Foliar Feeding of Micronutrient Mixtures on Growth and Yield of Okra (Abelmoschus esculentus)

H. Mehraj, T. Taufique, M.S.H. Mandal, R.K. Sikder and A.F.M. Jamal Uddin

The United Graduate School of Agricultural Sciences, Ehime University, 3-5-7 Tarami, Matsumaya, Ehime 790-8556, Japan
Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh
Scientific Officer, CRP-Hill Agriculture, Krishi Gobeshona Foundation, Bandarban-4600, Bangladesh
Horticulture Development Division, BADC, Dhaka-1000, Bangladesh

Abstract: An experiment was conducted to study the performance of foliar feeding of micronutrients on growth and yield of okra. Foliar application of 100-ppm of six micronutrients (Zn, B, Fe, Cu, Mo and Mn) mixture were done and treatments were considered as M1: Control (Fresh water spray) M2: one times foliar application (20 days after sowing (DAS) and M3: two times foliar application (20 DAS and 35 DAS). The tallest plant (90.5 cm), longest petiole (29.1 cm), longest internode (12.1 cm) and longest pod (17.4 cm) was also found from M1, while the shortest from M3. The maximum stem diameter (3.3 cm), number of leaves (50.8/plant), leaf area (30.9 cm²), number of branches (5.6/plant), number of internodes (21.6/plant), fresh weight (87.2 g/plant), dry weight (11.6 g/plant), number of pod (34.1/plant), pod diameter (1.7 cm) and yield (368.7 g/plant, 3.2 kg/plot and 17.8 t.ha) was found from M1, whereas the minimum from M3. Foliar feeding of micronutrients mixture can increases the growth and yield of okra.

Key words: Okra • Zn • B • Fe • Cu • Mo • Mn • growth and yield

INTRODUCTION

Okra (Abelmoschus esculentus) belongs to Malvaceae family originated in Asia and Africa [1] is an important summer vegetable in Bangladesh [2]. It plays an important role to meet the demand of vegetables of the country when vegetables are scanty in the market [3]. Although okra is very much popular in Bangladesh but average yield is very low which is about 4.2 t/ha [4], while yield varied from 11.0 to 15.0 t/ha from region to region [5]. Micro nutrients are required for optimal growth [6, 7] specifically six micronutrients (Zn, B, Fe, cu, Mn) play vital roles in plant physiology and biochemical processes [8, 9]. Zinc influence on basic plant life processes, nitrogen metabolism, uptake of nitrogen and protein quality, photosynthesis, chlorophyll synthesis, carbon anhydrase activity; resistance to abiotic and biotic stresses, protection against oxidative damage [10], membrane integrity and phytochrome activities [11]. Boron (B) for reproductive plant parts, cell wall formation and stabilization, membrane integrity, carbohydrate utilization, stomatal regulation and pollen tube formation (Marschner, 1995), Copper (Cu) for physiological redox processes, pollen viability and lignifications [12], Manganese (Mn) for enzyme activation, electron transport and in disease resistance [13]. Iron (Fe) is an important micronutrient for chlorophyll formation, photosynthesis, enzyme systems and respiration of plants [14]. Sometimes Fe application might cause nutritional disorder by its antagonistic effect with other cationic micronutrients, in particular with Mn [15] but potassium uptake was increased due to application of Cu and Fe [16]. Scarcity and excess of any nutrient in soil can be a barrier to growth [17]. Besides, application of these nutrients in soil is inaccessible to plant roots if soil pH is more [18, 19]. Foliar spray of micronutrients is more effective to control deficiency problem than soil application [20]. Foliar application of these nutrients [9] is generally done to
eliminate the effects of soil pH on the availability of these nutrients [21] and for less costly [22]. It was previously found as effective technique in tomato [9], wheat [23] and sorghum [17]. The aim of this study was to improve growth and yield characters of okra by foliar feeding of the micronutrients mixture.

MATERIALS AND METHODS

Experimental site, genetic materials and duration: Experiment was conducted in the Sher-e-Bangla Agricultural University, Dhaka, Bangladesh to find out the performance of okra (BARI Dherosh 1) from April to September 2014.

Treatments and experimental design: Foliar application of 100-ppm of six micronutrients (Zn, B, Fe, Cu, Mo and Mn) mixture were applied and treatments were considered as M1: Control (Fresh water spray) M2: one times foliar application (20 days after sowing (DAS) and M3: two times foliar application (20 DAS and 35 DAS) in Randomized Complete Block Design with three replications.

Unit Plot Size and Seed Sowing Pattern: The size of the each plot was 1.5 m × 1.2 m. Seeds were sown in the plot with maintaining distance between row to row and plant to plant was 40 cm and 50 cm, respectively.

Fertilization: Cowdung @ 10t/ha, urea 120 @ 90 kg/ha, triple super phosphate (TSP) @ 90 kg/ha and muriate of potash (MP) @ 150kg/ha were used, respectively as basal dose.

Parameters and Procedures for Data Collection: Five plants were randomly selected from each unit plot for the collection of data. Data were collected on plant height, stem diameter, number of leaves/plant, number of branches/plant, length of petiole, number of internode/plant, length of internode, leaf area, fresh weight of plant, dry matter of plant, days to 50% flowering, number of flower buds/plant, number of pods/plant, length of pod, diameter of pod, yield/plant, yield/plot. After harvesting, 150 g plant sample (above ground) previously sliced into very thin pieces were put into envelop and placed in oven maintained at 70°C for 72 hours. The sample was then transferred into desiccators and allowed to cool down at room temperature. The final weight of the sample was taken.

The dry matter contents of plant were computed by simple calculation from the weight recorded by following formula:

%Dry matter content of plant = (Dry weight/Fresh weight)×100

Statistical Analysis: Collected data were analyzed statistically using MSTAT-C computer package program. The significance of the difference among the treatments was estimated by Duncan’s Multiple Range Test (DMRT) at 5% level of probability [24].

RESULTS

Plant Height and Stem Diameter: Plant height and stem diameter of okra varied significantly among treatments at different DAS (days after sowing). The tallest plant was found from M3 (90.3 cm) which was statistically identical with M2 (88.3 cm), while the shortest from M1 (78.9 cm) (Fig. 1a). The maximum stem diameter was found from M3 (3.3 cm) which was statistically identical with M2 (2.3 cm), while the minimum from M1 (1.6 cm) at 60 DAS (Fig. 1b).

Number of Leaves and Leaf Area: Spraying frequency of six micronutrients mixture showed a significant variation for number of leaves and leaf area of okra at different DAS. The maximum number of leaves was found from M3 (50.8/plant) which was statistically identical with M2 (49.2/plant), whereas the minimum was observed from M1 (41.6/plant) at 60 DAS (Fig. 2a). The maximum leaf area was found from M3 (30.9 cm²) which was statistically similar with M2 (29.7 cm²), while the minimum from M1 (24.8 cm²) at 60 DAS (Fig. 2b).

Number of Branches and Length of Petiole: The maximum number of branches was found from M3 (5.6/plant) which was statistically identical with M2 (5.4/plant), while the minimum from M1 (4.6/plant) at 60 DAS (Fig. 3a). The longest petiole was found from M3 (12.1 cm) which was statistically similar with M1 (11.6 cm), whereas the shortest from M1 (10.1 cm) at 60 DAS (Table 6).

Number and Length of Internodes: The maximum number of internodes was recorded from M1 (21.6/plant) which was statistically identical with M2 (21.2/plant), while the minimum from M1 (18.9/plant) at 60 DAS (Fig. 4a). The longest internode was found from M1 (12.1 cm) which was statistically similar with M1 (11.6 cm), whereas the shortest from M1 (10.1 cm) at 60 DAS (Table 6).
Fig. 1: Effect of spraying frequency of six micronutrient mixture on (a) plant height and (b) stem diameter of okra

Fig. 2: Effect of spraying frequency of six micronutrient mixture on (a) number of leaves and (b) leaf area of okra

Fig. 3: Effect of spraying frequency of six micronutrient mixture on (a) number of branches and (b) length of petiole of okra

Fig. 4: Effect of spraying frequency of six micronutrient mixture on (a) number of internodes and (b) length of internodes of okra
Table 1: Responses of spraying frequency of six micronutrient mixture to the okra plant on different growth and yield related attributes

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Weight/plant (g)</th>
<th>Number of Days to 50% flowering</th>
<th>Flower buds/plant</th>
<th>Pods/plant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fresh</td>
<td>Dry</td>
<td>Fresh</td>
<td>Dry</td>
</tr>
<tr>
<td>M₁</td>
<td>68.8 c</td>
<td>9.3 b</td>
<td>47.9 a</td>
<td>36.4 b</td>
</tr>
<tr>
<td>M₂</td>
<td>82.5 b</td>
<td>11.2 a</td>
<td>44.1 b</td>
<td>42.9 a</td>
</tr>
<tr>
<td>M₃</td>
<td>87.2 a</td>
<td>11.6 a</td>
<td>43.8 b</td>
<td>42.1 a</td>
</tr>
<tr>
<td>LSD(0.05)</td>
<td>4.5</td>
<td>0.4</td>
<td>2.2</td>
<td>1.3</td>
</tr>
<tr>
<td>CV (%)</td>
<td>7.3</td>
<td>9.7</td>
<td>4.7</td>
<td>8.3</td>
</tr>
</tbody>
</table>

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

Table 2: Responses of spraying frequency of six micronutrient mixture on pod characters and yield of okra

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Pod length (cm)</th>
<th>Pod diameter (cm)</th>
<th>Yield (g/plant)</th>
<th>Yield (kg/plot)</th>
<th>Yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M₁</td>
<td>M₂</td>
<td>M₃</td>
<td>M₁</td>
<td>M₂</td>
</tr>
<tr>
<td>LSD(0.05)</td>
<td>0.6</td>
<td>1.6</td>
<td>1.7 a</td>
<td>5.1</td>
<td>0.2</td>
</tr>
<tr>
<td>CV (%)</td>
<td>3.8</td>
<td>6.4</td>
<td>7.3</td>
<td>2.9</td>
<td>2.9</td>
</tr>
</tbody>
</table>

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

**Fresh and Dry Weight:** The maximum fresh weight was found from M₁ (87.2 g/plant), while the minimum from M₁ (68.8 g/plant) (Table 1). The maximum dry weight was found from M₁ (11.6 g/plant) which was statistically identical with M₂ (11.2 g/plant), while the minimum from M₃ (9.3 g/plant) (Table 1).

**Days to 50% Flowering:** Early flowering was found from M₁ (43.8 days) which was statistically identical with M₂ (44.1 days), while late from M₃ (47.9 days) (Table 1).

**Number of Flower Buds and Pods:** The maximum number of flower buds was found from M₁ (42.9/plant) which was statistically identical with M₂ (42.1/plant), while the minimum from M₃ (36.4/plant) (Table 1). The maximum number of pods was found from M₁ (34.1/plant) which was statistically identical with M₂ (31.9/plant), whereas the minimum from M₃ (23.7/plant) (Table 1).

**Pod Length and Diameter:** The longest pod was found from M₁ (17.4 cm) which was statistically identical with M₂ (16.9 cm), while the shortest from M₃ (15.1 cm) (Table 2). Pod diameter varied significantly due to the variation of the organic manures. The maximum pod diameter was found from M₁ (1.7 mm), while the minimum from M₃ (1.1 mm) (Table 2).

**Yield:** Yield of okra showed significant variation due to variation of spraying frequency of six micronutrient mixtures. However, the maximum yield was found from M₁ (368.7 g/plant, 3.2 kg/plant and 17.8 t/ha), whereas the minimum from M₃ (235.7 g/plant, 2.0 kg/plot and 11.2 t/ha) (Table 2).

**DISCUSSION**

From the study it was found that foliar application of micronutrients mixture improved the growth and yield of okra. Zn, B, Fe, Cu, Mo and Mn micronutrients have significant effect on plant physiology and also involved in biochemical processes [8, 9]. Deficiency of these micronutrients may cause reduction in plant yield due to lack of proper growth. It was found that all parameters showed better result by the foliar application of micronutrients mixtures but two times application was found as best than the single foliar application. It may be due to getting the sufficient amount of these nutrients stimulated enzymatic activities [25], leading to an improvement in biochemical processes like photosynthesis, respiration and protein synthesis [26]. Micronutrients involves in different physiological process like enzyme activation, electron transport, chlorophyll formation and stomatal regulation etc. which ultimately resulted in greater dry matter [27, 28]. Inadequate level of micronutrients may responsible for lower plant growth and yield of okra and for that reason two times foliar application made the plants adequate absorption and utilization of these nutrients that accelerate plant growth and get a higher yield of okra. Similar observations were also found by Ali [21] as being due to foliar application of
micronutrient. Our study showed that inadequate or imbalanced use of micronutrients is one of the key factors for low yield of okra. This paper also suggests that foliar application of micronutrients mixture is an effective technology for increasing the yield of okra.

CONCLUSION

Significant variation among treatments was found in all parameters. Twice (20 DAS and 35 DAS) foliar application of micronutrients mixture was found to be better than the single foliar application (20 DAS) and control. Therefore, foliar application of a micronutrient mixture (Zn, B, Fe, Cu, Mo and Mn) @ 50 ppm is suggested for better plant growth and getting maximum yield from okra.

REFERENCES


