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Effect of foliar application of micronutrients and growth regulators on growth and yield of cabbage (*Brasicca oleracea* L. Var. capitata) cv. GOLDEN ACRE

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Abstract : The field experiment was conducted with a view to work out effects of micronutrients and growth regulators alone or in combination of both on growth and yield of cabbage. Among different treatments of micronutrients (zinc sulphate, 0.5%) and growth regulators, (GA_3 @ 100 ppm) recorded significantly higher plant height, leaf area, head volume, head diameter, average head weight, and cabbage head yield. Among all the interactions of micronutrients and growth regulators treatments, interaction M_1G_2 (zinc sulphate 0.5% + GA_3 100 ppm) recorded significantly highest plant height (15.85 cm), stem girth (7.37cm), leaf area (385.93 cm^2), head diameter (16.85 cm), head volume (1089.17 cm^3), average head weight (1018.33 g), cabbage head yield (30.48 t /ha). Other morphological parameter *viz*., plant spread, number of leaves per plant, days taken to head formation remained unaffected by the different levels micronutrients and growth regulators over control.

Key words : Cabbage, Growth, Yield, Micronutrients, Growth regulators

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Cabbage (*Brasicca oleracea* L.Var. capitata) is one of the important leafy vegetable crop and used as salad, cooked, pickling as well as dehydrated vegetable. The cabbage head is rich source of vitamin A, B, C and also contains minerals. It has cooling effect and helps in preventing constipation, increase appetite, speed up digestion and very useful for patients of diabetes.

Due to the intensive cultivation and judicious use of only nitrogenous fertilizers, soils are become deficit in secondary and micronutrients. Since micronutrients are costly chemicals, amelioration of such deficiencies through soil application may increase the cost of cultivation whereas foliar applications may reduce the cost owing to the lesser quantities required and better absorption through the foliage. Similarly growth regulators are also becoming very popular for obtaining higher yields in vegetable crops. They help in the synthesis of metabolites as well as translocation of nutrients and assimilation in different parts, which ultimately resulted in higher yields. Among several growth regulators, gibberellins, and auxins are very popular and being used in commercial scale on number of vegetable crops. Plant growth regulators are effective at very low concentration when used at active growth stage *i.e.*, vegetative growth of the crop. Hence, this trial was undertaken to find out the effect of micronutrients and growth regulators on growth and production of cabbage which is being a very commonly used as salad vegetable.

RESEARCH METHODS

A field experiment was conducted on cabbage cv. GOLDEN ACRE at Horticultural Research cum Demonstration Farm, Department of Horticulture, B.A. College of Agriculture, Anand Agricultural University, Anand during the *Rabi* season of the years 2007 and 2008 with Factorial Randomized Block Design. The treatments comprised of three levels of micronutrients (0.0, zinc sulphate 0.5%, ferrous sulphate 0.5%) and five levels of growth regulators(0.0, GA_3 @ 50ppm, GA_3 @ 100 ppm, NAA @ 100ppm, NAA @ 200ppm) total fifteen

combinations were applied as foliar sprays at 3rd and 5th week after transplanting of cabbage.

RESEARCH FINDINGS AND DISCUSSION

The result obtained from the present investigation has been discussed under following heads.

Growth characters:

Data portrayed in Table 1 indicated that significant response of micronutrients in cabbage plant height at the time of harvest on pooled basis and leaf area at harvest during 1st and 2nd year as well as on pooled basis. The treatment M_1 (zinc sulphate 0.5%) recorded the maximum plant height *i.e.* 24.36 cm on pooled basis and maximum leaf area per plant *i.e.* 333.19 cm^2, 311.77 cm^2 and 322.48 cm^2 during 1st and 2nd year as well as on pooled basis, respectively.

The increased in plant height and leaf area might be due to the role of zinc in chlorophyll formation, it also influenced the cell division, meristematic activity of plant tissues and expansion of cells and formation of cell wall by active synthesis of aromatic amino acid *i.e.*, tryptophane, which is the primary precursor of auxin and stimulate the growth of plant tissues by cell elongation and cell division (Chaudhary and Mukherjee, 1999 and Sarma *et al.*, 2005). In case of growth regulators, significantly the highest plant heights at the time of harvest *i.e.* 24.91 cm and 24.78 cm during 1st and 2nd year and leaf area per plant *i.e.* 323.45, 290.30 and 306. 87 during 1st and 2nd year as well as on pooled basis, respectively were recorded by the treatment G_2 (GA_3 @ 100 ppm), this could be due to fact that substance like gibberellins inducing cell division, cell elongation and cell enlargement. Such significant response of gibberellins was reported by Yadav *et al.* (2000), Bokade *et al.* (2006) and Tandel (2009) in cabbage. The results of interactions between micronutrient and plant growth regulator treatments showed significant effect on stem girth and leaf area per plant of cabbage. Significantly the highest stem girth *i.e.* 7.37 cm on pooled basis and leaf area per plant *i.e.* 385.93 cm^2 during 1st year, respectively were recorded with the interaction of M_1G_2 (zinc sulphate 0.5% +GA_3 100 ppm). The increased in growth parameters *i.e.* stem girth and leaf area might be due to the combine beneficial effect of micronutrient and plant growth regulator application in improving the growth. This finding is in accordance with Muthoo *et al.* (1987) and Reddy (1989) in cabbage and cauliflower, respectively.

Yield characters:

The results revealed that the yield characters like volume of head, weight of head and head diameter were influenced by zinc sulphate and gibberellins found significantly (Table 2 and 3). The treatment M_1 (zinc sulphate 0.5%) recorded significantly the highest head volume *i.e.* 975.0, 961.0 and 968 cm^3 and head weight *i.e.* 888.00, 753.33, 820.67g /head during 1st and 2nd year as well as on pooled basis, respectively as well as head diameter *i.e.* 13.93 cm during 2nd year, these resulted in to higher cabbage yield *i.e.* 25.97 and 24.36 t/ha during

Table 1 : Effect of micronutrients and growth regulators on growth characters of cabbage cv. GOLDEN ACRE

Treatments	Plant height (cm) at the time of harvest			Stem girth at the time of harvest			Leaf area (cm^2) at the time of harvest		
	1st Year	2nd Year	Pooled	1st Year	2nd Year	Pooled	1st Year	2nd Year	Pooled
Micronutrients									
M_0 (Contro)	23.44	23.02	23.23	6.57	6.81	6.69	196.08	158.98	177.53
M_1 (zinc sulphate 0.5%)	23.86	24.86	24.36	6.84	6.80	6.82	333.19	311.77	322.48
M_2 (ferrous sulphate 0.5%)	23.54	23.55	23.55	6.61	6.73	6.67	293.60	258.62	276.11
S.E. ±	0.36	0.30	0.26	0.09	0.14	0.08	7.88	12.98	7.59
C.D. (P=0.05)	NS	1.11	0.75	NS	NS	NS	22.82	37.60	21.52
Growth regulators									
G_0 (Control)	22.65	23.07	23.05	6.66	6.68	6.67	223.41	167.66	195.53
G_1 (GA_3 @ 50ppm)	23.17	23.11	23.14	6.44	6.80	6.62	288.56	239.32	263.94
G_2 (GA_3 @ 100 ppm)	24.91	24.78	24.32	6.84	7.00	6.92	323.45	290.30	306.87
G_3 (NAA @ 100ppm)	23.46	23.44	24.07	6.72	6.76	6.74	240.40	251.04	245.72
G_4 (NAA @ 200ppm)	23.86	24.66	23.99	6.70	6.67	6.68	292.29	267.31	279.80
S.E. ±	0.47	0.50	0.62	0.12	0.18	0.11	10.17	16.76	9.80
C.D. (P=0.05)	1.35	1.44	NS	NS	NS	NS	29.45	48.55	27.78
Sig. Int.	-	-	-	-	-	MXG	MXG	-	-
C.V. %	8.29	7.51	7.94	5.33	7.81	6.71	11.15	20.68	16.09

NS=Non-significant

1st year and on pooled basis, respectively over the rest of treatments. The improvement in yield attributes might be due to foliar application of zinc, which accelerated and stimulated the physiological forms and functions of cell, tissue and whole plant resulted in increase the yield parameters of cabbage which conforms the findings of Mehrotra and Misra (1974) in cauliflower, Sarma *et al.* (2005), Narayanamma *et al.* (2007), Nandi and Nayak (2008). In case of application of plant growth regulators, the treatment G_2 (GA_3 @ 100 ppm) recorded the highest head volume *i.e.* 1030.56, 1001.67 and 1016.11 cm^3 and diameter of head *i.e.* 15.53, 14.30 and 14.92 cm as well as head weight *i.e.* 940.00, 786.11 and 863.06 g during 1st and 2nd year as well as in pooled basis, respectively, these resulted in to higher cabbage yield *i.e.* 27.57, 25.82, 26.69 t/ha during 1st and 2nd year as well as on pooled basis, respectively over the rest of the treatments due to exogenous application of growth regulators, which enhanced and activated the enzymatic activities for various physiological process and metabolic activities *viz.*,

Table 2 : Effect of micronutrients and growth regulators on volume of head and diameter of head of cabbage

Treatments	Volume of head (cm^3)			Diameter of head (cm)		
	1st Year	2nd Year	Pooled	1st Year	2nd Year	Pooled
Micronutrients						
M_0 (Control)	912.33	894.00	903.17	14.36	13.05	13.70
M_1 (zinc sulphate 0.5%)	975.00	961.00	968.00	14.60	13.93	14.27
M_2 (ferrous sulphate 0.5%)	916.23	907.00	911.67	14.06	13.82	13.94
S.E. ±	11.73	11.94	8.37	0.22	0.17	0.27
C.D. (P=0.05)	33.98	34.59	23.72	NS	0.49	NS
Growth regulators						
G_0 (Control)	898.89	906.67	902.78	14.06	13.27	13.67
G_1 (GA_3 @ 50ppm)	919.44	895.00	907.22	14.23	13.72	13.98
G_2 (GA_3 @ 100 ppm)	1030.56	1001.67	1016.11	15.53	14.30	14.92
G_3 (NAA @ 100ppm)	896.69	903.33	900.00	13.96	13.47	13.72
G_4 (NAA @ 200ppm)	927.22	896.67	911.94	13.93	13.21	13.57
S.E. ±	15.15	15.41	10.81	0.28	0.22	0.18
C.D. (P=0.05)	43.86	44.65	30.62	0.81	0.64	0.54
Sig. Int.	MXG	MXG	MXG	MXG	MXG	MXG
C.V. %	4.86	5.02	4.94	5.84	4.86	5.41

NS=Non-significant

Table 3 : Effect of micronutrients and growth regulators on weight of head and yield of cabbage head

Treatments	Weight of head (g)			Yield of head (t/ha)		
	1st Year	2nd Year	Pooled	1st Year	2nd Year	Pooled
Micronutrients						
M_0 (Control)	802.00	686.80	744.40	22.53	21.78	22.15
M_1 (zinc sulphate 0.5%)	888.00	753.33	820.67	25.97	22.75	24.36
M_2 (ferrous sulphate 0.5%)	852.00	710.33	781.17	25.84	22.29	24.06
S.E. ±	17.65	13.83	11.21	0.80	0.48	0.47
C.D.(P=0.05)	51.13	40.04	31.77	2.99	NS	1.32
Growth regulators						
G_0 (Control)	835.56	696.67	766.11	22.94	20.25	21.60
G_1 (GA_3 @ 50ppm)	833.33	728.89	781.11	25.52	21.89	23.71
G_2 (GA_3 @ 100 ppm)	940.00	786.11	863.06	27.57	25.82	26.69
G_3 (NAA @ 100ppm)	807.78	734.44	771.11	25.03	21.82	23.42
G_4 (NAA @ 200ppm)	820.00	638.00	729.00	22.87	21.59	22.23
S.E. ±	22.79	17.85	14.48	1.03	0.62	0.60
C.D.(P=0.05)	66.01	51.70	41.02	2.99	1.80	1.71
Sig. Int.	MXG	MXG	MXG	MXG	MXG	MXG
C.V. %	8.06	7.47	7.85	12.52	8.37	10.88

NS=Non-significant

vegetative growth, photosynthetic area and leaf pigments to maximize yield of the crop. Earlier reports also indicated same findings (Yadav *et al*.,2000; Chauhan and Tandle, 2009). Interaction effect between micronutrients and growth regulators on yield and yield character were found significant and interaction of M_1G_2 (zinc sulphate 0.5% +GA_3 100 ppm) was found superior and recorded the higher volume of head *i.e.* 1098.33 1080.00 and 1089.17 cm^3, diameter of head *i.e.* 18.09, 15.61 and 16.85 cm, weight of head *i.e.* 1110.00, 926.57, 1018.33 g and thereby the yield of cabbage head. This might be due synergistic effect of micronutrients and growth regulator on cabbage from early stage of growth which ensured healthy plants and thereby more yield.

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