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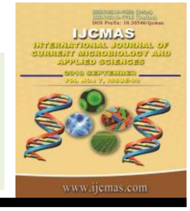

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Effect of Different Combinations of PGR's and Micronutrients on Quality in Papaya (*Carica papaya* L.) cv. Pusa Nanha

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A B S T R A C T

An investigation was carried out to assess the "Effect of different combinations of PGR's and micronutrients on quality of papaya (*Carica papaya* L.) cv. Pusa Nanha" during 2013-14 and 2014-15 at Central Research Field, Department of Horticulture, Sam Higginbottom University of Agricultural Technology and Sciences, Allahabad, U.P. The experiment was laid out in Randomized Block Design (RBD) with fifteen treatment combinations replicated thrice. Observations were recorded during both years of successive experiment on Total soluble solids (T.S.S.), Sugars and Ascorbic acid. Among them different treatment combination of PGR and micronutrients foliar application of Copper sulphate 0.25%+ Manganese sulphate 0.25%+ GA_3 60 ppm (T_{14}) proved to be the best treatment in terms of T.S.S., reducing sugar, non-reducing sugar, total sugar and ascorbic acid. The maximum total soluble solids 10.31 was obtained with foliar application of Copper sulphate 0.25%+ Manganese sulphate 0.25%+ GA_3 60 ppm (T_{14}), while the minimum total soluble solids 5.42 was obtained in control. The maximum Ascorbic acid 22.93 was obtained with foliar application of Copper sulphate 0.25%+ Manganese sulphate 0.25%+ GA_3 60 ppm (T_{14}). The maximum total sugar 9.41 was obtained with foliar application of Copper sulphate 0.25%+ Manganese sulphate 0.25%+ GA_3 60 ppm (T_{14}).

Introduction

Papaya (*Carica papaya* L.) is a delicious fruit, belonging to family Caricaceae. It is native to tropical America (Mexico). Papaya is now cultivated in most countries with tropical climate like India, South Africa, Sri Lanka, Philippines, Australia, Mexico, Indonesia and Bangladesh. A well-drained sandy loam soil, rich in plant food, is the best for papaya cultivation (Bose and Mitra, 1990).

It has attained enormous impact on economical and nutritional value. The ripe fruits of papaya are eaten throughout the world. Papaya fruits also used for several preparations like jam, soft drinks and ice-cream flavouring. It is rich in carotene, vitamin 'C' and minerals such as calcium, phosphorus and iron (Chadha, 1992). The fruits are also vital source of Vitamin-A. The immature papaya fruit contains papain which is in huge demand in the international market all over the world. Papain is used in meat tendering, chewing gum, cosmetics and for degumming materials in silk and to give resistance against shrinkage to wool.

Naphthalene Acetic Acid (NAA) belongs to synthetic forms of Auxins. Auxins play a key role in cell elongation, cell division, vascular tissue, differentiation, root initiation, apical dominance, leaf senescence, leaf and fruit abscission, fruit setting and flowering while Gibberellic acid (GA), a plant hormone stimulating plant growth and development. GAs stimulate seed germination, trigger transitions from meristem to shoot growth, juvenile to adult leaf stage, vegetative to flowering and determines sex expression (Gupta and Chakrabarty, 2013).

Foliar application of micronutrients like B, Cu, Mn, Fe and Zn are vital for controlling deficiencies of these elements in fruit crops as well as it advantageous over soil application. These advantages are high effectiveness, rapid plant response, convenience, elimination and reduction of toxic symptoms. If all these nutrients are applied, it may give additional benefits to the plant. Copper sulphate plays a vital role in photosynthesis protein carbohydrate formation in agricultural plants. Many horticultural plants show symptoms of necrosis over the young leaves which results in defoliation of the foliage. Gummosis (Exanthema) and dieback occurs due to copper deficiency.

Manganese sulphate is an essential element in plant respiratory system and plays a crucial role in cell division and development. It also involved in destruction of indole-3 acetic acid (IAA). It activates decarboxylase, dehydrogenase, and oxidase enzymes which are important in photosynthesis, nitrogen metabolism and nitrogen assimilation. Deficiency of Manganese sulphate causes necrosis in agricultural crops.

Materials and Methods

An investigation was carried out to assess the “Effect of different combinations of PGR’s and micronutrients on quality of papaya (*Carica papaya* L.) cv. Pusa Nanha” during 2013-14 and 2014-15 at Central Research Field, Department of Horticulture, SHUATS, Allahabad, U.P. The experiment was laid out in Randomized Block Design (RBD) with fifteen treatment combinations replicated thrice. Observations were recorded during both years of successive experiment on Total soluble solids (T.S.S.), Reducing sugars, Non-reducing sugar, Total sugar and Ascorbic acid.

The Total Soluble Solids of fruits was recorded with the help of a hand refractometer (Rangana, 2010). The titratable acidity of mango hybrids was determined by the method as suggested by Rangana (2010).

The reducing sugar and Total sugars were estimated by Lane and Eyon (1923). Ascorbic acid content of the juice was determined by method as suggested by A.O.A.C, 2000. Statistical analyses of the data obtained in the different sets of experiment were calculated, as suggested by Panse and Sukhatme (1989).

Results and Discussion

Biochemical attributes of fruit

Total Soluble Solids (T.S.S.)

The data presented in Table 1 revealed that all the treatments showed significant differences at after planting in first year and second year and their pooled data. The maximum total soluble solids 10.31 was obtained with foliar application of Copper sulphate 0.25% + Manganese sulphate 0.25% + GA_3 60 ppm (T_{14}) followed by 10.25 with the spray of Copper sulphate 0.25% + Manganese sulphate 0.25% + NAA 30 ppm (T_{11}), which were at par with each other. While, the minimum total soluble solids 5.42 was obtained in control.

The increase in TSS of treated fruit juice might be due to the increase in mobilization of carbohydrates from the source to sink i.e., fruits by PGR. This may be attributed to the fact that application of PGR might have increased α-amylase activity and thus there was conversion of starch into sugars and hence improved total soluble solids content. This increase in TSS with the combined application micronutrients and PGR, might be due to the facts that they are helpful in the process of photosynthesis which leads to the accumulations of oligosaccharides and polysaccharides in higher amount besides this also regulators the enzymatic activity and the enzymes that metabolize the carbohydrates into simple sugars. These results are agreement with the findings of Bal and Randhawa (2007) and Bhati and Yadav (2003) in ber.

Reducing sugar

The data presented in Table 2 revealed that all the treatments showed significant differences at after planting in first year and second year and their pooled data. The maximum Reducing sugar 7.91 was obtained with foliar application of Copper sulphate 0.25% + Manganese sulphate 0.25% + GA_3 60 ppm (T_{14}) followed by 7.88 with the spray of Copper sulphate 0.25% + NAA 30 ppm + GA_3 60 ppm (T_{12}), which were at par with each other. Whereas, the minimum Reducing sugar 3.84 was obtained in control. The possible reason might be due to the fact that micronutrients and PGR help in the process of photosynthesis which leads to the accumulations of oligosaccharides and polysaccharides in higher amount. Besides this they also regulate the enzymatic activity and the enzymes that metabolize the carbohydrates into simple sugars.

These findings are in accordance with the result of Singh and Vashistha (1997), reported higher total sugar with 0.5 % $ZnSO_4$ in ber cv. Gola. Kale *et al.,* (2000) and Ram *et al.,* (2005) reported that the growth regulators promoted hydrolysis of starch into sugars or reduced competition between the fruits for metabolites. This increase in fruit sweetness with potassium sprays might be due to increased photosynthetic activity and building of more carbohydrates and its transport to fruits. Similar findings were earlier reported by Bhatia *et al.,* (2001) in guava. Under the influence of chemicals, the acids might have been quickly converted into sugar and its derivatives by the reactions involving reversal of glycolytic pathway. These results are agreement with the findings of Dutta and Banik (2007) and Kher *et al.,* (2005) in guava; Katiyar *et al.,* (2010) in ber also reported an increase in sugars.

Non-reducing sugar

The data presented in Table 3 revealed that all the treatments showed significant differences at after planting in first year and second year and their pooled data. The maximum non-reducing sugar 0.71 was obtained with foliar application of Copper sulphate 0.25% + Manganese sulphate 0.25% + GA_3 60 ppm (T_{14}) followed by 0.68 with the spray of Copper sulphate 0.25% + Manganese sulphate 0.25% + NAA 30 ppm + GA_3 60 ppm (T_{15}), which were at par with each other. Whereas, the minimum non-reducing sugar 0.25 was obtained in control.

The possible reason might be due to the fact that micronutrients and PGR help in the process of photosynthesis which leads to the accumulations of oligosaccharides and polysaccharides in higher amount. Besides this they also regulate the enzymatic activity and the enzymes that metabolize the carbohydrates into simple sugars.

Table.1 Effect of different combination of plant growth regulators and micronutrients on total soluble solids (^{0}Brix) of papaya (*Carica papaya* L.) cv. Pusa Nanha

Treatments	2013-14	2014-15	Pooled
T_0	5.23	5.60	5.42
T_1	6.76	7.13	6.95
T_2	7.19	7.56	7.38
T_3	7.72	8.09	7.91
T_4	9.71	10.08	9.90
T_5	9.02	9.39	9.21
T_6	9.51	9.88	9.70
T_7	9.79	10.16	9.98
T_8	8.69	9.06	8.88
T_9	9.59	9.96	9.78
T_{10}	8.29	8.66	8.48
T_{11}	10.16	10.33	10.25
T_{12}	9.59	9.76	9.68
T_{13}	10.08	10.25	10.17
T_{14}	10.22	10.39	10.31
T_{15}	7.10	7.47	7.29
F- test	S	S	S
S. Ed. (±)	0.340	0.523	0.426
C. D. (P = 0.05)	0.702	1.079	0.880

Table.2 Effect of different combination of plant growth regulators and micronutrients on reducing sugar of papaya (*Carica papaya* L.) cv. Pusa Nanha

Treatments	2013-14	2014-15	Pooled
T_0	3.78	3.90	3.84
T_1	4.11	4.23	4.17
T_2	4.64	4.76	4.70
T_3	5.17	5.29	5.23
T_4	7.17	7.30	7.24
T_5	7.29	7.32	7.31
T_6	7.21	7.31	7.26
T_7	7.35	7.33	7.34
T_8	7.04	7.13	7.09
T_9	7.55	7.36	7.46
T_{10}	5.74	5.86	5.80
T_{11}	7.74	7.87	7.81
T_{12}	7.86	7.89	7.88
T_{13}	7.78	7.88	7.83
T_{14}	7.92	7.90	7.91
T_{15}	7.56	7.39	7.48
F- test	S	S	S
S. Ed. (±)	0.968	0.498	0.706
C. D. (P = 0.05)	1.997	1.028	1.458

Table.3 Effect of different combination of plant growth regulators and micronutrients on non-reducing sugar of papaya (*Carica papaya* L.) cv. Pusa Nanha

Treatments	2013-14	2014-15	Pooled
T_0	0.21	0.28	0.25
T_1	0.25	0.32	0.29
T_2	0.30	0.37	0.34
T_3	0.35	0.42	0.39
T_4	0.41	0.48	0.45
T_5	0.44	0.51	0.48
T_6	0.52	0.59	0.56
T_7	0.53	0.60	0.57
T_8	0.46	0.53	0.50
T_9	0.62	0.69	0.66
T_{10}	0.47	0.54	0.51
T_{11}	0.53	0.60	0.57
T_{12}	0.56	0.63	0.60
T_{13}	0.61	0.68	0.65
T_{14}	0.67	0.74	0.71
T_{15}	0.64	0.71	0.68
F- test	S	S	S
S. Ed. (±)	0.064	0.036	0.050
C. D. (P = 0.05)	0.132	0.075	0.104

Table.4 Effect of different combination of plant growth regulators and micronutrients on total sugar of papaya (*Carica papaya* L.) cv. Pusa Nanha

Treatments	2013-14	2014-15	Pooled
T_0	5.13	4.69	4.91
T_1	4.76	5.02	4.89
T_2	5.29	5.55	5.42
T_3	5.34	5.70	5.52
T_4	8.80	8.79	8.80
T_5	8.84	8.83	8.84
T_6	8.28	8.55	8.42
T_7	8.59	8.76	8.68
T_8	8.56	8.43	8.50
T_9	8.56	8.72	8.64
T_{10}	5.91	6.27	6.09
T_{11}	9.37	9.36	9.37
T_{12}	8.71	8.74	8.73
T_{13}	8.85	9.12	8.99
T_{14}	9.41	9.40	9.41
T_{15}	8.71	8.74	8.73
F- test	S	S	S
S. Ed. (±)	1.000	0.588	0.790
C. D. (P = 0.05)	2.064	1.215	1.630

Table.5 Effect of different combination of plant growth regulators and micronutrients on ascorbic acid (Vitamin C) mg/100 g pulp of papaya (*Carica papaya* L.) cv. Pusa Nanha

Treatments	2013-14	2014-15	Pooled
T_0	16.79	17.62	17.21
T_1	17.12	17.95	17.54
T_2	17.65	18.48	18.07
T_3	18.18	19.01	18.60
T_4	22.36	22.32	22.34
T_5	22.09	22.05	22.07
T_6	21.63	21.59	21.61
T_7	22.38	22.33	22.36
T_8	22.10	21.40	21.75
T_9	22.00	22.56	22.28
T_{10}	18.75	19.58	19.17
T_{11}	22.93	22.89	22.91
T_{12}	22.66	22.62	22.64
T_{13}	22.20	22.16	22.18
T_{14}	22.91	22.95	22.93
T_{15}	22.95	22.90	22.92
F- test	S	S	S
S. Ed. (±)	1.066	0.973	1.018
C. D. (P = 0.05)	2.201	2.009	2.101

These findings are in accordance with the result of Singh and Vashistha (1997), reported higher total sugar with 0.5 % $ZnSO_4$ in ber cv. Gola. Kale *et al.,* (2000) reported that the growth regulators promoted hydrolysis of starch into sugars or reduced competition between the fruits for metabolites. This increase in fruit sweetness with potassium sprays might be due to increased photosynthetic activity and building of more carbohydrates and its transport to fruits. Similar findings were earlier reported by Bhatia *et al.,* (2001) in guava. Under the influence of chemicals, the acids might have been quickly converted into sugar and its derivatives by the reactions involving reversal of glycolytic pathway. These results are agreement with the findings of Dutta and Banik (2007) and Kher *et al.,* (2005) in guava; Katiyar *et al.,* (2010) in ber also reported an increase in sugars.

Total sugar

The data presented in Table 4 revealed that all the treatments showed significant differences at after planting in first year and second year and their pooled data. The maximum total sugar 9.41 was obtained with foliar application of Copper sulphate 0.25% + Manganese sulphate 0.25% + GA_3 60 ppm (T_{14}) followed by 9.37 with the spray of Copper sulphate 0.25% + Manganese sulphate 0.25% + NAA 30 ppm (T_{11}), which were at par with each other. Whereas, the minimum total sugar 4.91 was obtained in control.

The possible reason might be due to the fact that micronutrients and PGR help in the process of photosynthesis which leads to the accumulations of oligosaccharides and polysaccharides in higher amount. Besides this they also regulate the enzymatic activity and the enzymes that metabolize the carbohydrates into simple sugars. These findings are in accordance with the result of Singh and Vashistha (1997), reported higher total sugar with 0.5 % $ZnSO_4$ in ber cv. Gola. Ram *et al.,* (2005) reported that the growth regulators promoted hydrolysis of starch into sugars or reduced competition between the fruits for metabolites. This increase in fruit sweetness with potassium sprays might be due to increased photosynthetic activity and building of more carbohydrates and its transport to fruits. Similar findings were earlier reported by Bhatia *et al.,* (2001) in guava. Under the influence of chemicals, the acids might have been quickly converted into sugar and its derivatives by the reactions involving reversal of glycolytic pathway. These results are agreement with the findings of Dutta and Banik (2007) in guava; Katiyar *et al.,* (2010) in ber also reported an increase in sugars.

Ascorbic acid

The data presented in Table 5 revealed that all the treatments showed significant differences at after planting in first year and second year and their pooled data. The maximum Ascorbic acid 22.93 was obtained with foliar application of Copper sulphate 0.25% + Manganese sulphate 0.25% + GA_3 60 ppm (T_{14}) followed by 22.92 with the spray of Copper sulphate 0.25% + Manganese sulphate 0.25% + NAA 30 ppm + GA_3 60 ppm (T_{15}), which were at par with each other. Whereas, the minimum Ascorbic acid 17.21 was obtained in control.

This increase in ascorbic acid content might have been resulted due to the enhanced synthesis of ascorbic acid, due to favourable metabolic activity involving certain enzymes and metallic ions under the influence of plant growth regulators and micronutrients. An Increase in ascorbic acid content might be due to perpetual synthesis of glucose-6-phosphate throughout the growth and development of fruits which is thought to be the precursor of vitamin-C. These results are in accordance with Sharma *et al.,* (2011) and Katiyar *et al.,* (2009) in guava. Singh *et al.,* (2007) confirmed that combined spray of (0.5%) ZnSO4 + (10 ppm) NAA + (25 ppm) GA3 significantly improved ascorbic acid content in aonla cv. NA-10.

From the above experiment it can be concluded that with the application of foliar spray of Copper sulphate 0.25% + Manganese sulphate 0.25% + GA_3 60 ppm (T_{14}) the quality parameters in papaya can be improved significantly.

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