Effect of different IBA levels on growth and rooting of semi- hardwood cuttings in pomegranate cv. Kandhari

Original Research Article

Abstract:

Pomegranate (*Punica granatum* L.) is a highly valued fruit crop known for its nutritional and medicinal properties belonging to family Punicaceae. This study aims to investigate the effect of Indole-3- butyric acid on growth rooting of semi hardwood cuttings in Pomegranate cv. Kandhari, conducted at the Experimental Farm of Department of Seed Science & Technology, Dr Y S Parmar University of Horticulture and Forestry Nauni, Solan, HP, India during 2022-2023. Plants raised from seeds show a great variability with respect to tree vigour, precocity and quality of fruits. Therefore, vegetative propagation by cuttings is the most commercial, convenient and cheap method to get true to type plants. The experiment was laid out in Randomized Block Design (Factorial) with twelve treatment combinations replicated thrice, comprising of four IBA levels (0, 1000, 1500 and 2000 ppm) and three cutting segments (top, middle and basal). Among different levels of IBA, the treatment IBA @ 2000 ppm exhibited significantly higher per cent sprouting (60.00 %), number of shoot per cutting (5.21), shoot length (22.16 cm), shoot diameter (4.56 mm), number of leaves per cutting (14.78), leaf area (7.32 cm^2), leaf chlorophyll content (6.03 mg g^{-1}), fresh weight of shoots (7.24 g), dry weight of shoots (4.93 g), per cent rooting (58.89 %), number of roots per cutting (12.02), maximum root length (14.14 cm), fresh weight of roots (3.35 g), dry weight of roots (1.59 g) and biomass of cuttings (6.51 g). Among cutting segments, basal segment resulted in significantly increased per cent sprouting (56.67 %), number of shoots per cuttings (5.54), shoot length (21.86 cm), shoot diameter (4.46 mm), number of leaves per cutting (16.30), leaf area (8.68 cm^2), leaf chlorophyll content (6.22), fresh (8.04 g) and dry weight of shoots (4.85 g), per cent rooting (60.42 %), number of roots per cutting (13.89), maximum root length (14.54 cm), fresh (3.63 g) and dry weight of roots (1.79 g) and biomass of cuttings (6.64 g). Therefore, it is concluded that the application of IBA-2000 ppm and basal segment of semi hardwood cutting of Pomegranate cv. Kandhari; shows the best result for all parameters like, per cent sprouting, number of shoot per cuttings, shoot diameter and length, numbers of leaves par cutting, fresh and dry weight of shoot, number of leaves per cuttings, leaf area, rooting percentage of cutting, length of roots, fresh and dry weight of roots, number of roots per cutting, biomass of cuttings. This research has been recognized as practical application by nursery man of pomegranate for preparation of better quality planting materials along with better survivability.

Keywords: Fruit Crop, Nursery plants, Indole-3-butyric 1000 ppm, Indole-3-butyric 1500 ppm, Indole-3-butyric 2000 ppm, Growth, Rooting, Top, middle and basal cutting segments.

Introduction:

Pomegranate, scientifically known as *Punica granatum* L., is a highly esteemed fruit recognised for its nutritional and medicinal benefits. It belongs to the family Punicaceae and is believed to have originated in ancient regions such as Persia, Afghanistan and Baluchistan (De Candolle; 1967). This fruit has been valued across various cultures for its rich symbolism and health-promoting properties. Pomegranate is the most popular fruit it is cultivated worldwide in multiple climates. It is cultivated worldwide, with an estimated global cultivated area of approximately 300,000 hectares and a total production of around 3 million metric tons. In India, area is approximately 28.98 million hectares with a production of around 353.19 million tonnes (National Horticulture Board, 3rd Advance estimate; 2023 -

2024). Maharashtra (leading state), Karnataka, Gujarat, Andhra Pradesh and Tamil Nadu are major pomegranate producing states. Kandhari is a large fruited variety with deep red skin and sub-acidic taste (Singh; 2014) with shrub like growth habit. Shrubs are deciduous, vigorous and upright growing. Fruit weight per fruit was maximum in Mrigbahar (317.6 g); whereas in Ambebahar it was 190.4 g/fruit. Arils are sweet in taste with light pink in colour with semi hard seeds and is recommended for cultivation in the mid hill zone of Himachal Pradesh (Kumar; 2005).

Plants raised from seeds show a great variability with respect to tree vigour, precocity and quality of fruits. Therefore, vegetative propagation by cuttings is the most commercial, convenient and cheap method to get true to type plants. In order to reduce the high mortality of rooted cuttings under field conditions, it is highly desirable to build a healthy and well developed root system for enabling better field establishment of pomegranate trees through the use of suitable plant growth regulator treatment.

Indole-3-butyric acid (IBA), a synthetic auxin, has been extensively studied for its role in promoting root formation in woody plant cuttings. Its application can enhance rooting success by stimulating root initiation and growth. This research paper aims to investigate the effects of different IBA concentrations on the growth and rooting of semi-hardwood cuttings in pomegranate. By understanding the optimal conditions for rooting, this study seeks to contribute to more efficient propagation methods, ultimately supporting the cultivation and commercialization of pomegranate.

Materials and Methods:

The experiment was carried out during the year 2022 – 2023 at the experimental farm of department Seed Science and Technology, College of Horticulture, Dr YS Parmar University of Horticulture and Forestry Nauni, Solan, India located at a latitude of 30˚85'8" North and longitude 77˚15'8" East in the hilly regions of the Western Himalayas falling into the mid hill zone of the state . The climate of this area is typically sub-temperate, where summers are moderately hot during May-June and winters during December-January are severe. The annual rainfall of the area ranges between 800 and 1500 mm, major amount of which is received during monsoon period from July to September. The experiment was conducted with semi hardwood stem cuttings of pomegranate cultivar cv. Kandhari under field conditions. Consisting of three cutting segments of length 20-25cm prepared from basal, middle and top portions of shoot taken from current season suckers in the month of July by giving the slant cut at the basal end of the cuttings to expose maximum cambium surface area for effective rooting. Root promoting chemical, IBA at three concentrations i.e. 1000 ppm, 1500 ppm and 2000 ppm were used along with control i.e. 50% ethanol treatment applied. The required of the concentrations of growth regulator IBA (1000 ppm, 1500 ppm and 2000 ppm) were prepared by making stock solution of 5000 ppm for this, 2.5 gm of IBA were dissolved in 50 per cent ethanol and making the final volume to 500 ml with 50 per cent ethanol. From the stock solution, three different IBA levels viz., 1000, 1500 and 2000 ppm was prepared by using ethanol and distilled water (1:1) and by applying the formula $N_1V_1 = N_2V_2$. A quick dip for 10 seconds was given to the cuttings. The basal 5 cm portion of the cuttings was dipped for 10 seconds in IBA solution prepared in 50 per cent ethanol (quick dip method). The treated cuttings were then placed in shade for a while to ensure sufficient absorption of IBA before planting in the nursery beds. Cuttings were planted in inclined position at an angle approximately 45 degree to the horizontal to avoid dew or rain drops enter through cut surface and to a depth of 1-2 nodes below the soil. The planting distance between row to row and between adjacent cuttings was kept as 15 centimetre. The experiment was laid out in Randomized Complete Block Design (Factorial) with three replications and twenty cuttings in each replication. The planted cuttings were allowed to root for 90 days. Polythene bags were watered well prior to removal of cuttings from them. The cuttings (Five Number per treatment per replication) were carefully removed from the polybags and dipped in water to remove the sand particles adhering to roots to record the observations pertaining to roots. These five cuttings were Tags for recording observations throughout the study. After the cuttings were planted as per the treatments, the site of the

experiment daily visited and the cuttings was sprouted in each replication was noted carefully. Than the calculation of the days taken for initiation of sprouting after the planting of cuttings was given by the difference between date of planting of cutting and the date of which the pomegranate cuttings were started to sprout. The total number of cuttings survived under each treatment in each replication was recorded and survival percentage of rooted cuttings was calculated. The data obtained during experimentation was statistically analyzed as per method given by Panse and Sukhatme (1978) and C.D. will be evaluating at 5% level of significance. Where MSE = Mean sum of squares due to error. The calculation of C.D. at 5% of table value will be carry out with the help of following formula. C.D. = Critical difference S.E. m± = Standard error of mean.

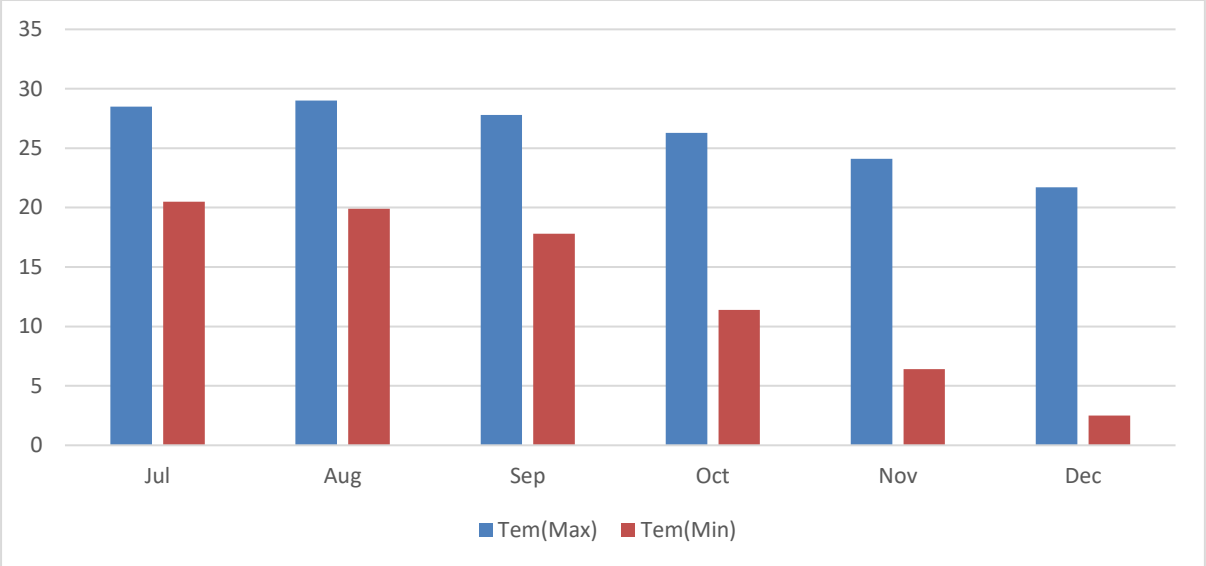

Fig.1: Graphical representation of monthly meteorological data pertaining to the temperature during the crop season (July, 2022 to December, 2022)

RESULT AND DISCUSSION

The data pertaining to the effect of plant growth regulators on growth, yield and return bloom are presented in Tables 1 or 2 and Graph 1 or 2.

The contemplation of data indicate that the application of IBA treatments exert the significant effect on percentage of sprouted cuttings, which ranged from 21.67 to 60.00%.The maximum per cent sprouting (60.00 %) was observed in the treatment IBA @ 2000 ppm which was significantly higher than the other treatments. The minimum sprouting (21.67 %) was recorded in the control. Among the cutting segments, significantly higher sprouting (56.67 %) was observed in basal segments followed by middle segments (45.83 %), whereas minimum percent sprouting (39.17 %) was recorded in top segments. Kaur et al. (2018) in pomegranate semi-hardwood cuttings found IBA 1000 ppm + PHB 750 ppm best for producing highest proportion of sprouted cuttings (86.40 %). Similarly, Damini (2021) also recorded the highest per cent sprouting in hardwood cuttings of Bud 9 apple rootstock taken from basal segments and treated with IBA @ 2500 ppm.

Observations were recorded on account of the number of shoot per cuttings, that ranges from 2.12 to 5.21. Maximum number of shoots (5.21) was observed under the treatment IBA @ 2000 ppm which was significantly higher over other treatments of IBA levels. The minimum number of shoots (2.40) was obtained in control. Within cutting segments, basal segment produced significantly more number of shoots per cutting (5.54). However, the number of shoots per cutting (3.02) was minimum among top segment of cuttings. Among the interaction, number of shoots (7.15) per cutting obtained was significantly higher in basal segment cuttings, when treated with IBA @ 2000 ppm. However, minimum number of shoots (2.12) was recorded in top segment with no treatment of IBA.

Raut et al. (2015), who noted the highest number of shoots (28.33) in hardwood pomegranate cuttings with IBA at 2500 ppm. Rajkumar et al. (2016) found that IBA @ 2500 ppm with vermiculite substrates added the highest number of shoots. Damar et al. (2014), who also noticed the highest number of shoots in pomegranate hardwood cuttings when added with IBA @ 2000 ppm solution. Tanwar et al. (2024) found that IBA @ 2000 ppm with coco peat, perlite and vermiculite resulted in the maximum number of shoots per cutting.

Observations were recorded on account of shoot length of cutting. The data have been recorded at 90 DAP, the shoot length ranged varies from (6.67-29.17cm). Among the treatments maximum shoot length(22.16 cm) was significantly higher in the cuttings treated with IBA @ 2000 ppm followed by IBA @ 1500 ppm with shoot length of 20.53 cm. The minimum length of shoot (6.81 cm) was obtained under control. Among cutting segments, significantly increased shoot length (21.86 cm) was recorded in basal segment cuttings followed by middle segments (17.56 cm) whereas, minimum shoot length (12.00 cm) was obtained in top segment cuttings. Within the interaction, the maximum shoot length (29.17 cm) was recorded in basal segment cuttings with treatment of IBA @ 2000 ppm. The minimum shoot length (6.67 cm) was recorded in top segments without IBA treatment. Patel et al. (2017) suggested that applied IBA 2000 ppm gave maximum shoots length in Pomegranate. Singh et al. (2011) found that pomegranate cv. Ganesh cuttings treated with 2000 ppm IBA had resulted into maximum shoot length. Similarly, Satnam et al. (2022) observed that pomegranate cv. Bhagwa semi hardwood cuttings treated with IBA @ 1000 ppm gave maximum shoot length. Tanwar et al. (2024) found that IBA @ 2000 ppm with coco peat, perlite and vermiculite resulted in the maximum length of the shoots per cutting.

The data recorded on shoot diameter reveals that the shoot diameter (4.56 mm) was maximum in the treatment with IBA @ 2000 ppm followed by IBA @ 1500 ppm comprising (4.19 mm) shoot diameter. Shoot diameter was recorded minimum (2.23 mm) under the control. Within cutting segments, the significant increase in shoot diameter (4.46 mm) was recorded in the basal cutting segments. However, minimum shoot diameter (2.93 mm) was found in top cutting segments. Within the interaction, significantly higher shoot diameter (5.46 mm) was observed in basal cutting segments with IBA @ 2000 ppm followed by basal segments under treatment with IBA @ 1500 ppm contributing to 5.11-millimetre shoot diameter. The shoot diameter was minimum (2.14 mm) in top cutting segments without application of IBA. Shukla et al. (2010) observed that in peach hardwood cuttings treated with IBA 2000 + PHB 1000 + B50 ppm considerably enhanced the diameter of sprouts. Similarly, Seiar (2016) also advocated that pomegranate semi hardwood cuttings treated with IBA 1500 ppm + NAA 1500 ppm had the greatest diameter of shoot (5.9 mm).

The data were recorded on account of number of leaves per cuttings revealed that maximum number of leaves (14.78) was observed under treatment IBA @ 2000 ppm whereas minimum number of leaves per cutting (5.57) was recorded in control. As in the case of cutting segments, maximum number of leaves (16.30) were observed in basal cutting segments and found to be significantly more over all other segments, whereas, the number of leaves per cutting (9.17) was observed minimum in top cutting segments. Ram et al. (2005) found that the administration of 2500 ppm IBA + 1500 ppm PHB in pomegranate cv. Ganesh and Kandhari led to the production of the greatest number of leaves. Negi et al. (2015) also recorded more number of leaves in the cuttings of apple clonal rootstock Merton 793 when treated with IBA @ 2000 ppm.

The observation was recorded on account of leaf area revealed that among different levels of IBA, significantly higher leaf area (7.32 cm^2) was recorded under treatment IBA @ 2000 ppm. However, minimum leaf area (2.18 cm^2) was recorded in control. Among cutting segments, basal cutting segments were found to have maximum leaf area (8.68 cm^2), whereas minimum leaf area (2.61 cm^2) was recorded in top cutting segments. Shahzad et al. (2019) found that grape cuttings treated with a solution of IBA at a concentration of 2000 mg L^{-1} by quick dip for 10 seconds produced leaves with a maximum area of 24.03 cm^2. Similarly, Rao

et al (2020) also recorded the maximum leaf area in Kandhari pomegranate cuttings with the application of IBA @ 5000 ppm.

Maximum leaf chlorophyll content (6.03 mg g^{-1}) was recorded under treatment IBA @ 2000 ppm and found to be significantly higher over all other levels of IBA. However, leaf chlorophyll content was recorded minimum (4.22 mg g^{-1}) with no application of IBA. Among cutting segments, significantly higher leaf chlorophyll content was found in basal segment (6.22 mg g^{-1}), whereas, minimum leaf chlorophyll content (4.62 mg g^{-1}) was recorded in top cutting segments. According to Shahab et al. (2013) cuttings have more leaves improved nutrient absorption, which in turn boosted the generation of photosynthates and supplied enough fuel for the plant's metabolic activities. Our finding are in line with Rao et al. (2020) who obtained the highest chlorophyll concentration in the leaves after treating pomegranate cuttings with IBA @ 5000 ppm.

The observation was recorded on account of fresh weight of shoot recorded. The treatment IBA @ 2000 ppm recorded maximum fresh weight of shoots (7.24 g); however, the minimum fresh weight of shoots (3.41 g) was observed in control. Among the cutting segments, significantly higher fresh weight of shoots (8.04 g) was observed in basal segments followed by middle segments (5.17g), whereas top cutting segments recorded minimum fresh weight of shoots i.e. 4.33 grams. Rajkumar et al. (2016) showed that planting pomegranate cuttings in vermiculite and treating them with IBA at 2000 ppm resulted in improved shoot growth and highest fresh weight of shoot. According to Seiar (2016) pomegranate had the maximum fresh weight of sprout (9.03 g) per cutting when IBA 1500 ppm + NAA 1000 ppm were applied. Kaur et al. (2020) noticed higher fresh weight of shoot in basal cuttings of pear cv. Patharnakh. Tanwar et al. (2024) found that IBA @ 2000 ppm with coco peat, perlite and vermiculite resulted in the maximum fresh weight of shoots per cutting. Damini (2021) also recorded maximum fresh weight of shoot in basal cutting segments of Bud 9 apple rootstock treated with IBA @ 2500 ppm.

Observation on account of dry weight of shoot recorded higher shoot dry weight (4.93 g) under the treatment with IBA @ 2000 ppm followed by IBA @ 1500 ppm with 4.54 grams dry weight of shoots. Whereas, minimum dry weight of shoots (1.26 g) was recorded control. Or in case of cutting segments, maximum dry weight of shoots (4.85 g) was observed in basal cutting segments whereas, dry weight of shoots (2.44 g) was observed minimum in top cutting segment. Hakim et al. (2018), noticed the maximum dry weight of shoot (10.8 and 12.6 g) in cuttings of Bhagwa and Ruby cultivars of pomegranate with the treatment of IBA @ 1500 ppm + NAA @ 1500 ppm + Biomix. Similarly, Seiar (2016) observed that IBA 1500 ppm + NAA 1000 ppm in pomegranate led to the maximum dry weight of shoot (4.66 g) per cutting.

The data were recorded on account of per cent rooting reveals that the significantly higher per cent rooting (58.89) was observed in treatment with IBA @ 2000 ppm whereas minimum rooting percentage (18.33) was recorded in the control. Among the cutting segments, significantly higher per cent rooting (60.42) was observed in basal segments followed whereas minimum percent rooting (27.92) was recorded in cuttings of top segments. Singh and Bahadur (2015) recorded maximum rooting in treatment combination of IBA 400 ppm + NAA 200 ppm by dipping hardwood cuttings of phalsa in prepared solution for 24 hours. Similarly, Seiar (2016) showed highest rooting percentage (60.40%) in pomegranate cuttings treated with IBA 1500 ppm + NAA 1500 ppm.

The observations were recorded on account of number of roots per cutting. Among the treatments maximum number of roots per cutting (12.02) was recorded in treatment IBA @ 2000 ppm, whereas, lowest number of roots (5.87) was observed in control. As regards the effect of cutting segments, significantly higher number of roots (13.89) was observed in basal segments followed by middle segments (8.57), whereas minimum number of roots per cutting (6.15) was recorded in top segments. Kaur et al. (2018) reported that IBA 1000 ppm + PHB 750 ppm gave maximum number of roots (24.65) in pomegranate cv. Ganesh. Kumar et al. (2016) found that pomegranate cv. Phule Arakta with IBA @ 2500 ppm grown in vermiculite substrate recorded the maximum number of roots per cutting.

Observation on account of root length recorded the maximum root length (14.14 cm) with the application of IBA @ 2000 ppm whereas minimum average root length (5.85 cm) was recorded with in control. In case of the effect of cutting segments, significantly maximum root length (14.54 cm) was observed in basal cutting segments whereas, the minimum root length was observed (7.73 cm) in top cutting segments. Singh et al. (2009) recorded maximum average root length in semi-apical cuttings of pear treated with 100 ppm IBA. Rathore et al. (2020) also observed pomegranate hardwood cutting treated with IBA @ 2000 ppm recorded maximum root length. Damini (2021) recorded significant increase in root length in middle segments of Bud 9 apple rootstock cuttings treated with IBA @ 2500 ppm.

Observation on account of fresh weight of roots was recorded. The treatment of IBA @ 2000 ppm recorded maximum fresh weight of roots (3.35 g) whereas the minimum (0.99 g) fresh weight of roots was recorded in control . Within the cutting segments, significantly higher fresh weight of roots (3.63 g) was observed in basal cutting segments whereas top cutting segments recorded the minimum (1.46 g) fresh weight of roots. Kumar et al. (2016)recorded that the maximum fresh weight produced using IBA 2500 ppm treatments with vermiculite substrate in pomegranate cv. Phule Arakta. Similarly, Kumar et al. (2022) found that IBA @ 2500 ppm produced the maximum fresh weight of roots in pomegranate. Bhat et al. (2004) also observed that 500 ppm IBA plus 1% Borax for 15 minutes produced maximum fresh weight of roots in pomegranate.

Observation on account of fresh weight of roots was recorded and maximum dry weight of roots (1.59 g) was recorded under treatment IBA @ 2000 ppm. However, dry weight of roots was recorded minimum (0.40 g) with the no application of IBA. Among cutting segments, basal cutting segments were found to have maximum dry weight of roots (1.79 g) which was significantly superior to other levels of cutting segments. Whereas, minimum dry weight of roots (0.52 g) was recorded in top cutting segments. Bhat et al. (2004) observed that 500 ppm IBA plus 1% borax for 15 minutes produced the greatest dry weight of root in pomegranate. Similarly, Kumar et al. (2016) also recorded maximum dry weights of roots in pomegranate cv. Phule Arakta were with IBA 2500 ppm.

The contemplation of data indicate that the maximum biomass of rootstocks (6.51 g) was found in IBA @ 2000 ppm, which was closely followed by IBA @ 1500 ppm with 5.69 grams biomass of rootstock. However, minimum biomass of rootstocks (1.66 g) was found in control. As regards the effect of cutting segments, significant increase in biomass was observed in basal cutting segments (6.64 g) which was followed by middle (4.35 g) and top cutting segments (2.95 g). Rana et al. (2015) studied the kiwi fruit cv. Allison and observed that the highest shoot and root biomass was achieved with a dosage of 5000 ppm IBA. Similarly, Damini (2021) observed maximum biomass in Bud 9 rootstock of apple basal cuttings when treated with IBA @ 2500 ppm.

The contemplation of data indicate that the shoot: root ratio was maximum (5.01) in treatment with IBA 1000 ppm which was statistically at par with IBA @ 1500 ppm with 4.64 and IBA @ 2000 ppm with 4.40 shoot: root ratio. Shoot: root ratio was minimum (3.34) under control. Whereas, among cutting segments the maximum shoot: root ratio (5.04) was recorded in the middle cutting segments while minimum (3.31) in basal cutting segments. Sharma et al. (2014) noticed that hardwood cuttings of Merton 793 treated with 2500 ppm IBA + girdling treatment had a higher shoot: root ratio. However, Damini (2021) reported maximum shoot: root ratio in the top cutting segments of Bud 9 clonal rootstock of apple, when treated with IBA @ 2000 ppm.

IBA Levels	Percent sprouting	No. of shoots per cutting	Shoot length (cm)	Shoot diameter	No. Of leaves per cuttings	Leaf area (cm^2)	Leaf chlorophyll content (mg g^{-1})	Fresh weight of shoots(g)	Dry weight of shoots (g)
Control	21.67	2.40	6.81	2.23	5.57	2.18	4.22	3.41	1.26
IBA-1000 ppm	52.78	4.20	19.04	3.93	13.74	5.45	5.42	6.04	3.85

IBA-1500 ppm	54.44	4.86	20.53	4.19	14.74	6.53	5.80	6.69	4.54
IBA-2000 ppm	60.00	5.21	22.16	4.56	14.78	7.32	6.03	7.24	4.93
C.D at 5%	2.25	0.18	0.18	0.10	0.80	0.26	0.18	0.23	1.35

Table 1: Effect of plant growth regulators on shoot growth of Semi hardwood cuttings in pomegranate cv. Kandhari

IBA Levels	Percent rooting	Number of roots per cuttings	Maximum root length (cm)	Fresh weight of roots (g)	Dry weight of roots (g)	Biomass of cuttings	Shoot root ratio
Control	18.33	5.87	5.85	0.99	0.40	1.66	3.34
IBA-1000 ppm	45.56	9.62	11.30	2.60	0.87	4.72	5.01
IBA-1500 ppm	52.20	10.64	12.43	2.87	1.16	5.69	4.64
IBA-2000 ppm	58.89	12.0	14.14	3.35	1.59	6.51	4.40
C.D at 5%	2.47	2.47	0.20	0.23	0.50	1.29	1.19

Table 2: Effect of plant growth regulators on rooting and biomass of Semi-Hardwood cuttings in pomegranate cv. Kandhari

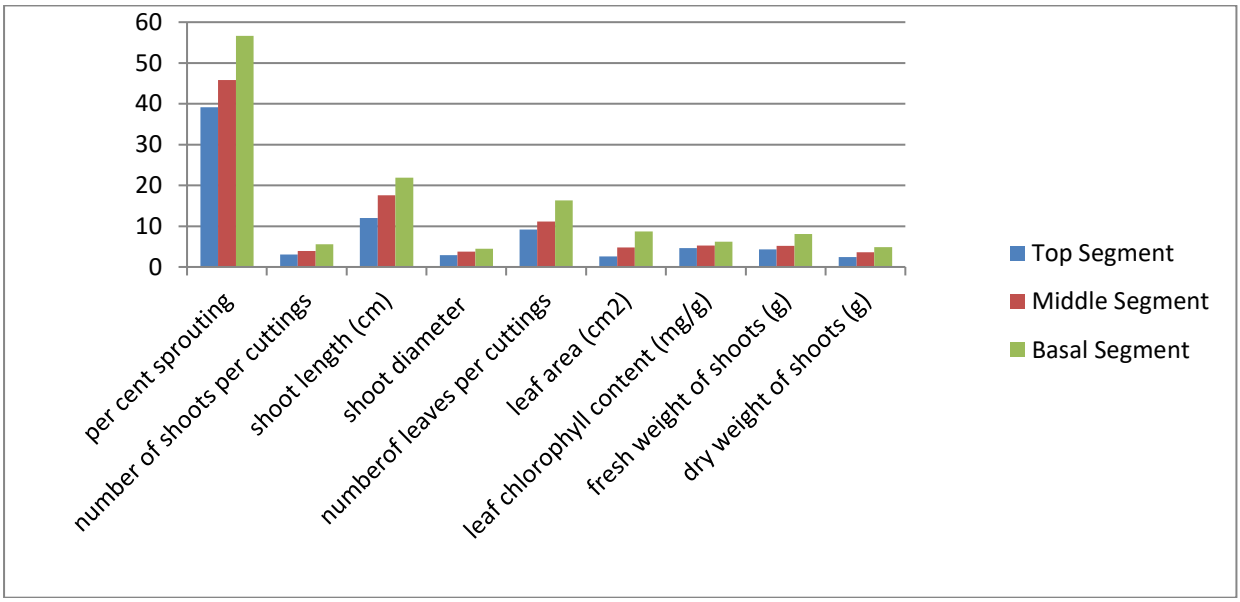

Fig.2: Interaction effect of plant growth regulators and cutting segments on shoot growth of Semi-Hardwood cuttings in pomegranate cv. Kandhari

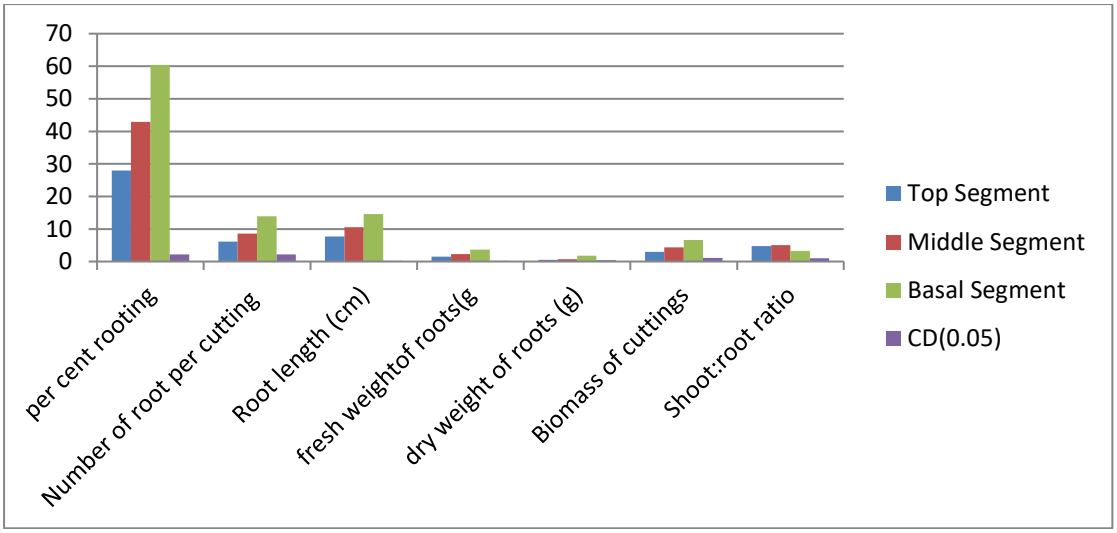

Fig.3: Interaction effect of plant growth regulators and cutting segments of semi-Hardwood cuttings on rooting and biomass of pomegranate cv. Kandhari

Conclusion: Among various concentration of IBA, 2000 ppm concentration of IBA shows the best performance in terms of per cent sprouting, number of shoots per cutting, soot length, shoot diameter, number of leaves per cuttings, fresh weight of shoot and roots as well as dry weight of roots. Hence, it can be concluded from the experiment that the higher concentration of IBA positively affect the shoot growth as well as rooting behaviour in semi hardwood cuttings of Pomegranate cv. Kandhari.

DISCLAIMER (ARTIFICIAL INTELLIGENCE):
Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS: Authors have declared that no competing interests exist

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