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Effect of foliar spray of Micronutrients on Yield of Cabbage (*Brassica oleracea* L. var. Capitata)

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Abstract
The experiment was conducted during *rabi*, 2016-2017 at Regional Horticultural Research Station, Navsari Agricultural University, Navsari, Gujarat, India to evaluate the yield performance of cabbage (*Brassica oleracea* L. var. Capitata) through foliar spray of micronutrients. The experiment was arranged over 9 treatments comprising micronutrient sources T_1 :Ammonium molybdate (0.1%), T_2 :Boric acid (0.2%), T_3 : Zinc sulphate (0.5%), T_4 :Copper sulphate (0.5%), T_5 :Ferrous sulphate (0.5%), T_6 :Manganese sulphate (0.5%), T_7 :1% General grade-1 (Fe-2.0, Mn-0.5, Zn-4.0, Cu-0.3, B-0.5), T_8:1% General grade-1 + T1 which was laid out in a Randomized Block Design with three replications. The application of 1% General grade-1 + T_1 (0.1% Ammonium molybdate) had shown significant impact on highest head yield per hectare (24.24 t), yield of head per plot (31.42 kg) and other yield attributes *viz*., polar diameter of head (15.46 cm), equatorial diameter of head (13.35 cm), gross weight of head (1.24 kg/plant) and net weight of head (748.00 g/plant) were recorded significantly highest in T_8 (1% General grade-1 + T_1) treatment. While head compactness did not show any significant differences.

Keywords: Cabbage, Foliar spray, Micronutrients, Yield

1. Introduction
Cabbage (*Brassica oleracea* L. var. Capitata) is important among winter vegetables in India belonging to Brassicaceae family and is one of the important cole crops. The cabbage head is rich source of vitamin A, B, C and minerals. It helps in preventing constipation, increase appetite, speed up digestion and very useful for diabetic patients (Kotecha *et al*. 2016) [1]. Cabbage requires a fairly good amount of nutrients for better yield. Such a heavy demand of nutrients by cabbage cannot be met from soil without supplementing them. The micronutrients though required in small quantities are as important as macronutrients. The role of micronutrients in regulation plant growth and yield is established (Narayanamma *et al*. 2007) [6]. The intensive cultivation and judicious use of only nitrogenous fertilizers, soils becoming deficient in secondary micronutrients. Since, the micronutrients are costly chemicals, amelioration of such deficiencies through soil application may increase the cost of cultivation, whereas, foliar applications might reduce the cost owing to the small quantities required and better absorption through the foliage. Now a days, it is realized that foliar spary of micronutrients are proved beneficial to increase yield, quality and improving shelf life of cabbage (Kotecha *et al*. 2011) [2]. Cabbage requires all the essential micronutients *viz*., Ammonium molybdate, B, Zn, Cu, Fe, Mg etc. which are rarely applied to the soils. In foliar feeding of nutrients are better applied to the side of their metabolism and are not subjected to the losses as in case of soil application. Thus, to get higher yield, appropriate foliar feeding of micronutrients are essential (Yadav *et al*. 2009) [8].

2. Materials and Methods
The experiment was carried out at Regional Horticultural Research Station (RHRS), ASPEE College of Horticulture and Forestry (ACHF), Navsari Agricultural University, Navsari, Gujarat during *rabi*, 2016-17 in cabbage cv. Golden Acre. The experiment was planned with nine treatments *viz*., 0.1% Ammonium molybdate (T_1), 0.2% Boric acid (T_2), 0.5% Zinc sulphate (T_3), 0.5% Copper sulphate (T_4), 0.5% Ferrous sulphate (T_5), 0.5% Manganese sulphate (T_6), 1% General grade-1 (T_7), 1% General grade-1+Ammonium molybdate (T_8) and Control (T_9) in a Randomized Block Design (RBD) with three replications. Cabbage plants were grown in 14.4m x 24.3m area at the spacing of 60 x 45 cm and fertigated with

recommended dose of FYM 20 t/ha at the time of land preparation and fertilizers N:P:K at the rate of 150: 60: 80 kg/ha at the time of planting. Two spray of each treatment were made during cropping season of cabbage, first at the 45 DAT and second at 60 DAT. Plants in control plots were sprayed with ordinary water. The data were taken from randomly selected five plants from each plot on various characters *viz*., polar diameter (cm), equatorial diameter (cm), gross weight of head (kg/plant), net weight of head (g/plant), head compactness, yield of head per plot (kg) and yield of head per hectare (t).

3. Results and Discussion

The Performance of cabbage cv. Golden Acre in response foliar application of different micronutrient s is presented as mean values with statistical notation in the different tables.

4. Yield and attributes

The results on effect of foliar application of micronutrients on various yield and attributes *viz.*, polar diameter, equatorial diameter, gross weight of head, net weight of head, head compactness, yield of head per plot and yield of head per hectare in cabbage as influenced by foliar application of micronutrients are presented in Table 1. The maximum polar and equatorial diameter of head (15.46 cm and 13.35 cm) was recorded in T_8 (1% General grade-1+T_1) followed by T_7 treatment. The occurrence of higher polar and equatorial diameter upon T_8 treatment was combination of Fe, Mn, Zn, Cu and B, which is the best for production of highest diameter of head. This could be due to the application of micronutrient induced the synthesis of chlorophyll which in turn resulted in higher growth yield. This is in accordance with Narayanamma *et al.* (2007) [6], Yadav *et al*. (2009) [8], Kotecha *et al.* (2011) [2] in cabbage. The observations revealed that differences in the average gross weight were significantly influenced by micronutrients spray during the period of investigation and T_8 noticed highest gross weight of head (1.24 kg/plant), which was at par with T2 (1.16 kg/plant), T3 (1.15 kg/plant) and T7 (1.21 kg/plant). This could be due to the foliar application of combined micronutrients consist Zn, which accelerated and stimulated the physiological forms and functions of cell, tissue and whole plant resulted in increase the yield parameters of cabbage. Related findings were reported by Mehrotra and Mishra (1974) in cauliflower, Sharma *et al*. (2005) [7], Nrayanamma *et al*. (2007) & Nandi and Nayak (2008) [5] in cabbage.

The treatment T8 produced significantly maximum net weight of head per plant (748.00 g), which was at par with T2 (668.66 g/plant), T3 (651.66 g/plant) and T7 (719.33 g/plant). Among various treatments, T8 (1% General grade-1+T1) recorded maximum head yield per plot and yield of head per hectare 31.42 kg and 24.24 t, respectively which was statistically at par with T2 (28.11 kg and 21.68 t), T3 (27.39 kg and 21.13 t) and T7 (30.22 kg and 23.32 t) respectively. This is attributed to the presence of higher polar and equatorial diameter (cm), gross weight of head (kg), net weight of head (g), yield of head per plot (kg) and highest yield of head per hectare (t). These results are in close agreement with the findings of earlier researchers like Nrayanamma *et al.* (2007), Yadav *et al*. (2009) [8], Kotecha *et al*. (2011) [2], Nandi and Nayak (2008) [5] in cabbage and Naga Sivaiah *et al*. (2013) in tomato.

5. Conclusion

The result inferred that the foliar spray of micronutrients of 1% General grade-1 (Fe-2.0, Mn-0.5, Zn-4.0, Cu-0.3 and B-0.5) +T1 (Ammonium molybdate-0.1 %) is favorably increase maximum yield attributes. Results clearly emphasized the importance of foliar spray of micronutrients for higher yield produce hence, gave a remunerative return. Based on the trend of head yield and economical aspect of cabbage observed in the present study; it is concluded that for getting higher yield of cabbage head treatment (T8) i.e. General grade-1 + T1 two spray of micronutrients at 45 days after transplanting and 60 days after transplanting was found better.

Table 1: Effect of foliar application of micronutrients on yield and attributes of cabbage

Treatments	Polar diameter (cm)	Equatorial diameter (cm)	Head compactness	Gross weight of head (kg/plant)	Net weight of head (g/plant)	Yield of head per plot (kg)	Yield of head per hectare (t)
T_1: Ammonium molybdate (0.1%)	13.20	12.85	26.02	1.07	577.00	24.24	18.70
T_2: Boric acid (0.2%)	13.45	13.07	28.64	1.16	668.66	28.11	21.68
T_3: Zinc sulphate (0.5%)	13.17	12.76	29.90	1.15	651.66	27.39	21.13
T_4: Copper sulphate (0.5%)	13.55	13.00	24.79	1.08	582.66	24.47	18.88
T_5: Ferrous sulphate 0.5%)	12.84	12.34	30.29	1.08	584.00	24.53	18.93
T_6: Manganese sulphate (0.5%)	12.84	12.19	31.08	1.11	609.66	25.62	19.76
T_7: General grade-1 (1%)	14.24	13.19	27.93	1.21	719.33	30.22	23.32
T_8: 1% General grade-1+T_1	15.46	13.35	24.98	1.24	748.00	31.42	24.24
T_9: Control	12.11	12.05	29.97	1.02	526.33	22.10	17.05
S.E.m. ±	0.588	0.285	2.455	0.045	41.078	1.722	1.329
$C.D._{0.05}$	1.76	0.86	NS	0.14	123.13	5.16	3.98
C.V. %	7.58	3.87	15.09	6.92	11.30	11.27	11.27

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