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Impact of Bioregulatorson Biochemical Parameters in cuttings of Passion fruit [*Passiflora edulis flavicarpa* Deg.]

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ABSTRACT

Passion fruit through seed propagation is showing good performance but due to high vaiability and heterozygosity which result in uneven plants in orchard. Also plant raised through seed takes more time to grow than vegetatively propagated. Therefore by considering the importance of propagation by stem cuttings, a present investigation was conducted on the response of different bioregulators on biochemical parameters in cuttings of the Yellow passion fruit variety [Passiflora edulis flavicarpa Deg.]. The cuttings of passion fruit were treated with various concentrations of Indole butyric acid [300, 500 and 700 ppm] and Paclobutrazol[20, 40 and 60 ppm]for 15 minutes under quick dip method along with control [distilled water]. Cuttings consist of 3-4 nodes and are approximately 15-20 cm in length. The results obtained from the study revealed that significantly higher concentrations of chlorophyll a [4.25 mg/g], chlorophyll b [1.02 mg/g], total chlorophyll [5.27 mg/g], carotenoid concentration [1.06 mg/g] and total soluble sugar [3.07 mg/g] when cuttings were subjected to T1 PBZ @ 60 ppm. Among the IBA treatments, 700 ppm was recorded best concentration in biochemical parameters viz., chlorophyll a [3.07 mg/g], chlorophyll b [0.78 mg/g], total chlorophyll [3.85 mg/g], carotenoid concentration [0.65 mg/g] and total soluble sugar [2.87 mg/g].

Keywords: Cuttings, Indole butyric acid, Nodes, Paclobutrazol, Passion fruit, Chlorophyll, Total soluble sugar.

Introduction

Passion fruit [*Passiflora edulis flavicarpa* Deg.], is a high-value and export-oriented minor fruit crop that is native to tropical America [Brazil]. It belongs to the Passifloraceae Family having chromosome number 2n= 18. It is mostly grown in tropical and subtropical regions of the world.South America is currently the world's greatest producer of passion fruit [1]. In India, passion fruit was introduced in the early twentieth century but its cultivation is confined to the Western Ghats such as Nilgiris, Kodaikanal, Coorg and Malabar and North Eastern States like Manipur, Nagaland and Mizoram [2]. The total world production of passion fruit is estimated to be 684,000 metric tonnes[3]. The estimated area of cultivation for passion fruit in India is 11,000 ha, with a production of 57,000 metric tones[4]. Manipur shares the highest production of passion fruit in India followed by Nagaland. The average productivity of passion fruit in India is around 5.02 tons/ha which is lower than in other countries where Productivity is 30-35 tons/ha[3].The fruit can be used for consumption or for its juice, which is frequently added to other fruit juices to enhance aroma.The fruit contains nutrients such as Vitamins A, B_2, and C, as well as non-nutritive phytochemicals, carotenoids, and polyphenols [5].

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Passion fruit is used to cure urinary infections, as a moderate diuretic, as a digestive stimulant, and as a heart tonic, as well as to treat asthma, whooping cough, and cancer [5]. Passion fruit vine is commercially propagated sexually, through seeds and asexually by cuttings, grafting and layering. The plant raised from seedlings takes many weeks for transplanting and also induces variability. Plants are grown in soil-borne pathogens and have poor germination [6]. Among these, stem cuttings are the most convenient, simple and popular method of plant propagation as they carry all the desirable characteristics of a mother plant to the offspring. Adventitious root induction and initiation on stem cuttings of woody species are complex physiological, genetic and environmental processes [7]. Different classes of plant growth regulators have been proven to influence root initiation. To date, auxins have been shown to have the greatest effect on rooting [8].Olive cuttings root well using synthetic auxin indole-3-butyric acid [7], but in difficult-to-root cultivars the auxin either fails to promote rooting or promotes it only slightly [9]. [11] reported that in IBA- treated cuttings, the number of roots was high but their overall growth was reduced. Application of plant growth retardants has been reported to improve rooting ability and survival in several plant species. Cuttings of fig treated with IBA @ 3500 ppm recorded the highest survival percentage as compared to the control [39]. Paclobutrazol (PBZ), a gibberellin synthesis inhibitor is involved in maintaining low levels of rooting inhibitor in the cutting [12] and in increasing the sink capacity of the base of cuttings for carbohydrates [10]. Guava cuttings treated with PBZ shows the highest cutting success and rooting.

Passion fruit through seed propagation is showing good performance in the Jammu region but due to high viability and heterozygosity it results in uneven plants in the orchard. Also, plant raised through seed takes more time to grow than vegetatively propagated. Therefore, by considering the importance of propagation by cuttings, very little study has been conducted on the propagation of passion fruit through cuttings by using different bioregulators. In the view of above factors an investigation was undertaken to study the effect of bioregulators on biochemical changes in cuttings.

Material and Methods

The present investigations were conducted in the Department of Plant Physiology, Faculty of Basic Sciences, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Main Campus, Chatha, Jammu during 2022-2023. The experiment consists of seven treatments, three replications, and ten cuttings per replication. Semi-hardwood cuttings of about 15-20 cm in length with 3-4 nodes were collected froma healthy, disease-free, vigorous-growing adult mother plant of yellow passion fruit. There were three different concentrations of IBA viz., 300 ppm, 500 ppm, and 700 ppm, and PBZ viz., 20 ppm, 40 ppm and 60 ppm along with control. The basal 1.5-2.0 cmportion of cuttings was treated with various concentrations of IBA and PBZ for 15 min under the quick dip method. Cuttings were then planted in a slanting position in polybags of size 25x15 cm2 consisting of soil, sand, vermicompost and cocopeat in the ratio of 1:1:1:1. Irrigationwas provided as and when required. During the entire course of the study, all passion fruit cuttings were given uniform cultural operations. Various biochemical parameters were recorded at the vegetative stage of cuttings. The data recorded was analyzed by using the statistical tool- Completely Randomized Design [CRD].

Results and Discussion

Effect of bioregulators on Chlorophyll 'a', 'b' and total chlorophyll (mg/g F.W)

A significantly higher chlorophyll 'a' concentration [Table 1 and Fig. 1] was recorded in cuttings treated with PBZ @ 60 ppm, 40 ppm, and 20 ppm [4.25, 3.88 and 3.47 mg/g F.W] respectively followed by IBA @ 700 ppm and 500 ppm [3.07 and 2.80 mg/g F.W] in comparison to control [2.41 mg/g F.W]. Non-significant increase in chlorophyll a concentration was noticed in IBA-treated cutting @ 300 ppm [2.48 mg/g F.W] in comparison to control [2.41 mg/g F.W].As evident from Table 1PBZ when applied @ 60 ppm, 40 ppm and 20 ppm, there was a significantly higher chlorophyll 'b' concentration [1.02, 0.88 and 0.81 mg/g F.W] respectively followed by IBA @ 300 ppm, 500 ppm and 700 ppm [0.78, 0.73 and 0.66 mg/g F.W] was noticed in comparison to control [0.57 mg/g F.W].Corresponding to chlorophyll 'a' and 'b', total chlorophyll concentration [Table 1] toa significant increase in cuttings treated with PBZ @ 60 ppm, 40 ppm and 20 ppm [5.27, 4.76 and 4.28 mg/g F.W] respectively followed by IBA @ 300 ppm, 500 ppm and 700 ppm [3.85, 3.53 and 3.14 mg/g F.W] in comparison to control [2.98 mg/g F.W]. This is because, PBZ increases the endogenous cytokinin level in xylem sap. This increased level of cytokinin increases the activity of antioxidant enzymes, delaying senescence and restricting protein degradation, thus promoting chlorophyll biosynthesis [13]. Our findings are in agreement with [14] who reported that PBZ treatment increases the chlorophyll content in yellow passion fruit seedlings. Chlorophyll content was increased in PBZ-treated plants as reported by [15] in herbaceous peonies and [16] in mulberry. [17] Recorded the highest value of chlorophyll a, chlorophyll b, and total chlorophyll contents [1.01, 0.39, and 1.40 mg/g FW respectively] with PBZ treated plant @ 75 ppm and lowest in control *Chrysanthemum indicum*. [18] Revealed that when IBA was applied at a rate of 2500 ppm to semi-hardwood cuttings of lemon (*Citrus limon*), the maximum leaf chlorophyll content [45.41 mg/g] was determined. [19] Recorded that black rice plants treated with either 25 or 50 ppm PBZ have greener leaves in comparison to control. Similarly, studies on Jatropha by [20] and Camelina by [21] showed chlorophyll content higher in PBZ- treated plants [22],[21],[15],[19] and [23]. More concentrated chlorophyll content inside the cell is due to the inhibitor effect of growth retardant that produces smaller cells reported by [24].

Effect of bioregulators oncarotenoid and total soluble sugar (mg/g F.W)

Carotenoid concentration [Table 2 and Fig 2] was recorded significantly higher in cuttings treated with PBZ @ 60 ppm, 40 ppm and 20 ppm [1.06, 0.87 and 0.72 mg/g F.W] respectively followed by IBA @ 700 ppm and 500 ppm [0.65 and 0.57 mg/g F.W] respectively in comparison to control [0.46 mg/g F.W]. Non- significantly lower carotenoid content was found in cuttings treated with IBA @ 300 ppm [0.51 mg/g F.W] in comparison to control [0.46 mg/g F.W].Data depicted in [Table 2] noticed significant increase in total soluble sugar in cuttings treated with PBZ @ 60 ppm [3.07 mg/g F.W] followed by IBA @ 700 ppm [2.87 mg/g F.W], PBZ @ 40 ppm and 20 ppm [2.80 and 2.76 mg/g F.W] and IBA @ 500 ppm [2.75 mg/g F.W] in comparison to control [2.57 mg/g F.W]. A non- significant increase in total soluble sugar was noticed in cuttings treated with IBA @ 300 ppm [2.62 mg/g F.W] in comparison to control [2.57 mg/g F.W]. PBZ activates certain enzymes related to sucrose synthesis and catalysis which increases the content of TSS recorded by [25]. The activity of enzymatic and non-enzymatic antioxidant increases in PBZ-treated plants which prevents oxidative damage. [26] Reported that carotenoid pigments also increased which help to protect the photosynthetic machinery and has a positive effect on Xanthophylls and the pigment cycle. [27] Reported that, PBZ increases the chlorophyll content, and rate of photosynthesis and also increases the accumulation of carbohydrates in the leaves of plants. Our results were proved by other researchers [28], [22], [29], [30] and [31] reported that total soluble sugar content in leaf, stem, and bud organs were increased by paclobutrazol treatment in carrot, almond, tomato, mango, canola plants respectively. [32] Reported that the highest content of TSS (6.0 mg/g) was found by applying the highest dose of PBZ [2.5 g a.i.-1, linear canopy] in mango cultivar. [33] Noticed that, cutting treated with IBA @ 1000 mg/l increases the activities of POD, and PPO and induces more total soluble sugar accumulation. PBZ treatment increases the carbohydrates and TSS [34]. [17] Noted the increased carotenoids content in *Chrysanthemum indicum* treated with cycocel and PBZ. [35] and [36] on poinsettia plants and, [37] on sunflowers have confirmed that growth retardants have a stimulatory impact on enhancing the carotenoid synthesis. [38] Reported that PBZ application increases the carotenoid and carbohydrates content in stevia.

Table 1: Effect of different concentrations of bioregulators on chlorophyll a, b, and total chlorophyll (mg/g F.W) in passion fruit (PassifloraedulisflavicarpaDeg.)

Treatments	Chlorophyll "a" (mg/g F.W)	Chlorophyll "b" (mg/g F.W)	Total chlorophyll (mg/g F.W)
T1(Control)	2.41	0.57	2.98
T2(IBA 300 ppm)	2.48	0.66	3.14
T3(IBA 500 ppm)	2.80	0.73	3.53
T4(IBA 700 ppm)	3.07	0.78	3.85
T5(PBZ 20 ppm)	3.47	0.81	4.28
T6(PBZ 40 ppm)	3.88	0.88	4.76
T7(PBZ 60 ppm)	4.25	1.02	5.27
CD at 5%	0.07	0.06	0.09
SE	0.02	0.02	0.03

Table 2: Effect of different concentrations of bioregulators on carotenoid and total soluble sugar (mg/g F.W) in passion fruit (Passiflora edulis flavicarpa Deg.)

Treatments	Carotenoid (mg/g F.W)	Total soluble sugar (mg/g F.W)
T1(Control)	0.46	2.57
T2(IBA 300 ppm)	0.51	2.62
T3(IBA 500 ppm)	0.57	2.75
T4(IBA 700 ppm)	0.65	2.87
T5(PBZ 20 ppm)	0.72	2.76
T6(PBZ 40 ppm)	0.87	2.80
T7(PBZ 60 ppm)	1.06	3.07
CD at 5%	0.06	0.06
SE	0.02	0.02

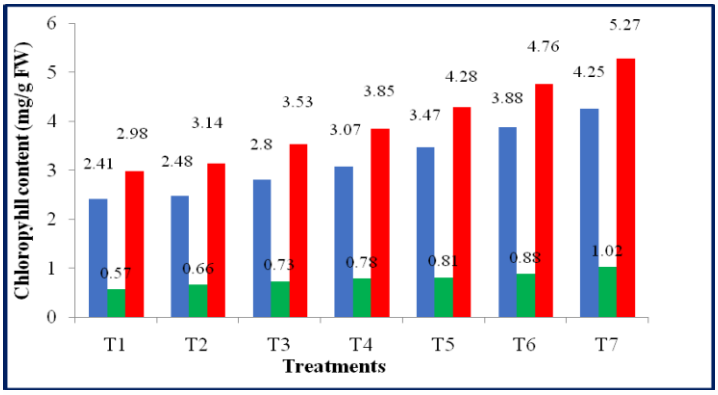

Fig 1: Effect of different concentrations of bioregulators on chlorophyll a, b, and total chlorophyll (mg/g F.W) in passion fruit (Passiflora edulis flavicarpa Deg.)

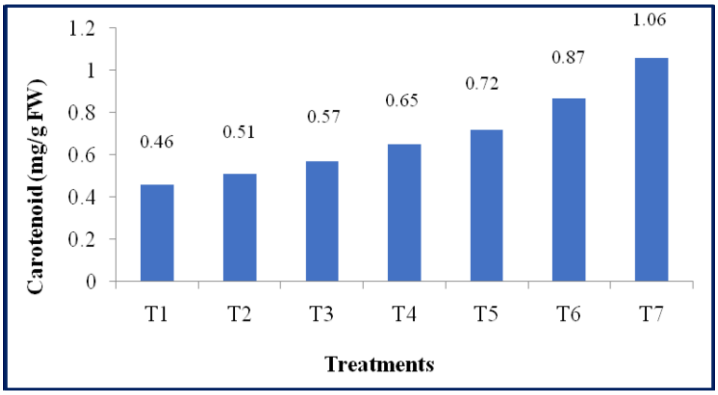

Fig2: Effect of different concentrations of bioregulators on carotenoid (mg/g F.W) in passion fruit (PassifloraedulisflavicarpaDeg.)

Conclusion

The conclusion is presented here based on the current investigation's findings. The stem cuttings treated with 60 ppm paclobutrazol for 15 minutes showed a good response on planting medium containing soil, sand, vermicompost, and cocopeat after planting in polybags. Due to the better development of roots, the different biochemical traits that were recorded also shows better results at 60 ppm PBZ. Therefore, 3-4 nodes of passion fruit cuttings poured in 60 ppm of paclobutrazol can be used effectively for the multiplication of passion fruit plants.

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Future Scope of the study

Considering the great importance of vegetative propagation by stem cutting of yellow types of passion fruits in conservation and characterization of genetic resources programs, breeding programs and development of biotic and abiotic stress resistance plantlets, the technological advancement worked out with the purpose of optimizing the methodologies used in plantlet production by cutting. Propagation a plant by cuttings will always allow keeping the special characteristics of that plant. Therefore, above mentioned work together with using different bioregulators gives a new height for the propagation of yellow passion fruit by cutting method in future.

Conflict of interest

No conflicts of interest are disclosed by the author

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