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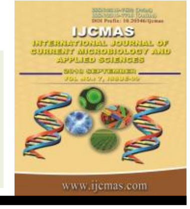

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Effect of Zinc, Boron and Iron on Growth and Phenological Characters of Brinjal (*Solanum melongena* L.)

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A B S T R A C T

An experiment was conducted to find out the suitable micronutrient or their combinations for foliar sprays in brinjal at the Horticulture Research Farm, R.A.K College of Agriculture, Sehore (M.P). The experiment comprised of total eight treatments micronutrients and control. The experiment was laid out in randomized completely block design with three replications. Application of RDF and foliar spray of micronutrients treatment T_8 (RDF+ Borax (0.2%) + $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%) recorded significantly growth (viz., plant height, number of leaves plant^{-1}, number of branches plant^{-1}, leaf area plant^{-1} and leaf area index) and phonological parameters (i.e. earliest first flowering, first fruit set and first picking and highest number of flowers cluster^{-1} and number of fruits cluster^{-1}). All the growth and phenological attributes of brinjal *viz*., plant height (82.67 cm),no. of leaves (173.27), no of branches (12.60), leaf area (2431.12 cm^2), leaf area index (0.540), and days to 1st flower initiation (37.33), days to first fruit set (42.33), days to 1st picking (58.33), number of clusters/plant (3.6), no. of flowers per cluster (5.2), number of fruits/ cluster (3.3) were recorded best in treatment T_8 (RDF+ Borax (0.2%) + $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%).

Introduction

Brinjal (*Solanum melongena* L.), or eggplant is one of the most common, popular and principle vegetable crop grown in India and other parts of the world. The brinjal is of much important in the warm areas of Far East, being grown extensively in India and other Asian countries like Bangladesh, Pakistan, and Philippines. Other major brinjal producing countries are China, Turkey, Japan, Egypt, Indonesia, Iraq, Italy, Syria and Spain. India contributes 13.44 million tonnes to the global production of brinjal in 2014-2015 and ranks second to China (NHB, at a galance 2015).

Brinjal occupies third position amongst vegetable crops grown in India, it covers i.e. 680.0 thousand hectare with a productivity of 18.70 t ha^{-1} and produces 12706.0 thousand tonnes in India in 2014-2015. Analysis of soil and plant samples has indicated that 49% soils in India are potentially deficient in Zn, 12% Fe, 5% Mn, 3% Cu, 33% B and 11% in Mo. Basal application to soil and or foliar sprays of Zn, B and Mo and foliar sprays of Fe and Mn have been recommended as the most suitable methods for correcting such deficiencies in crops (Singh 2008). Extent of micronutrients deficiency in NFSM States- (in M.P. sample deficient Zn 44%, Cu <1%, Fe>1%, Mn 1%, B 22%, Mo 18%). Application of micronutrients along with judicious use of nutrients (at RDF) will not only enhance productivity but will also increase the total production and the efficiency of fertilizer use in brinjal crop. While doing so, there is an urgent need to augment supplies of customized fertilizers supplying secondary and micronutrient to support sufficiently, the integrated use of nutrient management in brinjal production

Materials and Methods

The experiment was conducted at the Horticulture Research Farm, R.A.K College of Agriculture, Sehore (M.P) during kharif season of 2016-17. The land topography of the experimental site was almost uniform with an adequate surface drainage. The experiment was laid out in randomized completely block Design with three replications and eight treatments (Table 1).

Details of treatments used in the study

T_1-RDF (100:60:50 kg NPK/ ha) as control

T_2 -RDF+ Borax 0.2 %

T_3-RDF+ $FeSO_4$ 0.5%

T_4-RDF+$ZnSO_4$ 0.5%

T_5-RDF+ Borax (0.2%) + $FeSO_4$ (0.5%)
T_6-RDF+ Borax (0.2%) + $ZnSO_4$ (0.5%)

T_7-RDF+ $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%)

T_8-RDF+ Borax (0.2%) + $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%)

30 days old seedlings of brinjal (cv. UTKARSHA-F_1 hybrid Ankur) with a spacing of 75 cm row to row and 60 cm plant to plant transplanted in the plots in the afternoon hours immediately followed by irrigation for proper establishment of the seedlings.Observations were recorded on growth and phenological parameters. The data so generated was statistically analysed.

Results and Discussion

Effect of different treatments of foliar sprays of micronutrients on growth parameters of brinjal

The data presented in Table 1 demonstrates that the foliar application of micronutrients significantly influenced the growth parameters of brinjal plants. It clearly shows that the combine foliar sprays of micronutrients (zinc, boron and iron) caused an increase in height of the eggplant but in control treatments without foliar application of micronutrient shows decreased in plant height. The maximum plant height of eggplant (82.67cm) was found in treatment T_8 (RDF+ Borax (0.2%) + $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%) followed by T_6 (RDF+ Borax (0.2%) + $ZnSO_4$ (0.5%) (60.86 cm) at 120 days after transplanting. However, minimum plant height (63.68cm) was observed in treatment T_1 (RDF 100:60:50 kg NPK/ ha) as control. The increase in plant height may be due to application of major and minor nutrients, through foliar sprays of different micronutrients, increased the photosynthetic activity, chlorophyll formation, nitrogen metabolism and auxin contents in the plants which ultimately improving the plant height. The findings is also in agreement with the findings of Naga *et al.,* (2013), Mohsen (2013), Singh *et al.,* (2014), Gogoi *et al.,* (2014), Kadari, *et al.,* (2015), Meena *et al.,* (2015), Samira *et al.,* (2015), and Pandav *et al.,* (2016).

The treatments T_8 (RDF+ Borax (0.2%) + $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%) was recorded maximum number of leaves plant^{-1} followed by T_6 (RDF+ Borax (0.2%) + $ZnSO_4$ (0.5%) and T_5 (RDF+ Borax (0.2%) + $FeSO_4$ (0.5%) and treatment T_8 and T_6 were at par with each other at 120 DAT. However, minimum number of leaves/plant was observed in treatment T_1 (RDF 100:60:50 kg NPK/ ha) as control.

Foliar sprays of Zinc, Iron and Boron increased the nitrogen content of the leaves. Number of leaves increased may be due to promotive effects of macro and micronutrients on vegetative growth which ultimately lead to more photosynthetic activities. Similar results have been reported by Kiran *et al.,* (2010), Ali *et al.,* (2013), Singh *et al.,* (2014), Gogoi *et al.,* (2014), Tawab *et al.,* (2015) and Samira *et al.,* (2015).

The number of branches/plant of brinjal increased significantly with the increased crop growth period. Treatments T_8 (RDF+ Borax (0.2%) + $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%) was recorded maximum number of branches/plant followed by T_6 (RDF+ Borax (0.2%) + $ZnSO_4$ (0.5%) and T_5 (RDF+ Borax (0.2%) + $FeSO_4$ (0.5%) and treatment T_8 and T_6 were at par with each other at 120 DAT. However, minimum number of branches/plant was observed in treatment T_1 (RDF 100:60:50 kg NPK/ ha) as control. Probable reason for increased number of branches due to the increased rates of photosynthesis and photosynthates supply for maximum branches growth or change in endogenous auxin in turn in apical dominance. These findings are in agreement with the findings of Natesh *et al.,* (2005), Kiran *et al.,* (2010), Savitha *et al.,* (2010), Dubey *et al.,* (2013), Naga *et al.,* (2013), Mohsen (2013), Singh *et al.,* (2014), Gogoi *et al.,* (2014) and Meena *et al.,* (2015).

Similarly maximum leaf area/plant was exhibited in T_8 (RDF+ Borax (0.2%) + $FeSo_4$ (0.5%) + $ZnSO_4$ (0.5%) followed by T_6 (RDF+ Borax (0.2%) + $ZnSO_4$ (0.5%).

Leaf area was significantly increased by nitrogen, possibly because nitrogen helps in greater assimilation of food material by the plant which resulted in greater meristematic activities of cells and consequently the number of leaves, length and width of leaf of plant. These findings are in agreement with the results reported by Das *et al.,* (1978) and Yadav *et al.,* (2001).

The leaf area index increased significantly with the increased crop growth period. Significantly maximum leaf area index was estimated in T_8 (RDF+ Borax (0.2%) + $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%) followed by T_6 (RDF+ Borax (0.2%) + $ZnSO_4$ (0.5%) as compared to rest of the treatment, while, the minimum leaf area index was observed in treatment T_1 (RDF 100:60:50 kg NPK/ ha) as control. Leaf area index was significantly increased by nitrogen, possibly because nitrogen helps in greater assimilation of food material by the plant which resulted in greater meristematic activities of cells and consequently the number of leaves, length and width of leaf of plant.

Effect of different treatments of foliar sprays of micronutrients on phenological parameters of brinjal

Among phenological parameters, the days to first flower initiation, days to first fruit set, days to first picking, number of flowers/cluster, number of fruits/cluster and number of cluster/plant were studies in brinjal (Table 2).

Table.1 Effect of micronutrients on plant height (cm), No of leaves/plant, No of branches/plant, Leaf area (cm^2), Leaf area index of brinjal cv UTKARSHA-F_1 hybrid Ankur

Treatment	Plant height(cm)	No of leaves/plant	No of branches/plant	Leaf area (cm^2)	Leaf area index
T_1=RDF (100:60:50 kg NPK/ ha) control	63.68	144.07	7.40	1826.37	0.406
T_2=RDF+ Borax 0.2 %	72.29	162.33	10.00	2112.63	0.470
T3=RDF+ $FeSo_4$ 0.5%	69.25	149.07	8.70	1921.93	0.427
T_4=RDF+$ZnSo_4$ 0.5%	70.76	156.87	9.30	1994.47	0.443
T_5=RDF+ Borax (0.2%) + $FeSo_4$ (0.5%)	74.11	166.20	11.33	2294.12	0.510
T_6=RDF+ Borax (0.2%) + $ZnSo_4$ (0.5%)	80.61	170.80	12.20	2393.71	0.532
T_7=RDF+ $FeSo_4$ (0.5%) + $ZnSo_4$ (0.5%)	72.04	159.53	9.67	2010.86	0.469
T_8=RDF+ Borax (0.2%) + $FeSo_4$ (0.5%) + $ZnSo_4$ (0.5%)	82.67	173.27	12.60	2431.12	0.540
S.Em±	0.51	2.82	0.59	33.13	0.007
C.D.5% level	1.55	8.56	1.79	100.51	0.022

Table.2 Effect of micronutrients on Days to 1st flower initiation, Days to first fruit set, Days to 1st picking, Number of clusters/plant, No. of flowers per cluster and Number of fruits/ cluster of brinjal cv UTKARSHA-F_1 hybrid Ankur

Treatment	Days to 1st flower initiation	Days to first fruit set	Days to 1st picking	Number of clusters/plant	No. of flowers per cluster	Number of fruits/ cluster
T_1=RDF (100:60:50 kg NPK/ ha) control	41.67	47.67	64.33	5.3	3.2	2.1
T_2=RDF+ Borax 0.2 %	39.33	45.00	61.00	4.5	4.4	2.7
T3=RDF+ $FeSO_4$ 0.5%	41.00	47.00	63.33	4.6	3.7	2.4
T_4=RDF+$ZnSO_4$ 0.5%	40.67	46.67	62.67	4.4	3.8	2.5
T_5=RDF+ Borax (0.2%) + $FeSO_4$ (0.5%)	39.00	44.33	60.33	4.4	4.6	2.7
T_6=RDF+ Borax (0.2%) + $ZnSO_4$ (0.5%)	38.00	43.00	59.00	4.1	4.8	2.9
T_7=RDF+ $FeSO_4$ (0.5%) + $ZnSo_4$ (0.5%)	40.00	45.67	61.67	4.3	4.0	2.7
T_8=RDF+ Borax (0.2%) + $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%)	37.33	42.33	58.33	3.6	5.2	3.3
S.Em±	0.26	0.38	0.35	0.23	0.23	0.17
C.D.5% level	0.79	1.17	1.08	0.70	0.72	0.51

The earliest first flowering was recorded under treatment T_8 (RDF+ Borax (0.2%) + $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%) as compared to other treatment the and late flowering was noted in treatment T_1 (RDF 100:60:50 kg NPK/ ha) as control. B showed the highest P and K uptake at the pre flowering (P&K) and flowering (P only) stages. This was attributed to the increased photosynthesis and effective translocation of photosynthates. The findings are in agreement with findings of Naidu *et al.*, (2002), Khedr *et al.*, (2004), Dubey *et al.*, (2013), Ali *et al.*, (2013), and Meena *et al.*, (2015).

The days to first fruit set was significantly influenced due to various treatments of micronutrients. The earliest first fruit set was recorded under treatment T_8 (RDF+ Borax (0.2%) + $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%), followed by T_6 (RDF+ Borax (0.2%) + $ZnSO_4$ (0.5%). This might be due to the role of boron in flower development pollen germination fertilization and fruit abscission. Foliar spray of borax at 60 and 90 DAT closely synchronized with fruit development as it plays role in translocation of carbohydrates to developing fruits (Das, 2007). These findings are in agreement with the results reported by Khedr *et al.*, (2004), Natesh *et al.*, (2005), Ali *et al.*, (2013) and Suganiya and Kumuthini. (2015).

The early first picking were recorded in T_8 (RDF+ Borax (0.2%) + $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%). Foliar spray of borax at 60 and 90 DAT closely synchronized with fruit development as it plays role in translocation of carbohydrates to developing fruits, the findings are in agreement with the findings of Dubey *et al.*, (2013).

The number of flowers/cluster was significantly influenced due to various treatments. Significantly highest number of flowers/cluster was recorded in treatment T_8 (RDF+ Borax (0.2%) + $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%). Similarly highest number of fruits/cluster was recorded in treatment T_8 (RDF+ Borax (0.2%) + $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%). Whereas highest number of cluster/plant was recorded in treatment T_1 (RDF 100:60:50 kg NPK/ ha) as control and lowest cluster/plant as observed under the treatment T_8 (RDF+ Borax (0.2%) + $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%).Increased number of flower per cluster, number of flowers/cluster, number of fruits/cluster due to foliar spray of micronutrients might be attributed to enhanced photosynthetic activity, resulting in increased production and accumulation of carbohydrates and favorable effect on vegetative growth and flowers, which might have increased number of flower cluster^{-1}. These findings are in agreement with the results reported by Ali *et al.*, (2013), Mohsen (2013), Suganiya and Kumuthini. (2015) and Meena *et al.*, (2015).

On the basis of results of present investigation it is concluded that foliar application of micronutrients enhanced most of the growth and phenological attributes of eggplant cv. UTKARSHA-F_1 hybrid Ankur. Application of RDF and foliar spray of micronutrients treatment T_8 (RDF+ Borax (0.2%) + $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%) were recorded significantly higher growth (viz., plant height, number of leaves plant^{-1}, number of branches plant^{-1}, leaf area plant^{-1} and leaf area index) and phonological parameters (i.e. earliest first flowering, first fruit set and first picking and highest number of flowers cluster^{-1} and number of fruits cluster^{-1}).

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