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## Effect of different rooting media, planting time and IBA treatment on shoot characters of pomegranate cuttings under open field conditions

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### Abstract

A field study on the effect of time of planting, IBA treatment and rooting media on plantlets survival and shoot characters was carried out in CCSHAU, Hisar during 2017. The experiment consisted of three treatment combinations, i.e. time of planting cuttings viz. February and March, Indole Butyric Acid (IBA) treatment viz. IBA @ 2000 ppm and without IBA and ten different rooting media. The results indicated that the cuttings planted in the month of February after giving IBA 2000 ppm treatment and planted in the media combination of cocopeat, perlite and vermicompost in ratio of 4:1:1 resulted in minimum number of days taken for sprouting (8.17). Also, the shoot parameters viz. number of sprouts per cutting (6.43, 8.16 and 10 after 30, 45 and 60 days of planting respectively), sprouted cutting percentage (82.6%), sprouted cutting survival percentage (100%), plant height (41.16 cm), stem diameter (11.58mm), number of leaves (203.3), shoot fresh weight (22.10g) and shoot dry weight (10.59g) significantly increased in cuttings planted in the month of February after giving IBA 2000 ppm treatment and planted in the media combination of cocopeat, perlite and vermicompost in ratio of 4:1:1.

**Keywords:** IBA, rooting media, cocopeat, perlite, vermicompost

### Introduction

Pomegranate (*Punica granatum* L.), belongs to the Lythraceae family, is one of the most popular nutritionally rich table fruits having unique colour, flavour, taste and medicinal properties. It can be propagated either sexually or vegetatively but the seedlings raised by seeds will have variations in progeny with respect to plant vigour, precocity and fruit quality, therefore, vegetative method of propagation is preferred for eliminating the high degree of variability and to ensure early bearing, transfer of good characters and genetic purity of a cultivar. Propagation through cuttings is simple, convenient, inexpensive and rapid, thus, best method for (Upadhyay and Badyal, 2007) [23] obtaining well developed and stronger plants in considerably less time. Hardwood cuttings are convenient to handle, store for longer time and need no special equipment during rooting. The success in multiplication of pomegranate and other fruit crops through stem cuttings depends upon many factors like condition of the mother plant, cutting type, time of operation, temperature, media and rooting hormones used (Polat and Caliskan, 2009) [23]. Among these, time of operation, rooting media and hormones play an important role in rooting of cuttings. Although the young developing leaves and shoots of pomegranate produce natural auxins but synthetic auxin is used to prevent failure of cuttings (Kasim and Rayya, 2009) [9]. Indole butyric acid (IBA) is important synthetic auxin to accelerate rooting success up to three folds (Melgareo *et al.*, 2008) [11], stimulate root initiation and to increase the number and quality of roots in cuttings of various fruit plants (Upadhyay and Badyal, 2007) [23]. Pomegranate can be grown in various types of soil but deep and alluvial soil is ideal for its cultivation. Due to difficulty in getting good top soil and low success rate of planting material in soil, the use of other soilless media is promoted. There is no universal or ideal medium for cuttings because the requirement depends on the species, types of cutting, season and propagation system (Hartmann *et al.*, 2002) [6]. The type of medium used is also critical to the rooting process since no single medium fulfills all the requirements, therefore, different combinations are developed. Along with rooting media and indole butyric acid, the planting time of cuttings also play important role in rooting and survival of pomegranate cuttings. The earlier planted cuttings sprouted early due higher accumulation of carbohydrates, as it succeeded dormant season as compared to late planted cuttings. The cuttings planted at end of February had higher rooting percentage than those planted at the beginning of October

(Hambrick *et al.*, 1991) [5]. Therefore, the present study was carried out to select the best rooting media, time of planting cuttings and optimal concentration of IBA.

**Materials and Methods**

**Geographical location and climate of experimental site**

The experiment was conducted at Centre for Quality Planting Material, CCS Haryana Agricultural University, Hisar, Haryana situated at 215.2 meter above sea level with coordinates of 29°10'N latitude and 75°46'E longitudes during the year 2017. Hisar has a semi-arid climate with hot dry summer and cold winters.

**Experimental details**

The hardwood cuttings of pomegranate cv. Bhagwa procured from the orchard of the Department of Horticulture, CCS Haryana Agricultural University, Hisar were planted in open field conditions during February and March with different combinations of rooting media *viz.* T<sub>1</sub>: Sand, T<sub>2</sub>: Cocopeat, T<sub>3</sub>: Cocopeat + sand (1:3), T<sub>4</sub>: Cocopeat + vermicompost (4:1), T<sub>5</sub>: Cocopeat + perlite + vermicompost (4:1:1), T<sub>6</sub>: Cocopeat + perlite + vermicompost (6:1:1), T<sub>7</sub>: Cocopeat + perlite + vermicompost (8:1:1), T<sub>8</sub>: Cocopeat + perlite + vermiculite (4:1:1), T<sub>9</sub>: Cocopeat + perlite + vermiculite (6:1:1), T<sub>10</sub>: Cocopeat + perlite + vermiculite (8:1:1).

**Growth regulator formulation**

The required concentration of indole butyric acid (IBA) 2000 ppm was prepared by dissolving 2 g IBA in small quantity of ethanol and final volume was made to 1000 ml using distilled water.

**Preparation and planting of cuttings**

One year old, healthy, disease free and mature branches of 7.5-10 mm thickness were selected for the preparation of cuttings. After removing the leaves completely, the cuttings of 20 cm in length with 5 to 6 buds were prepared for planting. Cuttings were freshly prepared on the day of planting and kept in water just after their preparation to maintain moisture

level up to planting time. Thereafter, the basal portion of half number of the cuttings was treated with a solution of IBA 2000 ppm for 2 minutes and remaining half of the cuttings was planted without IBA treatment. Immediately after the application of growth regulator, the cuttings were planted as per the treatment in poly bags containing rooting media.

**Parameters recorded**

The days taken for sprouting after planting were counted with the difference between date of planting of cuttings and the date on which the cuttings sprouted. The number of sprouts was recorded on each cutting 30, 45 and 60 days after planting. Percentage of sprouted cuttings was calculated by using following formula:

$$\text{Percentage of sprouted cuttings} = \frac{\text{Number of sprouted cuttings}}{\text{Total planted cuttings}} \times 100$$

The survival percentage was calculated by using following formula:

$$\text{Survival percentage of cuttings} = \frac{\text{Total survived cuttings}}{\text{Total sprouted cuttings}} \times 100$$

Plant height and stem diameter was measured 120 days after planting with the help of scale and Vernier calliper, respectively. Also, the number of leaves on the cuttings was counted 120 days after planting. Fresh weight of the shoot was taken 120 days after planting with the help of weighing balance. The shoots were dried in hot air oven at 55 °C until a constant weight was attained and then dry weight was taken on weighing balance.

**Statistical analysis**

The experiment was laid out in Factorial Complete Randomized Design. Each treatment was replicated six times. The effect of rooting media, planting time and IBA treatment and their interactions were determined on shoot characters of pomegranate cuttings using a three-way analysis of variance (ANOVA) as presented in table 1.

**Table 1:** Analysis of variance (*F* value) for the effects of planting time, rooting hormone and different media on shoot characters of pomegranate cuttings

Source	Degree of freedom	Mean sum of square										
		Sprouting characters						Shoot growth characters				
		Number of days to sprout	Number of sprouts at 30 DAP	Number of sprouts at 45 DAP	Number of sprouts at 60 DAP	Sprouted cutting percentage	Sprouted cutting survival percentage	Plant height (cm)	Stem diameter (mm)	No. of leaves	Shoot fresh weight (g)	Shoot dry weight (g)
Time of planting (T)	1	498.82**	48.06**	84.16**	73.65**	3054.41**	1177.74**	1559.19**	100.45**	24502.60**	267.50**	124.37**
IBA Treatment (G)	1	866.40**	119.82**	128.86**	130.82**	8213.23**	3110.79**	1719.51**	139.37**	14836.54**	535.50**	216.35**
Rooting media (M)	1	140.90**	231.33**	30.52**	40.60**	3362.85**	1200.00**	856.28**	14.05**	27071.013**	442.98**	92.17**
Interaction (TxM)	9	1.06	1.45**	0.19**	0.83**	7.17	3.28	0.003	0.23	172.04**	0.42	0.14
Interaction (GxM)	9	0.42	1.17**	0.29**	0.44**	35.90**	15.62**	0.003	0.29	98.20	0.16	0.24*
Interaction (TxG)	9	2.02	3.19**	2.04**	1.84**	314.28**	145.47**	40.82**	20.43**	37.60	0.009	16.81**
Interaction (TxGxM)	9	1.11	0.23**	0.63**	0.33**	14.74	6.08	0.02	0.29	37.89	0.300	0.05
Error												
Total												

Significance values: \**p* < 0.05; \*\**p* < 0.01

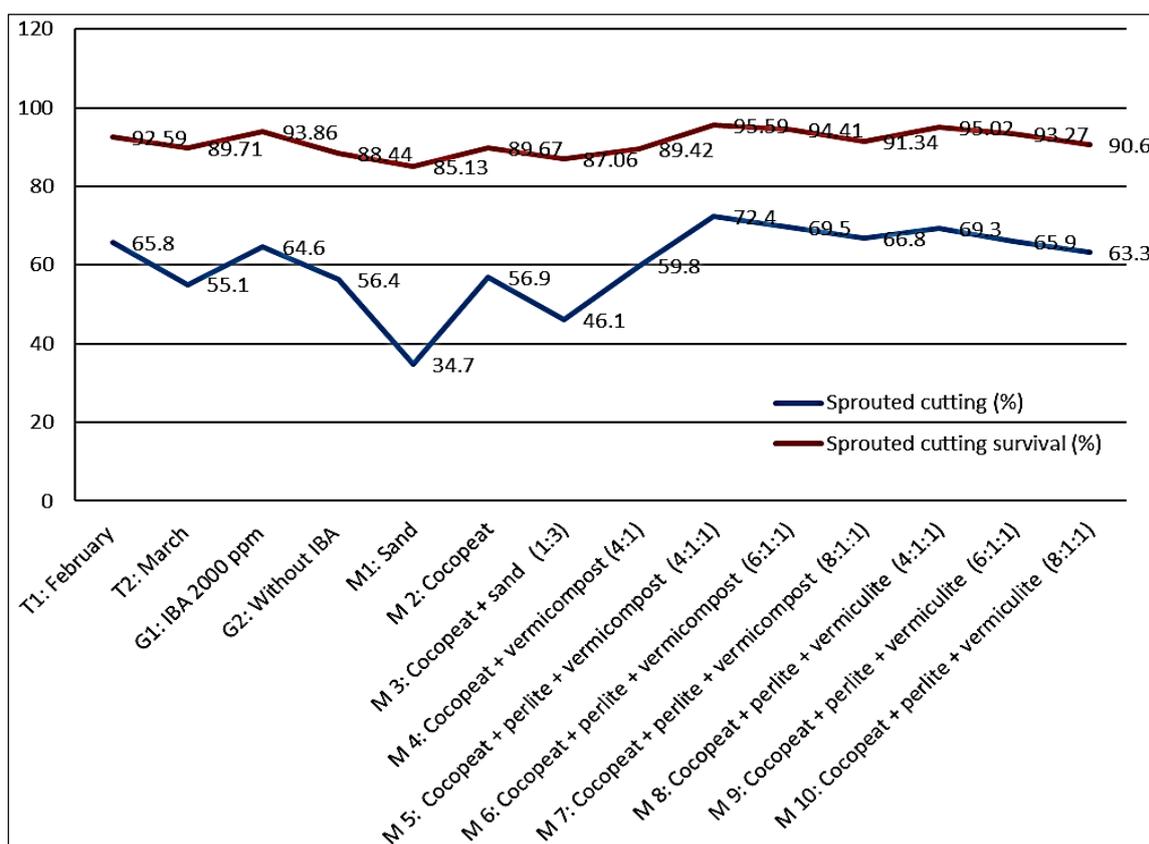
**Results**

The results revealed that time of planting cuttings, IBA treatment and different growing media significantly

influenced the shoot parameters of pomegranate cv. Bhagwa cuttings (Table 1 and 2 and Fig 1 and 2).

**Table 1:** Effect of time of planting, IBA treatment and rooting media on number of days taken for sprouting, number of sprouts, sprouted and survival percentage of pomegranate

Treatments	Days taken to sprout	No. of sprouts at 30 DAP	No. of sprouts at 45 DAP	No. of sprouts at 60 DAP
<b>Time of Planting</b>				
February (T <sub>1</sub> )	13.21	3.58	5.42	6.75
March (T <sub>2</sub> )	16.09	2.69	4.24	5.65
C.D. (P=0.05)	0.52	0.05	0.07	0.09
<b>IBA Treatment</b>				
IBA 2000 ppm (G <sub>1</sub> )	12.75	3.84	5.56	6.94
Without IBA (G <sub>2</sub> )	16.55	2.43	4.24	5.46
C.D. (P=0.05)	0.52	0.05	0.07	0.09
<b>Rooting Media</b>				
M <sub>1</sub> : Sand	19.71	1.54	3.29	4.58
M <sub>2</sub> : Cocopeat	15.17	2.33	3.96	5.29
M <sub>3</sub> : Cocopeat + sand (1:3)	17.71	2.08	3.66	4.62
M <sub>4</sub> : Cocopeat + vermicompost (4:1)	14.88	2.66	4.12	5.37
M <sub>5</sub> : Cocopeat + perlite + vermicompost (4:1:1)	12.04	4.81	6.66	8.20
M <sub>6</sub> : Cocopeat + perlite + vermicompost (6:1:1)	12.88	4.00	5.66	7.33
M <sub>7</sub> : Cocopeat + perlite + vermicompost (8:1:1)	13.88	3.20	5.03	6.12
M <sub>8</sub> : Cocopeat + perlite + vermiculite (4:1:1)	12.38	4.24	6.25	7.87
M <sub>9</sub> : Cocopeat + perlite + vermiculite (6:1:1)	13.29	3.62	5.24	6.79
M <sub>10</sub> : Cocopeat + perlite + vermiculite (8:1:1)	14.58	2.87	4.42	5.83
C.D. (0.05)	1.15	0.10	0.15	0.19

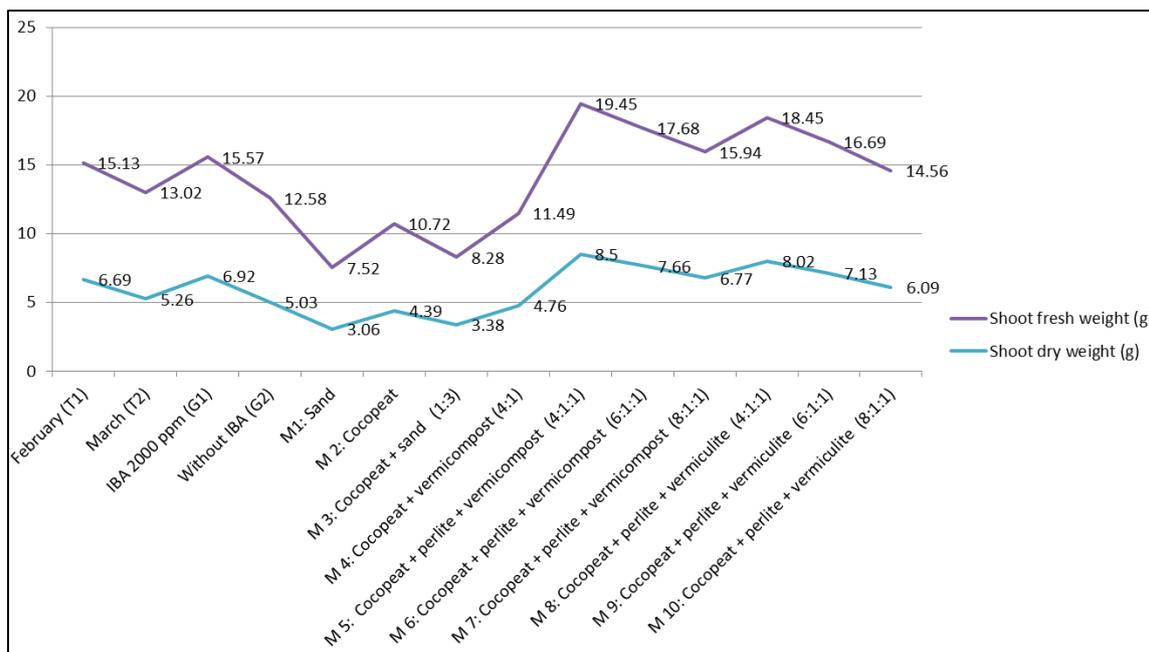


**Fig 1:** Effect of time of planting, IBA treatment and rooting media on sprouted and survival percentage of pomegranate

**Table 2:** Effect of time of planting, IBA treatment and rooting media on plant height, stem diameter, no. of leaves of pomegranate

Treatments	Plant height (cm)	Stem diameter (mm)	No. of leaves
<b>Time of Planting</b>			
February (T <sub>1</sub> )	30.90	8.70	145.28
March (T <sub>2</sub> )	25.80	7.41	129.56
C.D. (P=0.05)	0.40	0.30	1.91
<b>IBA Treatment</b>			
IBA 2000 ppm (G <sub>1</sub> )	31.03	8.82	147.52
Without IBA (G <sub>2</sub> )	25.67	7.29	127.32
C.D. (P=0.05)	0.40	0.30	1.91

Rooting Media			
M <sub>1</sub> : Sand	19.02	6.87	92.79
M <sub>2</sub> : Cocopeat	22.54	7.47	104.46
M <sub>3</sub> : Cocopeat + sand (1:3)	21.21	7.21	99.29
M <sub>4</sub> : Cocopeat + vermicompost (4:1)	25.03	7.55	107.17
M <sub>5</sub> : Cocopeat + perlite + vermicompost (4:1:1)	35.51	9.29	181.54
M <sub>6</sub> : Cocopeat + perlite + vermicompost (6:1:1)	34.20	8.57	165.17
M <sub>7</sub> : Cocopeat + perlite + vermicompost (8:1:1)	30.52	8.52	145.79
M <sub>8</sub> : Cocopeat + perlite + vermiculite (4:1:1)	34.20	8.81	176.17
M <sub>9</sub> : Cocopeat + perlite + vermiculite (6:1:1)	31.96	8.43	156.54
M <sub>10</sub> : Cocopeat + perlite + vermiculite (8:1:1)	29.31	8.06	145.29
C.D. (P=0.05)	0.90	0.68	4.27



**Fig 2:** Effect of time of planting, IBA treatment and rooting media on shoot fresh and dry weight of pomegranate

**Effect of time of planting on shoot characters**

The cuttings planted in the month of February recorded minimum number of days for sprouting (13.21), maximum number of sprouts (3.58, 5.42 and 6.75) after 30, 45 and 60 days of planting respectively, sprouting percentage (65.8%) and survival percentage (92.59%) when as compared to those planted in March. Also, increased plant height (30.90 cm), stem diameter (8.70mm), number of leaves (145.28), fresh weight of shoot (15.13g) and shoot dry weight (6.69g) was recorded in the cuttings planted during February.

**Effect of IBA treatment on shoot characters**

The cuttings treated with IBA 2000 ppm sprouted in minimum number of days (12.75), recorded maximum number of sprouts (3.84, 5.56 and 6.94) after 30, 45 and 60 days of planting, respectively, sprouting percentage (64.60%), survival percentage (93.86%), enhanced height (31.03cm), stem diameter (8.82mm), number of leaves (147.52), shoot fresh weight (15.57g) and shoot dry weight (6.92g) in comparison to untreated cuttings.

**Effect of rooting media on shoot characters**

The minimum number of days for sprouting (12.04), highest number of sprouts (4.81, 6.66 and 8.20) 30, 45 and 60 days after planting respectively, maximum sprouted cuttings percentage (72.4%), percentage of sprouted cuttings survival (95.59%), plant height (35.51 cm), stem diameter (9.29mm), number of leaves (181.54), fresh weight of shoot (19.45g) and

shoot dry weight (8.50g) was registered with media combination of cocopeat, perlite and vermicompost in ratio of 4:1:1, whereas, the maximum number of days (19.71) for sprouting, lowest number of sprouts (1.54, 3.29 and 4.58) 30, 45 and 60 days after planting, minimum sprouted cutting percentage (34.7%), percentage of sprouted cuttings survival (85.13%), height (19.02cm), stem diameter (6.87mm), number of leaves (92.79), fresh weight of shoot (7.52g) and shoot dry weight (3.06g) was recorded under cuttings planted in sand medium.

**Combined effect of time of planting and rooting media on shoot characters**

The combined effect of time of planting and rooting media significantly enhanced the shoot parameters in terms of number of sprouts 30, 45 and 60 days after planting and sprouting percentage. However, the shoot parameters viz. number of days taken for sprouting, survival percentage of sprouted cuttings, plant height, stem diameter, number of leaves, shoot fresh and dry weight were not affected significantly by the interaction effect of time of planting and rooting media (Table 3 and 4). The cuttings planted in the media combination of cocopeat, perlite and vermicompost in ratio of 4:1:1 in the month of February recorded maximum number of sprouts (5.29, 7.16 and 8.92) after 30, 45 and 60 days of planting, respectively and highest sprouting percentage (78.60%).

**Table 3:** Interaction effect of time of planting and rooting media (T x M) on number of days taken for sprouting, number of sprouts, sprouted and survival percentage of pomegranate

Treatments	Days taken to sprout	No. of sprouts at 30 DAP	No. of sprouts at 45 DAP	No. of sprouts at 60 DAP	Sprouted cutting (%)	Sprouted cutting survival (%)
T <sub>1</sub> M <sub>1</sub>	18.08	1.66	3.74	4.91	38.9 (38.4)	86.32
T <sub>1</sub> M <sub>2</sub>	13.83	2.49	4.58	5.83	59.6 (50.5)	90.47
T <sub>1</sub> M <sub>3</sub>	16.42	2.41	4.24	5.00	51.4 (44.6)	88.21
T <sub>1</sub> M <sub>4</sub>	13.75	2.99	4.83	5.74	64.0 (53.2)	91.01
T <sub>1</sub> M <sub>5</sub>	10.33	5.29	7.16	8.92	78.6 (60.9)	96.98
T <sub>1</sub> M <sub>6</sub>	11.33	4.74	6.24	7.99	75.3 (58.7)	96.32
T <sub>1</sub> M <sub>7</sub>	12.67	3.49	5.58	6.83	73.2 (57.4)	92.96
T <sub>1</sub> M <sub>8</sub>	10.67	5.08	7.00	8.75	74.8 (59.4)	96.78
T <sub>1</sub> M <sub>9</sub>	11.75	4.33	5.83	7.16	72.2 (56.3)	94.61
T <sub>1</sub> M <sub>10</sub>	13.25	3.33	5.00	6.41	69.3 (55.0)	92.26
T <sub>2</sub> M <sub>1</sub>	21.33	1.41	2.83	4.24	30.6 (33.4)	83.95
T <sub>2</sub> M <sub>2</sub>	16.50	2.16	3.33	4.75	54.1 (47.4)	88.88
T <sub>2</sub> M <sub>3</sub>	19.00	1.75	3.08	4.24	40.7 (40.8)	85.90
T <sub>2</sub> M <sub>4</sub>	16.00	2.33	3.41	4.99	55.7 (48.3)	87.83
T <sub>2</sub> M <sub>5</sub>	13.75	4.33	6.16	7.50	66.3 (56.3)	94.21
T <sub>2</sub> M <sub>6</sub>	14.42	3.25	5.08	6.66	63.1 (54.5)	92.49
T <sub>2</sub> M <sub>7</sub>	15.08	2.91	4.49	5.41	60.1 (52.6)	89.73
T <sub>2</sub> M <sub>8</sub>	14.08	3.41	5.49	6.99	63.6 (53.7)	93.25
T <sub>2</sub> M <sub>9</sub>	14.83	2.91	4.66	6.41	59.7 (52.5)	91.92
T <sub>2</sub> M <sub>10</sub>	15.92	2.41	3.83	5.24	57.3 (50.6)	88.94
C.D. (0.05)	NS	0.14	0.22	0.27	2.7	NS

**Table 4:** Interaction effect of time of planting and rooting media (T x M) on plant height, stem diameter, no. of leaves, shoot fresh and dry weight of pomegranate

Treatments	Plant height (cm)	Stem diameter (mm)	No. of leaves	Shoot fresh weight (g)	Shoot dry weight (g)
T <sub>1</sub> M <sub>1</sub>	21.57	7.42	98.25	8.47	3.64
T <sub>1</sub> M <sub>2</sub>	25.07	8.06	110.33	11.78	5.09
T <sub>1</sub> M <sub>3</sub>	23.74	7.78	105.58	9.31	4.03
T <sub>1</sub> M <sub>4</sub>	27.57	8.08	113.33	12.59	5.44
T <sub>1</sub> M <sub>5</sub>	38.07	10.05	191.08	20.46	9.25
T <sub>1</sub> M <sub>6</sub>	36.74	9.31	174.3	18.59	8.37
T <sub>1</sub> M <sub>7</sub>	33.07	9.48	153.08	17.07	7.57
T <sub>1</sub> M <sub>8</sub>	36.74	9.38	186.5	19.43	8.77
T <sub>1</sub> M <sub>9</sub>	34.51	9.1	164.25	17.71	7.87
T <sub>1</sub> M <sub>10</sub>	31.91	8.85	156.08	15.95	6.93
T <sub>2</sub> M <sub>1</sub>	16.48	6.33	87.33	6.57	2.48
T <sub>2</sub> M <sub>2</sub>	20.01	6.88	98.58	9.67	3.7
T <sub>2</sub> M <sub>3</sub>	18.67	6.64	93	7.25	2.73
T <sub>2</sub> M <sub>4</sub>	22.49	7.02	101	10.39	4.08
T <sub>2</sub> M <sub>5</sub>	32.95	8.53	172	18.44	7.75
T <sub>2</sub> M <sub>6</sub>	31.66	7.82	156	16.77	6.95
T <sub>2</sub> M <sub>7</sub>	27.97	7.56	138.5	14.81	5.97
T <sub>2</sub> M <sub>8</sub>	31.66	8.25	165.83	17.47	7.26
T <sub>2</sub> M <sub>9</sub>	29.41	7.76	148.83	15.69	6.39
T <sub>2</sub> M <sub>10</sub>	26.7	7.27	134.5	13.18	5.25
C.D. (0.05)	NS	NS	NS	NS	NS

**Combined effect of IBA treatment and rooting media on shoot characters**

Interaction between IBA treatment and rooting media did not significantly influenced the shoot characters except number of sprouts per cutting and percentage of sprouted cuttings as presented in Table 5 and 6. Maximum number of sprouts

(5.63, 7.41 and 9.00) after 30, 45 and 60 days of planting, respectively and higher sprouting percentage (75.90%) was observed in the pomegranate cuttings planted in media combination of cocopeat, perlite and vermicompost in ratio of 4:1:1 after IBA treatment at the concentration of 2000 ppm.

**Table 5:** Interaction effect of IBA treatment and rooting media (G x M) on number of days taken for sprouting, number of sprouts, sprouted and survival percentage of pomegranate

Treatments	Days taken to sprout	No. of sprouts at 30 DAP	No. of sprouts at 45 DAP	No. of sprouts at 60 DAP	Sprouted cutting (%)	Sprouted cutting survival (%)
G <sub>1</sub> M <sub>1</sub>	17.58	1.99	3.83	5.24	42.9 (40.9)	88.32
G <sub>1</sub> M <sub>2</sub>	13.50	2.91	4.83	6.17	60.7 (51.2)	92.08
G <sub>1</sub> M <sub>3</sub>	15.83	2.41	4.24	5.08	49.4 (45.8)	89.19
G <sub>1</sub> M <sub>4</sub>	13.00	3.33	4.91	6.08	64.1 (53.2)	92.56
G <sub>1</sub> M <sub>5</sub>	10.25	5.63	7.41	9.00	75.9 (63.6)	98.42
G <sub>1</sub> M <sub>6</sub>	10.83	4.91	6.49	8.08	72.7 (60.7)	97.05
G <sub>1</sub> M <sub>7</sub>	11.92	3.91	5.74	6.83	70.6 (59.0)	94.13
G <sub>1</sub> M <sub>8</sub>	10.58	5.16	7.08	8.83	73.6 (60.2)	98.08
G <sub>1</sub> M <sub>9</sub>	11.33	4.66	5.99	7.58	68.9 (58.3)	95.74
G <sub>1</sub> M <sub>10</sub>	12.67	3.50	5.08	6.94	66.9 (56.4)	93
G <sub>2</sub> M <sub>1</sub>	21.83	1.08	2.74	3.91	26.6 (31.0)	81.95
G <sub>2</sub> M <sub>2</sub>	16.83	1.75	3.08	4.41	53.1 (46.7)	87.27
G <sub>2</sub> M <sub>3</sub>	19.58	1.75	3.08	4.16	42.8 (39.6)	84.93
G <sub>2</sub> M <sub>4</sub>	16.75	1.99	3.33	4.66	55.6 (48.2)	86.28
G <sub>2</sub> M <sub>5</sub>	13.83	4.00	5.91	7.42	69.0 (54.5)	92.76
G <sub>2</sub> M <sub>6</sub>	14.92	3.08	4.83	6.58	66.2 (52.6)	91.77
G <sub>2</sub> M <sub>7</sub>	15.83	2.49	4.33	5.41	63.1 (51.0)	88.56
G <sub>2</sub> M <sub>8</sub>	14.17	3.33	5.42	6.91	64.9 (52.9)	91.95
G <sub>2</sub> M <sub>9</sub>	15.25	2.58	4.49	5.99	62.9 (50.6)	90.79
G <sub>2</sub> M <sub>10</sub>	16.50	2.24	3.75	5.16	59.7 (49.2)	88.2
C.D. (0.05)	NS	0.14	0.22	0.27	2.7	NS

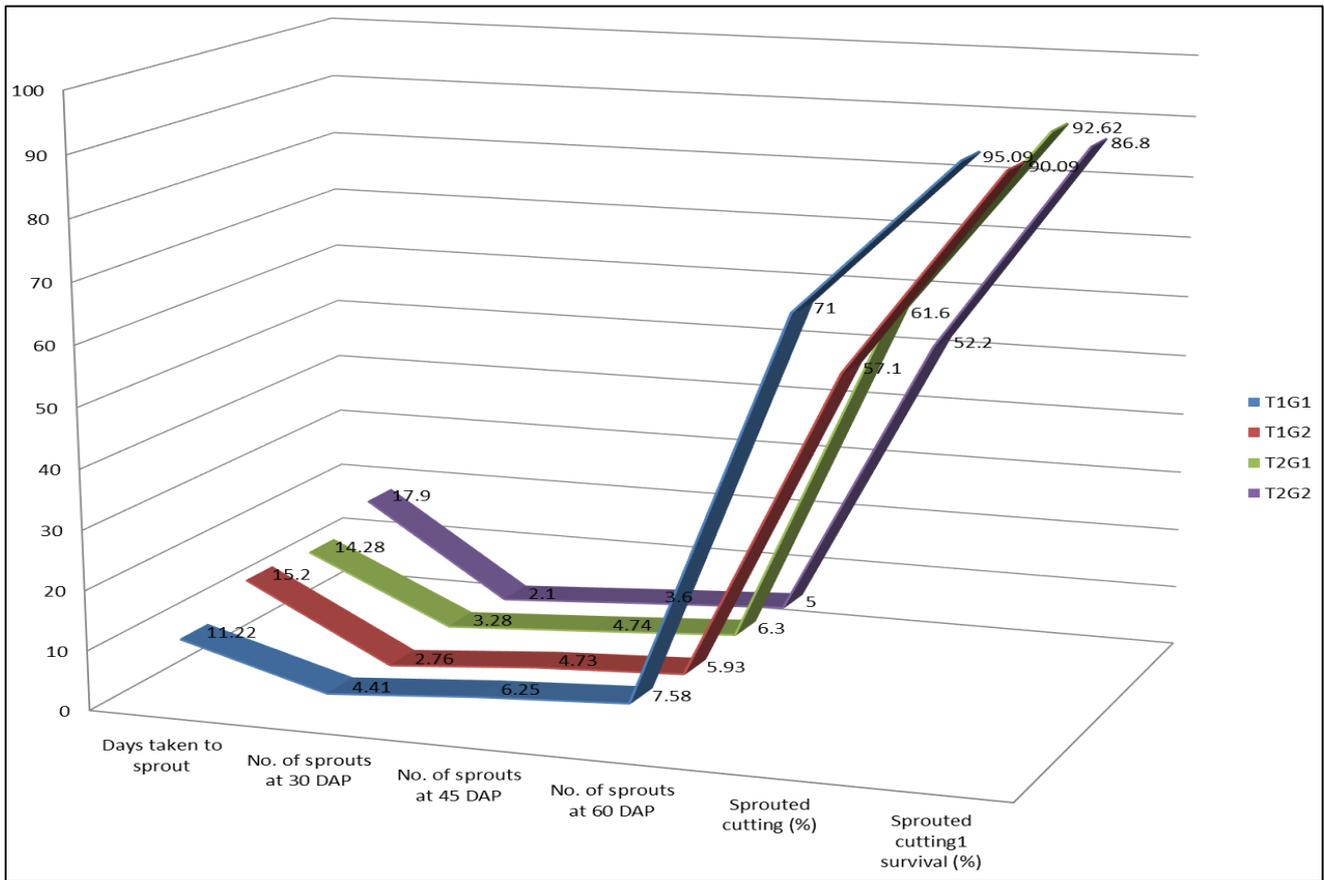
**Table 6:** Interaction effect of IBA treatment and rooting media (G x M) on plant height, stem diameter, no. of leaves, shoot fresh and dry weight of pomegranate

Treatments	Plant height (cm)	Stem diameter (mm)	No. of leaves	Shoot fresh weight (g)	Shoot dry weight (g)
G <sub>1</sub> M <sub>1</sub>	21.7	7.57	98.58	8.83	3.81
G <sub>1</sub> M <sub>2</sub>	25.22	8.21	116.17	12.22	5.33
G <sub>1</sub> M <sub>3</sub>	23.87	7.82	107.42	9.73	4.21
G <sub>1</sub> M <sub>4</sub>	27.7	8.26	116.67	12.98	5.68
G <sub>1</sub> M <sub>5</sub>	38.18	10.29	192.75	21.06	9.55
G <sub>1</sub> M <sub>6</sub>	36.87	9.38	177.25	19.15	8.69
G <sub>1</sub> M <sub>7</sub>	33.19	9.04	158.17	17.53	7.81
G <sub>1</sub> M <sub>8</sub>	36.87	9.47	190.42	19.93	9.02
G <sub>1</sub> M <sub>9</sub>	34.63	9.2	167.33	18.23	8.16
G <sub>1</sub> M <sub>10</sub>	32.04	8.9	152.5	16.07	7.01
G <sub>2</sub> M <sub>1</sub>	16.35	6.17	87	6.2	2.32
G <sub>2</sub> M <sub>2</sub>	19.87	6.73	94.75	9.23	3.46
G <sub>2</sub> M <sub>3</sub>	18.54	6.6	91.17	6.83	2.54
G <sub>2</sub> M <sub>4</sub>	22.36	6.84	97.67	10.01	3.84
G <sub>2</sub> M <sub>5</sub>	32.84	8.29	170.33	17.83	7.45
G <sub>2</sub> M <sub>6</sub>	31.53	7.76	153.08	16.21	6.63
G <sub>2</sub> M <sub>7</sub>	27.85	7.51	133.42	14.34	5.73
G <sub>2</sub> M <sub>8</sub>	31.53	8.15	161.92	16.97	7.02
G <sub>2</sub> M <sub>9</sub>	29.29	7.66	145.75	15.17	6.1
G <sub>2</sub> M <sub>10</sub>	26.57	7.23	138.08	13.06	5.17
C.D. (0.05)	NS	NS	NS	NS	NS

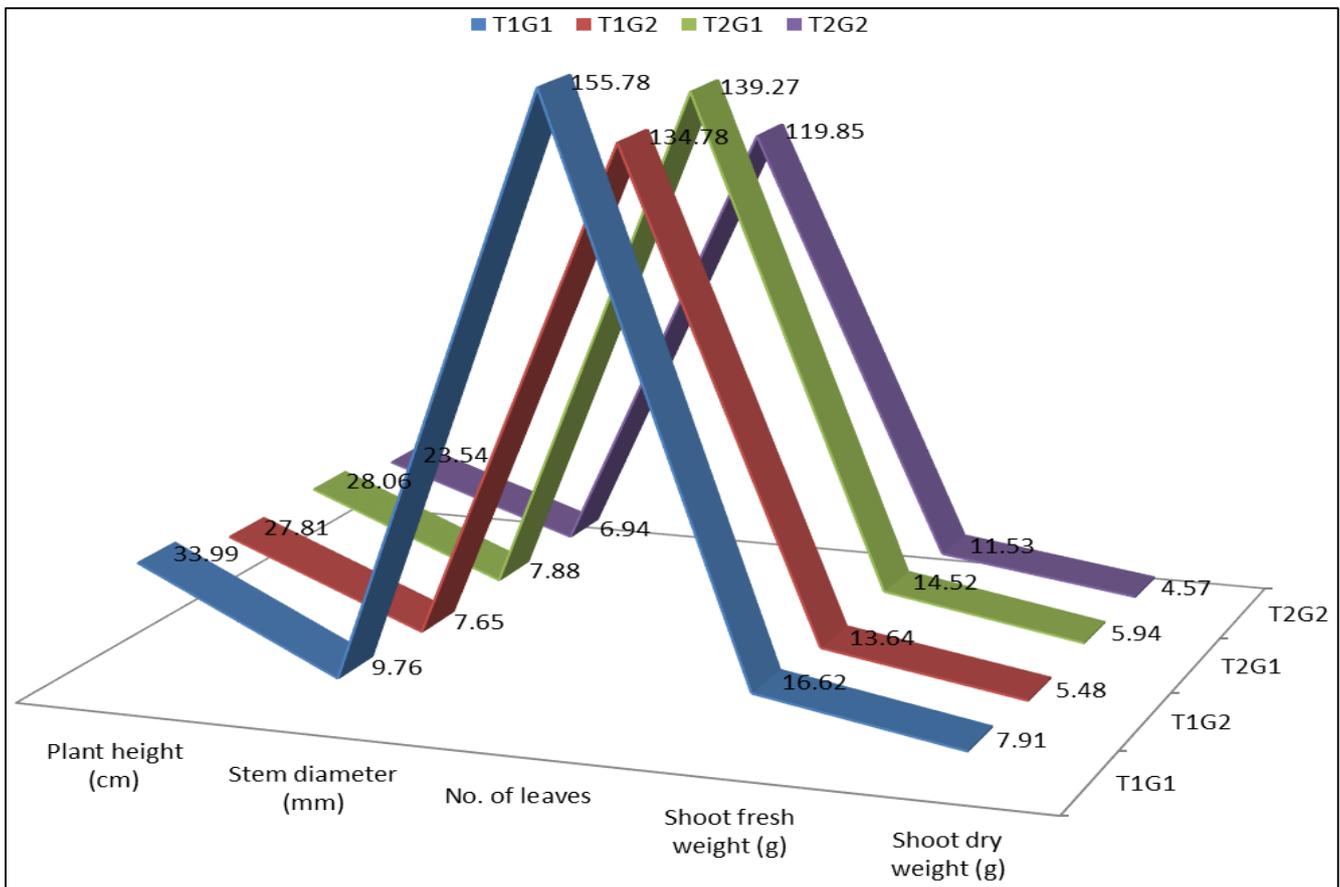
**Combined effect of time of planting and IBA treatment on shoot characters**

The shoot characters *viz.* number of sprouts per cutting, sprouted cuttings percentage, height, diameter and dry weight were significantly influenced by the interaction effect between time of planting and IBA treatment (Fig 3 and 4).

Maximum number of sprouts per cutting (4.41, 6.25 and 7.58) after 30, 45 and 60 days of planting, respectively, sprouted cutting percentage (71.00%), plant height (33.99cm), diameter (9.76mm) and shoot dry weight (7.91g) was recorded in the cuttings planted during February after IBA treatment.



**Fig 3:** Interaction effect of time of planting and IBA treatment (T x G) on number of days taken for sprouting, number of sprouts, sprouted and survival percentage of pomegranate



**Fig 4:** Interaction effect of time of planting and IBA treatment (T x G) on plant height, stem diameter, no. of leaves, shoot fresh and dry weight of pomegranate

### Combined effect of time of planting, IBA treatment and rooting media on shoot characters

The combined effect of time of planting, IBA treatment and rooting media did not affected the shoot parameters except number of sprouts per cutting. Highest number of sprouts (6.43, 8.16 and 10.00) after 30, 45 and 60 days of planting was found in the cuttings treated with IBA 2000 ppm and planted in the cocopeat, perlite and vermicompost media (4:1:1) in February month.

### Discussion

The improvement in shoot parameters of cuttings planted in February month might be due to better ecological conditions. The early sprouting of pomegranate cuttings might be attributed to the fact that exogenous application of auxin promoted growth and produced more favorable conditions for sprouting of dormant buds on cuttings (Hartmann *et al.*, 2002)<sup>[6]</sup>. The higher number of sprouts per cutting with optimum IBA treatments might be due to better root growth, which augmented absorption and translocation of nutrients from medium to the shoots, which might have taken active part in various plant metabolic processes (Singh, 2001; Pilet, 1977)<sup>[20]</sup>. Also, it might be associated with cell division stimulation by auxin at sprout union (Hakim *et al.*, 2018)<sup>[4]</sup>. The probable cause of increased shoot length might be the better utilization of carbohydrates, nitrogen and other nutrients, which had been aided by growth regulators (Babaie *et al.*, 2014)<sup>[1]</sup>. The increase in diameter might be due to higher cell activity and the synthesis of more food material through a process of photosynthesis (Kamboj *et al.*, 2017)<sup>[8]</sup>. The probable reason for an increase in fresh and dry weight of shoot might be the better utilization of carbohydrates, nitrogen and other nutrients, aided by growth regulators (Hakim *et al.*, 2018)<sup>[4]</sup>. The more fresh weight of shoots per cutting might also be due to an increase in number of leaves, length of shoots and number of shoots per cutting (Swathi, 2013)<sup>[22]</sup>. These results are in accordance with the findings of Singh and Lal (1985)<sup>[21]</sup> who reported that hard wood stem cuttings of rose treated with auxin took less number of days for sprouting and Upadhyay and Badyal (2007)<sup>[23]</sup> who reported maximum survival percentage of pomegranate cuttings and their height when applied IBA 2000 ppm as compared to control, Panwar *et al.* (2001)<sup>[12]</sup> who observed maximum plant height under different IBA concentrations.

Schie (1999)<sup>[19]</sup> reported that the cocopeat is an organic material with medium ion absorption capacity since it has aerial porosity and better capacity of water and nutrients maintenance (Por-Hossein *et al.*, 2009)<sup>[16]</sup>; (Firoozabadi *et al.*, 2009)<sup>[3]</sup>. Cocopeat has the capacity to supply nutrients to pomegranate cuttings for longer period (Raut *et al.*, 2015)<sup>[17]</sup>. Because of excellent water retention property, the cuttings in cocopeat medium requires less water, therefore, it helps in avoiding loss of nutrients through leaching (Yahya *et al.*, 2009)<sup>[24]</sup>. Perlite is considered as a substrate with excellent features in soilless cultivation since it has higher water absorption capacity and increased water efficiency (Djedidi *et al.*, 1999)<sup>[2]</sup>. Better results in favour of vermicompost as potting medium might be due to its high moisture retention capacity and hormone induced activity associated with high levels of humic acids and humates in vermicompost rather than boosted by high levels of plant available nutrients (Kumar *et al.*, 2016)<sup>[10]</sup>. This was also indicated by several workers that vermicompost contains growth promoting hormone (auxins and cytokinins) and flowering hormone

(gibberellins) secreted by earthworms. Rumble *et al.* (1996)<sup>[18]</sup> who observed that plant height, stem diameter and number of leaves of tomato were higher in soilless culture than in field soil and Hassan *et al.* (2011)<sup>[7]</sup> who observed the highest number of leaves and plant height in cocopeat medium and the lowest in control (soil cultivation).

### Conclusion

Based on the above findings it was concluded that shoot characters of pomegranate cuttings could be improved by planting the cuttings in media combination of cocopeat, perlite and vermicompost in ratio of 4:1:1 after treating with IBA at 2000 ppm during February. Thus, propagation of pomegranate through cuttings could be done more precisely by selecting right time for the operation, optimal rooting hormone concentration and appropriate rooting media combination.

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