutrients. Nitrogen is a primary and most consistently required plant nutrient in larger amounts, nitrogen compounds are important in plant chemical compounds such as protein, nucleic acid, chlorophyll and enzymes structure (Herdrich, 2001). Iron is a member of the electron transmitter enzymes for example cytochrome and ferredoxin (Marschner, 1995). It is active in photosynthesis and respiration. Foliar application can guarantee access the plants to the nutrients to achieve high yield. From an ecological perspective, foliar fertilization is more acceptable, since lower values of nutrient elements are provided for immediate consumption by plant.The aim of the work was to determine the effect of different levels of nitrogen and iron foliar application on growth and yield attributes of safflower.

MATERIALS AND METHODS

This experiment was carried out in an experimental field Crop Research Farm of Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. This area is situated on the right side of the Yamuna River by the side of Prayagraj - Rewa road. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.3), low in organic carbon (0.57%), available N (230 kg/ha), available P (32.10 kg/ha) and available K (235 kg/ha).The treatments consist of three levels of Nitrogen (30, 40 and 50 kg/ha) soil application and three levels of Iron (0.3%, 0.5% and 0.6%) foliar spray respectively. The experiment was laid out in randomized block design with nine treatments each replicated thrice and control *i.e.,* recommended N, P and K (40:40:20 kg/ha) alone. The plots were prepared with dimension of 5 m × 3 m and seeds of variety PVNS-19 were sown with a spacing of 45cm × 15cm.

Growth characteristics plant height (cm), number of branches per plant, dry weight per plant (g), crop growth rate (g/m^2/day) and relative growth rate (g/g/day) were recorded, with following formulas (A & B). The crop was completely harvested at physiological maturity stage and their biometric observations such as number of capitulums per plant, number of seeds per capitulum, 100 seed weight (g), seed yield (kg/ha) and stalk yield (kg/ha) were recorded.

Formulas: Crop growth rate (CGR) denotes overall growth rate of the crop plants and measured after fixed period of time, irrespective of the previous growth rate (Leopold and Kridemann, 1975).

$$CGR = \frac{W_2 - W_1}{p\,(t_2 - t_1)}$$

Where, W_2 and W_1 are dry weight of plant (g) recorded at time t_2, t_1 (days) and p is ground area respectively.

Relative growth rate (RGR) indicates the amount of growth per unit dry weight of plant per unit time (Leopold and Kridemann, 1975). It is expressed as grams of dry matter produced by a gram of existing dry matter in a day.

$$RGR = \frac{\mathrm{Log_e}\, W_2 - \mathrm{Log_e}\, W_1}{t_2 - t_1}$$

Where Log_e: Logarithm to the base, W_1: Dry weight of the plant at t_1, W_2: Dry weight of the plant at t_2.

Statistical Analysis. The data was taken and recorded from all the treatments and subjected to statistical analysis by adopting the method of analysis of variance (ANOVA) as described by Gomez (1984). The significance of comparison was tested. The significant difference values were computed for 5 percent probability of error. Wherever the variance ratio (F value) was found significant, critical difference (CD) values were computed for the comparison among the treatment means.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been presented under following heads:

Growth parameters. Table 1 shows that, at harvest significantly higher plant height was observed in treatment with the application of 50 kg/ha N + 0.3% iron foliar spray (108.63 cm) which is statistically at par to 50 kg/ha N + 0.5% iron foliar spray (108.24 cm) and 50 kg/ha N + 0.6% iron foliar spray (108.43 cm).Similarly, significantly highest number of branches per plant were observed in 50 kg/ha N + 0.6% iron foliar spray (21.88) which was statistically at par with the application of 50 kg/ha N + 0.5% iron foliar spray (21.30), 50 kg/ha N + 0.3% iron foliar spray (21.51).Application of 50 kg/ha N + 0.5% iron foliar spray recorded significantly higher dry matter accumulation (35.37 g/plant) which is statistically at par with the application 50 kg/ha N + 0.6% iron foliar spray (35.30 g/plant) and 50 kg/ha N + 0.3% iron foliar spray (34.95 g/plant).At 40-60 DAS the significantly higher crop growth rate was observed in 50 kg/ha N + 0.5% iron foliar spray (9.26 g/m^2/day), Which was statistically at par with application of 50 kg/ha N + 0.6% iron foliar spray (8.98 g/m^2/day).In relative growth rate, there was no significant difference among treatments. The treatment receiving 50 kg/ha N might have helped in vigorous shoot growth, formation of chlorophyll, resulting in higher photosynthesis. The research of this investigation are in consonance with the findings of Siddiqui and Oad (2006). The beneficial effect might be due to interaction effect of nitrogen and iron their role in the synthesis of IAA, metabolism of auxin and formation of chlorophyll synthesis are directly influence on the plant height, crop growth rate and dry weight, findings of Ravi and Channal (2010). Dry matter production related to seed productivity contributes an important factor in source-sink relationship. The increase in dry matter due to increase in N levels could be attributed to enhanced plant height, number of leaves and photosynthates accumulation. These findings are in conformity by Vishwanath *et al.,* (2006); Tomar *et al.,* (2012); Sarkar and Mallik (2009).

Table 1: Influence of nitrogen and iron foliar spray on growth parameters of safflower.

Treatments	Plant height (cm)	Number of branches/ plant	Dry weight (g/plant)	Crop growth rate (g/m^2/day)	Relative growth rate (g/g/day)
T_1 : 30 kg/ha N + 0.3% iron foliar spray	105.94	18.84	30.91	7.01	0.049
T_2 : 30 kg/ha N + 0.5% iron foliar spray	106.60	19.57	32.20	7.28	0.051
T_3 : 30 kg/ha N + 0.6% iron foliar spray	106.83	19.98	33.43	7.57	0.044
T_4 : 40 kg/ha N + 0.3% iron foliar spray	107.64	19.91	34.27	7.60	0.050
T_5 : 40 kg/ha N + 0.5% iron foliar spray	107.35	20.37	34.17	7.46	0.047
T_6 : 40 kg/ha N + 0.6% iron foliar spray	107.10	20.44	34.75	7.85	0.050
T_7 : 50 kg/ha N + 0.3% iron foliar spray	108.63	21.51	35.95	7.89	0.048
T_8 : 50 kg/ha N + 0.5% iron foliar spray	108.24	21.30	35.37	9.26	0.052
T_9 : 50 kg/ha N + 0.6% iron foliar spray	108.43	21.88	35.30	8.98	0.048
sEm (±)	**0.30**	**0.32**	**0.20**	**0.38**	**0.002**
CD (p=0.05)	**0.90**	**0.97**	**0.59**	**1.13**	**-**

Yield attributes. Table 2 data pertaining that, significantly higher number of seeds per capitulum was obtained in 50 kg/ha N + 0.6% iron foliar spray (22.18). Which was statistically at par with the application of 50 kg/ha N + 0.5% iron foliar spray (21.08), 50 kg/ha N + 0.3% iron foliar spray (21.40), 40 kg/ha N + 0.6% iron foliar spray (20.90) and 40 kg/ha N + 0.5% iron foliar spray (19.95).Maximum number of seeds per capitulum

was obtained in 50 kg/ha N + 0.5% iron foliar spray (17.60). But there was no significant difference observed. Similarly, in 100 seed weight there was no significant difference between treatments. The significantly higher seed yield was obtained in 50 kg/ha N + 0.6% iron foliar spray (1427.6 kg/ha), which is statistically at par with T_8, T_7, T_6 and T_5 treatments. Significantly higher stalk yield (3695.2 kg/ha) was recorded with application of 50 kg/ha N + 0.6% iron foliar spray, whereas T_8, T_7 and T_6 treatments are statistically at par with T_9. Seed yield is the function of several yields attributing characters *viz.*, number of capsule per plant, number of seeds capsule and 100 seed weight. Cumulative effect of all the yield attributing characters due to adequate nutrition of nitrogen might have resulted in the production of higher seed yield reported by Tomar, (2012). It can be concluded that the use of Fe nanoparticles at flowering and seed formation stages as well as non-applying stress (optimum irrigation) has been able to increase the number of capsules per branch. The positive role of micronutrient fertilizers like iron on the number of capsules produced by safflower plants was also reported by Bibordi, (2008) and results conformity by Zareii *et al.,* (2014); (Haliloglu and Beyyavas, 2019).

Table 2: Influence of nitrogen and iron foliar spray on yield attributes of safflower.

Treatments	Number of seeds/ capitulum	Number of capitulums/ plant	100 seed weight (g)	Seed yield (kg/ha)	Stalk yield (kg/ha)
T_1 : 30 kg/ha N + 0.3% iron foliar spray	17.80	16.06	36.56	1202.3	3279.3
T_2 : 30 kg/ha N + 0.5% iron foliar spray	18.08	16.46	36.75	1250.6	3228.6
T_3 : 30 kg/ha N + 0.6% iron foliar spray	18.71	17.03	36.52	1275.3	3326.7
T_4 : 40 kg/ha N + 0.3% iron foliar spray	19.40	16.59	36.91	1280.2	3461.6
T_5 : 40 kg/ha N + 0.5% iron foliar spray	19.95	17.16	36.72	1341.0	3469.1
T_6 : 40 kg/ha N + 0.6% iron foliar spray	20.90	17.05	36.79	1355.0	3563.2
T_7 : 50 kg/ha N + 0.3% iron foliar spray	21.40	17.32	36.70	1403.2	3566.1
T_8 : 50 kg/ha N + 0.5% iron foliar spray	21.08	17.60	36.82	1423.6	3642.3
T_9 : 50 kg/ha N + 0.6% iron foliar spray	22.18	17.47	36.89	1427.7	3695.2
sEm (±)	**0.82**	**0.39**	**0.18**	**35.19**	**69.79**
CD (p=0.05)	**2.46**	**-**	**-**	**105.5**	**209.23**

CONCLUSION

It was concluded that, on the basis of present study application of 50 kg/ha N + 0.6% iron foliar spray recorded significantly maximum number of branches per plant (21.88), number of seeds per capitulum (22.18), seed yield (1427.7 kg/ha) and stalk yield (3695.2 kg/ha) respectively. These findings are based on one season; therefore, further trails may be required for further confirmation.

Conflicts of Interest. None.

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