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Effect of plant growth regulators on chemical quality of papaya (*Carica papaya*) cv. Red Lady

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Abstract
The present investigation has been conducted for two consecutive years (2018-19 and 2019-20) to determine the effect of various phyto bio regulators on chemical quality of papaya (*Carica papaya*) cv. Red Lady in a randomized block design using factorial arrangement with 11 treatments and 03 replications. The treatment consists of two concentrations i.e. 100 ppm & 150 ppm of various phyto bio regulators which includes Naphthalene acetic acid (100 and 150 ppm), Gibberellic acid (100 and 150 ppm), Benzyl adenine (100 and 150 ppm), Ethrel (100 and 150 ppm) and 2,3,5-Triiodo benzoic acid (100 and 150 ppm). The study revealed that phyto bio regulators significantly affect the chemical quality of papaya fruits. The ascorbic acid was found to be highest in 150 ppm of Gibberellic acid while Ethrel (150 ppm) recorded significantly highest value of TSS, total sugar, reducing sugar, non-reducing sugar, sugar: acid ratio and lowest value of titrable acidity.

Keywords: Papaya, phyto growth regulators and chemical quality

Introduction
The India is blessed with variety of fruit crops to fulfil the nutritional and medicinal needs of the people. Out of these fruit crops, Papaya (*Carica papaya*) is one the important fruit crop, which is commonly known as “wonder fruit” of tropical and subtropical regions (Radha and Mathew, 2007) [24] by virtue of it’s highly remunerative, nutritional and medicinal properties. Moreover, it is easy to cultivate that can be grown throughout the year and poses quick returns (Drew *et al.* 1998) [6].

The plant hormones (or phytohormones) are the naturally producing organic substance in the plant that are produced in minute quantities and regulates the growth and other physiological functions of a plant. Hence, such chemical substances have proven to be an important component of modern fruit production technology both for improving the quantity as well as quality of fruit crops (Jain and Dashora, 2011) [20]. It alters the parameters like vegetative growth (Hota *et al*., 2017a [13]; Priyadarshi *et al*., 2017 [23]), fruit set (Hota *et al*., 2017b) [15], fruit drop (Hota *et al*., 2017c) [16], yield attributing parameter (Hota *et al*., 2017d [18], Priyadarshi *et al*., 2018a [22]), physical parameters (Hota *et al*., 2017e) [19], chemical parameters (Hota *et al*., 2018 [14], Priyadarshi *et al*., 2018b [21]) and physico-chemical parameters (Hota *et al*., 2017f) [17]. Since, such chemical products have various diverse affects, hence, it is used at particular stage of production cycle to get maximum benefit out of them (Hota *et al*., 2019) [12]. Moreover, with the advancement of technology, these chemicals can be supplied exogenously, in both natural and synthetic form (as their chemical analogs, hormone releasing agents, hormone sensitivity altering agents and hormone synthesis inhibitors (Hajam *et al*., 2017) [9], in such a way that it can modify the plant production processes, thereby increasing the yield (Singh and Singh, 2009) [26]. Furthermore, the consumer acceptability of papaya fruits, largely depends on various physiochemical properties like TSS (Gaudence *et al*., 2019) [7], besides affecting it’s organoleptic value and shelf life (Vagadia *et al*., 2016) [27]. Considering this fact, the present investigation has been designed to determine the effect of various phyto bio regulators on qualitative aspect of papaya cv. Red Lady.

Materials and method

The Mahasamund district of Chhattisgarh is located at 20º47' to 21º31' N latitude and 82º00' to 83º15' longitude having sub humid climatic conditions with an average annual rainfall of 1200 mm. The present investigation was conducted at Farm of Krishi Vigyan Kendra, Mahasamund for two consecutive years (2018-19 and 2019-20) in a moderately sloped land with appropriate drainage system.

The healthy, disease and pest free Red Lady seeds were raised in polybags (12 x 10 cm size) filled with a mixture of Soil, Sand and Vermicompost. The polybags were regularly irrigated and utmost care of nursery plants is taken until they are ready for transplanting in the field. The experimental plants were planted at a distance of 2mt.x 2mt.and were cultivated adopting recommended package of practices. The experiment was designed in Randomized Block Design with three replications and 11 treatment combinations which were as follows: T_0, Control (Water Spray); T_1, Naphthalene acetic acid (NAA) 100 ppm; T_2, Naphthalene acetic acid (NAA) 150 ppm; T_3, Gibberellic acid (GA_3) 100 ppm; T_4, Gibberellic acid (GA_3) 150 ppm; T_5, Benzyl adenine (BA) 100 ppm; T_6, Benzyl adenine (BA) 150 ppm; T_7, Ethrel 100 ppm; T_8, Ethrel 150 ppm; T_9, 2,3,5-Triiodo benzoic acid (TIBA) 100 ppm; T_{10}, 2,3,5-Triiodo benzoic acid (TIBA) 150 ppm.

The foliar spray of growth regulators was done at different time slots i.e. 45, 75 and 125 days after transplanting. The solutions of different concentrations were sprayed to wet the whole plant with care to avoid its drooping on the soil surface. The data pertaining to quality parameters (Total Soluble Solids, Titrable Acidity, Ascorbic Acid, Sugar Acid Ratio and Sugars- Total, Reducing and Non-reducing) was recorded as per the methods suggested by Ranganna (1997) [25] and was subjected to statistical analysis of variance as described by Gomez and Gomez (1984)[8].

Results and Discussion

The phyto bio regulators pose significant effect on various chemical parameters of papaya fruit (Table-1). The significant maximum value of total soluble solids (16.80º Brix), total sugar (9.79 %), reducing sugar (7.54 %) and non-reducing sugar (2.25 %) as well as sugar acid ratio (79.76) along with lowest value of titrable acidity (0.123%) were recorded in Treatment T_8 i.e. 150 ppm of ethrel. Further Treatment T_4 i.e. GA_3 150 ppm recorded maximum value (82.41) of ascorbic acid content in papaya fruits

The total soluble solid (TSS) was found to be highest for T_8 treatment i.e. Ethrel 150 ppm. Since, the phyto bio regulators enhance the growth rate of plants, which causes higher metabolites accumulation besides increasing the conversion rate of starch into soluble sugars (Agrawal and Dikshit, 2010) [1]. This finding was in accordance with Hazarika *et al*. (2016) [10], where they had observed higher TSS with ethrel on papaya (Carica papaya) cv. Red lady.

The titrable acidity was significantly lowest in treatment T_8 i.e. Ethrel 150 ppm and was highest for treatment T_6 i.e. BA 150 ppm. Since, the benzyl adenine behaves as an anti-senescence agent, thereby affects the various biochemical processes that are responsible for metabolic deterioration in the fruits (Bhardwaj *et al*. 2005) [2].

For the various catabolic processes in fruits, organic acids acts as the necessary respiratory substrate (Chouksey *et al*., 2013) [5], Hence, BA reduces the conversion of organic acids into sugar, thereby increasing it's concentration as compared to other phyto bio regulators. Canli *et al*., 2009 [4] had also observed the similar effect of benzyl adenine (BA) on titrable acidity of pear fruit (*Pyrus communis*). On the other hand, ethrel as fruit ripener, increases the metabolic deterioration processes of organic acids in the fruit. This finding was in accordance with Hazarika *et al.* (2016) [10] and Yadav *et al* (2011) [28], where both of them independently observed the same trend.

Table 1: Effect of phyto growth regulators on chemical parameters of fruits

Treatment	TSS (ºBrix)	Acidity (%)	Ascorbic acid (mg/100 gm)	Total Sugar (%)	Reducing Sugar (%)	Non-reducing Sugar (%)	Sugar Acid ratio
T_0 Control (Water)	11.32	0.182	68.42	7.52	6.35	1.17	41.49
T_1 NAA 100 ppm	13.36	0.156	80.33	8.42	6.73	1.69	54.13
T_2 NAA 150 ppm	13.96	0.151	80.81	8.67	6.88	1.79	57.68
T_3 GA3 100 ppm	14.83	0.144	81.33	8.90	7.09	1.81	61.81
T_4 GA3 150 ppm	15.77	0.137	82.41	9.13	7.23	1.90	67.07
T_5 BA 100 ppm	12.00	0.174	69.62	7.79	6.42	1.37	45.00
T_6 BA 150 ppm	10.92	0.187	70.39	7.39	6.31	1.08	39.51
T_7 Ethrel - 100 ppm	16.39	0.130	69.32	9.33	7.34	1.99	71.87
T_8 Ethrel - 150 ppm	16.80	0.123	69.43	9.79	7.54	2.25	79.76
T_9 TIBA 100 ppm	12.65	0.168	72.35	7.96	6.58	1.38	47.37
T_{10} TIBA 150 ppm	12.76	0.162	71.61	8.16	6.63	1.53	50.36
SEM	0.15	0.007	0.36	0.10	0.13	0.16	3.51
CD at 5%	0.43	0.022	1.05	0.30	0.39	0.48	10.36

The ascorbic acid content was found to be highest for T_4 treatment (GA_3; 150 ppm). The probable reason for such highest value with gibberellic acid may be attributed due to it's catalytic action of it's precursor glucose-6-phosphate or by arresting the activity of an enzyme ascorbic acid oxidase (which metabolizes ascorbic acid to dehydroascorbic acid) or both. This finding was in accordance with Hazarika *et al.* (2016) [10] and Hetram (2017) [11] on papaya fruit

The total sugar (TS), reducing and non-reducing sugar content was highest for T_8 treatment i.e. ethrel treated plants i.e. 150 ppm. This increase in sugar content might be due to the early ripening action of ethrel that enhances the action of various hydrolytic enzymes that participates in the respiration and carbon assimilation functions in the papaya, thereby breaking the complex polysaccharides compounds and organic acids into simple sugars (Singh and Singh, 2009) [26]. The increase in both reducing and non-reducing sugar might be also due to the same reasons. Similar results were also observed by other researchers (Biswas *et al*., 1988; Yadav *et al*., 2001) [3, 28].

The sugar acid ratio is the ratio between produced sugar and acid produced. The ratio was found to be highest in Treatment T_8 (Ethrel 150 ppm) as the ethrel being a ripening hormone, converts starch to sugars through higher respiration and carbon assimilation activity. Further one of the reasons for lowest sugar acid ratio in T_6 i.e. BA 150 ppm, is that it lowers the catabolic activity of polysaccharides, and increases the level of acid content. Similar findings was observed by Hazarika *et al*. (2016) [10].

Conclusion
From the above investigation, it can be concluded that exogenous application of phyto bio regulators may acts as a useful tool not only for increasing the yield but also for improving the quality of fruits which helps in increasing consumer acceptability of produce. However, phyto bio regulators may be used judiciously to prevent any to prevent any ill effects, because of exogenous application of phyto bio regulators.

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