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Effect of IBA concentration and cultivars on number of leaves, leaf area and chlorophyll content of leaf in Pomegranate (*Punica granatum* L.) cuttings under temperate conditions of Kashmir

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Abstract
Studies on the Influence of Indole Butyric Acid on total number of leaves, leaf area and total chlorophyll content per leaf of Pomegranate (*Punica granatum* L.) cuttings cvs. Chawla, Nabha and Kandhari Kabuli, Ichakdana, Bhagwa, Arakta, Muskat, Mridula, P- 23 and Jodhpur Red was conducted at the Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar campus, J& K. The experiment was laid out in randomized complete block design (RCBD) comprising of hardwood cuttings and different IBA concentrations (1000, 2000, 3000, 4000 ppm IBA and control), replicated thrice. Among all the cultivars, maximum values in terms of leaves (30.30 and 26.47), leaf area (25.56 and 24.95 cm^2) and chlorophyll per cutting (30.16 and 28.32) were recorded in the cvs. Kandhari Kabuli and Nabha, respectively as compared to control. The interaction of cultivar and growth regulator significantly affected the leaf number and leaf area per cutting. The interaction of cultivar and growth regulator significantly affected leaf number and leaf area per cutting. Number of leaves (36.57 and 31.31) and leaf area (34.05 and 29.24 cm^2) were recorded significantly maximum values in the cvs. Kandhari Kabuli and Nabha, respectively with IBA @ 5000 ppm as compared to control. For all the parameters IBA@ 5000 ppm performed better followed by 4000 and 3000 ppm and least was reported in control.

Keywords: Pomegranate, IBA, Chlorophyll, number of leaves.

Introduction
Pomegranate (*Punica granatum* L.) is one of the oldest known edible fruits and its major cultivation is confined in tropical and sub-tropical regions. It is popularly called as “Anar”. It belongs to genera Punica and family Punicaceae. It is a genus of large shrubs or small trees with 2 species. One is granatum and other is protopunica. The scientific name *Punica granatum* is derived from the name Pomum (apple), granatus (grainy or seeded apple). *Punica granatum*, is reported to contain 2n=16, 18 chromosomes. Pomegranate (*Punica granatum* L.) is an important subtropical fruit crop, belongs to family punicaceae. It is native to Iran, where it had been cultivated in about 2000 B.C. ago. India globally has the largest area of pomegranate cultivation and production (Jadhav and Sharma, 2007) [3]. Pomegranate is commercially propagated by cuttings. Multiplication of plants through stem cutting is the most convenient method and by this method a stronger plant can be developed considerably in less time.

The rooting capability of cuttings varies from cultivar, location, season and age of the branch. With the use of synthetic root promoting growth it is possible to improve rooting ability and success per cent therefore in order to improve rooting ability and success per cent, one technique has been improved in which synthetic root promoting growth regulator is used. Various types of growth regulators such as auxins, cytokinins, inhibitors and ethylene influence the root initiation. Among these auxins have the greatest effect on root formation in cuttings. IBA is a plant hormone in the auxin family and is an ingredient in many commercial

horticultural plant rooting products. IBA induce rooting in stem cuttings and in air layers due to their ability to achieve to active cambium regeneration, cell division and cell multiplication (Kaur *et al*, 2016, Singh et al. 2017a; Singh et al. 2017b; Singh et al. 2017c; Singh et al. 2018; Tiwari et al. 2018; Tiwari et al. 2019a; Tiwari et al. 2019b; Kour et al. 2019; Singh et al. 2019) [6, 10, 11, 12, 13, 14, 15, 16, 17, 18]. Chlorophylls are a dominant factor controlling leaf optical properties of healthy green vegetation and are thus an essential part of the photosynthetic process. They harness light energy from the sun to store it as chemical energy. Leaf area is an important variable for most ecophysiological studies in terrestrial ecosystems concerning light interception, evapotranspiration, photosynthetic efficiency, fertilizers, and irrigation response and plant growth

Material and Methods

This experiment was carried out at Shere e Kashmir University of Agriculture Science and Technology of Kashmir. The hard wood cuttings of ten pomegranate cultivars (Chawla, Nabha and Kandhari Kabuli, Ichakdana, Bhagwa, Arakta, Muskat, Mridula, P- 23 and Jodhpur Red) were procured from Regional Horticultural Research Station, Bajaura, Himachal Pradesh. Cuttings were taken 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. Root promoting chemical, IBA were used at five concentrations of 5000 ppm, 4000 ppm, 3000 ppm, 2000 ppm and 0 ppm (without IBA). The basal 5 cm portion of the cutting was dipped in growth regulator formulation for 30 seconds subsequently they were air dried for 15 minutes and planted in soil under open conditions. Cuttings were 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 at regular intervals for optimum moisture maintenance and weeds in the plots were removed. The cuttings were watered well prior to removal of cuttings from the soil to record the observations pertaining to roots and shoots. Cuttings (five number per treatment per replication) were labelled and carefully removed from the soil and dipped in water to remove the soil adhering to roots. The data was recorded at 90 days after planting. The experiment was carried out in open field conditions. Randomized Complete Block Design (RCBD) was used.

Number of leaves per cutting

The number of leaves per cutting was counted 90 days after planting and their mean was used to record this parameter.

Leaf area per cutting (cm^2)

Leaf area per sprouted cutting under each treatment and replication was measured with the help of leaf area meter and the mean leaf area was calculated.

Total chlorophyll per cutting (SPAD units)

It was measured with the help of handhold chlorophyll meter. It was observed at 90 days after planting of randomly selected cuttings in each treatment. One top leaf of every plant was inserted in the equipment, which gives the chlorophyll percentage present in the leaf. Each leaf was clamped in the chlorophyll meter for a fraction of second then chlorophyll meter gave the value in SPAD on the digital display of the screen. The value of chlorophyll index (SPAD) shows the relative distribution of chlorophyll in leaves.

Results and Discussion

1. Number of leaves per cutting

The number of leaves formed on the shoots of Kandhari Kabuli (30.30) cuttings were significantly higher than remaing cultivars. Least number of leaves were reported in cv. Jodhpur Red (20.66). IBA concentrations significantly increased the number of leaves throughout the study. The maximum number of leaves were found in cuttings treated with IBA 5000 ppm (28.05) and minimum number of leaves (20.31) were observed in control (Table:1).

There was a significant difference between individual factors and interaction on average number of leaves per cutting. The cultivars interacted significantly with IBA concentrations throughout the investigation. Cuttings of Kandhari Kabuli produced significantly maximum number of leaves (36.57) followed by same cultivar treated with IBA 4000 ppm (33.63) and least was recorded in Jodhpur Red (18.52) i.e. control. Maximum number of leaves were produced in cuttings of cv. Kandhari Kabuli treated with IBA 5000 ppm.

This might be due to activation of shoot growth which probably increased the number of nodes that leads to development of more number of leaves. IBA at 5000 ppm produced healthier, lengthy roots which helps in absorbtion of water and nutrients that have great influence on production of more number of leaves by the cuttings. These results are in accordance with findings of Singh (2014) [19], who obtained maximum number of leaves in cv. Ganesh with IBA 5000 ppm. The results are similar to the findings of Seiar (2017) [7], who obtained maximum number of leaves with IBA 1000 ppm + NAA 1500 ppm in cv. Bhagwa

2. Leaf area per cutting (cm^2)

In respect of leaf area cv. Kandhari Kabuli (25.56) showed significantly superior compared to remaining cultivars (Table: 2). Irrespective of cultivars, different concentrations of growth regulators significantly influenced leaf area per cutting. Maximum leaf area was noticed in cuttings treated with IBA 5000 ppm (25.76) followed by IBA 4000 ppm (23.72), IBA 3000 ppm (22.52), IBA 2000 ppm (21.17) and the least (19.24) was recorded in control.

The interaction effect of cultivars and IBA concentrations was significantly different on leaf area per cutting. In cv. Kandhari Kabuli, maximum leaf area was recorded with IBA 5000 ppm (34.05). The minimum leaf area per cutting was recorded in cuttings of Jodhpur Red (16.10). The cuttings of cv. Kandhari Kabuli treated with IBA 5000 ppm recorded the highest leaf area. Ismail and Asghar (2007) [2] 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. The present findings are similar to findings of Navjot and Kahlon (2002) [5], they obtained highest total leaf area (293.00 cm^2) per cutting in cv. Kandhari when middle cuttings were treated with 100 ppm IBA.

3. Total chlorophyll per cutting (SPAD units)

The data (Table: 3) indicated that there were significant differences among cultivars in total chlorophyll content per cutting. The cuttings of Kandhari Kabuli showed superior result (30.16) with respect to chlorophyll content per cutting

than remaing cultivars. Minimum chlorophyll content per cutting were reported in cv. Jodhpur Red (19.20). Regardless of cultivars, IBA 5000 ppm (28.84) exhibited enhanced performance in relation to chlorophyll content per cutting followed by IBA 4000 ppm (26.51), IBA 3000 ppm (24.77) and minimum was observed in (19.88) control. There was no significant interaction between cultivars and IBA concentrations on total leaf chlorophyll content per cutting.

The cuttings of cv. Kandhari Kabuli treated with IBA 5000 ppm recorded maximum total leaf chlorophyll content per cutting. The increased leaf area with increased concentrations of auxins might activated more photosynthates resulting in more chlorophyll content of leaves per cutting. Growth hormones have been shown to play an important role in regulating the amount and distribution of assimilates in plants (Galston and Davies, 1969) [1]. Sahab *et al*. (2013) [8] 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. The present results are in accordance with findings of Kumari (2014) [4] in pomegranate propagation in cv. Ganesh.

Table 1: Interaction effect of IBA concentrations and pomegranate varieties on number of leaves in pomegranate cuttings

Variety (V)	IBA Concentration (C)					
	0 ppm	2000 ppm	3000 ppm	4000 ppm	5000 ppm	Mean
Arakta	19.77	21.74	23.46	24.77	26.90	23.33
Mridula	19.09	21.60	23.32	24.80	25.62	22.89
Muskat	20.23	21.69	22.91	23.84	25.93	22.92
Ichakdana	19.49	22.78	26.00	27.05	28.57	24.78
Chawla	20.63	21.82	24.53	27.54	30.11	24.92
Bhagwa	20.03	23.01	24.95	25.97	27.69	24.33
Kandhari Kabuli	22.54	27.45	31.32	33.63	36.57	30.30
Nabha	23.29	25.02	25.86	26.91	31.31	26.47
Jodhpur Red	18.52	19.48	20.77	21.43	23.10	20.66
P- 23	19.50	22.04	21.96	23.68	24.76	22.39
Mean	20.31	22.66	24.51	25.96	28.05	

C.D ($p \leq 0.05$)
Variety (V) 0.69
IBA concentration (C) 0.49
V × C 1.56

Table 2: Interaction effect of IBA concentrations and pomegranate varieties on leaf area (cm^2) of pomegranate cuttings

Variety (V)	IBA Concentration (C)					
	0 ppm	2000 ppm	3000 ppm	4000 ppm	5000 ppm	Mean
Arakta	19.97	21.55	22.68	23.72	24.48	22.48
Mridula	18.46	20.24	21.00	21.99	22.87	20.91
Muskat	18.86	19.98	20.94	22.48	23.44	21.14
Ichakdana	20.24	22.05	24.32	25.40	26.73	23.75
Chawla	20.39	22.27	25.59	26.68	28.26	24.64
Bhagwa	19.24	20.67	23.47	24.43	25.83	22.73
Kandhari Kabuli	20.60	22.76	24.02	26.38	34.05	25.56
Nabha	21.04	24.27	24.72	25.51	29.24	24.95
Jodhpur Red	16.10	18.77	18.53	19.53	20.83	18.75
P- 23	17.48	19.12	19.91	21.11	21.93	19.91
Mean	19.24	21.17	22.52	23.72	25.76	

C.D ($p \leq 0.05$)
Variety (V) 0.76
IBA concentration (C) 0.53
V × C 1.69

Table 3: Interaction effect of IBA concentrations and pomegranate varieties on total chlorophyll content (SPAD units) per cutting.

Variety (V)	IBA Concentration (C)					
	0 ppm	2000 ppm	3000 ppm	4000 ppm	5000 ppm	Mean
Arakta	19.06	22.26	23.07	25.29	28.20	23.57
Mridula	17.35	19.44	21.84	23.20	25.79	21.52
Muskat	18.56	20.87	22.78	25.11	27.52	22.91
Ichakdana	21.02	25.00	26.56	28.43	30.13	26.23
Chawla	22.06	25.44	28.04	29.70	32.27	27.50
Bhagwa	20.15	23.86	24.69	26.83	29.30	24.96
Kandhari Kabuli	25.72	28.38	30.29	31.57	34.86	30.16
Nabha	23.44	26.42	28.20	30.63	32.90	28.32
Jodhpur Red	15.00	17.34	19.34	21.48	22.85	19.20
P- 23	16.44	18.21	22.95	22.90	24.56	21.01
Mean	19.88	22.72	24.77	26.51	28.84	

C.D ($p \leq 0.05$)
Variety (V) 1.37
IBA concentration (C) 0.96
V × C NS

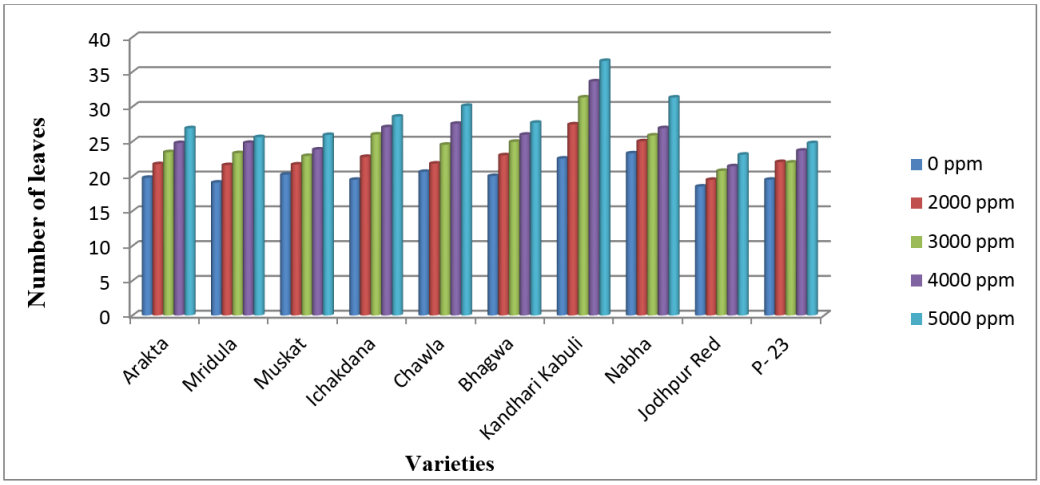

Fig 1: Interaction effect of IBA concentrations and pomegranate varieties on number of leaves in pomegranate cuttings

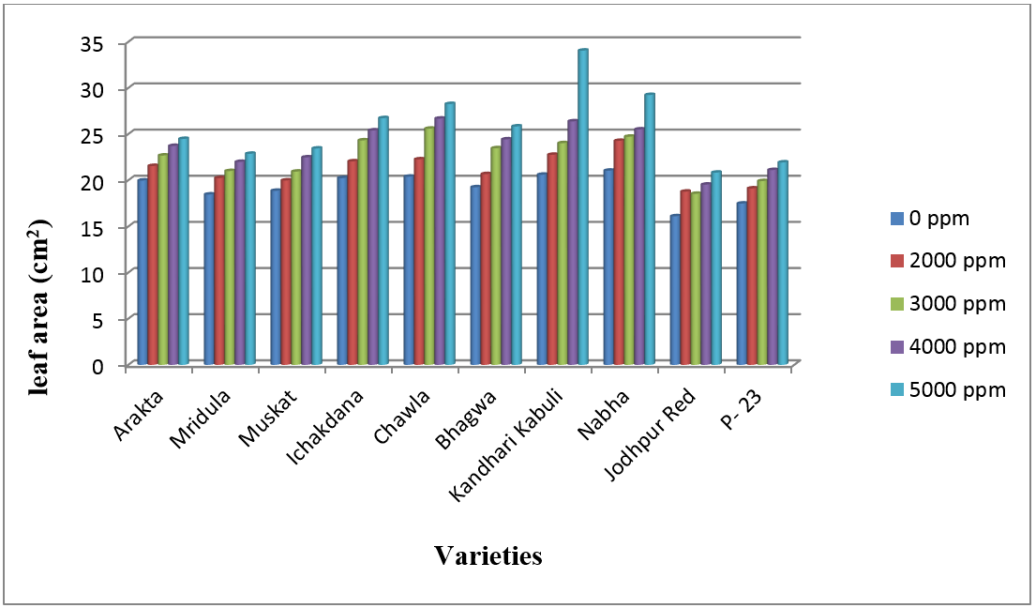

Fig 2: Interaction effect of IBA concentrations and pomegranate varieties on leaf area (cm^2) of pomegranate cuttings

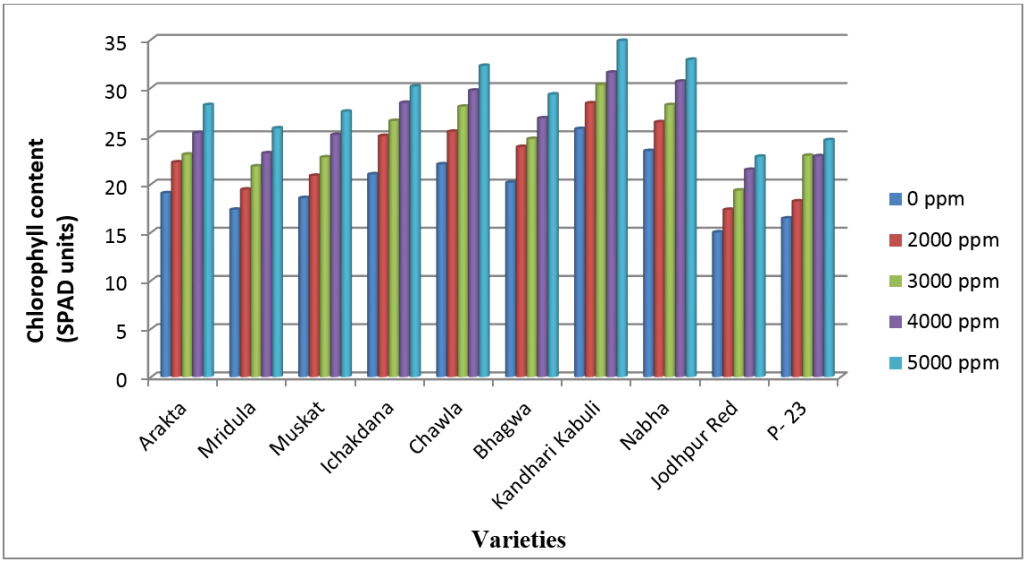

Fig 3: Interaction effect of IBA concentrations and pomegranate varieties on total chlorophyll content (SPAD units) per cutting

Summary and Conclusion

The shooting parameters namely, number of leaves, leaf area, chlorophyll per cutting were observed to be maximum in cuttings of Kandhari Kabuli, followed by Nabha, Chawla, Ichakadana, Bhagwa, Arkata, Muskat, Mridula, P-23, Jodhpur red. All these parameters were observed to be best in cuttings treated with IBA 5000 ppm followed by lower level of IBA 4000 ppm, 3000 ppm, 2000 ppm while the least was noticed

in untreated cuttings (control).Finally Kandhari Kabuli, Nabha and Chawla were found to be superior in number of leaves, leaf area and chlorophyll content per cutting in temperate conditions of Kashmir by treating the cuttings with 5000 ppm of IBA.

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