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**Vikas Kumar**
Chandigarh School of Business, Chandigarh Group of Colleges Jhanjeri, Chandigarh, Punjab, India

**Diksha Thakur**
Chandigarh School of Business, Chandigarh Group of Colleges Jhanjeri, Chandigarh, Punjab, India

**RP Srivastava**
Chandigarh School of Business, Chandigarh Group of Colleges Jhanjeri, Chandigarh, Punjab, India

**Dinanter Pal Kaur**
Chandigarh School of Business, Chandigarh Group of Colleges Jhanjeri, Chandigarh, Punjab, India

**Krishan Kumar Singh**
Department of Agriculture, Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala, Haryana, India

**Corresponding Author:**
**Vikas Kumar**
Chandigarh School of Business, Chandigarh Group of Colleges Jhanjeri, Chandigarh, Punjab, India

# Effect of different concentrations of IBA and types of stem cuttings on the rooting in sweet orange (*Citrus sinensis* L. Osbeck)

**Vikas Kumar, Diksha Thakur, RP Srivastava, Dinanter Pal Kaur and Krishan Kumar Singh**

**Abstract**
The present investigation was carried out at Chandigarh Group of Colleges Jhanjeri, Chandigarh, Punjab-India during the year 2021 to 2022. The field experiment conducted on the Effect of different Concentrations of IBA and Types of Stem Cuttings on the Rooting in Sweet Orange (*Citrus sinensis* L. Osbeck)." The treatments included type of cuttings (Hard wood cuttings, Semi-Hardwood cutting) and three IBA concentrations (1000, 2000, 3000) along with a control (distilled water). The experiment was laid out in Factorial Randomized Block Design (FRBD) with three replications. The maximum survival percentage of cuttings, sprouted cuttings, number of sprouts per cutting, length of longest sprout and rooting percentage of cuttings was recorded under $C_3$ (3000 ppm concentration of IBA) and $T_2$ (Semi-hardwood cutting) treatment.

**Keywords:** *Citrus sinensis*, cutting, IBA, rooting, sprouting

## Introduction
*Citrus sinensis* L. Osbeck is one of the major commercial fruit crops that is widely consumed both as fresh fruit or as juice attributed to its high vitamin-C content and its antioxidant. Sweet orange (Malta) has their own importance among citrus species (Gosh, 1990 and Sharma *et al*., 2012). Sweet orange (Malta) contains TSS 11%, Moisture 87.4%, Protein 0.9%, Fat 0.3%, Mineral 0.4%, Carbohydrates 10.6%, Vitamin A 350 IU, Vitamin B 120 mg, Vitamin-C 68 mg, Nicotinic Acid 0.3 mg, Riboflavin 60 mg and Calorific Value 49. In India, citrus is the third largest component of the fruit industry.

Vegetative propagation of plants by stem cuttings is the most commonly used method for producing herbaceous and woody plant in many parts of the world. A cutting is a piece of the part of plants used to propagate which regenerate there missing part is called cutting. Stem cutting can be classified as follows: hardwood cuttings, semi hardwood cuttings, softwood cutting and herbaceous cuttings. Stem cuttings have been used for the vegetative propagation of several fruit trees including citrus (Singh *et al*. 2013) [12]. Cutting is the commercial method of propagation in *Citrus aurantifolia* synthetic auxin (IBA, NAA, & IAA) and phenolic compounds help in rooting of cutting. However, age and physiological status of mother plant, type of wood time of planting, type of cutting media composition for planting cuttings determine the extent of success (Singh *et al*., 1965) [3]. The benefic effect of growth regulators (IBA and NAA) was observed in rooting of acid lime 'Tahiti' and sweet orange (Prati *et al*., 1999) [7]. IBA at 2000ppm gave the highest rooting percentage of lemon (cv. Baramasi) stem cutting (Kumar *et al*., 1995). Sadhu (1997e) [6, 9] noted that juvenile cuttings from one-year-old seedlings of sour orange and Cleopatra mandarin rooted easily than the mature cuttings from 15-year-old trees. Root production on mature cuttings was confined to the basal part around the cut end, whereas root formed on the whole of the earthed-up portion of juvenile cuttings. Sweet lime (*Citrus limettoides*) semi-hardwood cutting gave better rooting than hardwood (Gangwar and Singh, 1965) [3].

## Material and Methodology
The experiment was carried out at the agricultural research farm, Chandigarh Group of Colleges Jhanjeri, Chandigarh, Punjab. Geographically, the experimental site is located between latitudes 76°-22'E to 76°-46'E and longitudes 30°-36'N to 30°-39'N, with a mean elevation of 279 meters above sea level.

The experimental site was uniform in topography and well-drained. Chandigarh's climate is typically semi-arid and subtropical, with temperature extremes in both summer and winter, low rainfall, and moderate humidity. Summer temperatures can reach 45 degrees Celsius in May and June, while winter temperatures rarely fall below 4 degrees Celsius in December and January. Chandigarh's annual rainfall in 2021-2022 was 343 mm. Chandigarh is located in a semi-arid to subtropical climate zone. The monsoon season in this region typically begins in the third week of June and lasts until the end of September, or sometimes until the first week of October. Winter showers are common between the months of December and mid-February.

The experiment consisted of two treatment combinations, firstly concentrations of IBA *viz*; $C_1$ (1000 ppm), $C_2$ (2000 ppm), $C_3$ (3000 ppm) and $C_0$ (Control distilled water). Second treatment is type of cutting *viz*; $T_1$ (Softwood cutting) and $T_2$ (Semi hardwood cutting) of sweet orange. The basal portion of cuttings, up to 2.5 cm. was soaked in different concentrations of IBA for 10 second (Satpal *et al*., 2014) [11]. Total no of cutting taken 240 and for preparing the rooting media, the soil and farm yard manure (FYM) in ratio 2:1 were mixed thoroughly. The mixture was filled in the root trainers.

The survival of cuttings was recorded after four months at the termination of experiments and the survival percentage of cuttings was calculated. Total number of alive cuttings was noticed at 10 days interval and calculates the percentage alive cuttings. Total number of sprouted cuttings was noticed at 10 days interval and calculates the sprouted percentage of cuttings. At an interval of 10 days of each treatment the numbers of sprouts per cutting were calculated and the mean numbers of sprouts were worked out. The recorded data were analysed through statistical software for observation the parameter was statically significant Factorial Randomized Block Design (FRBD) with three replications as described as described by Cochran and Cox (1992) [2].

## Result and Discussion

The results present Fig. 1 to 7 indicated that survival percentage of cuttings was found significant with respect to types of cuttings, while various concentrations of IBA were found significant. The maximum survival percentage of cuttings (75.58%), percentage of sprouted cuttings (64.17%), length of longest sprout (8.35 cm) $T_2$, rooting percentage of cuttings (60.00%), average number of primary roots per cutting (4.25), fresh weight of roots per cutting (0.96 g) and Dry weight of roots per cutting (0.26 g) was recorded in $C_3$ (3000ppm) concentration of IBA treatment. IBA is a root-promoting hormone that promotes root induction and sprouting. Under $C_3$ (3000 ppm IBA) treatments. According to Haising (1973) [4], the lack of sprouting of cuttings was mainly due to a lack of root initiation in response to auxin application. Poor rooting when cuttings were planted during the warm season could be due to a greater inhibitor to promote ratio in these cuttings, or it could be due to a higher nitrogen to carbohydrate ratio. Hore and Sen (1992) [14] found that treating cuttings with IBA improved their sprouting success. Transversal and longitudinal sections of the base and callus tissues of semi-hardwood cuttings of sweet lemon showed the presence of two types of roots. One type initiated from the callus cells and the other endogenously near the vascular bundles in the region between cambium and pericyclic fibers in the parenchymatous cells (Sadhu, 1997d) [8].

It may be because a vast range of chemically and physiologically unrelated substances, including as phenols, gibberellins, and abscisic acid, have been discovered to influence the regeneration of roots in cuttings of several plants Sadhu (1997a) [10]. The cuttings' carbohydrate reserves are responsible for their optimal survival. Carbohydrate reserves in the cuttings are responsible for increasing the proportion of living cuttings, treatment $T_2$ (Semi-hardwood cutting) had the highest percentage of alive cuttings. Bhatt and Tomar (2011) [1] has reported the maximum root formation, length of root, diameter of root, sprout in shoot was recorded under 500ppm concentration of IBA.

In case of type of cutting, the maximum survival percentage of cuttings (69.67%), percentage of sprouted cuttings (54.17%), length of longest sprout (6.23 cm) and rooting percentage of cuttings (52.50%), average number of primary roots per cutting (3.25), fresh weight of roots per cutting (0.43g) and Dry weight of roots per cutting (0.10g) was recorded under $T_2$ (Semi hardwood cutting) type of cutting. While the type of cuttings and their interaction had no effect, Indole Butyric Acid. The higher number of sprouts per cutting with optimal IBA treatments could be attributed to improved root growth, which increased nutrient absorption and translocation from the soil, which are involved in a variety of plant metabolic activities (Singh *et al*. 2013, Singh, 2018) [12, 13]. The results of this investigation are comparable to those of a previous study. The proportion of rooted cutting was greater in treatment $C_3$ (3000 ppm IBA). It could be due to auxin's action, which triggered carbohydrate and nitrogenous material breakdown and translocation at the base of cuttings, resulting in faster cell elongation and cell division in a favorable environment (Hartmann *et al*., 2007) [5].

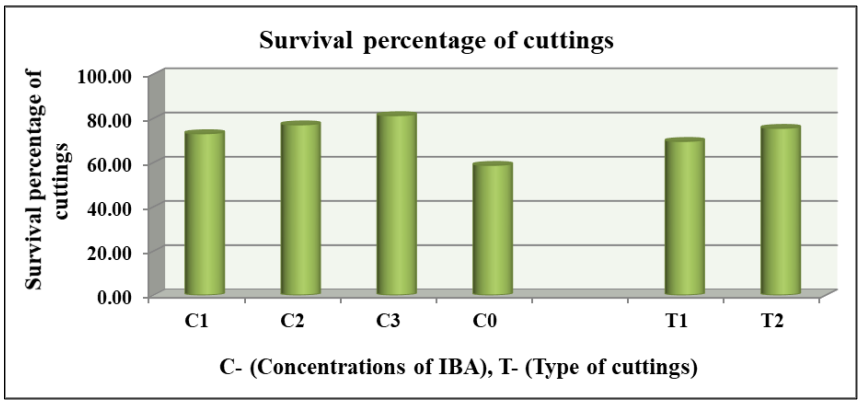


**Fig 1:** Effect of types of cuttings and various concentrations of IBA on the survival percentage of cuttings

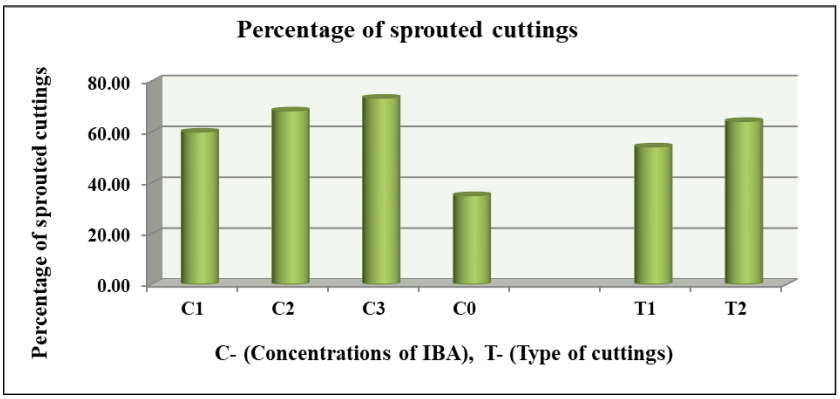


**Fig 2:** Effect of types of cuttings and various concentrations of IBA on the percentage of sprouted cutting

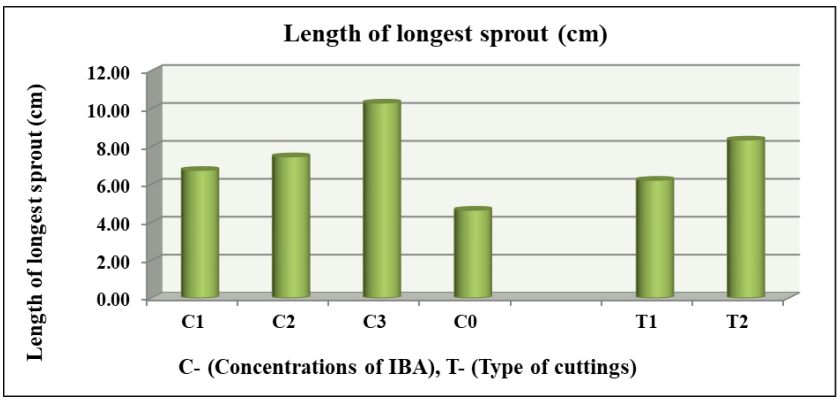


**Fig 3:** Effect of types of cuttings and various concentrations of IBA on the length of longest sprout (cm)

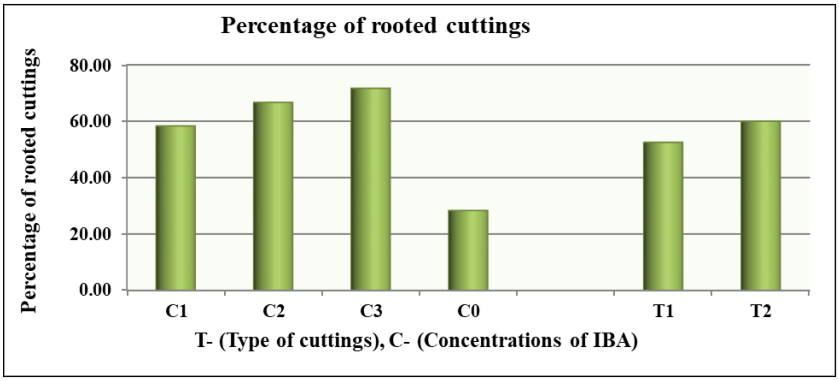


**Fig 4:** Effect of types of cuttings and various concentrations of IBA on the percentage of rooted cutting

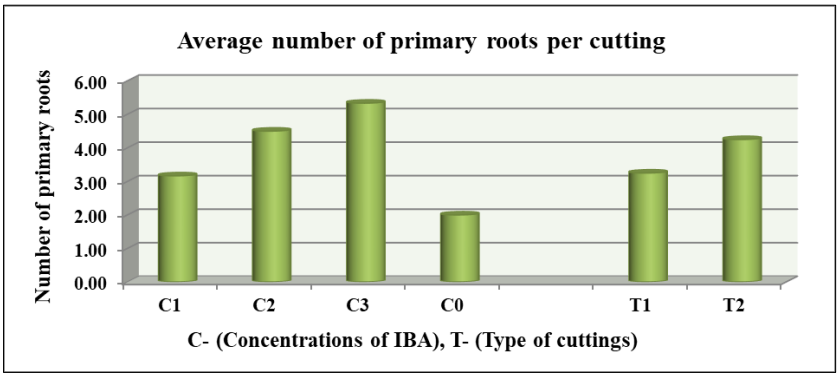


**Fig 5:** Effect of types of cuttings and various concentrations of IBA on the average number of primary roots per cutting

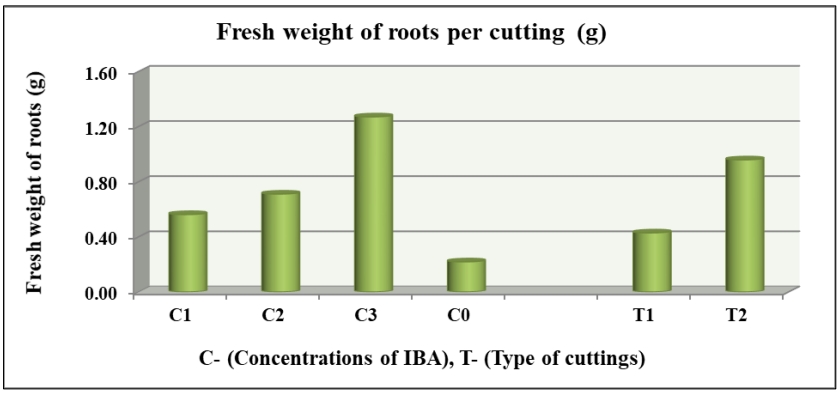


**Fig 6:** Effect of types of cuttings and various concentrations of IBA on the fresh weight of roots per cutting

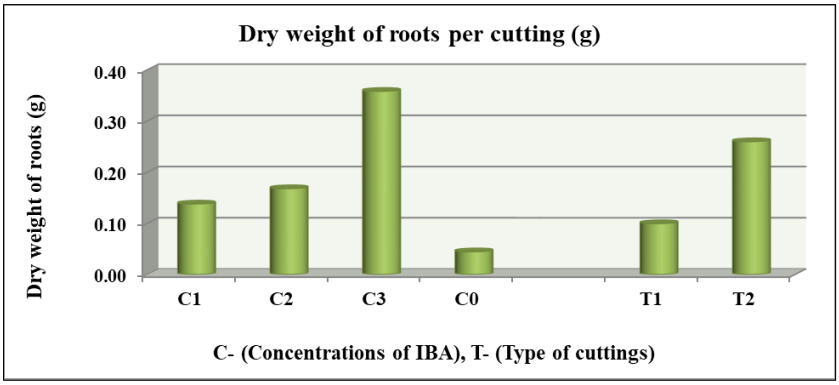


**Fig 7:** Effect of types of cuttings and various concentrations of IBA on the dry weight of roots per cutting

## Conclusion

It's been indicated that semi-hardwood cuttings treated with 3000 ppm IBA had the highest overall performance under shade conditions for producing the tallest sweet orange plants. The IBA concentration $C_3$ (300ppm IBA) treatment produced the greatest results.

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