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Influence of micronutrients and growth regulators on the performance of cabbage quality

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ABSTRACT : A field experiment was undertaken on cabbage cv. GOLDEN ACRE at Horticultural Research cum Demonstration Farm, Department of Horticulture, B.A. College of Agriculture, Anand Agricultural University, Anand in order to evaluate the performance of micronutrients (Zn and Fe) and growth regulators (Gibberellic acid and Naphthalene acetic acid) alone and their combinations applied as foliar spray for cabbage quality. The different levels of micronutrients were found significant on ascorbic acid and chlorophyll contents of cabbage head, maximum ascorbic acid (49.4 mg/100g fresh wt.) and chlorophyll content (0.412 mg/g fresh wt.) of cabbage head were recorded with treatment M_1 (zinc sulphate 0.5%). Among different levels of growth regulators, GA_3 @ 100 ppm recorded significantly highest ascorbic acid content (46.16 mg/100g fresh wt.), chlorophyll content (0.383 mg/g fresh wt.). While non-significant effect was recorded for total soluble solids on cabbage head. Among the interactions of micronutrients and growth regulators, the interaction M_1G_2 recorded significantly the highest ascorbic acid content (57.99 mg/100g fr. wt.), chlorophyll content (0.505 mg/g fr. wt.) of cabbage head.

KEY WORDS : Ascorbic acid, Cabbage, Chlorophyll, Total soluble solids

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Cabbage (*Brassica oleracea* L.var. *capitata*) belongs to Cruciferae family and one of the important leafy vegetable crops and used as salad, cooked, pickling as well as dehydrated vegetable.The word "Cabbage" is derived from the French word "coboche" means head. It is mostly employed as culinary and dietary article which is used alone or mixed with potatoes for vegetable purpose. The particular flavour in the cabbage head is due to the glycoside 'sinigrin' which contains sulphur also. 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 (Yadav *et al.*, 2000).

Due to the intensive cultivation and judicious use of only nitrogenous fertilizers, soils becoming deficient in secondary micronutrients. While, growth regulators are the organic substances (Leopold, 1963) which promote, inhibit or modify the physiological processes of plant and thereby it increases the yield with good quality. The foliar applications of micronutrients and growth regulators are proved beneficial to improve quality of cabbage. Among several growth regulators, gibberellins and auxins are very popular and being used in commercial scale on number of vegetable crops. Among the growth regulators, auxin causes enlargement of plant cell and gibberellins stimulates cell division, cell enlargement or both (Nickell, 1982). Gibberellic acid (GA_3) and naphthalene acetic acid (NAA) exhibited beneficial effect in several crops (Thapa *et al*., 2013; Mello *et al.*, 2012; Sharma and Sardana, 2012; Gayakvad *et al.*, 2014 and Chaurasiya *et al.*, 2014).

There were very little research work had been done on this aspect. Hence, the present experiment was undertaken to find out the effect of micronutrients and growth regulators for better quality of cabbage under the climatic conditions of Middle Gujarat.

RESEARCH PROCEDURE

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 and Anand during the *Rabi* season with Factorial Randomized Block Design. The treatments comprised of three levels of micronutrients *i.e.* (1) control (2) zinc sulphate 0.5 per cent and (3) ferrous sulphate 0.5 per cent and five levels of growth regulators *i.e.* (1) control (2) GA_3 @ 50ppm, (3) GA_3 @100 ppm, (4) NAA @ 100ppm, (5) NAA @ 200ppm) total fifteen combinations were applied as foliar sprays at 3rd and 5th week after transplanting of cabbage. The cabbage leaf was analysed for total soluble solids, ascorbic acid and chlorophyll. The total soluble solids (TSS) was recorded in percentage with help of hand refractometer. The small pieces of head were crushed out and a drop of juice was put on the glass prism of refractometer and observations were recorded from eyepiece and average reading of total soluble solids was worked out. The ascorbic acid (Ranganna, 1979) and chlorophyll content (Arnon, 1949) were also analysed.

RESEARCH ANALYSIS AND REASONING

The data on total soluble solids as influenced by micronutrient and plant growth regulator treatments during 1st and 2nd year as well as on pooled basis are presented in the (Table 1). The effect of micronutrient levels on total soluble solids was found non-significant during 1st year and on pooled basis. However, during 2nd year, it was found significant and the maximum and minimum total soluble solids content was recorded under the treatment M_2 (5.50%) and M_0 (4.50 %).

The foliar application of plant growth regulators on total soluble solids was found non-significant. Though, numerically higher total soluble solid was recorded with the treatment G_2 (GA_3 100 ppm) as compared to other growth regulators treatments. The minimum total soluble solids was recorded with treatment G_0 (control) *i.e.* 5.51, 4.96 and 5.23 per cent during 1st and 2nd year as well as on pooled basis, respectively. The interaction between

Table 1 : Effects of micronutrient and growth regulator on total soluble solids (%) of cabbage

Micronutrients	1st Year	2nd Year	Pooled
M_0 (Control)	5.44	4.50	4.97
M_1 (zinc sulphate 0.5%)	5.49	4.96	5.23
M_2 (ferrous sulphate 0.5%)	5.51	5.50	5.51
S.E.±	0.13	0.13	0.24
C.D.(P=0.05)	NS	0.37	NS
Growth regulators			
G_0 (Control)	5.51	4.96	5.23
G_1 (GA_3@50ppm)	5.30	4.63	4.97
G_2 (GA_3@100ppm)	5.72	5.28	5.39
G_3 (NAA@100ppm)	5.36	5.02	5.19
G_4 (NAA@200ppm)	5.51	5.06	5.39
S.E.±	0.16	0.16	0.12
C.D. (P=0.05)	NS	NS	NS
Sig. Int.	-	-	-
C.V. %	8.92	9.86	9.37

NS=Non-significant

micronutrient and plant growth regulator levels on total soluble solids was found non-significant.Our findings are in conformity with the results of the scientist (Singh and Saimbhi, 1968 in Chinese cabbage and Chauhan and Tandel, 2009 in cabbage, Tiwari *et al.*, 2003 in onion and Kumar *et al.*, 2005 in tomato). This could be ascribed to the fact that exogenous application of growth regulator increases of more area for photosynthesis and more accumulation of carbohydrates is directly involved in protein synthesis.

The data on ascorbic acid content as influenced by micronutrients and plant growth regulators and its

Table 2 : Effects of micronutrient and growth regulator on ascorbic acid (mg/100 g fresh wt.) content of cabbage

Micronutrients	1st Year	2nd Year	Pooled
M_0 (Control)	42.29	37.57	39.92
M_1 (zinc sulphate 0.5%)	50.12	48.68	49.40
M_2 (ferrous sulphate 0.5%)	45.04	45.45	45.25
S.E.±	0.316	1.591	0.816
C.D.(P=0.05)	1.04	4.61	2.363
Growth regulators			
G_0 (Control)	44.40	39.28	41.84
G_1 (GA_3@50ppm)	47.03	45.30	45.17
G_2 (GA_3@100ppm)	49.07	47.27	46.16
G_3 (NAA@100ppm)	44.58	44.32	44.44
G_4 (NAA@200ppm)	44.01	43.34	43.67
S.E.±	0.466	2.05	1.053
C.D.(P=0.05)	1.35	5.95	3.05
Sig. Int.	MXG	MXG	MXG
C.V. %	3.05	14.03	9.93

Table 3: Interaction effects of micronutrient and growth regulator on ascorbic acid content of cabbage head

Micronutrients	Growth regulators				
	G_0	G_1	G_2	G_3	G_4
1st Year					
M_0 (Control)	39.63	45.52	42.90	40.56	42.84
M_1 (zinc sulphate 0.5%)	44.72	47.13	61.29	47.82	49.63
M_2 (ferrous sulphate 0.5%)	48.85	48.45	43.02	45.35	39.55
S.E.±			0.81		
C.D. (P=0.05)			2.34		
2nd Year					
M_0 (Control)	25.17	41.49	41.76	39.33	40.09
M_1 (zinc sulphate 0.5%)	43.52	46.46	54.70	49.71	49.02
M_2 (ferrous sulphate 0.5%)	49.19	47.93	45.36	43.91	40.90
S.E. ±			2.05		
C.D. (P=0.05)			5.95		
Pooled					
M_0 (Control)	32.40	43.50	42.33	39.95	41.47
M_1 (zinc sulphate 0.5%)	44.12	46.80	57.99	48.76	49.33
M_2 (ferrous sulphate 0.5%)	49.00	48.19	44.19	44.63	40.23
S.E.±			1.82		
C.D. (P=0.05)			5.28		

significant interaction were presented in the (Table 2). Differences among the micronutrient treatments were found significant for ascorbic acid content of cabbage head at harvest during 1st and 2nd year as well as on pooled basis. Significantly the highest ascorbic acid content of cabbage head was recorded with the treatment M_1 (zinc sulphate 0.5%) *i.e.* 50.12, 48.68 and 49.40 (mg/100 g fresh wt.) during the 1st and 2nd year as well as on pooled basis, respectively over the control. It remained at par with M_2 (Ferrous sulphate 0.5%) *i.e.* 45.45 mg/100 g fresh wt. during 2nd year.The highest ascorbic acid content of cabbage head was recorded with the treatment G_2 (GA_3 100 ppm) *i.e.* 49.07, 47.27 and 46.16 mg/100 g fresh weight, respectively during 1st and 2nd year as well as on pooled basis.The interaction effect between micronutrients and growth regulators on ascorbic acid content was found significant during 1st and 2nd year as well as on pooled basis (Table 3 and Fig.1). Significantly the highest ascorbic acid content was recorded with the interaction M_1G_2 (Zinc sulphate 0.5% + GA_3 100 ppm) *i.e.* 61.29, 54.70 and 57.99 mg/100 g fresh weight during 1st and 2nd year as well as on pooled basis, respectively. However, it remained at par with M_2G_0, M_1G_3 and M_1G_4 during 2nd year only.This might be due to application of zinc and iron which works as active carrier to enzymatic activities of the plant and resulted in to higher ascorbic acid content in cabbage head. These results are in accordance with

Table 4 : Effects of micronutrient and growth regulator on chlorophyll (mg/g fresh wt.) content of cabbage

Micronutrients	1st Year	2nd Year	Pooled
M_0 (Control)	0.238	0.210	0.224
M_1 (zinc sulphate 0.5%)	0.422	0.402	0.412
M_2 (ferrous sulphate 0.5%)	0.382	0.345	0.364
S.E.±	0.005	0.024	0.012
C.D.(P=0.05)	0.014	0.069	0.034
Growth regulators			
G_0 (Control)	0.340	0.322	0.287
G_1 (GA_3@50ppm)	0.283	0.290	0.331
G_2 (GA_3@100ppm)	0.407	0.316	0.383
G_3 (NAA@100ppm)	0.328	0.322	0.325
G_4 (NAA@200ppm)	0.378	0.333	0.356
S.E.±	0.001	NS	0.016
C.D. (P=0.05)	0.018	NS	0.045
Sig. Int.	MXG	MXG	MXG
C.V. %	5.49	8.33	7.05

Table 5 : Interaction effects of micronutrient and growth regulator on chlorophyll content of cabbage head

Micronutrients	Growth regulators				
	G_0	G_1	G_2	G_3	G_4
1st Year					
M_0 (Control)	0.213	0.221	0.253	0.147	0.358
M_1 (zinc sulphate 0.5%)	0.331	0.334	0.521	0.481	0.438
M_2 (ferrous sulphate 0.5%)	0.475	0.295	0.455	0.356	0.338
S.E. ±			0.01		
C.D. (P=0.05)			0.03		
Pooled					
M_0 (Control)	0.180	0.215	0.244	0.162	0.321
M_1 (zinc sulphate 0.5%)	0.367	0.348	0.505	0.487	0.403
M_2 (ferrous sulphate 0.5%)	0.447	0.298	0.422	0.307	0.343
S.E.±			0.03		
C.D. (P=0.05)			0.09		

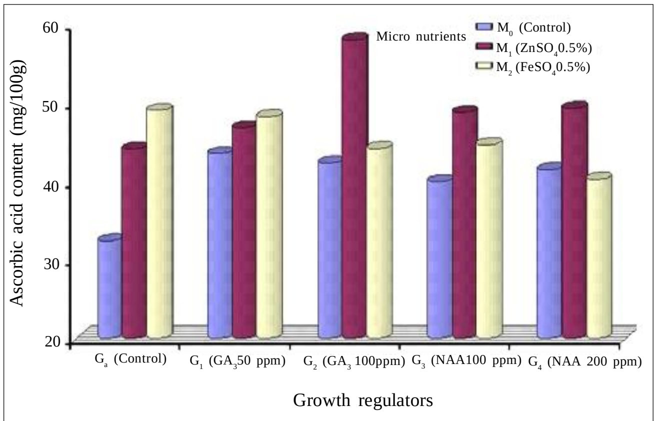

Fig. 1: Ascorbic acid content of head as affiected by micronutrients and growth regulators

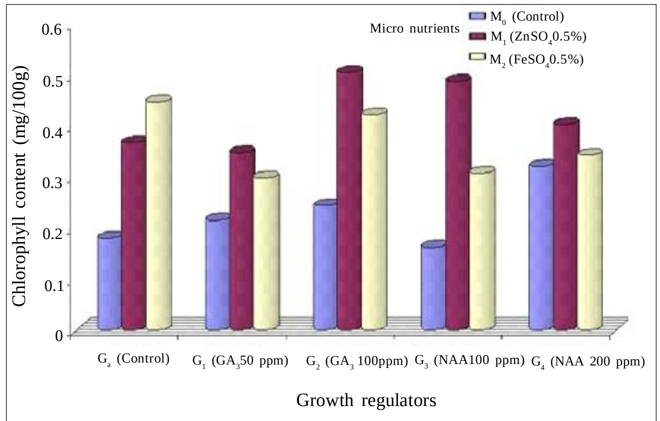

Fig. 2: Chlorophyll content of head as affiected by micronutrients and growth regulators

the Mehrotra and Mishra (1974) in cauliflower, Singh and Tiwari (2003) in onion and Yadav *et al.* (2001) in tomato.

The differences among the micronutrients was found significant for chlorophyll content of cabbage head after harvest during 1st and 2nd year as well as on pooled basis (Table 4). Significantly higher chlorophyll content of cabbage head was recorded with the treatment M_1 (zinc sulphate 0.5%) *i.e.* 0.422, 0.402 and 0.412 mg/g fresh weight during the 1st and 2nd year as well as on pooled basis, respectively over the control (M_0).The effect of different levels of plant growth regulatorson chlorophyll content of cabbage head was found significant during 1st year as well as on pooled basis. Significantly the highest chlorophyll content of cabbage head was recorded in the treatment G_2 (GA_3 100 ppm) *i.e.* 0.407 and 0.383 mg/g fresh weight during 1st year and on pooled basis as compared to rest of the treatments except G_4 (NAA 200 ppm) *i.e.* 0.356 mg/g fresh weight.The interaction effect between micronutrient and growth regulator on chlorophyll content was found significant during 1st year and on pooled basis (Table 5 and Fig.2). Significantly the highest chlorophyll content was recorded under the interaction M_1G_2 (zinc sulphate 0.5% + GA_3 100 ppm) *i.e.* 0.521 and 0.505 mg/ g fresh weight during 1st year and on pooled basis as compared to rest of the treatment combinations.These findings are in conformity with the results of the Singh and Saimbhi (1968) in Chinese cabbage and Chauhan and Tandel (2009) in cabbage, Tiwari *et al.* (2003) in onion, Kumar *et al.* (2005) in tomato. This could be ascribed to the fact that exogenous application of growth regulator increases of more area for photosynthesis and more accumulation of carbohydrates is directly involved in protein synthesis.

From the above findings, it can be concluded that among different treatments of micronutrient and growth regulators, zinc sulphate @ 0.5 per cent (M_1) and gibberellic acid @ 100 ppm (G_2) were found effective in increasing ascorbic acid and chlorophyll contents in cabbage.

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