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G Siva Koteswara Rao
Division of Fruit Science, FOH, SKUAST-Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir, India

Irfan Ahmad Bisati
Division of Fruit Science, FOH, SKUAST-Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir, India

Umar Iqbal
Division of Fruit Science, FOH, SKUAST-Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir, India

Amit Kumar
Division of Fruit Science, FOH, SKUAST-Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir, India

Sajad Ahmad Bhat
Division of Basic Sciences and Humanities, SKUAST- Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

Corresponding Author
G Siva Koteswara Rao
Division of Fruit Science, FOH, SKUAST-Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir, India

Effect of IBA concentrations on vegetative parameters of pomegranate cuttings under temperate conditions of Kashmir

G Siva Koteswara Rao, Irfan Ahmad Bisati, Umar Iqbal, Amit Kumar and Sajad Ahmad Bhat

Abstract
Present investigation was carried out at experimental field of Division of Fruit Science, SKUAST-Kashmir, Shalimar campus, Srinagar (J & K) to study vegetative growth habit of different pomegranate cultivars treated with different concentrations of IBA. Cuttings of about 20 cm long, 0.8-1.2 cm diameter and having four or five buds obtained from the properly matured one year old shoots in the month of March were procured. Before planting, the cuttings were treated with four levels i.e. 2000, 3000, 4000 and 5000 ppm of IBA using quick dip technique (for 30 seconds) along with control i.e., without IBA treatment and planted in soil. The results revealed that cv. Chawla (9.65) was earliest in sprouting whereas cv. Kandhari Kabuli (2.88) has maximum number of shoots along with maximum number of leaves/cuttings (30.30), leaf area (25.56 cm^2) and chlorophyll content (30.16). Maximum length of the longest shoot (26.70 cm), fresh weight of shoots (7.65 g) and dry weight of shoots (5.03 g) was recorded in cv. Nabha. The interaction between cultivars and IBA concentrations showed significantly results on vegetative growth parameters. From the present investigation it is clear that cvs. Chawla, Kandhari Kabuli and Nabha treated with IBA @ 5000 ppm were found to be superior in vegetative growth parameters.

Keywords: Pomegranate, propagation, cuttings, IBA, leaf area

Introduction
Pomegranate (*Punica granatum* L.) belongs to family Punicaceae which is a deciduous shrub or small tree. It is native from Iran to the Himalayas in Northern India, cultivated and naturalized over the whole Mediterranean region since ancient times (Pandey *et al.*, 2008) [8]. The pomegranate become popular in tropical and subtropical regions due to its hardy nature, low water requirement, higher yield and increased demand in national and international markets for table as well as for processing purpose. It also grows in wild and cultivated forms in North-Western Himalayan regions of the country. Since all the pomegranate cultivars were not performing equally well under temperate ecosystem with respect to yield and quality attributes due to extremes of low temperature (Verma *et al*., 2013) [14] and under the changing scenario of climatic conditions, pomegranate is becoming an alternative fruit crop for temperate region. Inspite of various pomegranate cultivars grown in different regions of India, there is no known cultivar for mild to high temperate conditions (Shukla *et al*., 2016). The pomegranate varieties show differential response in rooting due to the physiological conditions of the parent plant, cutting type, planting time, medium type and rooting hormone (Polat and Caliskan, 2009) [9].

Pomegranate is commercially propagated through cuttings (softwood, semi- hardwood and hardwood), which is the most commercial, convenient and cheap method to get true to the type plants (Melgarejo *et al.*, 2008; Polat and Caliskan, 2009) [7, 9]. 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 by treating with suitable plant growth regulators. Plants produce natural auxin in young shoots and leaves, but the synthetic auxin should be used for successful rooting to prevent cuttings death (Kasim and Rayya, 2009) [6]. Indole Butyric Acid (IBA) is the synthetic plant hormone. It is active in inhibiting axillary bud break on developing shoots, and it stimulates the root initiation. It is a leading plant hormone used to generate new roots in the cloning of plants through cuttings. Taking into the consideration of above fact the experiment was conducted to

know the effect of different IBA concentrations on vegetative parameters of pomegranate hardwood cuttings of different cultivars under temperate conditions of Kashmir.

Material and Methods

The experiment was carried out at experimental farm of Division of Fruit Science, SKUAST-Kashmir, Shalimar Campus, Srinagar (J & K) during 2018 with randomized block design under open conditions. The experiment comprised of hardwood cuttings of ten pomegranate cultivars (Arakta, Mridula, Muskat, Ichakdana, Bhagwa, Chawla, Kandhari Kabuli, Nabha, Jodhpur Red and P-23) treated with five concentrations of root promoting hormone IBA @ 5000 ppm, 4000 ppm, 3000 ppm, 2000 ppm and 0 ppm (without IBA). Fifteen hardwood cuttings under each replication were taken from each variety in the month of March from properly matured one year old shoots having diameter 0.8 cm to 1.2 cm and 20 cm in length with 4-5 buds each, making a slanting cut at the basal end just below the bud and at apical end just above the bud. The basal portion of each cuttings were dipped for 30 second with the prepared IBA concentrations and with water as a control treatment. The cuttings were air dried for 15 minutes and planted in an inclined position at an angle approximately 60° to the horizontal to avoid dew or raindrops enter through a cut surface and to a depth of 6-8 cm. The cuttings were planted 10 cm apart with row to row distance of 60 cm. The cuttings were watered regular intervals for optimum moisture maintenance and weeds were removed regularly. The planted cuttings were allowed to root for 90 days and five cuttings were labelled for taking the observations.

Observations were recorded on shoot parameters. The planted cuttings were observed daily under each treatment and the number of days required for sprouting was recorded, while number of shoots per cutting was counted after 90 days of planting. Length of longest shoot/cutting (cm), number of leaves/cutting and leaf area (cm^2) was recorded under each treatment. Leaf chlorophyll was measured with the help of handhold chlorophyll meter (SPAD units) by inserting the leaf in the equipment and averaged. Fresh and dry (oven dried at 65ºC for 48 hours) weight of shoots (g) was taken with the help of electronic balance and averaged. Data generated from these investigations were appropriately computed, tabulated and statistically analyzed as per the procedure given by Snedecor and Cochran (1994) [13]. The level of significance was tested for different variable at 5 per cent level of significance.

Results and Discussion

Significant results were obtained for all the studied characters with respect to shooting parameters. Data presented in Table 1 revealed that the number of days taken for first sprouting of cuttings was significantly influenced by different IBA concentrations and cultivars of pomegranate. IBA @ 5000 ppm (11.19 days) had recorded minimum number of days taken for first sprouting which statistically differs from others concentrations however maximum number of days was taken under control. Among cultivars, cv. Chawla was earliest in sprouting and took 9.65 days which was statistically different from other cultivars, followed by Nabha (10.76 days) whereas maximum number of days taken for first sprouting was observed in cv. Jodhpur Red (18.99). The interaction studies between cultivars and different concentrations of IBA on days to first sprouting differed significantly and cuttings of cv. Chawla treated with IBA @ 5000 ppm (7.46 days) sprouted earlier which was statistically at par with cv. Chawla treated with IBA @ 4000 ppm (7.82 days) and cv. Chawla treated with IBA @ 3000 ppm (8.14 days). Maximum number of days taken for first sprout to appear was observed in cuttings of cv. Jodhpur Red (20.67 days) without any IBA treatment i.e. control. The remaining treatments were in the range of 8.14-19.65 days. The early sprouting of cuttings may be due to increased level of auxins which resulted in earlier completion of physiological processes in rooting and sprouting of cuttings. Chandramouli (2001) [2] found that the increase in the concentration of IBA significantly decreased the number of days to first sprouting of cuttings and earliness in sprouting might be due to better utilization of stored carbohydrates, nitrogen and other factors with the help of growth regulators. These results are in conformity with findings of Damar *et al*. (2014) [3] on propagation of pomegranate.

Data presented in Table 1 indicated significant differences among cultivars, IBA concentration and their interaction for number of shoots per cutting. Maximum number of shoots per cutting was recorded in cv. Kandhari Kabuli (2.88) whereas minimum number of shoots per cutting was reported in cv. Jodhpur Red (1.56). With respect to concentration of IBA, maximum number of shoots per cutting was recorded when cuttings were treated with IBA @ 5000 ppm (2.84) however, minimum number of shoots per cutting was registered in control (1.45). The interaction effect of cultivars and IBA concentrations differed significantly for number of shoots per cutting. Cuttings of cv. Kandhari Kabuli treated with IBA @ 5000 ppm (4.13) recorded maximum number of shoots per cutting closely followed by cultivar Nabha treated with IBA @ 5000 ppm (3.73), while least number of shoots per cutting (1.08) were observed in cv. Jodhpur Red treated with water (0 ppm) i.e. control. The increased number of sprouts per cutting may be attributed to increased cell division and elongation at higher concentrations of IBA as reported by Alikhani *et al*. (2011) [1] who observed maximum number of shoots per cutting of pomegranate treated with NAA @ 4000 ppm.

Significant results were obtained for length of the longest shoot among the cultivars and also among IBA concentrations (Fig. 1). Maximum length of the longest shoot among the cultivars was recorded in cv. Nabha (26.70 cm) which was statistically at par with Kandhari Kabuli (26.65 cm) and Chawla (26.43 cm) whereas minimum length of the longest shoot was recorded in cv. Jodhpur Red (18.52 cm). IBA @ 5000 ppm (26.24 cm) recorded maximum length of the longest shoot which was significantly higher among all the IBA concentration however minimum was recorded under control (18.57 cm). Cultivars and IBA concentrations interaction depicts that maximum length of the longest shoot was registered in cv. Nabha cuttings treated with IBA @ 5000 ppm (33.85 cm) which was statistically at par with Kandhari Kabuli cuttings treated with IBA @ 5000 ppm (32.18 cm) whereas least was recorded in cv. Jodhpur Red treated with 0 ppm (16.39 cm) i.e. control. Length of the longest shoot was might be due to maximum number of roots per cutting enhanced the nutrient uptake and resulted in more photosynthate production. Food in the form of photosynthetates provides required energy for cell division and cell elongation and it results in maximum shoot length (Shahab *et al*., 2013) [11]. Longest shoot on cuttings may be attributed to the better utilization of stored carbohydrates, nitrogen and other factors with the help of growth regulators

(Chandramouli, 2001) [2]. Polat and Caliskan (2009) [9], Singh (2014) [12] and Seiar (2017) [10] also reported similar results on pomegranate propagation through cuttings.

Data related to average number of leaves per cutting and leaf area as influenced by cultivars, IBA concentrations and their interaction is presented in Table 2. Significant difference among individual factors and their interactions on number of leaves per cutting and leaf area was observed. The number of leaves recorded on the shoots of Kandhari Kabuli (30.30) cuttings was significantly higher than remaining cultivars whereas least number of leaves was reported in cv. Jodhpur Red (20.66). Statistically higher number of leaves was recorded in the cuttings treated with IBA @ 5000 ppm (28.05) however, minimum number of leaves (20.31) was observed in control. The cultivars interacted significantly with IBA concentrations and cuttings of Kandhari Kabuli produced significantly maximum number of leaves (36.57) when treated with IBA @ 5000 ppm followed by same cultivar treated with IBA @ 4000 ppm (33.63) and minimum was recorded in Jodhpur Red (18.52) treated with water (0 ppm) i.e. control. The increase in number of leaves may be attributed to increased cell division and elongation at higher IBA concentrations and its possible reason for increase and activation of shoot growth which probably increased the number of nodes that lead to development of more number of leaves. Singh (2014) [12] and Seiar (2017) [10] also reported maximum number of leaves in cv. Ganesh with IBA @ 5000 ppm and in cv. Bhagwa with IBA 1000 ppm + NAA 1500 ppm, respectively.

In respect of leaf area cv. Kandhari Kabuli (25.56 cm^2) showed significantly superiority as compared to remaining cultivars whereas minimum leaf area was observed in cv. Jodhpur Red (18.75 cm^2) (Table 2). Maximum leaf area was noticed in cuttings treated with IBA @ 5000 ppm (25.76) followed by IBA @ 4000 ppm (23.72) however minimum leaf area (19.24) was recorded in control (19.24 cm^2). The interaction effect of cultivars and IBA concentrations showed that cuttings of cv. Kandhari Kabuli treated with IBA @ 5000 ppm (34.05 cm^2) registered maximum leaf area which was significantly higher among all the interactions. Minimum leaf area was recorded in cuttings of cv. Jodhpur Red when treated with 0 ppm (water) i.e. control (16.10 cm^2). Ismail and Asghar (2007) [5] reported that when the cuttings treated with increasing concentrations of IBA results in more number of roots which increased nutrient uptake and aerial growth of the plants resulted in highest leaf area. There is a need to improve the photosynthetic rate and to produce more photosynthates by expanding their leaves and hence more leaf area was observed (Shahab *et al*., 2013) [11].

Significant differences were observed among cultivars and IBA concentrations for leaf chlorophyll content (Fig. 2). Data presented in the figure depicts that cuttings of cv. Kandhari Kabuli (30.16) showed maximum chlorophyll content which was significantly higher than other cultivars whereas with respect to IBA concentration, significantly higher chlorophyll content was recorded when the cutting were treated with 5000 ppm IBA (28.84). Minimum chlorophyll content was recorded in cv. Jodhpur Red (19.20) and control (19.88) i.e. 0 ppm, respectively. Non-significant effect was observed between interaction studies between cultivars and IBA concentrations on chlorophyll content. The increased leaf area with increased concentrations of auxins might activate more photosynthates resulting in more chlorophyll content of leaves. Shahab *et al*. (2013) [11] observed that cuttings with more number of leaves enhanced nutrients uptake thereby increased the photosynthates production and provided sufficient food contents for the metabolic activities of the plants.

Data presented in Table 3 depicts the significant results for fresh and dry weight of shoots. Cuttings of cv. Nabha (7.65 g and 5.03 g) observed maximum fresh and dry weight of shoots which was statistically at par with Kandhari Kabuli (7.32 g and 4.97 g) for both fresh and dry weight, respectively. Minimum fresh and dry weight of shoots was recorded in cv. P-23 (4.82 g) and cv. Jodhpur Red (2.76 g), respectively. IBA concentrations significantly increased the fresh and dry weight of shoots. Maximum fresh and dry weight of shoots was registered when the cuttings were treated with IBA @ 5000 ppm (7.66 g and 5.13 g, respectively), while the minimum was recorded in control (4.59 g and 2.78 g, respectively). The interaction studies between cultivars and IBA concentrations on fresh and dry weight of shoots showed significant results. Maximum fresh weight of shoots was obtained in cuttings of cv. Nabha treated with IBA @ 5000 ppm (9.35 g) which was statistically at par with cv. Kandhari Kabuli (8.90 g) treated with IBA @ 5000 ppm and least was recorded in cuttings of cv. Jodhpur Red (3.50 g) i.e. control. The dry matter accumulation in shoots of cv. Nabha was maximum in IBA @ 5000 ppm (6.80 g) treated cuttings which was statistically at par with cv. Kandhari Kabuli cuttings treated with IBA @ 5000 ppm and cv. Nabha treated with 4000 ppm IBA (6.20 g) whereas least accumulation of dry matter was recorded in cuttings of cv. Jodhpur Red (2.18 g) treated with 0 ppm (water) i.e. control. Maximum fresh weight of shoots per cutting was probably due to increase in number of leaves and number of shoots per cutting. Hakim *et al*. (2018) [4] reported fresh weight of shoots (10.80 and 12.60 g) was maximum in both the cvs. Bhagwa and Ruby, respectively with the application of IBA 1500 ppm + NAA 1500 ppm + Biomix. Seiar (2017) [10] recorded highest fresh and dry weight of sprout (9.03 g and 4.66 g) per rooted cutting with IBA 1500 ppm + NAA 1000 ppm.

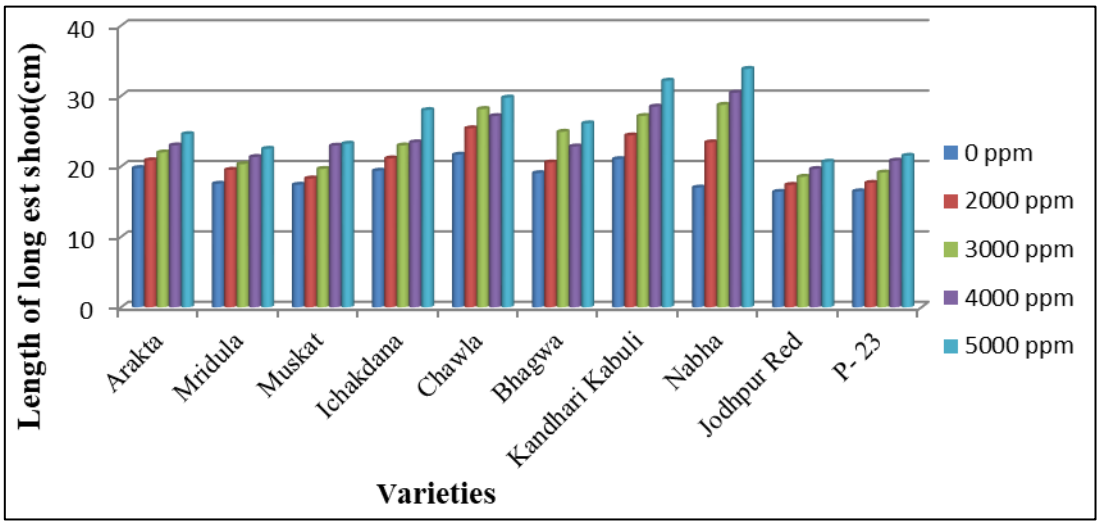

Fig 1: Effect of IBA on length of longest shoot per cutting (cm) of different varieties of pomegranate cuttings

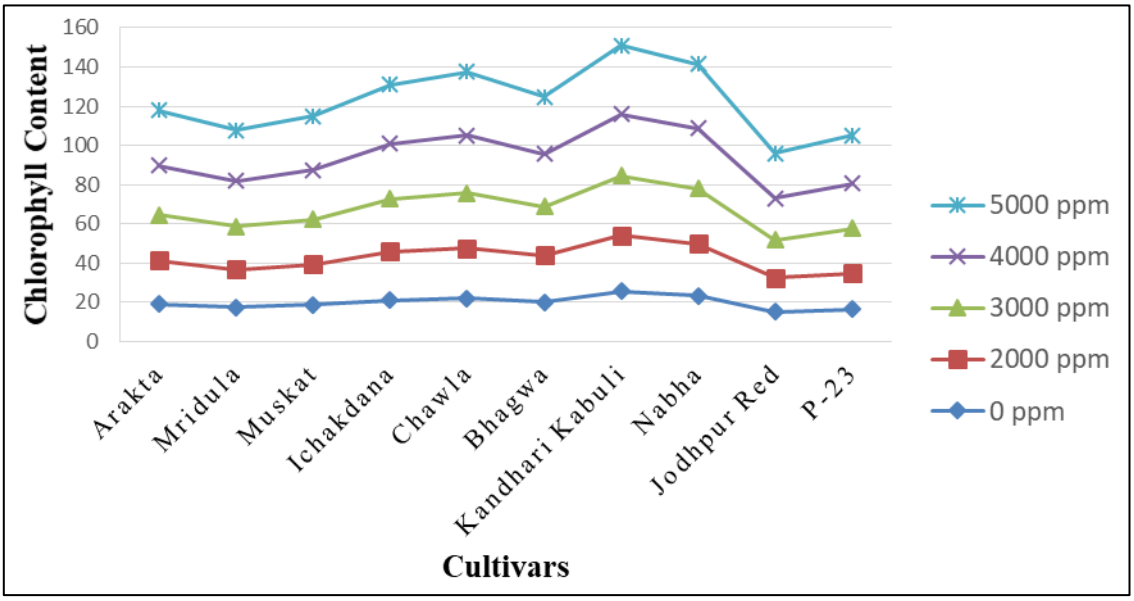

Fig 2: Effect of IBA on chlorophyll content of different varieties of pomegranate cuttings

Table 1: Effect of IBA on number of days taken for first sprouting and number of shoots/cutting of different varieties of pomegranate cuttings

Varieties	Number of days taken for first sprouting						Number of shoots per cutting					
	0 ppm (control)	2000 ppm	3000 ppm	4000 ppm	5000 ppm	Mean	0 ppm (control)	2000 ppm	3000 ppm	4000 ppm	5000 ppm	Mean
Arakta	15.80	13.19	12.28	12.03	10.30	12.72	1.36	1.83	2.16	2.19	2.58	2.02
Mridula	16.28	15.41	14.46	13.31	12.75	14.44	1.14	1.47	1.89	1.97	2.21	1.73
Muskat	15.08	14.06	13.16	12.46	11.02	13.16	1.26	1.44	1.77	1.95	2.36	1.75
Ichakdana	15.10	13.82	12.75	10.16	9.60	12.28	1.73	2.40	2.61	2.81	3.05	2.52
Chawla	12.52	12.30	8.14	7.82	7.46	9.65	1.52	2.32	2.58	2.78	3.52	2.54
Bhagwa	15.08	13.70	12.57	11.14	10.28	12.55	1.70	1.97	2.27	2.43	2.75	2.22
Kandhari Kabuli	13.17	13.07	10.13	9.91	9.04	11.07	1.92	2.48	2.84	3.03	4.13	2.88
Nabha	12.57	12.51	9.90	9.80	9.02	10.76	1.56	2.42	2.63	2.80	3.73	2.63
Jodhpur Red	20.67	19.65	19.19	18.02	17.42	18.99	1.08	1.47	1.63	1.63	1.98	1.56
P-23	19.61	18.40	17.51	16.63	15.01	17.43	1.30	1.37	1.50	1.71	2.10	1.59
Mean	15.59	14.61	13.01	12.13	11.19		1.45	1.91	2.18	2.33	2.84	
$CD_{0.05}$ Variety (V)			:	0.52					:	0.12		
IBA concentrations (C)			:	0.36					:	0.08		
V x C			:	1.16					:	0.27		

Table 2: Effect of IBA on number of leaves per cutting and leaf area of different varieties of pomegranate cuttings

Varieties	Number of leaves per cutting						Leaf area (cm^2)					
	0 ppm (control)	2000 ppm	3000 ppm	4000 ppm	5000 ppm	Mean	0 ppm (control)	2000 ppm	3000 ppm	4000 ppm	5000 ppm	Mean
Arakta	19.77	21.74	23.46	24.77	26.90	23.33	19.97	21.55	22.68	23.72	24.48	22.48
Mridula	19.09	21.60	23.32	24.80	25.62	22.89	18.46	20.24	21.00	21.99	22.87	20.91
Muskat	20.23	21.69	22.91	23.84	25.93	22.92	18.86	19.98	20.94	22.48	23.44	21.14
Ichakdana	19.49	22.78	26.00	27.05	28.57	24.78	20.24	22.05	24.32	25.40	26.73	23.75
Chawla	20.63	21.82	24.53	27.54	30.11	24.92	20.39	22.27	25.59	26.68	28.26	24.64
Bhagwa	20.03	23.01	24.95	25.97	27.69	24.33	19.24	20.67	23.47	24.43	25.83	22.73
Kandhari Kabuli	22.54	27.45	31.32	33.63	36.57	30.30	20.60	22.76	24.02	26.38	34.05	25.56
Nabha	23.29	25.02	25.86	26.91	31.31	26.47	21.04	24.27	24.72	25.51	29.24	24.95
Jodhpur Red	18.52	19.48	20.77	21.43	23.10	20.66	16.10	18.77	18.53	19.53	20.83	18.75
P-23	19.50	22.04	21.96	23.68	24.76	22.39	17.48	19.12	19.91	21.11	21.93	19.91
Mean	20.31	22.66	24.51	25.96	28.05		19.24	21.17	22.52	23.72	25.76	
$CD_{0.05}$ Variety (V)			:	0.69					:	0.76		
IBA concentrations (C)			:	0.49					:	0.53		
V x C			:	1.56					:	1.69		

Table 3: Effect of IBA on fresh weight of shoots and dry weight of shoots of different varieties of pomegranate cuttings

Varieties	Fresh weight of shoots (g)						Dry weight of shoots (g)					
	0 ppm (control)	2000 ppm	3000 ppm	4000 ppm	5000 ppm	Mean	0 ppm (control)	2000 ppm	3000 ppm	4000 ppm	5000 ppm	Mean
Arakta	4.60	5.40	6.40	6.56	7.20	6.03	3.10	3.60	4.19	4.50	4.98	4.07
Mridula	3.70	4.80	5.20	5.80	6.81	5.26	2.20	3.09	3.45	4.38	4.65	3.55
Muskat	3.90	4.29	5.50	5.69	7.10	5.29	2.67	3.62	4.15	4.43	4.79	3.93
Ichakdana	5.30	7.40	7.20	7.00	8.66	7.11	2.93	3.90	4.51	4.70	5.21	4.25
Chawla	5.19	6.60	7.29	8.29	8.73	7.22	2.57	3.80	4.21	5.50	6.03	4.42
Bhagwa	5.10	5.90	6.69	6.90	7.85	6.48	2.80	3.75	4.19	4.61	5.11	4.09
Kandhari Kabuli	5.00	6.72	7.50	8.50	8.90	7.32	3.75	4.20	4.54	5.98	6.40	4.97
Nabha	5.60	6.84	8.10	8.40	9.35	7.65	3.18	4.34	4.67	6.20	6.80	5.03
Jodhpur Red	3.50	4.59	5.38	5.58	5.86	4.98	2.18	2.64	2.75	2.97	3.26	2.76
P-23	4.00	4.11	4.41	5.38	6.20	4.82	2.43	2.87	3.19	3.41	4.11	3.20
Mean	4.59	5.66	6.36	6.81	7.66		2.78	3.58	3.98	4.66	5.13	
$CD_{0.05}$ Variety (V)			:	0.33					:	0.37		
IBA concentrations (C)			:	0.23					:	0.26		
V x C			:	0.74					:	0.82		

Conclusion

From the present experiment it is concluded that cv. Chawla performed better in sprouting, cv. Kandhari Kabuli registered maximum number of shoots per cutting, number of leaves per cutting, leaf area, chlorophyll content and cv. Nabha showed maximum length of longest shoot, fresh weight of shoots and dry weight of shoots after treated with IBA @ 5000 ppm.

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