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Effect of Gibberellic Acid and Zinc Sulphate on Growth, Yield and Quality of Cucumber (*Cucumis sativus* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted at Horticulture Research Field, Department of Horticulture, Naini Agricultural Institute, Faculty of Agriculture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, during February-May, 2023 on cucumber. The experiment was laid out in factorial randomized block design with twenty treatment combinations and was replicated thrice. The experiment consisted of two factors. Factor H: Hybrids (TMCU-1107, TMCU-1125, TMCU-3112 and Saira-934) and Factor T: Different concentrations of GA_3+$ZnSO_4$ (T0 - Control (water spray), T_1 -GA_3 @100ppm+$ZnSO_4$ @0.25%, T_2 - GA_3 @200ppm+ $ZnSO_4$ @0.50%, T_3 - GA_3 @300ppm+ $ZnSO_4$ @0.75% and T_4 - GA_3 @400ppm+$ZnSO_4$ @1%). TMCU-1125 recorded significantly higher yield attributes of cucumber over other hybrids in parameters like vine length at 80 DAS (102.6 cm),

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days to 50% flowering (40), days to 1st harvest (46), number of fruits per plant (11), fruit length (18.4 cm), average fruit weight (237.5 g), average fruit yield per plant (2.6 kg) and ascorbic acid content (0.8 mg/100g). Among different treatments, GA_3 @300ppm+ $ZnSO_4$ @0.75% resulted in significantly longer vine at 80 DAS (98.4 cm), Days to 50% flowering (43), days to 1st harvest (50), number of fruits per plant (9), fruit length (16.6 cm), average fruit weight (232.0 g), average fruit yield per plant (2.0 kg) and ascorbic acid content (0.5 mg/100g). The interaction effect of T8 (TMCU-1125 + GA_3 @300ppm+ $ZnSO_4$ @0.75% is best suited for getting higher growth, yield, quality of cucumber.

Keywords: Gibberellic acid; zinc; growth; yield; quality; cucumber.

1. INTRODUCTION

Vegetable are important nutritive components of the daily diet because their nutritive value as a vital source of micronutrient has been well recognized. Vegetables play an important role in the balance diet by providing not only energy but also supplying vital protective nutrients either mineral and vitamins. Thus, vegetables are getting increasingly higher importance in India as well as in the world due to their relevance in achieving nutritional security from emerging nutritional problems in human beings. Today, India is the second largest producer of vegetables in the world after China. According to recommendations given by Indian Council of Medical Research (ICMR) an average man with vegetarian or non-vegetarian food habit should consume (300 g) vegetables per day, which include 125g leafy vegetable, 100g root vegetable and 75g other vegetables, but its availability of vegetable in India is only 225g.

Plant growth regulators can enhance the uptake of utilization of micronutrients in plant. Certain PGRs can improve root growth and development, leading to increased exploration of soil for micronutrients. Foliar spray of plant growth regulators also promote growth, increases yield and quality in plants and micronutrients can serve as supplementary sources of essential elements for plants.

Gibberellins commonly known as gibberellic acids first came to the attention of western scientists in 1950s, they had been discovered much earlier in Japan. Gibberellic acid (also called gibberellin A3, GA, and GA3) is a hormone found in plants and fungi. Gibberellins (GAs) play important role in the development of lateral roots (LRs), which are critical for plant productivity. Therefore, it is of great importance for cucumber production to study the role of GAs in LR development. Here, the results showed that GAs regulated cucumber LR development in a concentration-dependent manner.

Zinc sulphate is the inorganic compound with the formula $ZnSO_4$. The addition of fertilizers to supplement natural soil fertility is a routine practice in modern agriculture, although temperate and tropical soils commonly remain deficient in micronutrients, particularly zinc (Zn) this work aimed to study the influence of foliar spray of zinc (as zinc sulphate) on growth parameters.

2. MATERIALS AND METHODS

The investigation was carried out at the Horticulture Research Field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj during Feb-May, 2023. The experiment was conducted in Factorial Randomized Block Design with 20 treatments in three replications *viz.* TC_1: H_1T_0 - TMCU-1107 + control (water spray), TC_2: H_1T_1 TMCU-1107 + GA_3 100ppm + $ZnSO_4$ 0 .25%, TC_3: H_1T_2 TMCU-1107 + GA_3 200ppm + $ZnSO_4$ 0 .5%, TC_4: H_1T_3 TMCU-1107 + GA_3 300ppm + $ZnSO_4$ 0.75%, TC_5: H_1T_4 TMCU-1107 + GA_3 400ppm + $ZnSO_4$ 1%, TC_6: H_2T_5 TMCU-1125 + control (water spray), TC_7: H_2T_6 TMCU-1125 + GA_3 100ppm + $ZnSO_4$ 0 .25%, TC_8: H_2T_7 TMCU-1125 + GA_3 200ppm + $ZnSO_4$ 0 .5%, TC_9: H_2T_8 TMCU-1125 + $GA_3$300ppm + $ZnSO_4$ 0 .75%, TC_{10}: H_2T_9 TMCU-1125 + GA_3 400ppm + $ZnSO_4$ 1%, TC_{11}: H_3T_{10} - TMCU-3112 + control (water spray), TC_{12}: H_3T_{11} TMCU-3112 + GA_3 100ppm + $ZnSO_4$ 0 .25%, TC_{13}: H_3T_{12} TMCU-3112 + GA_3 200ppm + $ZnSO_4$ 0 .5%, TC_{14}: H_1T_{13} TMCU-3112 + GA_3 300ppm + $ZnSO_4$ 0.75%, TC_{15}: H_3T_{14} TMCU-3112 + GA_3 400ppm + $ZnSO_4$ 1%, TC_{16}: H_4T_{15} Saira-934 + control (water spray), TC_{17}: H_4T_{16} Saira-934 + GA_3 100ppm + $ZnSO_4$ 0 .25%, TC_{18}: H_4T_{17} Saira-934 + GA_3 200ppm + $ZnSO_4$ 0 .5%, TC_{19}: H_4T_{18} Saira-934 +

$GA_3$300ppm + $ZnSO_4$ 0 .75%, $TC_{20:}$ H_4T_{19} Saira-934 + GA_3 400ppm + $ZnSO_4$ 1%. with four cucumber hybrids TMCU-1107, TMCU-1125, TMCU-3112 and Saira-934. Crop was planted with the spacing of 150×50 cm with the application of FYM@ 18 tonnes + NPK 100:50:50 as basal dose along with spraying of GA_3+$ZnSO_4$ which was done at 15 and 30 days after emergence of two true leaf stage. The data was recorded for the following parameters *viz* vine length (cm), days to 50% flowering, days to first harvest, number of fruits per plant, avg. Number of picking, avg. fruit length (cm), average fruit weight (g), fruit girth (cm), average yield per plant (kg), total yield (t/ha), TSS (^{o}Brix) and ascorbic acid content (mg/100 g). TSS was measured with the help of hand refractrometer and ascorbic acid content (mg/100g) was measured.

3. RESULTS AND DISCUSSION

The data on yield attributes of cucumber after application of gibberellic acid and zinc sulphate was recorded and is presented in Table 1. Among different hybrids. Hybrid H2 (TMCU-1125) recorded significantly longer vine at 80 DAS (102.6 cm), lesser number of days to 50% flowering (40), days to 1st harvest (46), number of fruits per plant (11), fruit length (18.4 cm), average fruit weight (237.5 g), average fruit yield per plant (2.6 kg) and ascorbic acid content (0.8 mg/100g) followed by vine at 80 DAS (101.3 cm), days to 50% flowering (41), days to 1st harvest (47), number of fruits per plant (10), fruit length (17.9 cm), average fruit weight (236.4 g), average fruit yield per plant (2.4 kg) and ascorbic acid content (0.7 mg/100g) in hybrid H1 (TMCU-1107) and shorter vine at 80 DAS (99.1 cm), more number of days to 50% flowering (42), late harvest (49), lower number of fruits per plant (9), lower fruit length (17.4 cm), average fruit weight (234.3 g), average fruit yield per plant (2.2 kg) and ascorbic acid content (0.6 mg/100g) in Hybrid H4 (Saira-934). Among different treatments, significantly longer vines at 80 DAS (107.1 cm), lesser number of days to 50% flowering (36), days to 1st harvest (42), number of fruits per plant (13), fruit length (19.9 cm), average fruit weight (244.2 g), average fruit yield per plant (3.2 kg) and ascorbic acid content (1.8 mg/100g) were recorded in (GA_3 @300 ppm + $ZnSO_4$ @0.75%). followed by vine at 80 DAS (104.9 cm), days to 50% flowering (40), days to 1st harvest (46), number of fruits per plant (12), fruit length (18.9 cm), average fruit weight (240.0 g), average fruit yield per plant (2.8 kg) and ascorbic acid content (0.8 mg/100g) in (GA3 @200 ppm + $ZnSO_4$ @0.50%) and shorter vine at 80 DAS (92.3 cm), more number of days to 50% flowering (46), late harvest (52), lower number of fruits per plant (6), lower fruit length (16.0 cm), average fruit weight (227.3 g), average fruit yield per plant (1.5 kg) and ascorbic acid content (0.4 mg/100g) in control (water spray).

Interaction data reaveled that treatment T8(TMCU-1125+ GA3 @300 ppm + @0.75%) recorded significantly longer vine at 80 DAS (107.8 cm), lesser number of days to 50% flowering (35), days to 1st harvest (41), number of fruits per plant (14), fruit length (20.9 cm), average fruit weight (245.7 g), average fruit yield per plant (3.4 kg) and ascorbic acid content (1.3 mg/100g) followed by in T3(TMCU-1107 + GA_3 @300ppm + $ZnSO_4$ @0.75%) vines at 80 DAS (107.6 cm), days to 50% flowering (36), days to 1st harvest (42), number of fruits per plant (13), fruit length (19.9 cm), average fruit weight (244.8 g), average fruit yield per plant (3.3 kg) and ascorbic acid content (1.0 mg/100g) in hybrid H1 (TMCU-1107) and shorter vine vine at 80 DAS (88.4 cm), more number of days to 50% flowering (48), late harvesting (54), lower number of fruits per plant (5), lower fruit length (15.2 cm), average fruit weight (225.5 g), average fruit yield per plant (1.2 kg) and ascorbic acid content (0.3 mg/100g) in Hybrid H4 (Saira-934).

Longer vine were reported in plants treated with optimum dose of gibberellic acid and zinc as gibberellic acid plays and important role in cell elongation and division leading to increase in longer internodal while zinc plays significant role in physiological and biochemical process of carbohydrate, proteins and auxins as well as in structure of cellular membranes, thereby increasing vine length. Kadi et al. [1] and Shafeek et al*.* [2]. Significantly lesser days taken to 50% female flowering were recorded with application of optimum dose of gibberellic acid and zinc which might due to the role of gibberellic acid in changing the direction of sexual differentiation in potentially male buds to female buds resulted in enhanced female flowering and reduced male flowering along with zinc's role in carbohydrate metabolism thereby increasing plants nutritional status triggering plants vegetative phase to reproductive phase. Significantly early number of days to first harvest were recorded with application of optimum dose gibberellic acid and zinc which might due to role of gibberellic acid and zinc in enhancing

Table 1. Effect of gibberellic acid and zinc sulphate of different cucumber hybrids on growth, yield and quality of cucumber

Hybrids → / Treatments ↓	Vine length at 80 DAS					Days to 50% flowering					Days to first harvest					No. of fruits/ plant				
	H1	H2	H3	H4	Mean T	H1	H2	H3	H4	Mean T	H1	H2	H3	H4	Mean T	H1	H2	H3	H4	Mean T
T0	93.4	96.9	90.6	88.4	92.3	45	44	46	48	46	52	51	53	54	52	7	7	6	5	6
T1	98.6	99.8	97.9	97.2	98.4	43	42	43	44	43	50	49	50	51	50	9	9	8	8	9
T2	105.4	105.6	104.9	103.6	104.9	40	39	40	41	40	46	44	46	47	46	12	12	12	11	12
T3	107.6	107.8	107.0	105.9	107.1	36	35	37	38	36	42	41	42	44	42	13	14	13	13	13
T4	101.7	102.7	100.6	100.3	101.3	41	41	42	42	41	48	47	48	49	48	10	11	10	10	10
Mean H	101.3	102.6	100.2	99.1		41	40	42	42		47	46	48	49		10	11	10	9	

Vine length at 80 DAS			Days to 50% flowering			Days to first harvest			No. of fruits/ plant		
Factors	SE(d) ±	CD0.05	Factors	SE(d) ±	CD0.05	Factors	SE(d) ±	CD0.05	Factors	SE(d) ±	CD0.05
Factor(H)	0.018	0.036	Factor(H)	0.043	0.088	Factor(H)	0.054	0.110	Factor(H)	0.018	0.036
Factor(T)	0.020	0.040	Factor(T)	0.048	0.098	Factor(T)	0.060	0.123	Factor(T)	0.020	0.040
Factor(HX T)	0.039	0.080	Factor(HX T)	0.097	0.197	Factor(HX T)	0.121	0.245	Factor(HX T)	0.039	0.080

Hybrids → / Treatments ↓	Fruit length (cm)					Average fruit weight (g)					Average fruit yield / plant (kg)					Ascorbic acid content (mg/100 g)				
	H1	H2	H3	H4	Mean T	H1	H2	H3	H4	Mean T	H1	H2	H3	H4	Mean T	H1	H2	H3	H4	Mean T
T0	16.3	16.5	15.9	15.2	16.0	227.7	229.4	226.5	225.5	227.3	1.5	1.7	1.4	1.2	1.5	0.4	0.5	0.3	0.3	0.4
T1	16.5	16.9	16.4	16.7	16.6	232.4	233.4	231.7	230.6	232.0	2.1	2.1	1.9	1.8	2.0	0.5	0.5	0.4	0.4	0.5
T2	19.0	19.2	18.8	18.6	18.9	240.5	241.5	239.5	238.5	240.0	2.9	2.9	2.8	2.7	2.8	0.9	0.9	0.9	0.8	0.8
T3	19.9	20.9	19.6	19.3	19.9	244.8	245.7	243.7	242.5	244.2	3.3	3.4	3.1	3.1	3.2	1.0	1.3	0.9	0.9	1.8
T4	17.9	18.4	17.2	17.2	17.8	236.4	237.4	235.5	234.5	236.0	2.4	2.6	2.2	2.2	2.4	0.6	0.8	0.7	0.6	0.7
Mean H	17.9	18.4	17.6	17.4		236.4	237.5	235.4	234.3		2.4	2.6	2.2	2.2		0.7	0.8	0.6	0.6	

Fruit length (cm)			Average fruit weight (g)			Average fruit yield / plant (kg)			Ascorbic acid content (mg/100 g)		
Factors	**SE(d) ±**	**CD0.05**	**Factors**	**SE(d) (±)**	**CD0.05**	**Factors**	**SE(d) ±**	**CD0.05**	**Factors**	**SE(d) ±**	**CD0.05**
Factor(H)	0.012	0.024	Factor(H)	0.104	0.051	Factor(H)	0.004	0.009	Factor(H)	0.023	0.046
Factor(T)	0.013	0.026	Factor(T)	0.116	0.057	Factor(T)	0.005	0.010	Factor(T)	0.026	0.052
Factor(HX T)	0.026	0.053	Factor(HX T)	0.233	0.114	Factor(HX T)	0.010	0.019	Factor(HX T)	0.051	0.104

Note: H1- (TMCU-1107), H2- (TMCU-1125), H3- (TMCU- 3112) and H4 - (Saira- 934)
T- Different concentrations of gibberellic acid and zinc sulphate

carbohydrate assimilation, translocation and mobilisation of nutrients resulting in earlier fruit set and fruit maturation and accelerating harvest time, Lin and Danfeng, [3]. Significantly higher numbers of fruit per plant were recorded with application of optimum dose of gibberellic acid and as they resulted in higher carbohydrate assimilation and enhanced female flowering thereby increasing number of fruits per plants. Gibberellic acid concentration might have suppressed the male flowers and promotes the female flowers which results in more number of fruit set there by increasing the number of fruits. Similar findings were reported by Batlang et al.[4] and Choudhury and Phatak et al. [5]. Significantly longer fruits and heavier fruits were recorded with application of optimum dose of gibberellic acid and zinc which might be attributed substances working together to stimulate cell elongation, optimize nutrient uptake, and promote healthy fruit development, ultimately resulting in cucumbers that were longer and of better quality. Similar findings were reported by Kadi et al. [1], Shafeek et al.[2], Farhana et al [6] and Dalai et al. [7],. Significant and higher TSS and ascorbic acid content was recorded with with application of optimum dose gibberellic acid and zinc which might due these substances working together to stimulate sugar accumulation, enhance nutrient uptake, and promote healthy fruit development, ultimately leading to cucumbers with higher TSS levels, ascorbic acid content and overall better quality. Kameswari et al. [8] and Meenakshi et al. [9].

4. CONCLUSION

Based on the results of the present investigation it is concluded that among the different treatment combinations of hybrids, gibberellic acid and zinc sulphate, treatment T8 (TMCU - 1125 + GA3 @300 ppm + ZnSO4 @0.75%) recorded significantly better results in vine length (100.9), days to 50% flowering (35), days to 1st harvest (41), number of fruits per plant (14), fruit length (20.9 cm), average fruit weight (245.7 g), average fruit yield per plant (3.4 kg) and ascorbic acid content (1.3 mg/100g) as well as significantly higher Benefit Cost Ratio of 3.41.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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