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Effect of foliar application zinc and boron on vegetative growth characters of okra

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Abstract
To know the effect of zinc and boron on crop growth a field experiment was conducted at vegetable research farm, College of Horticulture and Forestry, Pasighat during the rainy season of the year 2019. Two micronutrients (Zinc and Boron) in the form of zinc sulphate and borax were taken in different concentrations (0.5, 1.0 and 1.5%) and applied at 30 and 60 DAS respectively. The results indicated that among different treatments the highest plant height (141.18 cm) at final harvest, Number of nodes per plant (16.26), Inter-nodal length (8.78 cm) and Number of branches per plant (1.93) were recorded the highest with the treatment receiving Borax- 1.0% (T_5). The least days taken to first flowering (52.77) and fifty per cent flowering (60.13) were also recorded with the same treatment (Borax- 1.0%). All the other parameters found significantly lowest under control treatment (T_0).

Keywords: foliar application zinc, boron, vegetative, growth, okra

Introduction
Okra is a tall growing, annual, semi woody and warm season crop. It is self-pollinated crop, but occasionally up to 20% cross pollination occurs by insects. The okra flowers blossoms only one day. Okra pods are harvested when they reach the maximum size but still tender (may be 60-180 days from sowing) around 5-10 days after opening of flower depending on the cultivar grown (Adetuyil *et al*., 2008) [1]. Okra pods are considered nutritious, providing some human supplementary, vitamins such as vitamin C, A, B complex, calcium, potassium, iron and other minerals (Lee *et al*., 1990; Adebooye and Opunta, 1996) [2, 3]. Okra pod contains many nutritional contents which important for human health. One hundred gram of fresh pod has around; moisture (89.6 percent), K (103 mg), Ca (90 mg), Mg (43 mg), P (56 mg), vitamin C (18 mg) and some important metals such as iron and aluminium (Markose and Peter, 1990) [4].

Vegetable crops respond very well to the application of micro-nutrients under Indian condition. Generally micronutrients are applied in different ways *viz*., soil application, seedling root dipping, seed treatment and foliar spray. Among the four methods, foliar application is widely adopted due to convenience in application requirement in small quality. Foliar application of micronutrients is widely used that avoid the fixation in soil. Moreover, the uptake and assimilation of micronutrients through foliar application will be faster. It has been observed that the foliar spray of zinc, iron, copper, molybdenum and boron are often more effective than soil application because these elements are not highly soluble in the soil. It has also been proved that foliar feeding of nutrients is many time more effective and economical than soil application (Shanmugavelu, 1989) [5].

Micronutrients are essential for plant life cycle but required in relatively smaller quantities by the crop. Micronutrients are usually required in minute quantities, nevertheless, are vital to the growth of plant. Micronutrients such as iron, zinc, boron, manganese, *etc*., have been reported to play a vital role in modifying the growth and development of many horticultural crops. They improve general condition of plants and are known to act as catalyst in promoting organic reactions taking place in plant. Foliar application of micronutrients to crop plants is gaining popularity in increasing crop yield and quality with improved shelf life of the produce. Spraying of minor elements corrects the nutritional disorders.

Materials and Methods
The experiment was conducted at Vegetable Research Farm, College of Horticulture and Forestry, Central Agricultural University, Pasighat, East Siang, Arunachal Pradesh. The experiment was laid in randomized block design (RBD) with three replications in which the

treatments comprised of three levels of micronutrients *i.e.* Zinc sulphate (0.5. 1.0 and 1.5%) and Borax (0.5. 1.0 and 1.5%) respectively and compared with control.

The experimental field was prepared by three ploughing with the help of tractor drawn implement followed by harrowing and planking. Farm yard manure was applied at the rate of 10 t ha^{-1} along with recommended dose of NPK (120:60:60 kg ha^{-1}). In all cases, half of the of nitrogen dose in form of urea was applied as basal dose at the time of sowing and remaining half dose was applied in two equal splits as top dressing of 30 kg ha^{-1} at 30 and 60 days after sowing. The entire dose of phosphorus and potassium was applied uniformly to all the plots in form of single super phosphate and muriate of potash before sowing. Healthy uniform seeds were collected and soaked for 12 hours in water before sowing.

The micro-nutrients were sprayed on foliage in aqueous form by using fresh solution at each spray. Spraying was done with knapsack sprayer and the leaves were wetted thoroughly with fine mist. First foliar spray was applied at 30 days after sowing and second sprays at 60 days after sowing. For better absorption of spray solution by okra leaves, a pinch of sticker (Tipol) was added to the spray solution before spraying. The spraying was done during evening hours.

The data were collected from randomly selected five tagged plants and average of these plants was taken for statistical analysis. Days taken to first and fifty per cent flowering were calculated from the days of sowing to appearance of first flower and the fifty per cent of plants of each plot came to flower.

Results and Discussion

The highest plant height (141.18 cm) at the end of cropping season, number of nodes per plant (16.26), Inter-nodal length (8.78 cm) and branches per plant (1.93) was recorded with the treatment receiving borax- 1.0% (T_5) at 30 and 60 DAS which was found to be *at par* with rest of the treatments and significantly superior over control treatment (T_0). This might be due to fact that Boron involved in the various physiological activities in the plants such as, development of cell wall, metabolisms of RNA and protein, transport of sugar from source to sink during flowering and fruiting stage, synthesis of ATP (Adenosine triphosphate) thus, help in improving the growth attributes of the okra plant. The result is supported by findings of Satpute *et al*. (2013) [6] in okra, Patil *et al.* (2008) [7], Naga Sivaiah *et al.* (2010) [8], Salam *et al*. (2010) [9], Chand and Prasad (2017) [10] in tomato and Dubey *et al*. (2013) [11] in bell pepper. Improvement in the growth characters due to application of zinc over control might be due to zinc involved in various enzymatic and physiological activities inside the cell. It involved in formation of some growth hormones and maintains the accurate level of auxin in the cell in active form (Yawalkar *et al.,* 1997) [12]. Deficiency of zinc in plant causes less oxidation of carbohydrate, improper development of chlorophyll and low level of auxin which in turn reduced the proper growth and development of plant.

Amongst the different treatments the least days taken for the appearance of first and fifty per cent flowering (52.77 & 60.13 DAS) were also recorded with the T_5 (Borax- 1.0%) followed by application of boron and zinc at different concentration and significantly superior over control treatment (T_0). This might be due to fact that it involved in synthesis of Adenosine Triphosphate (ATP) and translocation of sugars which help in more flowering. Also boron involved in different enzymatic reaction and help in synthesis of different growth regulators which help in early flowering in okra. Similar result was reported by Kumar and Sen (2004) [13], Rani *et al*. (2013) [14], Satpute *et al.* (2013) [6] in okra.

Table 1: Effect of Zinc and Boron on Growth Characters of Okra

Treatments	Plant Height (cm)	Number of Nodes $Plant^{-1}$	Inter-Nodal Length (cm)	Number of Branches $Plant^{-1}$	Days taken to First Flowering	Days taken to 50% Flowering
T_0: Control	124.64	15.54	8.10	1.16	54.93	62.30
T_1: Zinc Sulphate- 0.5%	136.14	16.18	8.51	1.33	54.47	61.83
T_2: Zinc Sulphate- 1.0%	138.90	16.22	8.66	1.60	54.13	61.50
T_3: Zinc Sulphate-1.5%	136.50	16.20	8.52	1.43	54.37	61.73
T_4: Borax- 0.5%	138.68	16.22	8.64	1.40	53.53	60.87
T_5: Borax- 1.0%	141.18	16.26	8.78	1.93	52.77	60.13
T_6: Borax- 1.5%	139.36	16.26	8.66	1.80	53.57	60.93
SE(d)	3.08	0.13	0.08	0.24	0.79	0.56
C.D. at 5%	6.80	0.30	0.18	0.52	0.55	1.22

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