Assessing the impact of Indole Butyric Acid application & Varietal difference on various parameters of Hardwood cutting in pomegranate (*Punica granatum* L.) varieties

Abstract:

Aim: To determine the best combination of Indole-3-butyric acid & Variety for better growth of pomegranate cuttings.

Place and duration of study: Experiment was carried out during the year 2022-23 at the Instructional cum Research Department of Fruit Science, RVSKVV- K.N.K. College of Horticulture, Mandsaur (M.P).
Study Design: The experiment was laid out in Factorial Completely Randomized Design (FCRD) comprising of seven varieties hardwood cuttings (Mridula, Phule Arakta, Saharanpur, Jodhpur Red, Jalore Seedless, G-137, Bhagwa) and two IBA concentrations (3000 & 2500 ppm), replicated thrice.

Result: The interaction of cultivar and growth regulator significantly affected Days taken to 50% sprouting (15.34 Day), Number of shoots per cutting (9.88 & 10.43), Length of leaves (3.83 & 4.98 cm), width of leaves (1.76 & 2.10 cm) at 45 & 60 DAP respectively was recorded maximum value in Bhagwa cutting treated with 3000 ppm IBA , While SPAD Value observe non-significant.

Conclusion: The current study found that different dosages of IBA and different varieties cuttings significantly influenced in different parameters. Bhagwa treated with 3000 ppm IBA is best in different shoot parameters at both 45 and 60 DAP.

Key words: Hardwood cuttings, Indole Butyric Acid (IBA), Punica granatum L, Varieties

INTRODUCTION: Pomegranate, scientifically known as *Punica granatum* L. belong to Punicaceae family. It thrives in arid and semiarid climates and is a highly popular fruit crop worldwide. The pomegranate tree is deciduous in subtropical regions and evergreen in tropical regions Ozugan (1997). It is believed to have originated in Iran and has been cultivated since ancient times.

"Pomegranate" is a Latin word that means "apple with numerous seeds". According to smith (1976) *Punica granatum* has 2n = 16 or 18 chromosomes. The pomegranate is a naturally dense, deciduous, bushy, multi-stemmed shrub that typically grows to heights of 10 to 12 feet and produces highly coloured fruit filled with many juicy seeds. In most regions, pomegranates are trained into a multi-stem system, with slender, somewhat thorny branches and glossy, dark green leaves. The tree produces colourful orange-red flowers in the spring and summer, which are either bell-shaped (female) or vase-shaped (hermaphroditic), with the latter type being sterile. The edible part of the fruit, called an aril, consists of hundreds of seeds enclosed by juicy pigments, each surrounded by a seed coat Smith, 1976).

It has long been a symbol of wealth and ambition (Duman *et al.,* 2009). Pomegranate juice has numerous benefits for those suffering from leprosy. In Azerbaijan, citric acid extract and sodium citrate are derived from pomegranate juice. Additionally, the barks and skins of the fruit are commonly utilized for treating dysentery, diarrhea, and other digestive issues Gil *et al.* (2000).

The pomegranate has been recognized for centuries as a potent food medicine with a diverse range of clinical applications. According to Gil *et al.* (2000), pomegranate juice has an antioxidant capacity three times greater than red wine or green tea and 2-6 times higher than grape, grapefruit and orange juices, when tested individually (Rosenblat and Aviram, 2006). Pomegranate has gained popularity due to its health-promoting qualities, including its antimutagenic, antiatherogenic, antioxidant, antihypertensive properties, and high anthocyanin content (Basu and Penugonda, 2009).

Pomegranate can be propagated through both sexual and asexual means. Cheema *et al.* (1954) and Nagpal (1954) have recommended asexual or vegetative methods of propagation to eliminate the high degree of variability observed in seed plantations. Pomegranate is commonly propagated for commercial purposes using hardwood stem cuttings. This method is considered the most convenient and can produce a fully developed and strong plant in significantly less time. The most commonly used growth substances for better rooting of various plant parts are IAA, IBA, and NAA. Of these, IBA is preferred over the others (Avery and Johnson, 1947; Pearse, 1948; Garner, 1958; Leopold, 1958; Loreti and Hartman, 1962; Sarma and Sarma, 1991, Rao et al. 2020).

The ability of cuttings to root varies depending on the cultivar, location, season, and age of the branch used. The success of pomegranate cuttings depends on various factors, such as the conditions of the mother plants, the part of the tree from which the cuttings are taken, the timing of the operation, rainfall, temperature fluctuations, and aftercare. Moreover, different environmental conditions and growth regulators also play an essential role in the rooting and growth of pomegranate cuttings. The main aim of this study is to access the effect of combination of IBA and different varieties on different parameters of pomegranate hardwood cuttings Rao et al 2020, Tanwar et al 2020.

Material & Methods:

Experiment detail:

The experiment was laid out in factorial complete randomized design with a IBA and different varieties of pomegranate as fourteen treatment and three replications. Treatment combination are as under:

Treatment combinations:

T_1 - Mridula + IBA 2500 ppm	T_8- Mridula + IBA 3000 ppm
T_2 - Phule Arakta + IBA 2500 ppm	T_9- Phule Arakta + IBA 3000 ppm
T_3 - Saharanpur + IBA 2500 ppm	T_{10}- Saharanpur + IBA 3000 ppm
T_4 - Jodhpur Red + IBA 2500 ppm	T_{11}- Jodhpur Red + IBA 3000 ppm
T_5 - Jalore seedless+ IBA 2500 ppm	T_{12}- Jalore Seedless+ IBA 3000 ppm I_2

T_6 - G-137+ IBA 2500 ppm	T_{13}- G-137+ IBA 3000 ppm
T_7 - Bhagwa + IBA 2500 ppm	T_{14}- Bhagwa + IBA 3000 ppm

Growth regulator formulation:

The required concentration of indole butyric acid (IBA) 2500 & 3000 ppm was prepared by dissolving 2.5 & 3.0 g IBA in 10 ml of ethyl alcohol (90%) and final volume was made to 1000 ml using distilled water.

Study location:

Study was conducted during the year 2022-2023 at the Experimental Field of Department of Fruit Science, KNK College of Horticulture, Mandsaur (MP). Mandsaur is situated at 23.450 to 24.130 N latitude and 74.440 to 75.180 E longitudes at an altitude of 435 m mean sea level. Mandsaur temperature rises up to 46 ℃ during summer and falls to 3.6 ℃ during winter with an occasional occurrence of frost. The average annual rainfall is 797.6 mm, most of which occurred during July to September, winter and summer rains are uncommon.

Experimental data Collection:

Days taken to 50% sprouting

The days taken to 50% sprouting of total cutting were counted from date of planting till the 50% sprout comes out of total cutting planted and recorded as days taken to 50% sprouting.

Number of shoots per cutting at 45 and 60 DAP

The number of shoots per cutting was recorded randomly selected plants in each treatment and replication at 45 and 60 DAP.

Length of longest shoot (cm) at 45 and 60 DAP

The length of the longest shoot was measured on each sample of cutting and mean was recorded after 45 and 60 days after planting of cuttings.

Length of leaf (cm) at 45 and 60 DAP

Length in (cm) under each treatment was recorded after 45 and 60 days of planting with the help of scale and mean length of leaves per cutting was worked out.

Width of leaf (cm) at 45 and 60 DAP

width in (cm) under each treatment was recorded after 45 and 60 days of planting with the help of scale and mean width of leaves per cutting was worked out.

SPAD value at 45 and 60 DAG

The cuttings were randomly selected to measure the total chlorophyll content using a digital chlorophyll meter (SPAD-502). The mean value of the leaves was calculated, and the results were expressed in SPAD units (an acronym for Soil Plant Analysis Division.

Result and Discussion:

1. Days taken to 50% sprouting

Among seven distinct varieties, results showed that cultivars had considerable variations in days taken to 50% sprouting. Pomegranate cv. Bhagwa was shown to be the best variety, with the minimum days to 50% sprouting (15.47 days) than cvs. Mridula (15.88 days), Phule Arakta (16.60 days), Jodhpur Red (17.53 days), G137 (18.53 days), Jalore seedless (19.42 days) as opposed to the Saharanpur, which had the maximum days to 50% sprouting (20.10 days). In case of effect of different levels of growth regulator, it was seen that the earliest 50% sprouting (17.14 days) was observed with 3000 ppm IBA, whereas, IBA 2500 ppm took (18.15 days) days to 50 % of sprouting.

As regards different varieties and levels of growth regulator were reported significant to this attribute. However, the minimum days to 50 % of sprouting was reported in Bhagwa (15.34 days) treated with 3000 ppm followed by Mridula (15.35 days) treated with 3000 ppm and Bhagwa (15.60 days) treated with 2500 ppm. Whereas, maximum days (20.50) taken to fifty per cent sprouting of cuttings were recorded in Saharanpur treated with 2500 ppm IBA.

The minimum number of days required for first sprouting (12.97 days), minimum days taken to 50 % of sprouting (15.34) and greatest number of cuttings sprouted (7.67) found in Bhagwa treated with IBA 3000 ppm. Better and earlier sprouting might be due to an accumulation of endogenous growth stimulating chemicals present in the tissue of the cuttings reported by Kaur *et al.* (2020) in pomegranate cv. Bhagwa. The minimum number of days took to 50 % sprouting, it might be due to the higher level of auxins resulted in the completion of physiological processes involved cutting roots and sprouting sooner. Similarly, Gautheret (1969), Haissing (1972) observed that the first root initial cell division is dependent on either administered or endogenous auxin.

Table1: Effect of varieties and IBA concentrations on Day taken to 50% sprouting in pomegranate cuttings.

Variety (V)	IBA concentrations (I)		
	2500 ppm	3000 ppm	Mean
Mridula	16.4	15.35	15.88
Phule Arakta	17.1	16.1	16.6
Saharanpur	20.5	19.7	20.1
Jodhpur Red	18.1	16.95	17.53
Jalore Seedless	20.12	18.73	19.42
G 137	19.25	17.8	18.53
Bhagwa	15.6	15.34	15.47
Mean	18.15	17.14	
	S.Em.±	C.D. @ 5%	
V	0.0723	0.209	
I	0.0386	0.112	
VxI	0.102	0.296	

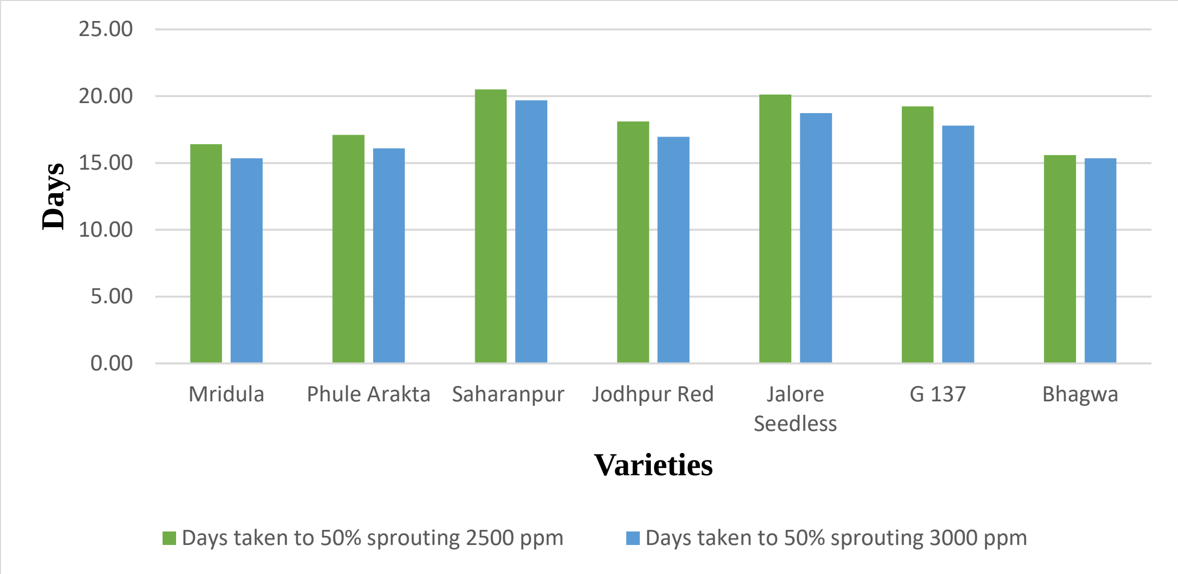

Fig.1. Effect of varieties & IBA concentration on Day taken to 50% sprouting

2. Number of shoots per cutting

Among the different varieties tested, variety Bhagwa exhibited the maximum number of shoots at 45 and 60 DAP, with values of 9.79 & 10.17 respectively then Mridula (9.26 & 9.68), Phule Arakta (8.87 & 9.14), Jodhpur Red (8.08 & 8.59), G-137 (4.24 & 8.21), Jalore Seedless (3.97 & 7.88), Saharanpur (3.92 & 7.69) at 45 and 60 DAP was recorded. In concentration of IBA maximum number of shoot (8.68 & 9.10) at 45 and 60 DAP respectively was observed in 3000 ppm IBA concentration while the minimum number of shoots per cuttings (7.96 & 8.43) at 45 and 60 DAP was recorded under 2500 ppm IBA.

The combining impact of varietals and IBA concentrations indicated significant difference in number of shoots per cutting at 45 and 60 DAP. The maximum number of shoot per cuttings (9.88 & 10.43) at 45 and 60 DAP in Bhagwa treated with 3000 ppm IBA concentration followed by Mridula (9.83 & 10.18) treated with 3000 ppm IBA, at 45 and 60 DAP respectively. While, Saharanpur (6.91 & 7.57) treated with 2500 ppm IBA recorded minimum number of shoots per cuttings at 45 & 60 DAP respectively.

It was observed that cuttings of cv. Bhagwa treated with IBA 3000 ppm sprouted significantly more number of shoots (10.43) compared to remaining treatments. The highest number of shoot development during higher auxin treatment may be due to reason that auxins support in the establishment of a strong root system, which may have improved nutrient absorption under the effect of IBA (Hiral *et al.*, 2017). Ghosh *et al.,* (2017) also reported that the use of IBA and NAA may have caused an increase in the number of shoots per cutting.

Table 2: Effect of varieties and IBA concentrations on number of shoots per cutting in pomegranate cuttings.

Variety (V)	IBA concentration (I)					
	45 DAP			60 DAP		
	2500 ppm	3000 ppm	Mean	2500 ppm	3000 ppm	Mean
Mridula	8.68	9.83	9.26	9.18	10.18	9.68
Phule Arakta	8.08	9.67	8.87	8.50	9.78	9.14
Saharanpur	6.91	7.31	7.11	7.57	7.81	7.69
Jodhpur Red	7.74	8.41	8.08	8.24	8.93	8.59
Jalore Seedless	7.11	7.68	7.40	7.61	8.16	7.88
G 137	7.51	8.01	7.76	8.01	8.40	8.21
Bhagwa	9.70	9.88	9.79	9.90	10.43	10.17
Mean	7.96	8.68		8.43	9.10	
	S.Em.±	C.D. @ 5 %		S.Em.±	C.D. @ 5%	
V	0.0689	0.199		0.1150	0.333	
I	0.0368	0.107		0.0615	0.178	
VxI	0.097	0.282		0.163	0.471	

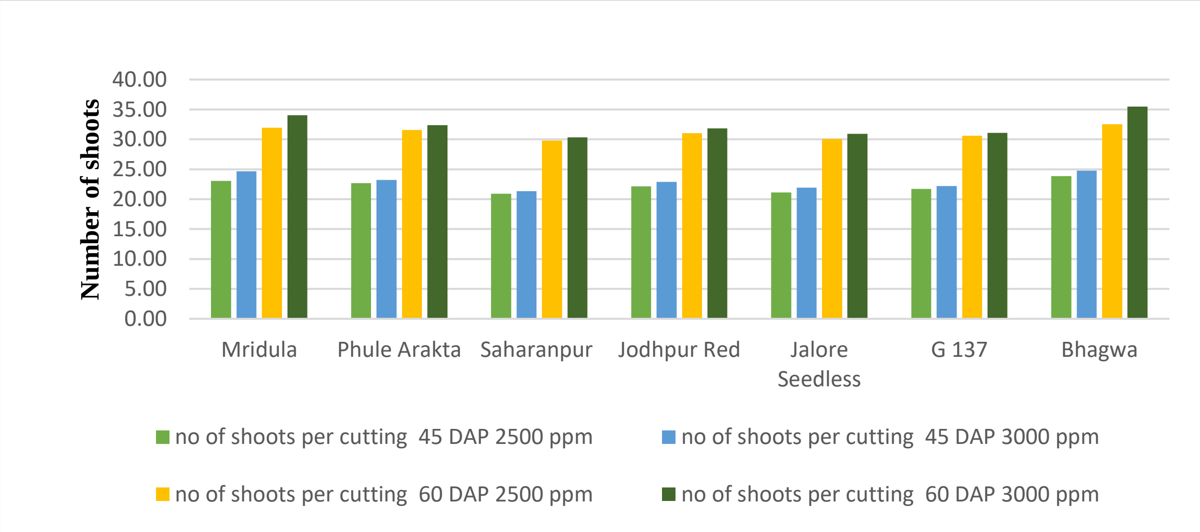

Fig.2. Effect of Varieties & IBA concentration on Number of shoots per cuttings

3. Length of Leaves (cm)

Among varieties, the maximum length of leaves formed on the shoot of Bhagwa (3.81 & 4.95 cm) at 45 & 60 DAP was reported significantly higher than remaining cultivars. It was followed by Mridula (3.68 & 4,81 cm), Phule Arakta (3.42 & 4.56 cm), Jodhpur Red (3.20 & 4.33 cm), G-137 (2.96

& 4.09 cm), Jalore Seedless (2.66 & 3.79 cm) while, least length of leaves was reported in cv. Saharanpur (2.39 & 3.51 cm) at 45 & 60 DAP.

A significant relationship between various cultivar and growth regulator interactions has been identified. IBA 3000 ppm applied to Bhagwa (3.83 & 4.98 cm) had the longest leaf followed by Mridula (3.78 & 4.91 cm). In contrast, Saharanpur treated with 2500 ppm IBA had the shortest length (2.2 & 3.30 cm) at 45 & 60 DAP respectively.

Cuttings of Bhagwa treated with 3000 ppm produced significantly maximum number of leaves (35.50), highest leaf length (4.98 cm), maximum width (2.10 cm) and maximum leaf area (10.10 cm^2). The growth regulators' ability to stimulate strong roots system, which helps to cuttings absorb more water and nutrients and produce more leaves may be the cause of the increase in leaf count. Additionally, as auxins encourage the growth of primary shoots and their quantity, the number of leaves may also have raised (Khapare *et al.,* 2012). The findings match those declared public by Singh (2014) in pomegranate, Dahale *et al.* (2018) in Fig fruit plants, Ghosh *et al.* (2017) in Phalsa and Mehta *et al*. (2018) in pomegranate.

Table 3: Effect of varieties and IBA concentrations on length of leaves in pomegranate cuttings

Variety (V)	IBA concentration (I)					
	45 DAP			60 DAP		
	2500 ppm	3000 ppm	Mean	2500 ppm	3000 ppm	Mean
Mridula	3.58	3.78	3.68	4.71	4.91	4.81
Phule Arakta	3.18	3.65	3.42	4.31	4.81	4.56
Saharanpur	2.20	2.58	2.39	3.30	3.71	3.51
Jodhpur Red	3.07	3.33	3.20	4.20	4.46	4.33
Jalore Seedless	2.43	2.88	2.66	3.56	4.01	3.79
G 137	2.83	3.08	2.96	3.96	4.21	4.09
Bhagwa	3.78	3.83	3.81	4.91	4.98	4.95
Mean	3.01	3.31		4.14	4.44	
	S.Em.±	**C.D. @ 5 %**		**S.Em.±**	**C.D. @ 5 %**	
V	0.0442	0.128		0.0405	0.117	
I	0.0236	0.068		0.0217	0.063	
VxI	0.062	0.181		0.057	0.166	

4. Width of leaves (cm):

It is evident from the data that Bhagwa, which greatly outgrew in terms of width of leaves (1.74 & 2.07 cm) followed by Mridula (1.71 & 2.03 cm), Phule Arkta (1.63 & 1.95 cm), Jodhpur Red (1.52 & 1.87 cm), G137 (1.40 & 1.74 cm) and Jalore Seedless (1.31 & 1.63 cm). The smallest leaf width (1.27 & 1.59 cm) was discovered in Saharanpur. IBA at 3000 ppm was shown to be much superior than other levels of growth regulator in the case of growth regulator, as seen by the greatest breadth (1.57 & 1.90 cm) of leaf that could be recorded with IBA 3000. While IBA at 2500 ppm was used to measure the minimum breadth of leaves (1.46 & 1.78 cm) at 45 & 60 DAP respectively.

It was discovered that there was a considerable interaction between different varieties and growth regulators. However, Bhagwa (1.76 & 2.10 cm) treated with 3000 ppm IBA and Mridula (1.72 & 2.04 cm) treated with 3000 ppm IBA were found to have the widest leaves respectively 45 & 60 DAP. In contrast, IBA 2500 ppm was found to have the smallest breadth (1.22 &1.55 cm) in Saharanpur at 45 & 60 DAP respectively.

Greater leaf size may have been the result of the plant's rapid growth as a result of the greater auxin content. Kaur and Kaur (2017) in fig and Patel *et al*. (2020) in Kagzi lime reported findings that were comparable.

Table 4: Effect of varieties and IBA concentrations on Width of leaves in pomegranate cuttings

	IBA concentration (I)					
Variety (V)	**45 DAP**			**60 DAP**		
	2500 ppm	**3000 ppm**	**Mean**	**2500 ppm**	**3000 ppm**	**Mean**
Mridula	1.70	1.72	1.71	2.02	2.04	2.03
Phule Arakta	1.54	1.71	1.63	1.86	2.03	1.95
Saharanpur	1.22	1.31	1.27	1.55	1.63	1.59
Jodhpur Red	1.42	1.62	1.52	1.76	1.97	1.87
Jalore Seedless	1.23	1.39	1.31	1.55	1.71	1.63
G 137	1.35	1.45	1.40	1.67	1.81	1.74
Bhagwa	1.72	1.76	1.74	2.04	2.10	2.07
Mean	1.46	1.57		1.78	1.90	
	S.Em.±	**C.D. @ 5 %**		**S.Em.±**	**C.D. @ 5%**	
V	0.0130	0.038		0.0181	0.053	
I	0.0070	0.020		0.0097	0.028	
VxI	0.018	0.053		0.026	0.074	

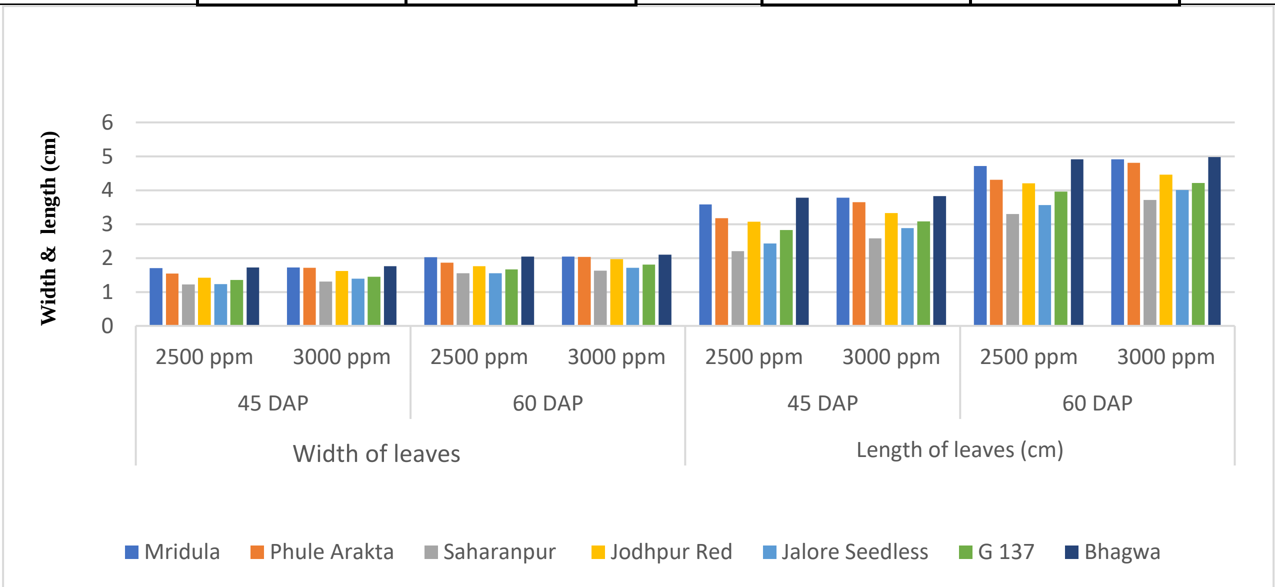

Fig.3. Effect of varieties & IBA concentration on Width & length of leaves

5. Chlorophyll or SPAD value

The findings showed that there were considerable variations in total chlorophyll concentration among cultivars. Bhagwa cuttings outperformed the other cultivars in terms of chlorophyll concentration per cutting (27.87) next to Mridula (27.80), Phule Arakta (26.51), Jodhpur Red (25.72), G 137 (25.11), Jalore Seedless (24.44) at 45 DAP. While, Mridula (31.10) outperformed in terms of chlorophyll concentration next to Bhagwa (30.37), G 137 (30.11), Phule Arakta (29.32), Jodhpur Red (28.84) and then Jalore Seedless (27.61) at 60 DAP. The minimum chlorophyll concentration was found in cv. Saharanpur (23.95 & 27.50) at 45 & 60 DAP. Regardless of cultivar, IBA 3000 ppm (26.55 & 29.79) outperformed on IBA 2500 ppm (25.28 & 28.73) at 45 & 60 DAP respectively.

There was no significant interaction between cultivars and IBA concentrations on total leaf chlorophyll amount per.

The increased concentration of auxins has been found to stimulate leaf growth, resulting in a higher leaf area. This, in turn, activates more photosynthates, leading to an increased chlorophyll content in the leaves of cuttings. Growth hormones, as demonstrated by Galston and Davies in 1969, play a crucial role in regulating the distribution and quantity of assimilates in plants. Sahab *et al.* in 2013 also observed that cuttings with a greater number of leaves had improved nutrient uptake, leading to increased production of photosynthates and providing an ample food supply for the metabolic activities of the plants. These findings align with the results of Kumari's study in 2014, which focused on pomegranate propagation in the cv. Ganesh. The results of this study were found to be closer to the findings of Kaur *et al*. (2002) in grapevine and Hakim *et al.* (2018) in pomegranate that raising IBA concentration improves total chlorophyll content, Ghani *et al.* (2019) in pomegranate cv. Phule Bhagwa Super.

Table 6: Effect of varieties and IBA concentrations on SPAD value in pomegranate cuttings

	IBA concentration (I)					
Variety (V)	45 DAP			60 DAP		
	2500 ppm	3000 ppm	Mean	2500 ppm	3000 ppm	Mean
Mridula	26.62	28.99	27.80	30.27	31.93	31.10
Phule Arakta	25.59	27.44	26.51	28.71	29.92	29.32
Saharanpur	23.82	24.08	23.95	27.86	27.13	27.50
Jodhpur Red	25.29	26.14	25.72	28.41	29.26	28.84
Jalore Seedless	23.78	25.10	24.44	27.00	28.22	27.61
G 137	24.74	25.48	25.11	29.26	30.96	30.11
Bhagwa	27.15	28.59	27.87	29.61	31.13	30.37
Mean	24.97	26.55		28.73	29.79	

	S.Em.±	$CD_{(0.05)}$		S.Em.±	$CD_{(0.05)}$
V	0.2298	0.666		0.3382	0.980
I	0.1228	0.356		0.1807	0.524
VxI	0.325	0.941		0.478	1.385

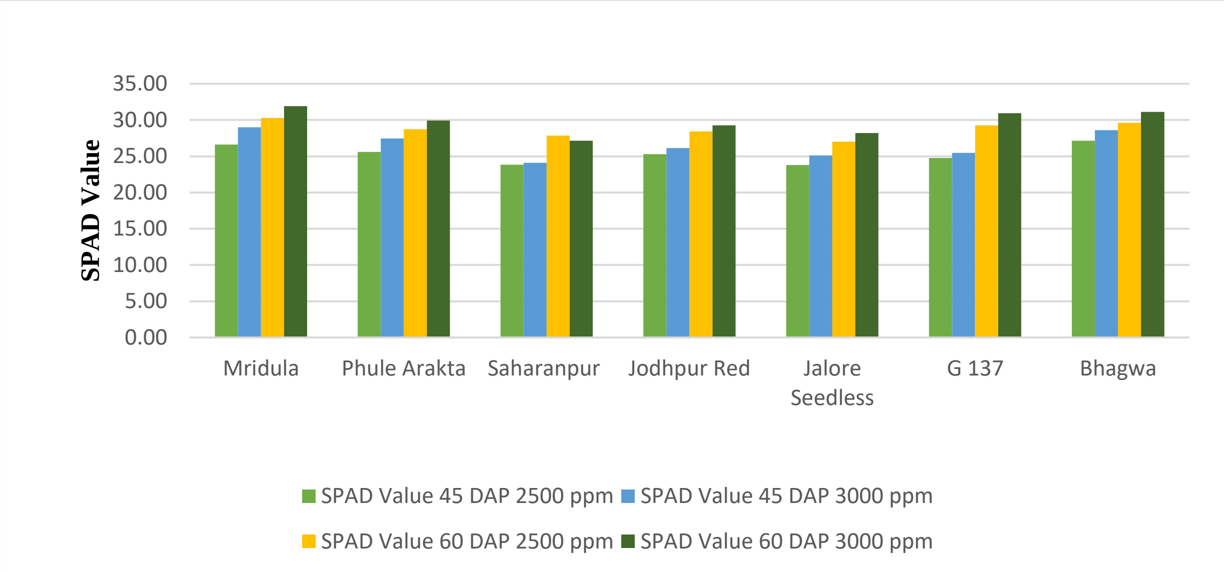

Fig.4. Effect of Varieties & IBA on SPAD Value

Conclusion:

The current study found that different dosages of IBA and different varieties cutting significantly influenced properties of pomegranate cuttings. The result revealed that among all the treatments Bhagwa treated with 3000 ppm best in 50% sprouting, width & length of leaves, number of shoot per cutting, Length of longest shoot of cuttings. Out of 7 cultivars investigated, cvs. Bhagwa, Mridula, and Phule Arakta performed best in respect of all root and shoot parameters, followed by cvs. Jodhpur Red, G 137, Jalore Seedless, and Saharanpur. In practically all root and shoot characteristics, IBA @ 3000 ppm outperformed followed by 2500 ppm.

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