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Effect of nitrogen and zinc levels on growth, yield and economics of safflower (*Carthamus tinctorius* L.)

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Abstract
A field experiment was conducted during *Rabi* 2020 at CRF (Crop Research Farm), Department of Agronomy, SHUATS, Prayagraj, Uttar Pradesh. The soil of the experimental field is sandy loam in texture, low in organic carbon and medium available nitrogen, phosphorus and low in potassium. The treatments consisted Nitrogen *viz.*, 20 kg/ha, 40 kg/ha and 60 kg/ha and Zinc (through soil application) *viz.*, 0 kg/ha, 10 kg/ha and 15 kg/ha whose effect is observed in Safflower (PBNS-12). The experiment was laid out in Randomized Block Design with nine treatments replicated thrice. The result revealed that the treatment with application of 60 kg N/ha + 10 kg Zn/ha recorded higher plant height (109.39 cm), number of branches/plant (22.13), dry weight (41.43 g), crop growth rate (4.99 g/m^2/day), relative growth rate (0.0052 g/g/day), no. of capitulum/plant (26.13), no. of seeds/capitulum (31.33), test weight (39.66 g), seed yield (1.60 t/ha), stover yield (4.18 t/ha), harvest index (29.38%) and oil content (28.99%). The maximum gross returns (88,097.11 ₹/ha) and net returns (56,397.11 ₹/ha) and Benefit: Cost (1.78) also recorded highest in the treatment of 60 kg N/ha + 10 kg Zn/ha respectively.

Keywords: Safflower, nitrogen, zinc, yield and economics

Introduction

Oilseed crops have been the backbone of several agricultural economies from antiquity and play a prominent role in agricultural industries and trade throughout the world. A major amount of edible oil comes from these crop resources. The other oilseed crops are groundnut, sunflower, soybean, safflower, and sesame yielding high-grade, edible oil. The non-edible oil producing species include castor and linseed.

Safflower (*Carthamus tinctorius* L.), is a member of the family Compositae. Cultivated mainly for its seed, which is used as edible oil and as bird seed. Safflower is most commonly known as 'kusum' (India, Pakistan), derived from the Sanskrit, 'kusumbha' (Chavan 1961) [2], Safflower is a highly branched, herbaceous, thistle-like annual or winter annual, usually with many long sharp spines on the leaves. Plants are 30-150 cm tall with globular flower heads (capitulum) and, commonly, brilliant yellow, orange or red flowers. Achenes are smooth, four-sided and generally lack pappus. Safflower is rich in nutritive content and high in fats 58%, proteins 39%, carbohydrates 11% and calories 26%. It has some beneficial minerals such as calcium (78 mg), potassium (687 mg), phosphorus (644 mg), potassium (687 mg), magnesium (353 mg), sodium (3 mg), iron (5 mg), zinc (5.05 mg). It also contains some vitamins such as vitamin B1 (1.163 mg), vitamin B6 (1.17 mg), vitamin B2 (0.415 mg), vitamin B5 (4.03 mg), vitamin B3 (2.28 mg) and vitamin A (50 IU). In total fats it contains polyunsaturated fat 28% and saturated fat 18%. India ranks first in area (51%) and production (37%) in the world. The safflower area in the country during 2017-18 was 0.81 lakhs/ha area as compared to the year 2016-17 (1.05 lakhs/ha). India is the largest producer of safflower (43.67 000' MT) in the world with highest acreage (4.3 lakhs/ha) but with an average productivity of only 843 kg/ha. Maharashtra and Karnataka are major safflower growing States, which contribute more than 90% of India's production accounting for 72 and 23 per cent of area and 63 and 35 per cent of production, respectively. Safflower is now mainly grown in India for its much-valued edible oil. Nitrogen is one of the most required nutrients by plants, since it is part of proteins, enzymes, chlorophyll, nucleic acids, and contribute to hormone synthesis. Nitrogen is the nutrient which normally produces the greatest yield response in crop plants, promoting rapid vegetative growth and giving the plant a healthy green color. Adequate nitrogen fertilization increases the root system depth, resulting in a higher volume of soil used, reducing the effects of water deficit (Dordas and Sioulas, 2008) [5]. Zinc is essential in the formation of auxins, which help with growth regulation and stem elongation.

Zinc activates enzymes that are responsible for the synthesis of certain proteins. It is used in the formation of chlorophyll and some carbohydrates, conversion of starches to sugars and its presence in plant tissue helps the plant to withstand cold temperatures. Micronutrients are involved in the key physiological process of photosynthesis and respiration (Marschner, 2002) [9]. Zinc deficiency leads to delay in flowering and fruit development, prolonged growth period causes low quality of yield and nutrient use efficiency. Zinc is not readily translocated from old to new tissues. During Zinc shortage, the deficiency symptoms usually appear on the recent new growth. Erenogin *et al.* (2002) [6] reported that the deficiency symptom mostly appear on the second or third fully matured leaves from the top of the plant.

Materials and Methods

The experiment was carried out during *Rabi* season of 2020 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (Allahabad) which is located at250 57" N latitude, 870 19" E longitude and at an altitude of 98 m above mean sea level. This area is situated on the right side of the river *Yamuna* and by the opposite side of Allahabad City. The soil samples were collected randomly from 0 to 15 cm depth from 5 spots of the experimental field just before layout of experiment. The soil texture of the experimental site was sandy loam having available N (225 kg/ha) P (21.50 kg/ha), potassium (87.00 kg/ha) and organic carbon of soil was of 0.28% with 7.4 available pH of soil. The experimental plot was laid out in randomized block design with having nine treatments which replicated three times with a suitable plot size of 3m×3m. There were nine treatments combination used for this experiment are T_1: 20 kg/ha N + 0 kg/ha Zn, T_2: 40 kg/ha N + 0 kg/ha Zn, T_3: 60 kg/ha N + 0 kg/ha Zn, T_4: 20 kg/ha N + 10 kg/ha Zn, T_5: 40 kg/ha N+ 10 kg/ha Zn, T_6: 60 kg/ha N+ 10 kg/ha Zn, T_7: 20 kg/ha N + 15 kg/ha Zn, T_8: 40 kg/ha N + 15 kg/ha Zn, T_9: 60 kg/ha N + 15 kg/ha Zn. The recommended dose of fertilizer is 40:40:20 kg/ha NPK. Fertilizer was applied at the time of sowing in the form of urea, SSP and MOP. The growth parameters were recorded at periodic intervals 20, 40, 60, 80, 100, 120 and at harvest from randomly selected plants from each treatment.

Results and Discussion

Growth attributes

Data presented in table-1 revealed the effect of nitrogen and zinc levels on growth of safflower (*Carthamus tinctorius* L.). The growth attributes that were considered in this experiment for observations were plant height (cm), number of branches/plant, dry weight (g), Crop Growth Rate (CGR) (g/m²/day) and Relative Growth Rate (RGR) (g/g/day).

The growth parameters of safflower were significantly influenced with increasing the levels of nitrogen and zinc. The highest (109.39 cm) plant height was achieved in T_6 (60 kg N/ha + 10 kg Zn/ha) which was significantly superior over all the treatment combination expect T_9 (60 kg N/ha + 15 kg Zn/ha) was found to be statistically at par with T_6. Number of branches per plant and dry weight per plant were significantly influenced by the increasement of nitrogen and zinc levels. Maximum (22.13) branches per plant was observed in T_6 (60 kg N/ha + 10 kg Zn/ha) which was found superior however, T_9 (60 kg N/ha + 15 kg Zn/ha) and T_8 (40 kg N/ha + 15 kg Zn/ha) are found statistically at par to T_6. The highest (41.43 g) dry weight was observed in T_6 (60 kg N/ha + 10 kg Zn/ha) which was found superior however, T_5 (40 kg N/ha + 10 kg Zn/ha), T_9 (60 kg N/ha + 15 kg Zn/ha) and T_8 (40 kg N/ha + 15 kg Zn/ha) were found statistically at par with T_6. In CGR, highest (4.99 g/m2/day) CGR was recorded in T_9 (60 kg N/ha + 10 kg Zn/ha) is superior over all treatments. In case of RGR, maximum (0.0052 g/g/day) RGR was reported in T_8 (40 kg N/ha + 15 kg Zn/ha).

The increase in plant height with higher levels of nitrogen was probably due to its beneficial effect on cell elongation which might have resulted in internodal elongation. The nitrogen was an integral part of protein, the blocks of the plant and it also helps in maintaining higher auxin level which might have resulted in better plant height (Singh *et al*., 2000). The significantly increased plant height and dry matter accumulation observed in application of zinc may be due to availability of these micronutrients to the crop at appropriate vegetative stage, which may have increased the nutrient uptake and chlorophyll content and resulted in increase in plant growth and it also might improve photosynthetic area of plants that cumulatively contribute to higher dry matter accumulation. Increase in more number of branches may be probably due to adequate application of nitrogen, which was directly involved in better absorption of applied nutrients and cell multiplication as well as expansion of deep green color of leaves due to better chlorophyll synthesis Vishwanath *et al.* (2006) [19]. Similar results of increased dry matter production with increased levels of N at all the growth stages of Safflower crop was reported by Nathan *et al.* (2018) [14] and Vishwanath *et al*. (2000) [19]. Dry matter production related to grain 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, and photosynthates accumulation.

Yield attributes

Data presented in table-2 indicated the effect of nitrogen and zinc levels on yield of safflower (*Carthamus tinctorius* L.). The yield characters that were considered in this experiment are seeds/capitulum (No.), capitulum/plant (No.), test weight (g), seed yield (t/ha), stover yield (t/ha), harvest index (%) and oil content (%).

The yield attributes of safflower were significantly influenced with increasing the levels of nitrogen and zinc. Significantly Maximum number of (31.33) seeds/capitulum was obtained with the application of T_6 (60 kg N/ha + 10 kg Zn/ha). The significantly highest (26.13) number of capitulum/plant was recorded in T_6 (60 kg N/ha + 10 kg Zn/ha). However, T_5 (40 kg N/ha +10 kg Zn/ha) and T_8 (40 kg N/ha + 15 kg Zn/ha) were found statistically at par with T_6 (60 kg N/ha + 10 kg Zn/ha). Maximum (39.66 g) test weight of seed was found with application of treatment combination *i.e.*, of T_6 (60 kg N/ha + 10 kg Zn/ha). Significantly highest (1.60 t/ha) seed yield was recorded in T_6 (60 kg N/ha + 10 kg Zn/ha). However, T_9 (60 kg N/ha + 15 kg Zn/ha), T_5 (40 kg N/ha + 10 kg Zn/ha) and T_7 (20 kg N/ha + 15 kg Zn/ha) were stastically at par with T_6. In stover yield highest (4.18 t/ha) significant value was shown in T_6 (60 kg N/ha + 10 kg Zn/ha) while, T_9 (60 kg N/ ha + 15 kg Zn/ha), T_5 (40 kg N/ha + 10 kg Zn/ha) and T_8 (40 kg N/ha + 15 kg Zn/ha) was found statistically at par with T_6 (60 kg N/ha + 10 kg Zn/ha). Maximum (29.38%) harvest index and (28.99%) oil content were found with application 60 kg/ha N in combination with 10 kg/ha Zn *i.e.*, of T_6.

The number of capsules/plant increased because the application of N fertilizer increased branches. Number of seeds/capitulum differed significantly among different levels of nitrogen. Application of adequate nitrogen produced large number of seeds/capitulum with improved plant vigour coupled with increased production and translocation of photosynthesis have accommodated more number of seeds/capitulum. Similar findings were reported by Ramu and Reddy (2003) [13]. Higher number of capitulum/plant and increase in test weight of seed due to adequate N nutrition is explainable in terms of possible increase in nutrient mining capacity of plant as a result of better root development and increased translocation of carbohydrates from source to growing points in well fertilized plots. Test weight of seed increased significantly highest with nitrogen application of nitrogen might have increased the protein percentage which in turn increased the seed weight. The same trend was followed by Rani *et al.* (2014) [15]. The results corroborates with the findings of Das and Ghosh (1993) [3]. The improvement in seed yield with application of nitrogen was due to increase in yield attributing characters of safflower such number of capsules per plant, number seeds per capsules, and test weight. All these yield components recorded significantly higher value at nitrogen and zinc. Similar increases in yield attributes with increasing levels of nitrogen and zinc were reported in safflower. Increase in stover yield was due to increase in plant height, branches/plant resulting from the application of higher doses of nitrogen and zinc Nathan *et al.* (2017) [14], Rashid *et al.* (1994) [11], Grewal *et al.* (1998) [7]. Nitrogen application brought about significant improvement in stover yield also been reported by Singh and Singh (2013). Zinc also plays an important role in the production of biomass and N metabolism which leads to high yield and yield components (Cakmak, 2008) [1].

Economic attributes

Data presented in table-3 shows the economics performance of different treatment combination which evaluation was based on cost of cultivation (₹/ha), gross return (₹/ha), net return (₹/ha) and benefit cost ratio (B: C). Highest cost of cultivation (₹ 31,700.00), gross return (88,097.11 ₹/ha), net return (56,397.11 ₹/ha) and benefit cost ratio (1.78) were found with the application of T_6 (60 kg N/ha + 10 kg Zn/ha). Increasing levels of nitrogen, increased the net returns and benefit cost ratio. This might be due to maximum recovery from application of nitrogen with less expenditure. The gross monetary return and net monetary returns were influenced variably due to different levels of fertilization. Application of nitrogen and zinc recorded higher parameters. It might be due to higher level of yield with increased with fertilizer application. Similar result was recorded by Patel *et al*. (2012) [10]. Application of N & Zn recorded higher value of B: C. Similar result obtained by Tanwar *et al*. (2011) [18].

Table 1: Effect of N and Zn levels on growth parameters of safflower (*Carthamus tinctorius* L.)

Treatments	Plant height (cm) at harvest	Number of Branches/plant at harvest	Dry weight (g) at harvest	CGR (g/m²/day) 120 DAS - at harvest	RGR (g/g/day) 120 DAS -at harvest
T_1- 20 kg N/ha + 0 kg Zn/ha	94.245	16.27	33.32	2.10	0.0027
T_2- 40 kg N/ha + 0 kg Zn/ha	97.68	17.07	32.76	1.14	0.0005
T_3- 60 kg N/ha + 0 kg Zn/ha	98.61	18.40	33.65	2.27	0.0018
T_4- 20 kg N/ha + 10 kg Zn/ha	99.28	18.53	34.87	1.79	0.0010
T_5- 40 kg N/ha + 10 kg Zn/ha	103.45	19.20	39.83	3.55	0.0033
T_6- 60 kg N/ha + 10 kg Zn/ha	109.39	22.13	41.43	1.12	0.0016
T_7- 20 kg N/ha + 15 kg Zn/ha	103.56	19.20	36.03	2.91	0.0031
T_8- 40 kg N/ha + 15 kg Zn/ha	104.42	20.27	37.61	3.89	0.0052
T_9- 60 kg N/ha + 15 kg Zn/ha	108.44	21.47	38.35	4.99	0.0031
SEM(+)	1.45	0.67	1.53	2.12	0.0021
C.D. (5%)	4.35	2.01	4.58	-	-

Table 2: Effect of N and Zn levels on yield attributes of safflower (*Carthamus tinctorius* L.)

Treatments	Seeds/Capitulum	Capitulum/ plant	Test weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)	Oil content (%)
T_1- 20 kg N/ha + 0 kg Zn/ha	21.60	26.00	36.60	1.34	3.48	28.13	27.76
T_2- 40 kg N/ha + 0 kg Zn/ha	21.67	26.20	37.57	1.37	3.51	28.34	28.34
T_3- 60 kg N/ha + 0 kg Zn/ha	23.27	26.53	38.40	1.40	3.77	27.94	27.58
T_4- 20 kg N/ha + 10 kg Zn/ha	21.93	27.47	37.03	1.46	3.78	28.27	27.90
T_5- 40 kg N/ha + 10 kg Zn/ha	25.13	30.20	38.50	1.47	3.95	28.71	28.28
T_6- 60 kg N/ha + 10 kg Zn/ha	26.13	31.33	39.66	1.60	4.18	29.38	28.99
T_7- 20 kg N/ha + 15 kg Zn/ha	22.73	28.20	37.59	1.47	3.5	28.65	27.98
T_8- 40 kg N/ha + 15 kg Zn/ha	23.73	28.27	38.40	1.40	3.93	28.90	28.53
T_9- 60 kg N/ha + 15 kg Zn/ha	25.53	30.87	39.42	1.56	4.08	29.33	28.95
SEM(+)	0.83	1.13	1.09	0.04	0.11	0.84	0.83
C.D. (5%)	2.49	3.39	-	0.13	0.34	-	-

Table 3: Effect of N and Zn levels on economics of safflower (*Carthamus tinctorius* L.)

Treatments	Cost of cultivation (₹/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	B:C
T_1- 20 kg N/ha + 0 kg Zn/ha	30,400.00	73,890.93	43,490.93	1.43
T_2- 40 kg N/ha + 0 kg Zn/ha	30,600.00	75,284.40	44,684.40	1.46
T_3- 60 kg N/ha + 0 kg Zn/ha	30,800.00	77,277.88	46,477.88	1.51
T_4- 20 kg N/ha + 10 kg Zn/ha	31,300.00	80,644.00	49,344.00	1.58
T_5- 40 kg N/ha + 10 kg Zn/ha	31,500.00	81,218.53	49,718.53	1.63
T_6- 60 kg N/ha + 10 kg Zn/ha	31,700.00	88,097.11	56,397.11	1.78
T_7- 20 kg N/ha + 15 kg Zn/ha	31,750.00	80,481.53	48,731.53	1.53
T_8- 40 kg N/ha + 15 kg Zn/ha	31,950.00	77,434.05	45,484.05	1.42
T_9- 60 kg N/ha + 15 kg Zn/ha	32,150.00	85,798.41	53,648.41	1.67

Conclusion

On the basis of one season of experiment in safflower it may be concluded that the application of 60 kg N/ha + 10 kg Zn/ha showed superiority in growth and yield attributing characters such as seed yield (1.60 t/ha) and stover yield (4.18 t/ha) and as well as it is economically more profitable, hence it is more desirable and preferable to farmers.

References

1. Cakmak I. Enrichment of cereal grains with zinc: Agronomic or genetic biofortification Plant Soil 2008;302:1-17.
2. Chavan VM. Niger and Safflower. Indian Central Oilseeds Committee Publication, Hyderabad, India 1961, 57-150.
3. Das NR, Ghosh N. Effect of number of tillage and N-levels on yields of rainfed safflower after transplanted wet rice. *Proceedings 3rd International Safflower Conference* 14-18 June. Beijing, China, 1993, 403-409.
4. Donald CM, Hamblin J. The biological yield and harvest index of cereals as agronomic and plant breeding criteria. Advanced Agronomy 1976;28:361-405.
5. Dordas C, Sioulas C. Safflower yield, chlorophyll content, photosynthesis, and water use efficiency response to nitrogen fertilization under rainfed conditions. Industrial Crops and Products 2008;27(1):75-85.
6. Erenogin EB, Nikolie M, Romheld V, Cakmak I. Plant soil 2002;146:241-250.
7. Grewal HS, Grahamb RD, Stangoulisb J. Zinc-boron interaction effects in oilseed rape. Journal of Plant Nutrition 1998;21(10):2231-2243.
8. Gomez KA, Gomez AA. Statistical procedures for agricultural research (2 edition). John wiley and sons, New York, 1984, 680.
9. Marschner H. Mineral nutrition of higher plants. Acdemic Press 2 Diago CA. 2002.
10. Patel Y, Dabgar YB, Joshi PN. Distribution and diversity of grass species in Banni Grassland, Kachchh District, Gujarat, India. International Journal of Science Researsch Revolution 2012;1(1):43-56.
11. Rashid AE, Rafique Bughio N. Diagnosing boron deficiency in rapessed and mustard by plant analysis and soil testing communication in soil and plant analysis 1994;25(17-18):2883-2897.
12. Rashid A. Monitoring of soil fertility in Pakistan. National Book of Soil Science 1996;2(1):262-270.
13. Reddi Ramu Y, Maheswara Reddy P. Yield, quality and economics of sunflower as influenced by nitrogen and sulphur nutrition. Journal of Oilseeds Research 2003;20(1):131-132.
14. Revanth Nathan JK, Madhavi Lata A, Joseph B, Madhavi A. Influence of Nitrogen and Sulphur on Growth Yield and Economics of Spineless Safflower under Irrigated Conditions. International journal of Pure & Applied Bioscience 2018;6(3):77-81.
15. Sandhya Rani B, Muniratnam P, Gayathri, N., K. and Padmalatha, Y. response of safflower *(Carthamus tinctorius* L.) Varieties to different nitrogen levels in calcareous vertisols. The Journal research ANGRAU 2014;42(2):74-76.
16. Singh MV. Sulphur management for oilseed and pulse crops. Indian Institute of Soil Science 2000, 29.
17. Singh A, Singh D, Verma VK, Pyare R, Hussain MF. Studies on the effect of zinc and boron on growth and yield of linseed (*Linum usitatissimum* L.) under limited irrigation. International Journal of Chemical Studies 2020;8(5):1964-1966.
18. Tanwar SPS, Rokadia P, Singh AK. Effect of row ratio and fertility levels on chickpea (*Cicer arietinim*) and linseed (*Linum usitatissimum* L.) intercropping system. Indian Journal of Agronomy 2011;56:217-222.
19. Vishwanath H, Pujari BT, Prakash SS, Ramesh Babu, Deshmanya JB. Growth attributes, dry matter production and its partitioning and nutrient uptake studies in spineless safflower (*Carthamus tinctorius* L.) var, NARI-6 as influenced by nitrogen and sulphur levels. Karnataka Journal of Agricultural Science 2006;19(4):913-917.