The Pharma Innovation Journal 2022; 11(7): 1409-1412

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(7): 1409-1412

www.thepharmajournal.com
Received: 03-04-2022
Accepted: 09-05-2022

Effect of micronutrient foliar application on growth and yield of Niger (*Guizotia abyssinica* L.) under Rainfed Condition

Idhole GP, Nimanwad BB, Pawar SB and Gokhale DN

Idhole GP
M.Sc. Scholar, Department of Agronomy, College of Agriculture, VNMKV, Parbhani, Maharashtra, India

Nimanwad BB
M.Sc. Scholar, Department of Agronomy, College of Agriculture, VNMKV, Parbhani, Maharashtra, India

Pawar SB
Ph.D., Scholar, Department of Agronomy, College of Agriculture, VNMKV, Parbhani, Maharashtra, India

Gokhale DN
Director of Instruction & Dean (F/A), VNMKV, Parbhani, Maharashtra, India

Corresponding Author:
Idhole GP
M.Sc. Scholar, Department of Agronomy, College of Agriculture, VNMKV, Parbhani, Maharashtra, India

Abstract
The field experiment was conducted during *Kharif* 2019 at Experiment farm of Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The experiment was laid out in a randomized block design with eight treatments and three replications. The treatments were T_1: Control (No any foliar application), T_2: B (0.5%), T_3: Zn (0.5%), T_4: Fe (0.5%), T_5: B (0.5%) + Zn (0.5%), T_6: B (0.5%) + Fe (0.5%), T_7: Zn (0.5%) + Fe (0.5%) and T_8: B (0.5%) + Zn (0.5%) + Fe (0.5%). Application of micronutrients in treatment T_8 i.e. B (0.5%) + Zn (0.5%) + Fe (0.5%) to niger crop recorded significantly higher values in growth attributes like plant height, number of functional leaves, number of branches, leaf area and total dry matter and followed by the treatment T_7 i.e. Zn (0.5%) + Fe (0.5%) at flowering. The lowest values of the above mentioned parameters was recorded with Control (No any foliar application) was applied in (T_1). The effect of different treatments on yield and yield attributing characters *viz*., number of capsule plant-1, weight of capsule plant-1 (g), weight of seed plant-1, number of seed capsule-1, test weight (1000 seeds), grain, straw, biological yields (kg ha-1) and harvest index were considerably higher with the application of B (0.5%) + Zn (0.5%) + Fe (0.5%) at flowering and capitula formation (T_8) followed by the application of Zn (0.5%) + Fe (0.5%) at flowering (T_7) and the lowest values of the above mentioned parameters was recorded with Control (No any foliar application) was applied in (T_1). On the basis of above findings, it may be inferred that, for getting maximum seed yield application of B (0.5%) + Zn (0.5%) + Fe (0.5%) at flowering and capitula formation was found to be effective in increasing production of niger crop.

Keywords: Micronutrient, Niger, growth, yield and yield attributes

Introduction

India is the largest economy in the world with 21 percent of the world' sare abut accounts for less than10 percent of the world's agricultural production to meet the need of about 16 percent of the world's population. Oil seed is the second largest agricultural commodity after cereals sharing 13 percent of the country's gross crop ped area and accounting for nearly 6 percent of gross national production and 10 percent of the value of all agricultural commodities.

There has been a serious imbalance in the availability through domestic production and demand of oil in the country because of phenomenal increase in human population. The increased demand of edible oil in country and low productivity of oil seeds led to tremendous increase in prices of oil seeds and edible oil. The increased rate of consumption coupled with geometrically increased population will exalt the dimension of oil deficit problems (Acharya, 1989) [1]. The review of experiences indicated that there has been serious imbalance in the availability through the domestic production and demand of oil in the country. Annual per capita consumption of oil sand fats remained only 14.8 kg as against 41 kg in developed countries and 26 kg world average (Hegde 2012) [6].

The low productivity of Niger in Maharashtra due to grown on the light soil, low yielding ability, lack of fertilizer and irrigation responsive genotypes and lack of information regarding micronutrient application, sowing time, seed rate and varieties suitable for specific region. Almost 72% of the total oilseeds area is confined to rainfed farming, cultivated mostly by small and marginal farmers. The problem of micronutrient deficiency zinc (Zn), iron (Fe) and boron (Bo) is becoming more serious due to introduction of high yielding varieties, increasing cropping intensity, use of high analysis fertilizers and limited use of organic manures These are causes for poor productivity of oilseed crops. According to Marschner (1993) [7], in arid regions' soils encountering Zn and Fe deficiency, soil application of Zn and Fe are not effective. Instead, foliar application of such nutrients in the early growth period of grain crops would increase their performance. Findings have demonstrated that spraying of micronutrients such as Bo, Zn and Fe significantly increases the number of seeds per head, 1000 seeds' weight, grain yield, oil, and protein content (Ravi *et al.* 2008) [10]. Foliar application of nutrients has become an efficient way to increase yield and quality of crops (Romemheld and El-Fouly, 1999). It is reported that foliar Zn and Mn application can improve the seed yield and seed quality of safflower (*Carthamus tinctorius* L.) grown under drought stress (Mohsen Movahhedy-Dehnavy, 2009) [8]. Micronutrient deficiency are now frequently observed in Marathwada region so for overcoming these problems and getting higher yield of niger must need to use foliar application of micronutrients. Hence, it is necessary to study adopt the proper micronutrient management practices increasing the productivity of oilseed crops.

Niger require relatively in smaller quantity micronutrients. They include iron (Fe), manganese (Mn), zinc (Zn), boron (B), copper (Cu), molybdenum (Mo) chlorine (Cl). In oilseeds these micronutrients play a major role in translocation of photosynthates, increasing seed setting percentage, essential for translocation of sugar, germination of pollen grains, stigma receptivity, amino acid and protein synthesis which ultimately increase the productivity of oilseed crops. Zinc, Boron, Ferrous is an essential micronutrient and plays a key role as a structural constituent or regulatory cofactor of a wide range of different enzymes and proteins in many important biochemical pathways like carbohydrate metabolism, photosynthesis, conversion of sugars to starch, protein metabolism, auxin (growth regulator) metabolism, pollen formation, integrity of biological membranes and resistance to infection by certain pathogens. Micronutrients are needed in small, but critical concentrations and if the amount available is not adequate, plants will suffer from physiological stress. Under Zinc, Boron, Ferrous deficient conditions, flowering and fruit development is reduced and growth period is prolonged resulting in delayed maturity, leading to lower yield, poor quality and suboptimal nutrient use efficiency.

Materials and Methods

The experiment was carried out at experimental farm, Department of Agronomy, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani, during *Kharif* 2019. The topography of experimental plot was fairly levelled. The soil was medium black in colour, high retentive of moisture, deep well and fairly well drained, medium in organic carbon, poor in nitrogen, medium in available phosphorus and high in potash and slightly alkaline in reaction. Geographically parbhani is situated at 19016' North latitude and 76047' East longitude and at 409 m altitudes above sea level and has a semi- arid climate. The total rainfall received during the crop growth period (July to Nov. 2019) was 731.7 mm over 53 rainy days. During this period, monthly maximum rainfall 332 mm was received in the month of September and minimum rainfall 26.3 mm was received in the month of October.

The experiment was laid out in Randomized Block Design with three replications. The treatments were consisting of RDF and foliar application of micronutrient at flowering and capitula formation constituting eight treatments i.e. T_1: Control (No any foliar application), T_2: B (0.5%), T_3: Zn (0.5%), T_4: Fe (0.5%), T_5: B (0.5%) + Zn (0.5%), T_6: B (0.5%) + Fe (0.5%), T_7: Zn (0.5%) + Fe (0.5%), T_8: B (0.5%) + Zn (0.5%) + Fe (0.5%). The layout was consisted of 24 experimental units in three replications with 8 experimental units in each replication.

The gross and net plot size of each experimental unit was 5.4 m x 4.5 m and 4.8 m x 4.3 m, respectively. Sowing was done on 4th July 2019 by dibbling method at spacing of 30 x 10 cm. The recommended cultural practices and plant protection measures were undertaken.

The recommended dose of fertilizer (40:20:20 kg N, P2O5, K2O ha-1) was applied as basal dose at the time of sowing through urea SSP and muriate of potash was applied as per treatments. The crop was harvested on 14th October 2019.

Mean emergence count and final plant stand at harvest were taken from each net plot. The biometric observations were recorded at various stages of crop growth on different characteristics *viz*., plant height, number of functional leaves, leaf area, number of branches and dry matter on five plants select from each net plot. Post-harvest studies include number of capsule plant-1, number of seed capsule-1,weight of capsule plant-1and weight of seed plant-1 were recorded with five plant samples from each net plot at the time of harvest. The seed and straw yield was also recorded from each net plot at the time of harvest. The test weight (g), seed, straw, biological yields (kg ha-1) and harvest index (%) were also calculated.

Results and Discussion

The results as well as discussions of the various treatment have been presented under following heads:

Effect on growth parameters

Effect of different micronutrient foliar application on plant height, number of functional leaves, number of branches, leaf area and total dry matter are presented in Table 1 & 2. All the growth parameters achieved higher values like plant height (121.53cm), number of functional leaves/plant (67.27), number of branches/plant (15.93) were recorded with application B (0.5%) + Zn (0.5%) + Fe (0.5%) at flowering and capitula formation(T8) during the entire crop growth period. The lower value like plant height (110.92 cm), number of functional leaves/plant (64.40), number of branches/plant (9.83), number of capsule/plant (18.3),weight of capsule/plant (3.67) and weight of seed plant (1.52) were recorded with treatment (T_1) that is control (No any foliar application).

Micronutrients foliar application at flowering and capitula formation which are readily better uptake and translocate to growing plants and thereby instantly available to plants. The increase in plant height, number of branches per plant in response to application of micronutrients is probably due to enhanced availability and efficiency of nutrients. The variation in plant height due to nutrient sources was considered to be due to variation in the availability of nutrients. More number of branches and plant height might be due to the more availability of nitrogen, Boron, zinc and ferrous which plays a vital role in cell division, translocation of sugar, cell development, absorption of nutrients. Several workers have reported marked superiority in growth parameters like plant height and branches/plant due to adequate nutrient supply in niger. The productivity of niger plant is greatly dependent on the number of capsule per plant, weight of capsule per plant and weight of seed per plant. In present investigation maximum number of capsule per plant, weight of capsule per plant and weight of seed per plant were observed in the all the treated plants. Similar increase in these yield attributes have also been advocated by the several researchers (Fakeerappa *et al*. (2015) [4], Ali Taddayon *et al*. (2017) [2] and Chatterjee *et al*. (2019) [3].

Table 1: Effect of micronutrient foliar application on mean plant height (cm), no of functional leaves plant^{-1} and no. of branches plant^{-1} of Niger crop as influenced by different treatments.

Tr. No.	Treatment	Mean plant height (cm)			No of functional leaves plant-1			No. of Branches plant-1		
		60 DAS	90 DAS	At harvest	45 DAS	60 DAS	At harvest	45 DAS	60 DAS	At harvest
T_1	Control (No any foliar application)	103.29	109.9	110.92	45.33	64.40	10.53	6.20	9.27	9.83
T_2	B (0.5%)	99.64	109.7	111.49	44.07	63.60	11.47	6.47	9.93	10.27
T_3	Zn (0.5%)	100.75	111.8	112.49	44.70	65.33	10.53	6.67	10.07	10.33
T_4	Fe (0.5%)	98.65	109.7	109.90	43.73	64.93	10.00	6.67	10.33	10.60
T_5	B (0.5%) + Zn (0.5%)	98.98	110.9	111.68	43.07	64.73	10.33	6.80	10.67	10.47
T_6	B (0.5%) + Fe (0.5%)	102.88	112.1	113.55	44.60	63.80	10.00	6.47	10.53	11.50
T_7	Zn (0.5%) + Fe (0.5%)	105.14	116.7	118.25	45.67	65.13	11.73	8.00	11.53	12.13
T_8	B (0.5%) + Zn (0.5%) + Fe (0.5%)	110.12	119.2	121.53	47.00	67.27	13.00	9.60	14.07	15.93
S.Em±		2.10	1.81	1.66	1.07	1.78	0.50	0.20	0.34	0.39
CDat5%		6.36	5.47	5.03	3.25	5.37	1.52	0.62	1.02	1.20
GM		102.43	112.49	113.72	44.47	63.03	10.95	7.10	10.80	11.38

Table 2: Effect of micronutrient foliar application on mean leaf area (dm^2), mean total dry matter (g) plant^{-1} and no. of capsule plant^{-1} (g) of Niger crop as influenced by different treatments.

Tr. No.	Treatment	Mean leaf area (dm^2)			Mean total dry matter (g) plant^{-1}			No. of capsule plant^{-1} (g)		
		60 DAS	75 DAS	At harvest	61-75 DAS	76-90 DAS	91-At harvest	60 DAS	90 DAS	At harvest
T_1	Control (No any foliar application)	9.37	5.87	3.13	9.93	10.73	11.40	14.00	17.67	18.03
T_2	B (0.5%)	9.93	6.47	3.70	10.87	13.67	14.00	13.67	16.33	16.70
T_3	Zn (0.5%)	10.17	6.67	4.10	10.07	12.30	12.80	13.33	16.67	17.00
T_4	Fe (0.5%)	10.33	6.67	4.27	10.33	12.40	13.07	13.00	16.00	16.37
T_5	B (0.5%) + Zn (0.5%)	10.80	6.80	4.30	10.67	12.33	12.67	12.67	16.67	17.03
T_6	B (0.5%) + Fe (0.5%)	11.47	6.47	4.23	12.57	13.47	13.73	14.67	17.67	18.03
T_7	Zn (0.5%) + Fe (0.5%)	12.53	8.00	4.73	13.73	16.50	16.73	15.00	18.67	19.00
T_8	B (0.5%) + Zn (0.5%) + Fe (0.5%)	13.87	9.60	5.90	14.07	17.73	18.40	16.33	23.00	23.33
S.Em±		0.52	0.23	0.47	1.01	1.38	1.39	-	-	-
CDat5%		1.59	0.69	1.43	3.07	4.16	4.21	-	-	-
GM		11.05	7.06	4.29	11.53	13.64	14.1	14.08	17.83	18.18

Effect on yield and yield attributing characters

The effect of different treatments on yield and yield attributing characters *viz*., number of capsule plant-1, weight of capsule plant-1 (g), weight of seed plant-1, number of seed capsule-1, test weight (1000 seeds), grain, straw, biological yields (kg ha-1) and harvest index were considerably higher with the application of B (0.5%) + Zn (0.5%) + Fe (0.5%) at flowering and capitula formation (T_8) followed by the application of Zn (0.5%) + Fe (0.5%) at flowering (T_7). The lowest values of the above mentioned parameters was recorded with Control (No any foliar application) was applied in (T_1) Table 3 & 4. There was 40.93% increase in seed yield due to foliar applications of B (0.5%) + Zn (0.5%) + Fe (0.5%) at flowering and capitula formation stage (T_8).

The increase in seed yield could be due to the increase in yield attributes (number of capsule per plant, weight of capsule per plant and weight of seed per plant) consequently. Niger required fully dry spell during flowering and seed setting, rainfall at flowering and seed setting period is very much detrimental for the crop yield, due to this reason yield variations were found among the experimental years. The increase in yield components can be due to the fact that available more water enhanced nutrient availability which improved nitrogen and other macro and micro elements absorption as well as enhancing the production and translocation of the dry matter content from source to sink. The superiority in seed yield due to foliar applications of micronutrients supplemented increases efficiency of nutrients as per needs by the crop. Several workers have emphasized for such improved nutrient use efficiency through the foliar applications of fertilizers in niger and other resembling crops under varying agro-climatic conditions (Fakeerappa Arabhanvi *et al*., 2015, Hedage, 2012, Galvi *et al*., 2012, Praveen *et al*., 2020) [4, 9].

Table 3: Effect of micronutrient foliar application on weight of capsule plant^{-1}, wt. of seed^{-1} plant (g) and no. of seed capsule^{-1}, no. of seed plant^{-1} (g) and thousands of seed weight (g) of niger crop as influenced by different treatments.

Tr. No.	Treatment	Weight of capsule plant^{-1} (g)			Wt. of seed^{-1} plant^{-1} (g)	No. of seed capsule^{-1}	No. of seed plant^{-1} (g)	Thousands of seed weight (g)
		60 DAS	75 DAS	At harvest				
T_1	Control (No any foliar application)	1.33	3.90	3.67	1.52	17.33	405.00	3.42
T_2	B (0.5%)	1.63	3.53	3.47	1.53	18.00	435.33	3.25
T_3	Zn (0.5%)	1.57	3.93	3.80	1.54	17.33	466.67	3.43
T_4	Fe (0.5%)	1.67	3.77	3.57	1.66	17.33	477.67	3.35

T_5	B (0.5%) + Zn (0.5%)	1.57	3.70	3.60	1.59	17.67	468.33	3.34
T_6	B (0.5%) + Fe (0.5%)	1.63	3.97	3.90	1.76	19.00	472.67	3.50
T_7	Zn (0.5%) + Fe (0.5%)	1.73	4.27	3.97	1.91	20.00	493.00	3.71
T_8	B (0.5%) + Zn (0.5%) + Fe (0.5%)	2.13	4.80	4.67	2.27	22.00	508.67	3.98
S.Em±		-	-	-	0.11	0.74	18.57	0.09
CDat5%		-	-	-	0.34	2.26	56.08	0.28
GM		1.65	3.98	3.82	1.72	18.53	465.91	3.49

Table 4: Effect of micronutrient foliar application on Seed, straw, biological yield (kg ha^{-1}) and harvest index (%) of Niger crop as influenced by different treatments.

Tr. No.	Treatment	Yield (kg ha-1)			
		Seed	**Straw**	**Biological**	**Harvest index (%)**
T_1	Control (No any foliar application)	358.33	1604.00	1962.33	18.26
T_2	B (0.5%)	370.00	1631.67	2001.67	18.48
T_3	Zn (0.5%)	388.00	1673.33	2061.33	18.82
T_4	Fe (0.5%)	402.33	1652.33	2054.67	19.58
T_5	B (0.5%) + Zn (0.5%)	417.00	1736.67	2153.67	19.36
T_6	B (0.5%) + Fe (0.5%)	432.00	1759.33	2191.33	19.71
T_7	Zn (0.5%) + Fe (0.5%)	494.70	1925.70	2420.30	20.43
T_8	B (0.5%) + Zn (0.5%) + Fe (0.5%)	505.00	1952.33	2457.33	20.55
S.Em±		11.09	56.56	54.64	-
CDat5%		33.50	170.78	164.99	-
GM		420.91	1741.92	2162.83	19.40

Conclusion

The application of B (0.5%) + Zn (0.5%) + Fe (0.5%) at flowering and capitula formation (T_8) will be beneficial for achieving higher growth, yield attributes and seed yield in niger crop which was significantly superior over all treatments and found at par with (T_7) Zn (0.5%) + Fe (0.5%). The lowest values of the above mentioned parameters was recorded with Control (No any foliar application) was applied in (T_1).

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