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Flowering response of mutants of dahlia (*Dahlia variabilis* L.) cultivars to different concentration of IBA and NAA

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Abstract
Effect of rooting hormones (IBA and NAA) on propagation of mutants of Dahlia cultivar Kenya Blue and Kenya Yellow was investigated to evaluate response of rooting hormones in flowering characters. Plants treated with IBA @ 500 ppm perform great in days taken for first bud appearance, number of days taken to full bloom, flower diameter, number of ray floret flower^{-1}, and longevity of flower and duration of flowering. IBA @ 1000 gave better result flower stalk diameter, number of flower plant^{-1} and flower weight. However, the number of days taken for flower opening and flower stalk length was best in IBA @ 250 ppm + NAA @ 250 ppm. Mutants of cultivar Kenya Blue gave superior result in most of the flowering character like days taken to first bud appearance, flower diameter, number of ray floret, longevity of flower and flower weight whereas, mutants of Kenya Yellow perform best in other floral characters.

Keywords: Rooting, hormone, mutants, propagation, IBA, NAA, bloom, flowering, cultivar

Introduction
Dahlia (*Dahlia variabilis* L.) is a famous tuberous-rooted perennial herbaceous flowering plant that is prized for its beautiful, magnificent blossoms. This plant is grown for its lovely ornamental blooms in a variety of colours for garden beautification, cut flowers, and as a loose flower in many parts of the world. It is a member of the Asteraceae family. Dahlia is a plant that originated in Mexico and was named by Cavanilles in 1791 to honour the work of Swedish botanist Dr. Andreas Dahl, a student of Linneaus (Smith, 1971) [17]. The Agri-Horticultural Society of India (previously the Royal Agri-Horticultural Society of India) first brought dahlia to India in 1857. The Netherlands produces the most tuberous-rooted dahlias. The commercial cultivation of dahlias in India is limited to the Eastern Indian hills and plains. Dahlias are grown for a variety of reasons and utilised in a variety of settings. The production of dahlia in the country has increased in recent years particularly due to the development of propagation techniques that has set new demands on, rooting hormones as well. Rooting hormones are natural or manufactured substances that influence the physiological processes of plants, modifying their growth and development and thereby enhancing crop output (Kakimoto, 2003) [7]. Auxin is well known to stimulate the rooting of cuttings (Hartmann *et al*., 2002) [6]. The most widely used auxin for commercial rooting is IBA (Nickel, 1990) [13]. Today, IBA and NAA are still the most widely used auxins for rooting stem cuttings and for rooting tissue-culture-produced micro cuttings (Zimmerman and Wilcoxon, 1935) [20]. Although the use of different doses of IBA and NAA is encouraged in the modern production system of dahlia and also helpful in altering various growth characteristics but their unjudicial use can threaten the environment and effect the consumer acceptability. The standardization and specification of rooting hormones, suitable auxin type and their usage in optimum dosage for specific crop will enhance their acceptability by the growers as well as consumers. Keeping in view the above truth, the present study was conducted to scrutinize the most suitable dose of rooting hormone for growth and flower production of mutants of Dahlia (*Dahlia variabilis* L.)

Material and Method
The present investigation entitled Flowering response of mutants of Dahlia (*Dahlia variabilis* L.) to different concentration of IBA and NAA was carried out at Horticultural Research cum Instructional Farm, Department of Floriculture and Landscape Architecture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.), during 2019-20. In the experiment 8-9 cm long

cuttings with 3-4 pairs of leaves were obtained from terminal (tip) portions of healthy plants of mutants of two dahlia cultivar *viz*. Kenya Blue and Kenya Yellow were treated with two auxins, namely IBA and NAA, each at 250, 500 and 1000 ppm individually and their combinations each at 125, 250 and 500 ppm, along with control (distilled water), were used.. The basal portion of cuttings was dipped in the respective auxins for a few seconds while the Control was dipped in distilled water. Treated cuttings were planted in planted in portrays having 9×11 cells. Temperature was maintained at 18-25°C, and relative humidity at 80-85% within the mist chamber. After the rooting seedlings were planted in pots to make three replications with five pots each and arranged under Factorial Completely Randomized Design (FCRD) under open field conditions. Water soluble fertilizers *viz* nitrogen (4.5 g/l), P2O5 (6 g/l) and K2O (1.5 g/l) were applied manually to each treatment at fortnightly intervals starting from a month after planting. Different flowering characters were analyzed. Days taken to first bud appearance was recorded by counting the number of days from the date of planting to the stage at which the first flower bud was initiated in each cultivar. The number of days taken for floral bud opening and number of days taken for full bloom was recorded from the date of transplanting. For flower diameter, flowers was measured at the point of maximum breadth at the full bloom stage by using Vernier calipers. The number of ray florets flower^{-1} head was counted in each plant at full bloom stage. Flower stalk length was taken from the origin of that stalk to the neck of the flower of main stem using measuring scale whereas flower stalk diameter was measured in full bloom stage using Vernier calipers. The longevity of flower was measure from the day of the opening of flower to fading in the plant, meanwhile duration of flowering was calculated from the first flowering to the last flowering in a plant. The number of flowers produced in the tagged plants was recorded and the average number of flowers produced plant^{-1} was worked out and fresh weight of 3 flowers plant^{-1} (5 plants/treatment) were recorded in grams in the experimental plot with digital balance and then averaged. All parameters were subjected to Analysis of Variance (ANOVA) to determine the level of significance of the treatments on the mutants of different cultivars of dahlia.

Result and Discussions

1. Days taken for first bud appearance

The data presented in Table 1 reveals that rooting hormones, mutants of cultivar and their interactions had significant effect on days taken for first bud appearance. Untreated plants reported significantly maximum days taken for first bud appearance (99.03 days), however, treatment IBA @ 500 ppm took minimum days for first bud appearance (5.99 days). Significantly, minimum number of days taken for first bud appearance was recorded in mutants of cultivar Kenya Blue (87.19 days). Untreated plants of mutants of Kenya Yellow took significantly maximum days (101.90) for first bud appearance, whereas interaction of mutants of Kenya Blue treated with IBA 250 ppm + NAA 250 ppm took minimum (73.72) days, which was *at par* with interaction of treatment IBA @ 500 ppm and the same mutants of cultivar (74.50 days). This might be due to increase in cell elongation and rapid mobilization and accumulation of metabolites, which properly influences the floral morphogenesis, which rendered the early flowering. The results of this study are in close conformity with Bharmal *et al*. (2005) [3] in chrysanthemum and Haider *et al*. (2006) [5] in rose.

2. Number of days taken for flower opening

It is apparent from the data presented in Table 1 and graphically represented in Fig. 2. The effect of rooting hormones, mutants of cultivars and their interaction on number of days taken for flower opening was highly significant, treatment IBA @ 250 ppm + NAA @ 250 ppm took significantly least number of days for flower opening (10.63 days), whereas, a significant delay in flower opening was recorded in untreated plants (19.21 days). Plants of mutants of cultivar Kenya Blue took significantly maximum number of days (14.56) for the opening of flower. The untreated plants of mutants of cultivar Kenya Blue took significantly maximum number of days for flower opening (19.99 days) whereas, plants of mutants of cultivar Kenya Yellow treated with IBA @ 250 ppm + NAA @ 250 ppm took significantly least number of days taken for flower opening (9.33 days), which was at par with IBA @ 500 ppm (10.27 days). Earliness in flower opening by the combination of both NAA and IBA, leading to the early transformation of vegetative to reproductive phase shows a relation in earliness to flower opening (Zimmerman and Wilcoxon, 1935) [20]. This result has been unequivocally demonstrated by Dawa *et al*. (2017) in rose and Ullah *et al*. (2013) [19] in marigold.

3. Number of days taken for full bloom

The observation (Table 1) clearly indicates that the treatment of IBA @ 500 ppm induced significantly earliness in full blooming by taking only 4.99 days. Among the mutants of cultivar, minimum days required for full bloom was observed in plants of mutants of cultivar Kenya Yellow (8.14 days), which was *at par* with mutants of other one Kenya Blue i.e. 8.35 days. Significantly, plants of mutants of Kenya Yellow treated with IBA @ 500 ppm (4.25 days) required minimum days. However, untreated plants of mutants of cultivar Kenya Blue took maximum days (13.21) which was at par with untreated plants of mutants of another cultivar Kenya Yellow (12.87 days). The delay in late flower initiation ultimately resulted in full bloom, which may be due to reduction in the rate of various physiological processes and inhibition of plant growth. These results are in conformity with work of Susaj *et al*. (2012) [18] in rose and Ranipise *et al*. (2004) chrysanthemum.

4. Flower diameter (cm)

It is evident from the data presented in Table 1 that highly significant differences for this parameter were recorded, plants treated with IBA @ 500 ppm had largest flower size (18.05 cm) which was *at par* with treatment of IBA @ 1000 ppm i.e. 17.81 cm. However, the untreated plants had smallest diameter (12.96 cm). Mutants of cultivar Kenya Blue exhibited significantly maximum diameter of flower (15.66 cm) which was higher than the rest one. A critical rummages of data revealed that the plants of mutants of cultivar Kenya Blue treated with IBA @ 500 ppm exhibited significantly largest flower (18.95 cm), which was *at par* with interaction of treatment of IBA @ 1000 ppm with mutants of same cultivar (18.87 cm). However, the smallest diameter of flower (10.56 cm) was recorded in mutants of cultivar Kenya Yellow treated with IBA @ 250 ppm. The higher diameter might be due to increase in cell elongation and rapid mobilization and accumulation of metabolites that properly influences the floral morphogenesis rendered the bigger size of the flowers. The results regarding diameter of the flowers are in agreement with Gupta and Datta, (2000) in chrysanthemum,

Shivangowda (2000) in china aster and Anil (2004) [2] in French marigold.

5. Number of ray floret flower^{-1}

The data presented in Table 2 envisages that rooting hormones and mutants of cultivars had significant effect but their interaction had non-significant on number of ray floret flower-1. Among the treatments, significantly maximum number of ray floret flower^{-1} (146) was recorded in plants treated with IBA @ 500 ppm, which was statistically *at par* with IBA @ 1000 ppm (140.17). However, minimum number of ray floret flower-1 (115.50) recorded at treatment IBA @ 500 ppm + NAA @ 500 ppm, which was at par with treatment NAA @ 250 ppm, NAA @ 500 ppm and IBA @ 250 ppm (116, 119.25 and 123.08, respectively). These results are in conformity with findings of Girisha *et al.* (2012) in daisy and Ranipise *et al.* (2004) in chrysanthemum.

6. Flower stalk diameter (cm)

The data recorded for flower stalk diameter have been presented in Table 2 revealed that the effect of rooting hormones, mutants of cultivars and their interaction on flower stalk diameter was highly significant. The maximum flower stalk diameter (5.61 cm) was recorded in treatment IBA @ 1000 ppm, which was significantly higher than the rest of the rooting hormone treatments. Whereas, minimum flower stalk diameter (2.59 cm) was recorded at control. Plants of mutants of cultivar Kenya Yellow had significantly maximum flower stalk diameter 4.23 cm. However, untreated plants of mutants of cultivar Kenya Blue exhibited significantly minimum flower stalk diameter 2.38 cm, whereas, maximum flower stalk diameter (6.22 cm) was recorded in interaction of mutants of Kenya Yellow treated with IBA @ 1000 ppm. Flower stalk diameter increased in mutants of both cultivars with increased dose of rooting hormones. These results are in conformity with the work of Akhtar *et al.* (2002) and Nasri *et al.* (2015) [1, 12] in rose.

7. Flower stalk length (cm)

The perusal of the data presented in Table 2 depicts that the effect of rooting hormones, mutants of cultivar and their interaction was highly significant. Whereas, untreated plants resulted significantly shortest flower stalk (27.63 cm), while, longest flower stalk was recorded in plants treated with IBA @ 250 ppm + NAA @ 250 ppm (44.23 cm). Flower stalk length of mutants of cultivar Kenya Yellow was longest (38.47 cm) but untreated plants of mutants of cultivar Kenya Yellow had shortest flower stalk (25.39 cm). However, the plants of mutants of cultivar treated with NAA @ 500 ppm exhibited significantly longest flower stalk length (51.83 cm). These results are in parallel line with the findings of Ranipise *et al.* (2012), who recorded increase in flower stalk length with increase in dose of rooting hormones in chrysanthemum.

8. Longevity of flower (days)

The data pertaining to longevity of flower in days presented in Table 2 and Fig. 4, which influenced by mutants of two dahlia cultivar and different concentrations of rooting hormones but their interactions were non-significant. Irrespective of mutants of cultivars, untreated plants had lowest longevity (5.60 days), which was statistically at par with treatment IBA @ 125 ppm + NAA @ 125 ppm (5.95 days). However, significantly maximum longevity of flower was recorded in IBA @ 500 ppm (7.63 days), which was *at par* with treatment IBA @ 1000 ppm (7.45 days). Among the mutants of cultivars, plants of mutants of Kenya Blue had recorded significantly maximum longevity of flower (6.89 days), whereas, minimum longevity of flower was recorded in mutants of Kenya Yellow (6.32 days). The highest longevity of flower might be due to rapid mobilization and accumulation of metabolites by IBA, which properly influences the floral morphogenesis, rendered the longevity of flower. The result regarding longevity of flower are in agreement with the results of Kumar *et al.* (2014) [9] in carnation and Khuriwal *et al.* (2018) [8] in dahlia.

9. Number of flower plant^{-1}

The data presented in Table 3 envisages that rooting hormones, mutants of cultivars and their interactions had significant effect on number of flower plant^{-1}. Among the treatments, IBA @ 1000 ppm recorded significantly maximum number of flower plant^{-1} (9.53), which was significantly higher than the other treatment while untreated plants recorded minimum number of flower plant^{-1} (4.63). Cultivar Kenya Yellow had significantly maximum number of flower plant^{-1} (7.71), which was significantly higher than the other one. Whereas, plants of mutants of Kenya Yellow treated with IBA @ 1000 ppm recorded significantly maximum number of flower plant^{-1} (10.38). The number of flowers plant^{-1} was closely correlated with number of branches plant^{-1}. The results of this study is in close conformity with the findings of Anil (2004) [2] in French marigold.

10. Flower weight plant^{-1} (g)

It is evident from the data presented in Table 3 that the effect of rooting hormones, mutants of cultivar of dahlia and their interactions on flower weight plant^{-1} was significant, whereas, untreated plants exhibited minimum weight of flower plant^{-1} (14.66 g), however, treatment IBA @ 1000 ppm resulted significantly maximum flower weight (34.91 g). Irrespective of rooting hormones, plants of mutants of cultivar Kenya Blue had significantly maximum flower weight (32.83 g), which was significantly higher as compared to the mutants of cultivar Kenya Yellow (20.44 g). Untreated plants of mutants of cultivar Kenya Yellow resulted in minimum weight of flower plant^{-1} (10.74 g), whereas, plants of mutants of cultivar Kenya Blue treated with IBA @ 1000 ppm resulted significantly maximum flower weight (47.93 g). This may have attributed to availability of higher photosynthesis towards the sink i.e. flowers due to increased photosynthetic surface area and photosynthetic activity in leaves due to increase in chlorophyll content leaves. The results are in agreement with Khuriwal *et al.* (2018) [8] in dahlia, Bharmal *et al.* (2005) [3] in chrysanthemum and Ullah *et al.* (2013) [19] in marigold.

Table 1: Effect of rooting hormones in days taken for first bud appearance, number of days taken for flower opening, number of days taken for full bloom and flower diameter (cm) in dahlia mutants

Cultivar / Rooting hormones	Days taken for first bud appearance			Number of days taken for flower opening			Number of days taken for full bloom			Flower diameter (cm)		
	Kenya Blue	Kenya Yellow	Mean	Kenya Blue	Kenya Yellow	Mean	Kenya Blue	Kenya Yellow	Mean	Kenya Blue	Kenya Yellow	Mean
Control	96.17	101.90	99.03	19.99	18.43	19.21	13.21	12.87	13.04	13.55	12.36	12.96
IBA @ 250 ppm	91.80	87.43	89.62	14.65	12.67	13.66	8.69	7.44	8.06	15.86	10.56	13.21
IBA @ 500 ppm	74.50	77.48	75.99	12.67	10.27	11.47	5.74	4.25	4.99	18.95	17.16	18.05
IBA @ 1000 ppm	77.37	82.21	79.79	13.10	12.47	12.78	7.68	9.09	8.38	18.87	16.75	17.81
NAA @ 250 ppm	93.33	93.23	93.28	13.83	17.22	15.53	6.93	7.56	7.24	13.37	13.53	13.45
NAA @ 500 ppm	86.83	79.00	82.92	12.67	14.78	13.72	4.98	6.26	5.62	15.84	15.68	15.76
NAA @ 1000 ppm	93.67	95.27	94.47	14.50	15.07	14.78	9.29	9.63	9.46	14.41	15.40	14.91
IBA @ 125 ppm + NAA @ 125 ppm	96.27	95.85	96.06	18.00	14.33	16.17	11.72	9.47	10.60	16.45	15.50	15.98
IBA @ 250 ppm + NAA @ 250 ppm	73.72	85.49	79.60	9.33	11.92	10.63	6.41	7.37	6.89	15.93	14.14	15.03
IBA @ 500 ppm + NAA @ 500 ppm	88.20	90.87	89.53	16.83	13.83	15.33	8.90	7.43	8.17	13.33	13.05	13.19
Mean	87.19	88.87		14.56	14.10		8.35	8.14		15.66	14.41	
	CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±	
Rooting hormone	2.106	0.737		0.699	0.244		0.478	0.167		0.832	0.291	
Cultivar	0.942	0.330		0.312	0.109		0.214	0.075		0.372	0.130	
Rooting hormone × Cultivar	2.978	1.042		0.988	0.346		0.676	0.237		1.177	0.412	

Table 2: Effect of rooting hormones in number of ray floret flower^{-1}, flower stalk diameter (cm), flower stalk length (cm) and longevity of flower (days) in dahlia mutants

Cultivar / Rooting hormones	Number of ray floret flower^{-1}			Flower stalk diameter (cm)			Flower stalk length (cm)			Longevity of flower (days)		
	Kenya Blue	Kenya Yellow	Mean	Kenya Blue	Kenya Yellow	Mean	Kenya Blue	Kenya Yellow	Mean	Kenya Blue	Kenya Yellow	Mean
Control	134.67	125.50	130.08	2.38	2.80	2.59	29.86	25.39	27.63	5.79	5.41	5.60
IBA @ 250 ppm	129.33	116.83	123.08	3.73	3.43	3.58	33.66	32.92	33.29	6.01	6.42	6.22
IBA @ 500 ppm	148.67	143.33	146.00	4.75	5.11	4.93	34.18	36.52	35.35	7.99	7.26	7.63
IBA @ 1000 ppm	143.33	137.00	140.17	5.00	6.22	5.61	36.14	39.63	37.89	8.10	6.80	7.45
NAA @ 250 ppm	128.83	103.17	116.00	2.75	3.17	2.96	36.48	45.91	41.19	6.78	5.82	6.30
NAA @ 500 ppm	122.00	116.50	119.25	5.16	4.85	5.01	34.11	51.83	42.97	7.08	6.58	6.83
NAA @ 1000 ppm	124.00	131.67	127.83	3.51	4.61	4.06	48.10	36.96	42.53	7.05	6.10	6.57
IBA @ 125 ppm + NAA @ 125 ppm	132.33	130.33	131.33	4.27	3.07	3.67	36.44	39.22	37.83	5.99	5.90	5.95
IBA @ 250 ppm + NAA @ 250 ppm	137.83	126.67	132.25	4.65	4.70	4.68	43.82	44.64	44.23	7.19	6.74	6.97
IBA @ 500 ppm + NAA @ 500 ppm	119.83	111.17	115.50	4.70	4.37	4.53	35.03	31.66	33.35	6.90	6.19	6.54
Mean	132.08	124.22		4.09	4.23		36.78	38.47		6.89	6.32	
	CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±	
Rooting hormone	8.311	2.908		0.234	0.082		0.961	0.336		0.478	0.167	
Cultivar	3.717	1.300		0.105	0.037		0.430	0.150		0.214	0.075	
Rooting hormone × Cultivar	NS	4.112		0.331	0.116		1.358	0.475		NS	0.236	

Table 3: Effect of rooting hormones in number of flower plant^{-1}, flower weight plant^{-1} (g) and duration of flowering (days) in dahlia mutants

Cultivar / Rooting hormones	Number of flower plant^{-1}			Flower weight plant^{-1} (g)			Duration of flowering (days)		
	Kenya Blue	Kenya Yellow	Mean	Kenya Blue	Kenya Yellow	Mean	Kenya Blue	Kenya Yellow	Mean
Control	3.92	5.34	4.63	18.58	10.74	14.66	40.61	44.89	42.75
IBA @ 250 ppm	3.98	7.92	5.95	32.14	21.57	26.85	45.49	51.15	48.32
IBA @ 500 ppm	6.45	8.72	7.58	41.51	28.31	34.91	58.12	65.99	62.06
IBA @ 1000 ppm	8.69	10.38	9.53	47.93	27.56	37.75	57.61	49.03	53.32
NAA @ 250 ppm	5.13	5.35	5.24	21.40	10.88	16.14	45.48	46.88	46.18
NAA @ 500 ppm	5.69	8.26	6.98	39.74	22.43	31.08	51.25	56.95	54.10
NAA @ 1000 ppm	5.60	7.23	6.41	26.92	20.11	23.52	44.51	47.21	45.86
IBA @ 125 ppm + NAA @ 125 ppm	5.12	7.06	6.09	26.12	15.95	21.04	42.89	48.29	45.59
IBA @ 250 ppm + NAA @ 250 ppm	5.58	8.68	7.13	40.32	26.54	33.43	51.33	57.17	54.25
IBA @ 500 ppm + NAA @ 500 ppm	5.45	8.18	6.81	33.63	20.29	26.96	63.41	44.93	54.17
Mean	5.56	7.71		32.83	20.44		50.07	51.25	
	CD at 5%		S.Em±	CD at 5%		S.Em±	CD at 5%		S.Em±

Rooting hormone	0.423	0.148	0.905	0.317	1.371	0.480
Cultivar	0.189	0.066	0.405	0.142	0.613	0.214
Rooting hormone × Cultivar	0.598	0.209	1.280	0.448	1.938	0.678

11. Duration of flowering (days)

It is evident from the data that rooting hormones, mutants of cultivars and interactions of both had significant effect on flowering duration, untreated plants had shortest duration of flowering (42.75 days) while significantly longest duration of flowering (62.06 days) were observed in treatment in IBA @ 500 ppm. Among the mutants of two cultivars, mutants of Kenya Yellow had recorded significantly maximum duration of flowering (51.25 days), whereas, minimum duration of flowering was 50.7 days recorded in mutants of cultivar Kenya Blue. Interaction of control treatment and mutants of cultivar Kenya Blue exhibited shortest duration of flowering (40.61 days). However, significantly longest duration of flowering (65.99 days) recorded in plants of mutants of cultivar Kenya Yellow treated with IBA @ 500 ppm. Late bud initiation caused longer flowering period that was possibly due to late flower opening, these results were supported by Saffari *et al*. (2004) [15] in Rosa damascene and Mesen (1993) [10], who observed inhibition in shooting with increased concentration of IBA in other species.

References

1. Akhtar MS, Khan MA, Riaz A, Younis A. Response of different rose species to different root promoting hormones. Pak. J. Agri. Sci 2002;39(4):152-165.
2. Anil KS. Influence of plant bioregulators on growth and seed yield in French marigold (*Tagetes patula* Linn.). J Orn. Hort 2004;7(2):193-195.
3. Bharmal VS, Ranpise SA, Darwade RT. Effect of different levels of indole butyric acid (IBA) on rooting, growth and flower yield of chrysanthemum cv. Sonali Tara. Orissa Journal of Horticulture 2005;33(2):36-41.
4. Gupta VN, Dutta SK. Influence of gibberlic acid on growth and flowering in chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv. Jayanthi. India J. Plant Physiol 2000;6(4):420-422.
5. Haider A, Jaskani MJ, Hussain Z, Muhammad A. Response of rose cuttings against root promoting hormones during spring and autumn. Int. J. Biol. Biotech 2006;3(1):201-204.
6. Hartmann HT, Kester DE, Davis JFT, Geneve RL. Plant propagation: principles and practices. New Jersey: Prentice Hall 2002,880p. ISBN 0-13- 679235-9.
7. Kakimoto T. Perception and signal transduction of cytokinins. Annual Rev. of Plant Bio 2003;54(1):605-627.
8. Khuriwal KS, Kumar M, Pandey SK, Kasera S, Singh VK. Effect of plant growth regulators on plant growth, flower yield and quality of dahlia (*Dahlia variabilis* L.) cv. Kenya. Journal of Pharmacognosy and Phytochemistry 2018;1:603-604.
9. Kumar R, Ahmed N, Sharma OC, Lal S. Influence of auxins on rooting efficacy in carnation (*Dianthus caryophyllus* L.) cuttings. J Hortl. Sci 2014;9(2):157-160.
10. Mesen JF. Vegetative propagation of Central American hardwoods. Ph.D Thesis, University of Edinburgh, Scotland 1993.
11. Muneeb AW, Nazki IT, Ambreena D, Malik SA, Rather ZA. Photosynthate partitioning in Asiatic lilies under ammoniacal and nitrate sources of nitrogen. Agric Res 2016;5(3):230–235.
12. Nasri F, Fadakar A, Saba MK, Yousefi B. Study of Indole butyric acid (IBA) effects on cutting rooting improving some of wild genotypes of damask Roses (*Rosa damascena* mill.). Journal of Agricultural Sciences 2015;60(3):263-275.
13. Nickel LG. Plant growth regulators. Agricultural uses. Springer, New York 1900,4-5.
14. Ranpise SA, Bharmal VS, Darwade RT. Effect of different levels of indole butyric acid (IBA) on rooting, growth and flower yield of chrysanthemum cv. Sonali Tara. Journal of Ornamental Horticulture 2004;7:331-337.
15. Saffari VR, Khalighi A, Lesani H, Babalar M, Obermaier JF. Effects of different plant growth regulators and time of pruning on yield components of *Rosa damascena* Mill. Int. J Agric. Biol 2004;6:6.
16. Shivanagowda SP. Effect of mother plant nutrition and chemical spray on seed yield and quality of china aster (*Callistephus chinensis* (L.) Nees. M. Sc. (Agri.). Thesis, submitted to Uni. Agric. Sci., Dharwad, Karnataka 2000.
17. Smith AW. In: A Gardener's Dictionary of Plant Names. Cassell and Company Ltd, London 1971,390p.
18. Susaj E, Susaj L, Kallco I. Effect of different NAA and IBA concentrations on rooting of vegetative cuttings of two Rose cultivars. Research Journal of Agricultural Science 2012;44(3):385-389.
19. Ullah Z, Abbas SJ, Naeem N, Lutfullah G, Malik T, Khan MAU *et al*. Effect of indole butyric acid (IBA) and naphthalene acetic acid (NAA) plant growth regulators on Mari gold (*Tagetes erecta* L.). African Journal of Agricultural Research 2013;8(29):4015-4019.
20. Zimmerman PW, Wilcoxon F. Several chemical growth substances which cause initiation of roots and other responses in plants. Contrib. Boyce 1935;7:209-228.