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Effect of Plant Growth Regulator on Flowering and Yield Attributes of Papaya

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ABSTRACT: The present investigation was carried out to assess the effect of plant growth regulator on flowering and fruit yield attributes of Papaya plant Pusa dwarf (*Carica papaya*) during 2017-18 at Experimental Farm of Horticulture field of Uttar Banga Krishi Viswavidyalya, Cooch Behar. The experiment was laid out in the Randomized Blocked Design (RBD) with fourteen treatment combinations replicated thrice. The observation was recorded during the trial experiment on the Number of flowering, percentage of the male and female flower, days required from flowering to maturity, number of fruit bear in a plant, the weight of the fruits, percentage of fruit set, bearing height of first fruit, and yield. Pusa dwarf being an outsource cultivar, its hardening stage was regularly mandated for about 2 weeks until it was fully established. The study indicates that the growth, yield, and quality of papaya fruits were significantly influenced by plant growth regulators. The treatments considered were foliar sprays of PGR consisting of GA3, NAA, TIBA, and Brs at a concentrations i.e. GA3 (15 ppm, 30 ppm, and 45 ppm), TIBA (10 ppm, 20 ppm, 30 ppm), Brs (0.10 ppm, 0.25 ppm and 0.40 ppm) and NAA (20 ppm, 30 ppm, 40 ppm). Among them, foliar application of Brs (0.25 ppm) proved to be the best treatment with regard to yield, flowering, fruit set, fruit maturity, and fruit weight. Most treatments except NAA (20 ppm and 30 ppm) had significantly increased the yield over control.

Keywords: NAA (Naphthalene acetic acid), TIBA (Triiodobenzoic Acid), GA3 (Gibberellic acid), Brassinosteroids (BRs), Parts per million, foliar application, sex development; flower.

INTRODUCTION

Papaya (*Carica papaya* L.) is an important fruit crop of the tropical and subtropical regions of the world. The ripe fruits are used in the preparation of preserved products like jam, soft drinks, ice-cream flavoring, crystallized fruits, and syrup. Papain, prepared from the dried latex of immature fruits is a proteolytic enzyme similar in action to pepsin and is used in a meat tenderizing preparation, in the tanning industry, manufacture of chewing gums, and cosmetics. Growth regulators are found to play an important role in controlling growth stimulation, femaleness, enhancing flowering, and increasing fruiting and quality improvement in fruits. The height of fruit and sex in papaya have been reported to be altered by environmental changes and growth regulators. In view of the above findings, an experiment was undertaken with an objective to study the effect of different plant growth regulators on flowering and yield attributes of papaya under the Terai region. Plant height was enhanced by GA3 treatments; this effect was associated with increased internode length and became more marked as GA3 concentration increases in papaya (Kalalbandi *et al*., 2003; Kumar *et al.*, 2011). Maximum shoot growth was enhanced with 2% calcium nitrate + 40 ppm GA3 (Singh *et al.*, 2011). However, the best overall results with regard to shooting growth, early flowerings, and maximum reduction in the flowering period were obtained with 2% calcium nitrate with 100 ppm of NAA. The application of the NAA tends to increase the number of leaves produced per plant in papaya (Cobicanchi, 1972). The effect of the different plant growth regulators i.e., GA3 (25 ppm and 50 ppm), NAA (50 ppm and 100 ppm), Ethrel (300 ppm and 500 ppm), TIBA (25 ppm and 50 ppm), and MH (200 ppm and 500 ppm) sprayed at 45 days after transplanting is reflected in the observation that the values of the variables, namely, plant height and the intermodal length of the papaya are increased by NAA, GA3, and ethrel, while the values of the above variables are decreased due to MH and TIBA. All chemicals increase the girth and number of leaves per plant. Flowering is hastened by 10 to 20 days by the chemicals (Ghanta and Mitra, 1998). The plant girth, plant spread, and the reduction of the number of days taken for fruit bud differentiation are greatly influenced by the application of TIBA at the concentration of 100 ppm followed by 150 ppm in papaya (Jindal and Singh 1976). A field trial on the effect of plant growth regulators on papaya reports that the foliar application of NAA 100 ppm and 150 ppm and GA3 200 ppm on papaya cause the yield and yield attributing characters to attain maximum values under NAA 100 ppm over controls (Ram, 2007).

As described by Chung and Kim, (1989) the application of TIBA in soybean cotton and groundnut has a beneficial effect on its yield attributes (a) by checking the excessive vegetative growth and lodging tendency, (b) by reducing the abscission of flowers and immature pods and (c) by modification of crop canopy to improve the productivity of crops. Prakash *et al*., (2017) have shown that the use of Brassinosteroid in sesame is responsible for the improvement in yield. Bhatia and Kaur (1997) described the effect of homobrassinolide (brassinosteroids and humicil) is beneficial for an increase in chlorophyll content which ultimately reflects in the increase in yield components in mungbean. Numerous studies suggest that the application of TIBA and brassinosteroid records a beneficial effect on cereals and vegetable crops. Incidentally, there exist no research works wherein the effectiveness of the above growth hormones (TIBA and brassinosteroid) on fruit plants, like, apple, papaya, banana, etc. has been studied. The objective of the present study is to determine the effect of the Plant Growth Regulators on the different attributes related to the phenomena of flowering and yield.

MATERIALS AND METHODS

The experiment was carried out on cv. Pusa dwarf during *Monsoon* season (June - July) at the Agricultural farm, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal situated at 26^{o}19'86" N, 89^{o}23'53" E with an altitude of 43 m. The experimental site comes under the Sub Himalayan *Terai* agro-climatic zone of India. The average rainfall is 3000 mm, most of which is received from June – September each year. The mean daily temperature ranged from 13.93 -27.95°C during the crop season. Mean daily relative humidity fluctuated between 47 percent and 95 percent. The soil of the experimental site was sandy loam; available N, P, and K were 118.6 kg/ha, 15.98 kg/ha and120.33 kg/ha, respectively, with 0.78% organic carbon present. The soil was acidic with a pH of 5.4.

Thirty days old healthy and diseases free with uniform-sized tray seedlings were used for the experiment and transplanted on 26th July 2017. The trial was laid out in a randomized block design (RBD) structure involving fourteen (14) treatments (including two control treatments) in three (3) replications. The secondary hardened seedlings of the Pusa dwarf cultivar of papaya were planted at a spacing of 1.0 × 1.0 m (plant to plant) and 2.0 × 2.0 m (row to row). There was a total number of 14 treatment combinations as T_1, control (without water spray); T_2, control (with water spray); T_3, GA_3 15 ppm; T_4, GA_3 30 ppm; T_5, GA_3 45 ppm; T_6, NAA 20 ppm; T_7, NAA 30 ppm; T_8, NAA 40 ppm; T_9, TIBA 10 ppm; T_{10}, TIBA 20 ppm; T_{11}, TIBA 30 ppm; T_{12}, Br 0.10 ppm; T_{13}, Br 0.250 ppm, and T_{14}, Br 0.40 ppm. The plant growth regulators were applied thrice as a foliar application on 45th, 75th and 105th days after planting. Five plants from each plot were selected randomly and tagged for observation of plant growth characters. The observations on plant growth and yield characters were recorded following standard methods. The total number of flowers from each plant was determined and the days required from flowering to maturity were recorded. Percent fruit set was determined using the methodology and formula as described by Westwood, (1979) and the height of the first fruit-borne plant was measured. The Percentage of male flowers and the percentage of female flowers for each of male or female plant were determined. Fruit weight was taken using top pan digital balance. The data were analyzed using one-way analysis of variance (ANOVA) (Gomez and Gomez 1984), and the means were separated with the least significant difference analysis using Duncan's multiple range test (DMRT) at $P < 0.05$.

Fig. 1. Papaya plot and observation.

RESULT AND DISCUSSION

A. Effect of plant growth regulators on the vegetative growth of the plants

The effect of various plant growth regulators on the growth parameter have been enumerated in the Table 1. Plant growth regulators exhibited significant influence on the vegetative growth of papaya plants. Plant treated with Brassinosteroid 0.40 ppm required minimum days (148 days) from flowering to maturity and the control without water spray has the maximum days (168 days) to maturity from flowering. Present findings are in close association with the findings of Bhattacharayya and Rao, (1981) in papaya as BRs enhanced the development and activate vascular tissues activities of flowering which stimuli the hormones from the leaf to the axils parts, thus produces early flowering compared with other treatments.

The bearing height of the 1st fruit set was obtained highest (105.45 cm) in control without water spray and the minimum was obtained (81.70 cm) in Brassinosteroids 0.40 ppm. Similar findings were earlier shown by Gokbayrak and Engin (2018) in pomegranate as Brs considerably increases the overall sizes of floral parts in the bisexual flowers and provides the widest stigma, resulting in flowering earlier than the controls.

B. Effect of plant growth regulators on yield-attributing characteristics

The significant effect of various treatments on flowering and maturity is displayed in Table 1. The maximum number of flower was obtained with the foliar application of Brassinosteroids 0.250 ppm (99.30) which was significantly higher than other treatments while the minimum number of the flower was obtained in control without water spray (83.78). Percentage of the either male or female flower for each plant were observed. For the female plant, female flowers were having highest (65.90%) in plant treated with Brassinosteroids 0.40ppm and minimum (44.80%) in control without water spay whereas, in case of a male plant, the male flower was seen highest (55.20%) in control without water spray and the lowest (36.20%) in Brassinosteroids 0.40 ppm. On the contrary, Gokbayrak and & Engin (2018) finds that treating with a lower concentration of Brs increases the vigor of the ovary and the number of ovules present in a flower which induced to produce large flowers, which can lead to larger fruits. It provides wider and bigger flowers in terms of ovary width, base to sepal notch length, and total pistil length.

The percentages of fruits setting were obtained highest (65.00%) in Brassinosteroids 0.250 ppm and the least was seen (45.48%) in the treatment of control without water spay. The above confirmation was given by Ghanta and Mitra, (1998) in papaya and Greene (2006) in apple, who reported that TIBA and Brassinosteroids prevent the formation of abscission layer in apple, which may result in enhanced setting of fruits.

The number of fruits set per plant was recorded highest in plant treated with Brassinosteroids 0.250 ppm (64.55%) and the minimum (38.10%) was recorded in control without water spay. These findings are in accordance with the result given by Pipattanawong *et al.,* (1996) as foliar application of Brassinosteroids enhances yield.

The weight of the fruits was obtained highest (750 g) in Brassinosteroids 0.250 ppm and the minimum was obtained (525 g) in control without water spray. The increase in fresh weight and size of the fruit may also be explained by the fact that hormones play a regulatory role in the mobilization of metabolites within the plant and it is a well-established fact that developing fruits content extremely active metabolites which flows from the vegetative parts. (Singh and Bal 2006).

C. Effect of plant growth regulators on yield

Observation of yield/plant was found to vary significantly (Table 1). As data presented in Table 1 shows that Brassinosteriods (0.250 ppm) application resulted in the highest yield/plant (48.41 kg) and the minimum was observed (20.00 kg) in control without water spray. Our study was in close conformity with the study of Ghanta and Mitra (1998); Vishwakarma *et al.,* (2020) as they stated that foliar application of chemicals or hormones (brassinosteroid) may result in enhancement of the physiological and biological activities of papaya.

Table 1: Data analysis.

Treatment	Parameters								
	Number of flower per plant	Number of fruit per plant	Percentage of fruits set	Weight of the fruits (kg)	Days require from flowering to fruit maturity	Bearing height of first fruit	Percentage of male flower	Percentage of female flower	Yield per plant
T1	83.78	38.10	45.48	525	168	105.45	55.20	44.80	20.00
T2	85.60	40.20	46.96	550	165	102.23	52.30	47.90	22.11
T3	90.25	52.10	57.73	575	158	96.15	48.30	51.70	29.96
T4	92.30	56.20	60.89	600	156	94.60	45.10	54.90	33.72
T5	94.20	58.10	61.68	585	154	92.30	43.44	58.56	33.98
T6	88.45	48.30	54.60	560	160	98.32	50.75	49.25	27.05
T7	89.20	49.45	55.44	580	160	97.25	50.10	49.90	28.68
T8	89.30	45.60	51.06	595	159	99.40	51.85	48.15	27.13
T9	92.60	56.20	60.80	610	159	87.35	47.90	52.10	34.34
T10	94.80	59.10	60.34	650	156	84.20	41.55	58.50	38.41
T11	96.20	60.20	60.58	680	155	83.40	40.20	59.80	40.93
T12	98.20	62.30	63.44	663.33	153	82.60	38.35	61.65	41.12
T13	99.30	64.55	65.00	750	151	83.633	36.20	63.80	48.41
T14	99.10	63.75	64.33	670	148	81.70	34.10	65.90	45.37
SEM (±)	0.02	1.36	0.93	1.60	3.09	2.19	1.90	0.91	1.14
CD(P = 0.05)	2.56	2.85	2.74	14.72	4.37	3.90	2.84	2.63	3.96

CONCLUSION

From this experiment, we can conclude that the application of "Brs" has more positive effect on flowering and the yield attributes than TIBA, NAA and GA3. This was due to the physiological effect of brass inosteroids on flowering and fruit yield of the plant as a result of cell elongation and cell division. An increase in photosynthetic activity, better food accumulation, and an increase in the flowering parts especially the female part were due to the action of brass inosteroids.

FUTURE SCOPE

The author wants to conclude that application of plant growth regulators have a positive response, which in turn can be used for large scale cultivation without the use of fertilizers and other chemicals. Plant growth regulator not only provides better yield of the plant but also enhanced its crops establishment. Sustainable crop production requires the adoption of low-cost and environmentally friendly crops establishment techniques. Chemical enhancement with the foliar application of PGR is one of the most appropriate techniques in increasing growth and yield which can be exploited by the regular farmers at very low cost.

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Conflict of Interest. Nil.

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