Biological Forum – An International Journal **14(3): 1501-1505(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Influence of GA_3 and $ZnSO_4$ alone and in Combination on Fruit Drop, Yield and quality attributes of Mango (*Mangifera indica* L.)

Shubham Kumar[1*], V.K. Tripathi[2] and A.K. Dwivedi[3]
[1]M.Sc. Research Scholar Department of Fruit Science,
C.S. Azad University of Agriculture and Technology, Kanpur (Uttar Pradesh), India.
[2]Professor & Head, Department of Fruit Science,
C.S. Azad University of Agriculture and Technology, Kanpur (Uttar Pradesh), India.
[3]Assistant Professor, Department of Fruit Science,
C.S. Azad University of Agriculture and Technology, Kanpur (Uttar Pradesh), India.

(Corresponding author: Shubham Kumar)*
(Received 14 July 2022, Accepted 27 August, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: An experiment was carried out to study the "Influence of GA_3 and $ZnSO_4$ alone and in combination on fruit drop, yield and quality attributes of mango (*Mangifera indica* L.)" in the garden, Department of Fruit Science, C.S. Azad University of Agriculture and Technology, Kanpur-208 002 (U.P.), India, during the year 2022. For this twelve-years-old, uniform in growth 27 plants of mango cv. Dashehari planted at 7 × 7 m apart were taken for experimentation work. There were nine treatments *viz.*, two levels each of GA_3 (20 and 40 ppm), $ZnSO_4$ (0.5 and 1.0 %) alone and their combinations along with one control, replicated thrice in RBD were used for the present experimentation work. The recommended dose of fertilizers was applied in all treatments including control. The different doses of plant bio-regulator and mineral nutrient alone and in different combinations were sprayed on the tree at pea stage of fruit setting with a sprayer having a very fine nozzle. The foliar application of micronutrients along with plant bio-regulators plays an important role in manipulating many physiological phenomena, improving the yield and quality and enhanced the productivity of plants by fulfilling the nutritional needs of fruit crops. The utilization of boron helps in the movement of sugar and advances fruit bud formation. The spraying with the combination of GA_3 (40 ppm) + $ZnSO_4$ (0.5%) results in minimum fruit drop (83.74%) and maximum number of fruits per panicle (6.48), fruit retention (16.26%), fruit length (13.39 cm), width (9.48 cm), weight (254.35 g), volume (293.22 cc), fruit yield (60.36 kg/plant), specific gravity (1.18 g/cm^3), fruit pulp (72.20%), total soluble solids (22.37ºBrix), total sugars (21.70 %), ascorbic acid (37.74 mg/100g pulp) with minimum percentage of titratable acidity (0.53 %), fruit peel (11.31%) and stone (16.49 %) under plains of central Uttar Pradesh.

Keywords: Mango, GA_3, $ZnSO_4$, Fruit drop, Retention, Yield and Physio-chemical quality.

INTRODUCTION

Mango (*Mangifera indica* L.) belongs to the family Anacardiaceae and originated in the Indo-Burma region having chromosome number 2n=40. Mango is a highly nutritive fruit which is a rich source of vitamin A. Immature and green fruits are suitable for pickling and chutney preparation because of their acidic nature, whereas, ripe fruits are used in the preparation of juices, squash, jam, nectar, custard powder, baby food, mango leather along with various others value-added products. GA_3 application is more effective in increasing the fruit retaining percentage per panicle and also increased fruit size and weight in mango and many other fruit crops. Zinc is required for the growth and development and it is one of the necessary ingredients for the synthesis of chlorophyll and hence very beneficial for photosynthetic activity. Zinc is also found in certain enzymes and Indole acetic acid (IAA) in plants. Keeping in view the above facts, the present investigation entitled "Influence of GA_3 and $ZnSO_4$ alone and in combination on fruit drop, yield and quality attributes of mango (*Mangifera indica* L.)" was carried out in plains of north India.

MATERIALS AND METHODS

Twelve-years-old, uniform in growth 27 plants of mango cv. Dashehari planted at 7 × 7 m apart in the garden, Department of Fruit Science, C.S. Azad University of Agriculture and Technology, Kanpur-208 002 (U.P.), India, during the year 2022. There were nine treatments *viz.*, two levels each of GA_3 (20 and 40 ppm), $ZnSO_4$ (0.5 and 1.0 %) alone and their combinations along with one control, replicated thrice in RBD were used for the present experimentation work. The recommended dose of fertilizers was applied in all treatments including control. The plant bio-regulator and mineral nutrient were sprayed on the tree

at the pea stage of fruit setting with a sprayer having a very fine nozzle. The detergent powder was well mixed in the spray solution which act as a sticker before spraying. The information recorded on different parameters during experimentation period was statistically analyzed.

Observations on the number of fruits per panicle, fruit drop and fruit retention were recorded during the fruiting season. At each picking, data on fruit weight and yield per plant were recorded. The polar diameter and equatorial diameter of ten randomly selected fruits were measured with a vernier caliper and expressed in cm. Data on the volume and specific gravity of fruits were measured with the help of a volumetric flask by water displacement method and expressed in cc and g/cm^2, respectively. Quality parameter such as pulp, peel and stone per cent were also calculated. The TSS of fruits were recorded with the assistance of an Erma hand refractometer. The total sugars, titratable acidity and ascorbic acid contents were determined by the techniques as suggested in AOAC (1980).

RESULTS AND DISCUSSION

Fruit Drop and Retention. The plant which was treated with the combination of GA_3 (40 ppm) + $ZnSO_4$ (0.5%) exhibited lesser fruit drop (83.74%) and more fruit retention (16.26%) closely followed by treatment of GA_3 40 ppm+$ZnSO_4$ @ 1.0%, which gave 84.12% fruit drop and 15.88% fruit retention (Table 1). The plants which were deprived of hormonal and nutritional treatments *i.e.,* control, gave a maximum of 93.12% fruit drop and lesser fruit retention (6.88%).This increase in fruit retention and reduction in fruit drop per cent might be due to an increase in the endogenous level of auxin and other metabolites. The role of zinc is known to be essential for the biosynthesis of auxin (IAA), as it is an activator of the enzyme tryptophan synthesis. These results are in accordance with the findings of Tripathi and Shukla (2010) in strawberry and Kumar *et al*. (2008); Vashistha *et al.* (2010) in mango cv. Amrapali, Tsomu and Patel (2019) in mango cv. Mallika.

Number of Fruits per Panicle. Significantly higher number of fruits per panicle (6.48) was obtained from the plants which were treated with the combination of GA_3 (40 ppm) + $ZnSO_4$ (0.5%) followed by GA_3 40 ppm+$ZnSO_4$ 1.0% (5.70) treated plants (Table 1). This increased number of fruits per panicle may be the results of higher fruit retention and less drop with $GA_3$and Zinc sulphate treatment. The results are in conformity with the findings of Maurya *et al. (*2020); Kumar *et al*. (2018) in mango.

Fruit Yield. GA_3 (40 ppm) + $ZnSO_4$ (0.5%) treated plants produced significantly higher fruit yield of 60.36 kg per plant closely followed by treatment of $GA_3$40 ppm + $ZnSO_4$ 1.0 % which recorded 58.47kg of fruits per tree (Fig. 1). Untreated plants *i.e.,* control produced significantly lesser fruit yield of 40.39 kg per tree as compared to treated one. This increase in fruit yield due to foliar feeding with the combination of plant bio-regulator and micronutrient might be attributed to more uptake of metabolites because of efficient absorption and consequently more luxuriant vegetative growth at the initial stage, which later on resulted in more metabolites for developing fruits. The importance of these plant bio-regulator and micronutrient in improving the physiological activities is also very important, which increases fruit length, width, weight and ultimately the yield. The result of the present finding is also in conformity with findings of Tripathi and Shukla (2008); Singh and Tripathi (2010) in strawberry, Haldavnekar *et al.* (2018) in mango; Badal and Tripathi (2021) in papaya.

A. Physical Parameters

Fruit Size. The size of the fruit was measured with vernier calipers and an average value was worked out. The plants which were treated with the combination of GA_3 (40 ppm) + $ZnSO_4$ (0.5%) significantly hastened the length and width of fruits registering 13.39 cm and 9.48 cm, respectively, closely followed by the combination of GA_3 40 ppm + $ZnSO_4$ 1.0 % which gave 12.96cm fruit length and 8.32cm of fruit width (Table 1). In this regard, untreated plants (control) exhibit a minimum of 9.25 cm of fruit length and 5.45 cm of fruit width. This increase in fruit size with the spraying of GA_3 and $ZnSO_4$ in a higher concentration may be due to the efficient absorption in the plants which results more accumulation of metabolites in the initial stage of fruit development. Spraying of plant bio-regulators and micronutrients might have regulated the cell-wall permeability, thereby allowing more mobilization of water in fruit attributing to larger size. These results are in close conformity with the findings of Sarkar and Ghosh (2009) in mango cv. Amrapali, who reported maximum fruit length and fruit weight with GA_3 at 30mg/liter and Maurya *et al.* (2020) in mango.

Fruit Weight and Volume. Fruit weight (254.35g) and volume (293.22cc) get significantly increase with the combined application of GA_3 (40 ppm) + $ZnSO_4$ (0.5%) closely followed by the combination of GA_3 40 ppm + $ZnSO_4$ 1.0 %, which revealed 245.21 g and 278.23 cc, respectively of weight and volume (Table 1). The poorest fruit weight and volume were recorded which were produced from the plant kept under control (193.43 g and 168.15 cc, respectively). These findings are in accordance with the reports of Tripathi and Shukla (2006) in strawberry, Shukla *et al.* (2011); Singh *et al.,* (2009) in aonla. This increase in the weight and volume of fruits might be due to the direct involvement of GA_3 and zinc in growth and indirectly through more accumulation and translocation of food materials causing an increase in the size of fruits.

Specific Gravity of Fruits. Specific gravity of fruits was significantly influenced by the foliar application of plant bio-regulator, micronutrient and their combination during experimentation period (Table 1). It is observed that fruits with higher specific gravity (1.18 g/cm^3) were produced from the plants which were treated with GA_3 (40ppm) + $ZnSO_4$ (0.5%) followed by GA_3 (40 ppm) + $ZnSO_4$ (1.0%). Fruits with minimum specific gravity were produced from untreated plants (1.01g/cm^3). These finding are in accordance with the results of Verma *et al.* (2008) in aonla and Maurya *et al.* (2020) in mango. This increase in specific gravity of fruits with the use of GA_3 and zinc might be due to an increase in fruit pulp and decrease in stone weight.

Fruit Pulp, Peel and Stone per cent. Observations recorded on the fruit pulp, peel and stone per cent clearly indicate that the combined application of GA_3 (40 ppm) + $ZnSO_4$ (0.5%) resulted in a significant increase in the pulp per cent (72.20 %) and reduction in peel (11.31 %) and stone per cent (16.49 %) in fruits (Table 2). The minimum fruit pulp per cent (61.94 %) and maximum peel (16.63 %) and stone per cent (21.43 %) was recorded in the fruits which were produced from the plants kept under control. This increase in pulp percentage may be due to more absorption of water, hormones and nutrients which increased the volume of intercellular spaces in the pulp. These results are in accordance with the reports of Vejendla *et al.* (2008); Moazzam *et al.* (2011) in mango.

B. Chemical Parameters

Total Soluble Solids and total Sugars. The maximum total soluble solids (22.37°Brix) and total sugars (21.70 %) contents were recorded in fruits which were produced from the plants treated with the combined foliar application of GA_3 (40 ppm) + $ZnSO_4$ (0.5%) followed by GA_3 40 ppm + $ZnSO_4$ 1.0% (21.23°Brix and 20.37 %, respectively), which were significantly superior to the rest of other treatments under investigation. However, the minimum TSS (17.28°Brix) and total sugars (16.67 %) contents were recorded in fruits which were produced from the plants kept under control (Table 2). This increase in the total soluble solids and total sugars content in fruits may be due to the fact that GA_3 and zinc sulphate plays an important role in photosynthesis, which leads to the accumulation of carbohydrates and ultimately results an increase in the TSS and total sugar contents in fruits. The adequate amount of zinc also improved the auxin content and it also acts as a catalyst in the oxidation process. The results are in close conformity with the finding of Vashistha *et al.* (2010); Tsomu and Patel (2019) in mango.

Titratable Acidity and Ascorbic Acid Content. The lowest titratable acidity (0.53%) in fruits was found which were produced from the plants treated with the foliar application of GA_3 (40 ppm) + $ZnSO_4$ (0.5%) combination, whereas, the maximum titratable acidity (0.66%) content was recorded in fruits which were produced from the plants kept under control (Table 2). This decrease in titratable acidity of fruits with GA_3 and $ZnSO_4$ application might be due to the conversion of acid in to sugar and their derivatives through reverse glycolytic pathway. Similar results were also obtained by Yadav *et al.* (2011) in guava and Shrivastava and Jain (2006) in mango.

Significantly maximum amount of ascorbic acid (37.74mg/100gm pulp) was found in fruits which were produced from the plants treated with the combination of GA_3 (40 ppm) + $ZnSO_4$ (0.5%), whereas, minimum amount (29.85mg/100gm pulp) was recorded in fruits which were produced from the plants kept as control (Table 2). The increased ascorbic acid content in fruits was due to increase in the catalytic activity of enzymes and coenzymes, which are represented in ascorbic acid synthesis. The adequate amount of zinc improved the auxin content and it also acts as catalyst in oxidation process. These findings are in closely accordance with the results of Rajak *et al.* (2010); Maurya *et al.* (2020) in mango.

Table 1: Influence of GA_3 and $ZnSO_4$ alone and in combinations on Fruit drop, retention and physical fruit parameters in mango cv. Dashehari.

Treatments	Fruit drop (%)	Fruit retention (%)	Number of fruits per panicle	Fruit length (cm)	Fruit width (cm)	Average fruit weight(g)	Fruit volume (cc)	Specific gravity (g/cm^3)
T_1- Control (water spray)	93.12	6.88	3.81	9.25	5.45	193.43	168.15	1.01
T_2- GA_3 @ 20 ppm	92.41	7.59	3.58	9.18	5.31	206.28	250.20	1.14
T_3- GA_3 @ 40 ppm	92.13	7.87	4.19	10.23	6.32	209.22	272.32	1.13
T_4- Zinc sulphate 0.5%	90.52	9.48	4.79	10.63	6.54	211.35	202.18	1.03
T_5- Zinc sulphate 1.0%	88.39	11.61	4.88	11.38	7.48	219.30	247.41	1.09
T_6- GA_3 20 ppm+$ZnSO_4$ 0.5 %	86.58	13.42	5.15	11.44	7.53	203.24	252.26	1.07
T_7- GA_3 20 ppm+$ZnSO_4$ 1.0 %	85.23	14.77	5.35	12.78	8.14	224.23	270.10	1.05
T_8-GA_3 40 ppm+$ZnSO_4$ 0.5 %	83.74	16.26	6.48	13.39	9.48	254.35	293.22	1.18
T_9-GA_3 40 ppm+$ZnSO_4$ 1.0%	84.12	15.88	5.70	12.69	8.32	245.21	278.23	1.15
SE(m)±	1.57	0.57	0.53	0.45	0.29	3.82	4.83	0.00
CD at 5%	4.72	1.72	1.59	1.34	0.88	11.46	14.50	0.02

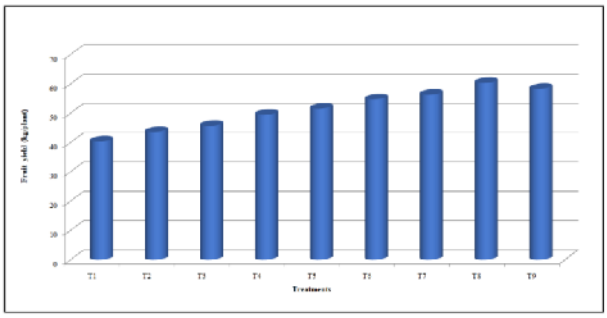

Fig. 1. Influence of GA_3 and $ZnSO_4$ alone and in combination on fruit yield (kg/plant).

Table 2: Influence of GA_3 and $ZnSO_4$ alone and in combinations on physico-chemical parameters of mango cv. Dashehari.

Treatments	Fruit pulp (%)	Fruit peel (%)	Fruit stone (%)	Total soluble solid (^{0}Brix)	Total sugar (%)	Titratable acidity(%)	Ascorbic acid (mg/100g pulp)
T_1- Control (water spray)	61.94	16.63	21.43	17.28	16.67	0.66	29.85
T_2- GA_3 @ 20 ppm	62.66	16.77	20.57	17.51	17.47	0.64	30.18
T_3- GA_3 @ 40 ppm	64.10	15.47	20.43	18.40	17.55	0.62	32.25
T_4- Zinc sulphate 0.5%	66.14	14.50	19.36	18.57	18.35	0.61	33.18
T_5- Zinc sulphate 1.0%	66.03	14.56	19.41	19.33	18.41	0.59	34.80
T_6- GA_3 20 ppm+$ZnSO_4$ 0.5 %	68.01	13.62	18.37	20.33	19.29	0.57	35.82
T_7- GA_3 20 ppm+$ZnSO_4$ 1.0 %	70.11	12.32	17.57	20.53	19.48	0.55	36.25
T_8- GA_3 40 ppm+$ZnSO_4$ 0.5 %	72.20	11.31	16.49	22.37	21.70	0.53	37.74
T_9- GA_3 40 ppm+$ZnSO_4$ 1.0%	70.23	12.29	17.48	21.23	20.37	0.54	36.88
SE(m)±	0.78	0.76	0.27	0.11	0.27	0.00	0.50
CD at 5%	2.35	1.29	0.82	1.30	0.81	0.02	1.52

CONCLUSION

From this experiment, it is can safely be concluded that the combination of GA_3 (40 ppm) + $ZnSO_4$ (0.5%) results in minimum fruit drop (83.74%) and maximum number of fruits per panicle (6.48), fruit retention (16.26%), fruit length (13.39 cm), width (9.48 cm), weight (254.35 g), volume (293.22 cc), fruit yield (60.36 kg/plant), specific gravity (1.18 g/cm^3), fruit pulp (72.20%), total soluble solids (22.37ºBrix), total sugars (21.70 %), ascorbic acid (37.74 mg/100g pulp) with minimum percentage of titratable acidity (0.53 %), fruit peel (11.31%) and stone (16.49 %) under plains of central Uttar Pradesh.

FUTURE SCOPE

The use of plant bio-regulators and micro-nutrients assumes a significant part in increasing the yield and quality of fruits with the reduction in fruit drop and increased fruit retention. Since mango is an important fruit crop all over the world in sub-tropical climate. That's why in future, more studies can be carried out on other cultivars alone or in the combination of both *i.e.*, plant bio-regulators and micro-nutrients on more parameters to standardize doses specific to the particular regions.

Acknowledgment. I extend my sincere thanks to Dr. V. K. Tripathi, Professor & Head, Department of Horticulture & Department of Fruit Science (my major advisor) and all my advisory committee members for giving me proper guidance throughout my study. I also sincerely thank Dr. D. R. Singh Sir, Vice-Chancellor, C. S. Azad University of Agriculture and Technology, Kanpur (U.P.) for providing me the required research facility in the university.
Conflict of Interest. None.

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How to cite this article: Shubham Kumar, V.K. Tripathi and A.K. Dwivedi (2022). Influence of GA_3 and $ZnSO_4$ alone and in Combination on Fruit Drop, Yield and quality Attributes of Mango (*Mangifera indica* L.). *Biological Forum – An International Journal*, *14*(3): 1501-1505.