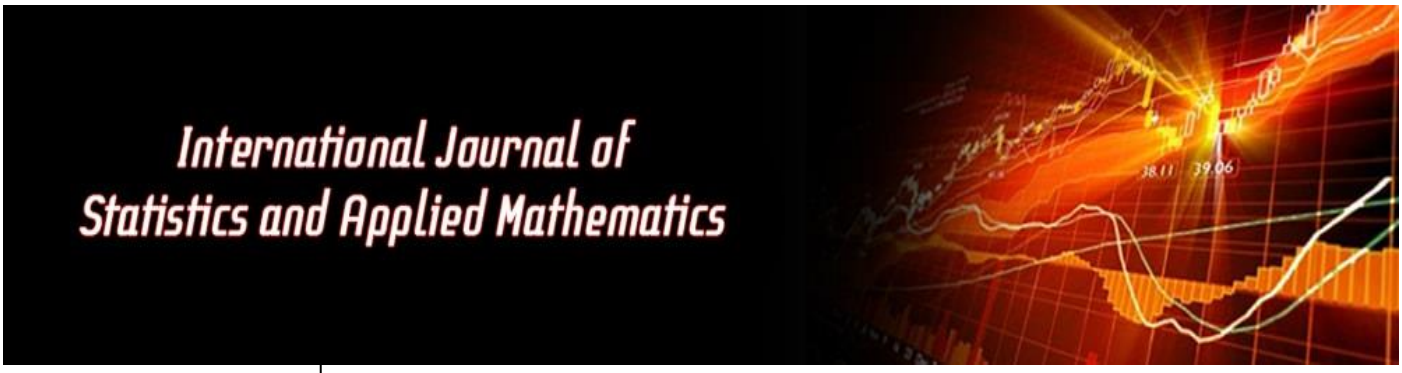

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Effect of Indole Butyric Acid (IBA) on shoot and root characters of pomegranate (*Punica granatum*) hardwood cuttings

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Abstract
The present investigation entitled "Effect of indole butyric acid (IBA) on root growth and survival of pomegranate (*Punica granatum*) hardwood cuttings" was conducted during October' 2022 to February' 2023 at the Department of Horticulture, School of Agricultural Sciences, GH Raisoni University, Saikheda (M.P.) during *Rainy* Season. The experiment was laid down in Randomized Block Design with three replication and seven treatment including control. The seven treatment of plant growth regulators and control (T_1 - Control, T_2 - 500 PPM IBA T_3 - 1000 PPM IBA, T_4 - 1500 PPM IBA, T_5 - 2000 PPM IBA, T_6 - 2500 PPM IBA and T_7 - 3000 PPM IBA). Observations of growth characters such as days taken to start sprouting, days taken to 50% sprouting, percentage of success of cutting, length of shoot after 60 days of planting (cm), length of shoot after 80 days of planting (cm), (b) Root characters such as number of roots per cutting, length of roots (cm) to be recorded. The results revealed that the minimum days taken to start sprouting (9.63 days) was found in T_7 and T_3, days taken to 50% sprouting (17.53 days) treatments - T_6, maximum percentage of success of cutting (80.89%) treatment - T_7, length of shoot after 60 days of planting (10.99 cm) treatment - T_6, length of shoot after 80 days of planting (17.18 cm) treatment T_8, Root characters such as number of roots per cutting (11.23) treatment -T_6, length of roots (11.89 cm) treatment T_7, while the minimum was found under the treatments T_1 - Control.

Keywords: IBA, hardwood cuttings, pomegranate, shoot of cuttings

Introduction
This fruit is native to Iran and is grown widely in Iran, Afghanistan, Spain, Morocco, Egypt, and Baluchistan, amongst other countries. It is also grown to some amount in Burma, China, Japan, India, and Italy. Pomegranate cultivation in India is primarily limited to a few areas across several states. It is mostly grown on 4500 hectares in Maharashtra. Pomegranates are also grown in modest amounts in the following states: Gujarat, Rajasthan, Uttar Pradesh, Andhra Pradesh, Madhya Pradesh, Haryana, Tamil Nadu, and Karnataka. However, there is quite a bit of potential for these areas to support large-scale farms.

Pomegranates were naturally adapted to areas with cold winters and hot summers, and they favor mild, semi-arid climates over subtropical ones. Pomegranates are planted virtually everywhere in India, covering a sizable 2.62 lakh hectare area and producing 30.34 MT year. Maharashtra is India's top producer of pomegranates. The states of Karnataka, Gujarat, Andhra Pradesh, and Rajasthan are home to the greatest pomegranate cultivation after Maharashtra. In accordance with Anonymous (2016), Rajasthan state currently contributes 7.47 thousand hectares of the country's total area and 13.12 thousand MT of its total production.

In contemporary fruit farming, fruit plant propagation is crucial. Raised from seedlings, trees display a great diversity of attractive characteristics. Stem cuttings are a common method of vegetative growth used to preserve an outstanding variety. This is the least expensive, fastest, and easiest way of vegetative propagation. It also doesn't require any specific skills, unlike grafting, budding, and layering. Pomegranate and other fruit crops' ability to be propagated through stem cuttings depends on a number of variables, including the mother plants' health, the portion of the tree from which the cuttings are taken.

The planting date, humidity, temperature, and rooting media care. Shortly after auxins and other growth regulators were discovered, synthetic auxins were developed, biofertilizer use became mandatory, and everyone began relying on synthetic auxins as growth regulators to facilitate rooting.

The pomegranate, or *Punica granatum* L., is a popular table fruit that is farmed professionally for its flavor. Many alkaloids found in stems and roots are widely used as treatments for diarrhoea and dysentery (E. l. Shaaraway and Nahapetian 1983) [19]. Fruit rinse, which is used to tan leather, has a high tannin content ranging from 47 to 68%, depending on the cultivar. In Azerbaijan, fruit juice from wild pomegranates is used to make sodium citrate and citric acid, which are utilized in medicine. Pomegranate seeds have a 15% oil content that has a high refractive index, a high iodine value, and a very low melting point. This oil has potential use in industry.

Materials and Methods

The present investigation entitled "Effect of indole butyric acid (IBA) on root growth and survival of pomegranate (*Punica granatum*) hardwood cuttings" was conducted during October' 2022 to February' 2023 at the Department of Horticulture, School of Agricultural Sciences, GH Raisoni University, Saikheda (M.P.) during *Rainy* Season. The experiment was laid down in Randomized Block Design with three replication and seven treatment including control. The seven treatment of plant growth regulators and control (T_1- Control, T_2- 500 PPM IBA T_3- 1000 PPM IBA, T_4- 1500 PPM IBA, T_5- 2000 PPM IBA, T_6- 2500 PPM IBA and T_7- 3000 PPM IBA). Observations of growth characters such as days taken to start sprouting, days taken to 50% sprouting, percentage of success of cutting, length of shoot after 60 days of planting (cm), length of shoot after 80 days of planting (cm), (b) Root characters such as number of roots per cutting, length of roots (cm) to be recorded.

Results and Discussion

Days taken to start sprouting

The earliest (9.63 days) sprouting of cutting was observed under treatment T_7- 3000 PPM IBA, which was at par with the treatment T_3- 1000 PPM IBA (9.63 days), followed by the treatment T_5- 2000 PPM IBA (10.03 days). Whereas, latest (14.63 days) sprouting of cutting was observed in control. This could be because low nitrogen and high carbohydrates have been shown to promote root development. These results concurred with the Bougainvillea study by Bose *et al.* (1968) [3].

Days taken to 50% sprouting

The earliest (17.53 days) taking to 50% sprouting of cutting was observed under the treatment T_6- 2500 PPM IBA, followed by the treatment T_2- 500 PPM IBA (18.63 days) and T_3- 1500 PPM IBA (19.93 days). Whereas, latest (22.13 days) taking to 50% sprouting of cutting was observed in control. Ishtiaq *et al.*, (1989) [4], who noted the favorable correlation pertaining to root growth and bud sprout in the peach cultivar Peshawar local, also corroborate these findings. These outcomes corroborated the findings of Singh *et al.*, (2011) [6], who observed that Bougainvillea cuttings treated with 3000 ppm IBA had a high sprouting percentage (100.0%). Melgarejo *et al.*, (2008) [5] also demonstrated that in pomegranates, most clones utilizing modest IBA application concentrations (3000 ppm) experienced an increase in the percentage of cuttings that rooted.

Percentage of success of cuttings

The percentage of success of cuttings was significantly increased under different concentration of IBA as compared to control. But maximum percentage of success (81.31%) of cuttings was recorded under T_6- 2500 PPM IBA, which was significantly superior to all other concentration of IBA and control (T_1). Whereas, minimum (55.69%) per cent of success of cutting, was recorded in control. This may be because IBA regulates several elements of a plant's growth and development, including cell division, elongation, and differentiation. These processes result in the construction of a large number of roots and shoots, which enhance the quality and survival of the plant (Davies, 2013) [7]. This might be explained by a more developed root system with high-quality root and shoot characteristics, which would allow the rooted cuttings to grow more effectively in the field after planting and account for the maximum field survivorship (Sharma *et al.*, 2009) [10]. These findings are in agreement with the research work of Ram *et al.*, (2005) [9] in pomegranate cv. Ganesh & Kandhari, Shukla *et al.*, (2010) [11] in peach. Diwaker and Katiyar (2013) [8] also reported the same in kagzi lime.

Length of shoot after 60, 80 and 100 days of planting (cm):

The longest (10.99 cm) shoot after 60 days of planting was found under T_6- 2500 PPM IBA, which was significantly superior to all treatment of IBA and Control (B0). The longest (17.18 cm) shoot after 80 days of planting was found under T_7- 3000 PPM IBA, followed by the other treatments i.e. T_6- 2500 PPM IBA (16.33 cm) and T_5- 2000 PPM IBA (15.39 cm), while the shortest length of shoot was recorded in control after 60 and 80. The timely application of IBA had a positive impact on *Bougainvillea peruviana* cutting (Singh, 2001) [12]. The current results regarding the average length of sprout per cutting are comparable to those of Bose *et al.*, (1968) [3]. Photosynthesis, increased food synthesis, and increased cell activity were the causes of the length and diameter increases. Singh (2014) [16-17] noticed a similar pattern on hardwood cuttings of Pomegranate cv. Ganesh and discovered that the treatment of 5 g. L^{-1} of IBA resulted in the maximum average sprout diameter of 3 mm. Additionally, Singh *et al.*, (2014) [16-17] looked studied Mulberry stem cutting under mist house conditions and found that the greatest average stem diameter (2.67 mm) is shown by the IBA at 2000 mg L-1.

Number of roots per cutting

The maximum (11.23) number of roots per cutting was found under T_6- 2500 PPM IBA, followed by the treatment T_7- 3000 PPM IBA (10.31) and T_5- 2000 PPM IBA (10.19). Whereas, minimum (5.29) number of roots per cutting was noted in control. The fact that IBA aided in promoting cell proliferation and differentiation under the influence of rooting hormones, as well as improved nutritional reserve hydrolysis leading to an enlarged root formation zone, may account for the increase of roots per rooted cutting. This work were supported by the finding of Tripathi and Shukla (2004) [1] in pomegranate, Reddy *et al.*, (2008) [2] in Fig, Ram *et al.*, (2005) [9] in pomegranate cv. Ganesh and Kandhari.

Length of roots (cm)

The longest (11.89 cm) root was found under T_6- 2500 PPM IBA, which was significantly superior to all concentration of IBA i.e. T_7- 3000 PPM IBA (10.89 cm) and T_5- 2000 PPM IBA (10.66 cm). While, the minimum (6.93 cm) length of root

was recorded in control. According to Strydem and Hartman (1960) [18], higher protein synthesis, cell division, and carbohydrate hydrolysis are the causes of the longer roots that have been treated with IBA. Research points to the possibility that auxin enhanced root length and rooting (Kaur and Kaur, 2016) [16]. When researching various genotypes of roses, Dawa *et al.* (2017) [13] discovered similar results: *Rosa banksiae* at 1000 ppm IBA produces a longer root (8.6 cm) than other genotypes. Additionally, Polat and Caliskan (2009) [15] found that when treated with IBA at 1000 ppm, 31 N 01 type outperformed the others in terms of root length (15.60 cm).

Table 1: Effect of Indole Butyric Acid (IBA) on shoot and root characters of pomegranate cuttings:

Treatment	Days taken to start sprouting	Days taken to 50% sprouting	Percentage of success of cuttings	Length of shoot (cm)		Number of roots per cutting	Length of roots (cm)
				60 days of planting	80 days of planting		
T_1- Control	14.63	22.13	55.69	6.66	10.66	5.29	6.93
T_2- 500 PPM IBA	10.63	18.63	67.45	9.69	14.19	6.53	8.96
T_3- 1000 PPM IBA	9.63	19.93	76.90	10.06	14.16	9.59	8.99
T_4- 1500 PPM IBA	10.63	21.03	78.48	10.16	13.39	10.09	10.59
T_5- 2000 PPM IBA	10.03	28.58	80.15	10.26	15.39	10.19	10.66
T_6- 2500 PPM IBA	11.83	17.53	81.31	10.99	16.33	11.23	11.89
T_7- 3000 PPM IBA	9.63	21.23	80.89	10.76	17.18	10.31	10.89
S.Em.±	0.051	0.104	0.275	0.042	0.062	0.064	0.047
CD at 5%	0.158	0.319	0.847	0.130	0.191	0.197	0.146

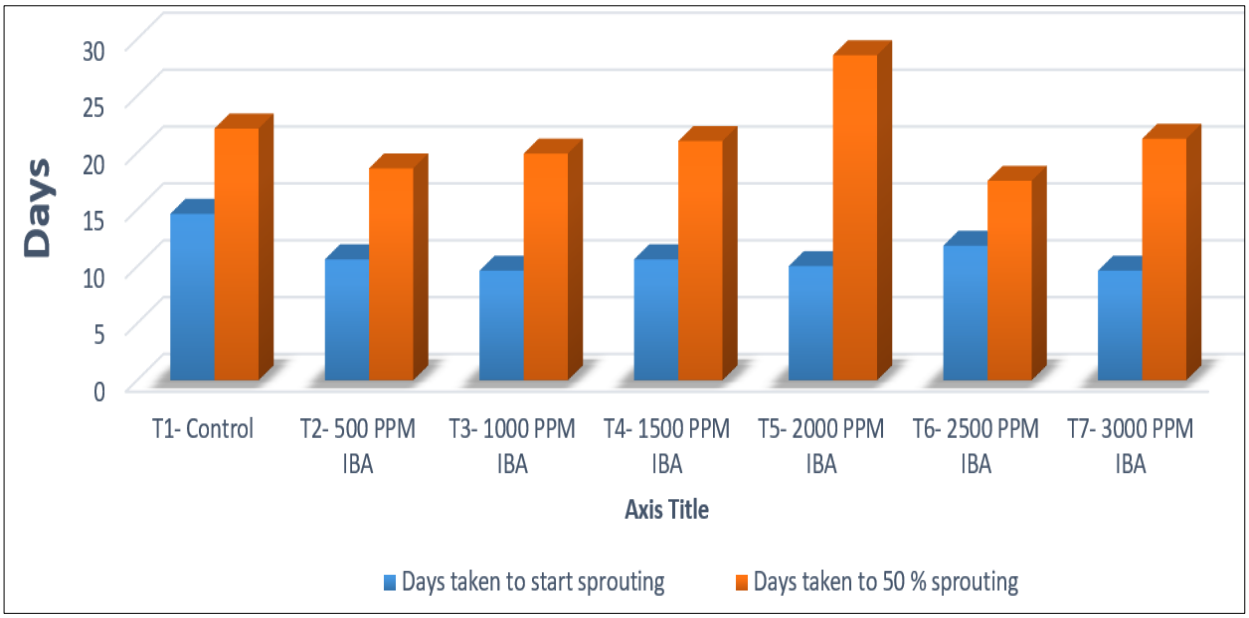

Fig 1: Effect of Indole Butyric Acid (IBA) on shoot characters of pomegranate cuttings

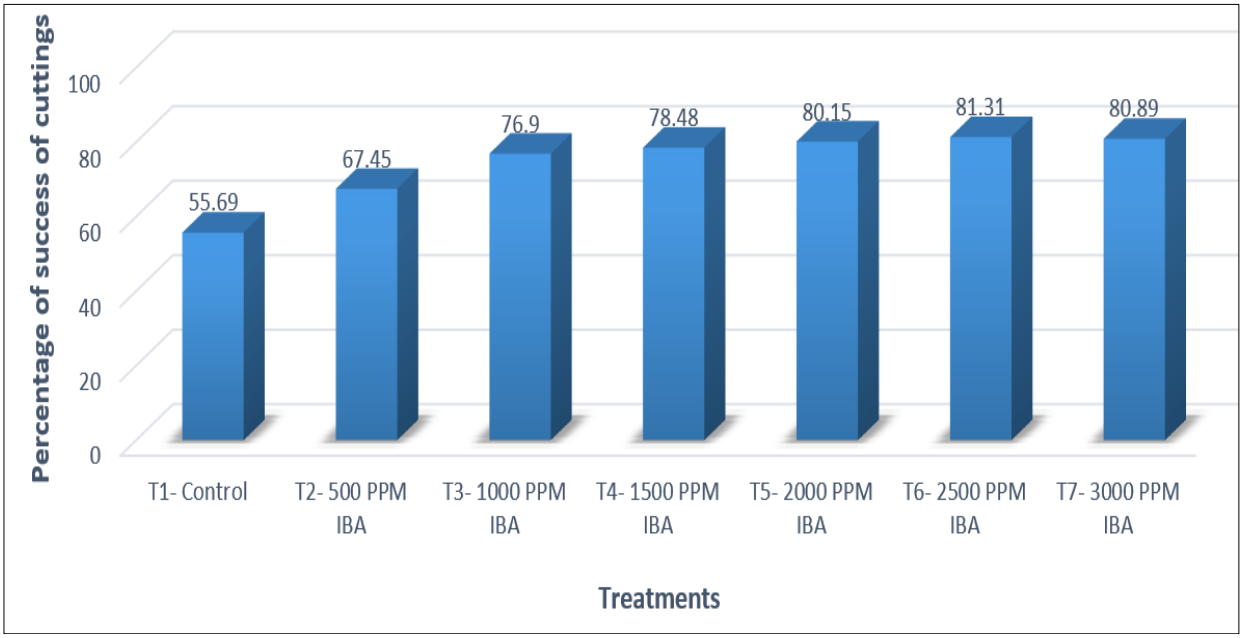

Fig 2: Effect of Indole Butyric Acid (IBA) percentage of success of cuttings of pomegranate cuttings

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