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Application of maleic hydrazide controlled plant height and ameliorate flower production in local dahlia

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An experiment on “Influence of maleic hydrazide on plant height and flower production of Local Dahlia” was conducted at Department of Horticulture, The University of Agriculture, Peshawar- Pakistan, during November 2017- May 2018. The experiment was laid out in Randomized complete block (RCB) Design with split plot arrangement, keeping maleic hydrazide concentrations (0, 600, 800, 1000, 1200 ppm) in main plot whereas foliar application time (20, 30, 40 days after transplantation) was in sub plots. Maleic hydrazide concentrations and application time significantly affected most of the studied attributes. Foliar application of Maleic Hydrazide at 1000 ppm resulted in decrease in plant height (95.13 cm), increase in stem diameter (1.88 cm), more number of branches plant^{-1} (20.49), higher chlorophyll content (57.51 SPAD), leaf area (637.60 cm^2), minimum days to flowering (83.89), maximum number of flowers plant^{-1} (55.76), increase in flower diameter (119.86 mm), with enhanced fresh and dry flower weight (31.74 & 3.18 g). Among application time, maximum flower diameter (115.72 mm) was recorded in plants treated with maleic hydrazide, 20 days after transplantation whereas application of maleic hydrazide after 30 days of transplantation resulted in maximum leaf area plant^{-1} (589.53 cm^2). It is concluded from the current research, that foliar application of maleic hydrazide at 1000 ppm proved best treatment for controlled plant height and better flower production in local dahlia under the agro-climatic conditions of Peshawar- Pakistan.

Keywords: Maleic hydrazide, flower production, Dahlia

INTRODUCTION

Dahlia is perennial herbaceous plant with tuberous roots. It belongs to family Asteraceae or compositae. It is one of the largest family consist of over 30 species and 20000 varieties all over the world. It is native to Mexico. It is very popular flower because of its wide varieties of different shapes and unique colours (Lalan et al., 2009). Flower colours ranges from white, yellow, pink, and orange etc. (Thill et al., 2012). Based on flower size, cultivars of dahlia ranges from miniatures with flower heads (5 cm in diameter) to giants with flower heads over (25 cm) diagonally (De Hertogh and Le Nard, 1993). Dahlia have many uses such as cut flower, in bouquets, in flower beds, as specimen plant, potted plant and in flower shows as well as exhibitions. Besides, it is used in pharmaceutical industry, cosmetics and as raw material for the extraction of dyes (Memon et al., 2013; Moldovan et al., 2017). Dahlia grows best in a climate which is frost free. Tuberous roots are mostly imported from Netherland (Malik et al., 2017). Dahlia is very responsive to its habitat and environment. Dahlia is day length sensitive (Mastalerz, 1985). Day length has direct effect on flowering and indirect effect on vegetative growth, dormancy and tuberous root formation. The vegetative growth is enhanced during day length of 12 hours or more and retarded by day length of 11 hours or less (Mosser and Hess, 1968). The longevity and quality of dahlia flower play significant role in cut flower business. Due to diverse climatic conditions in Pakistan, dahlia can be cultivated year round for continuous supply of its flowers to the market as cut flowers and for bedding purpose (Mukesh et al., 2001).

Plant growth regulators (PGRs) are organic chemicals that affect plant growth and or development. A major group among PGRs are compounds, which reduce shoot elongation and plant height. Such substances are often named "growth retardants (Rademacher, 2015). Plant growth retardants also improve flower quality, size and increase shelf life of flowering plants (Singh et al., 2017). Maleic hydrazide (MH) is a growth regulator falls in the class of pyridazinediones. It is used as a weedicide and growth inhibiter in the field of horticulture and agriculture (Andersen, 1979; Malik et al., 2017). Controlled plant size is an important characteristic in floricultural crops which can be achieved genetically, environmentally, culturally or chemically through plant growth regulators. There are some plant growth regulators (PGRs) such as maleic hydrazide, which are responsible for inhibition of plant height by interfering gibberellin biosynthesis pathway in treated plants (Malik et al.,2017).For most of the potted plants in floriculture, maleic hydrazide is used as a height regulator because it retards the division and elongation of plant cells (Pasian, 1999).

Local dahlia (open pollinated) is very cost effective and least expensive with high percentage of germination under the climatic conditions of (Peshawar) North West Pakistan. Local flora of dahlia has more diversity with respect to its variety of colours and shapes of flowers. It require less care, maintenance and are more adaptable to the local soil and environmental conditions but its plants are taller with relatively smaller flowers as compared to hybrid dahlia and are subjected to lodging (Nsabimana and Jiang 2011) but hybrid dahlia are very expensive when compared with the local one. Keeping in view the role of maleic hydrazide and its possible influence on local dahlia especially to control its height and improve its flower size and other attributes, current research project was designed with the objective to study the influence of foliar applied maleic hydrazide on vegetative and flowering attributes of local dahlia.

MATERIALS AND METHODS

Research study on "Foliar application of maleic hydrazide on the growth and production of local dahlia" was conducted during November, 2017- May, 2018 at the Ornamental Nursery, Department of Horticulture, The University of Agriculture, Peshawar. The latitude of test area (Peshawar) is 34.01 with longitude 71.58 having GSP coordinates 34° 1' 33.3012" N and 71° 33' 36.4860" E. Its elevation from sea level is 317 meters (https://www.latlong.net/place/peshawar-pakistan-5240.html accessed on 13th May, 2019). The experiment was carried out in a Randomized Complete Block design (RCBD) with split plot having two factors i.e. maleic hydrzide concentrations (control/distilled water/0, 600, 800, 1000 and 1200 ppm and application time (20, 30 and 40 days after transplantation). The experimental plot was thoroughly ploughed and well prepared. Recommended dose of fertilizers (NPK @ 100:80:80 kg ha^{-1}) was applied to the field. Phosphorus and potash was applied before the transplanting of seedlings whereases nitrogen was applied in two split doses. First dose of nitrogen was given at time of transplantation while second dose was applied after fifteen days of transplanting. Seedling were transplanted to the field when they were at two to three leaves stage keeping plant to plant distance 9 inches and row to row distance was 18 inches. All cultural practices (irrigation, weeding, hoeing) were performed uniformly. During the research data was collected on Plant height, Stem diameter, Number of branches $plant^{-1}$, Chlorophyll content (SPAD), Leaf area(cm^2), Days to flowering, Number of flowers $plant^{-1}$, Flower diameter (mm), Fresh and Dry flower weight (g).

Statistical analysis:

The data were subjected to analysis of variance suitable for randomized complete block design (RCBD) with split plot arrangement (Jan et al., 2009). The least significant difference test was used for comparison of significant means.

RESULTSAND DISCSSION

Plant height

The average data concerning plant height are placed in Table 1. The statistical analysis showed that maleic hydrazide significantly affected plant height, while application time and the interaction between maleic hydrazide concentrations and application time were non-significant. The mean data pertaining to various concentrations of maleic hydrazide showed that treatment of maleic hydrazide at 1000 ppm resulted in minimum plant height (95.13 cm) which was statically similar to plant height observed in plants of dahlia sprayed with maleic hydrazide at 1200 ppm and 800 ppm respectively. Tallest plants with plant height (136.87 cm) were found in control plots (treated with distilled water).

The findings concerning plant height clearly depict that maleic hydrazide reduced the plant height of local dahlia. It might be because of the fact that maleic hydrazide act as growth retardant and inhibit the biosynthesis of gibberellins that elongates shoot length (Latimer, 2009; Malik et al., 2017) and hence resulted in shorter plants with good health as compare to control. Maleic hydrazide also reduces the auxin activity thereby inhabiting cell division and elongation and as a result the height of plant is reduced (Patil, 1995). The results are in conformity with the findings of Kumar and Ughreja (1998) and Pasian (199); they reported reduced plant height in chrysanthemum and other ornamental potted plants with the application of maleic hydrazide because of its inhibitory role in cell division and elongation.

Stem diameter

The statistical analysis regarding stem diameter showed that maleic hydrazide has significantly affected stem diameter, while application time and interaction effect of maleic hydrazide and application time was non-significant. The average data regarding stem diameter are placed in Table 1. Mean data pertaining to the effect of maleic hydrazide levels showed that stem diameter was increased to the maximum (1.88 cm) with the application of 1000 ppm followed by 1.48 cm in plants sprayed with 600 ppm that was statistically similar to the stem diameter observed in plants sprayed with maleic hydrazide at 0, 800 and 1200 ppm respectively.

The findings of the current experiment showed that maleic hydrazide reduced the plant height with an increase in stem diameter of local dahlia. Stem diameter is an important factor for determining stem strength. It offers support to the leaves and flowers and keep the canopy of the plant in light for photosynthesis (Fitter and Hay, 2012). Though maleic hydrazide inhabits cell division and elongation of internodes but stem diameter tends to increase (Naylor and Davis, 1950; Sen and Maharna 1972; Khobragade et al., 2002); hence more diameter of stem was found in plants treated with maleic hydrazide as compared to control or untreated plant. These results are also in agreement with that of Mahallee*t al.* (2001) and Kim et al., (2010).

Number of branches plant^{-1}

The mean data related to number of branches plant^{-1} are placed in Table 1. The statistical analysis showed that maleic hydrazide significantly affected number of branches plant^{-1}, while application time and interaction between maleic hydrazide and application time was found non-significant. Mean data pertaining different concentrations of maleic hydrazide revealed that maximum number of branches plant^{-1} (20.49) were recorded with the application of maleic hydrazide at 1000 ppm which is statically similar to (17.07) at 600 ppm followed by 14.42 with application of maleic hydrazide at 800 ppm. Whereas minimum number of branches plant^{-1} (12.64) was found in plants sprayed with 1200 ppm maleic hydrazide.

Maleic hydrazide resulted in an increase in the number of branches with increasing concentration and highest number of branches was produced by the plants that received 1000 ppm of maleic hydrazide. Further increase in concentration of maleic hydrazide to 1200 ppm caused a decline in the number of branches in local dahlia. The possible reasons for maximum number of branches due to optimum concentration of maleic hydrazide might be because of the fact that growth retardants cut off the basipetal flow of auxins and induce the sprouting of lateral vegetative buds to enhance the production of more number of branches (Goren et al., 2004). The findings of the current experiment are in line with the results of Arora et al., (1982), who reported an increase in the number of branches in bottle gourd in response to the treatment of maleic hydrazide.

Chlorophyll content (SPAD)

The statistical analysis pertaining to chlorophyll content in response to maleic hydrazide application revealed that maleic hydrazide had significant effect on chlorophyll content, while application time and their interactive effect was non-significant (Table 1).

Table 1.Plant height, Stem diameter, No. of branches plant^{-1}, Chlorophyll content and Leaf area as affected by maleic hydrazide concentrations and application time.

Treatments	Plant height (cm)	Stem diameter (cm)	No. of branches plant^{-1}	Chlorophyll content (SPAD)	Leaf area (cm^2)
Maleic hydrazide (ppm)					
0	136.87a	1.39b	13.53bc	54.21b	467.06b
600	110.31b	1.48b	17.07ab	54.77b	441.70b
800	98.13c	1.34b	14.42bc	54.85b	582.72a
1000	95.13c	1.88a	20.49a	57.51a	637.60a
1200	97.91c	1.32b	12.64c	53.24b	456.27b
LSD value (P ≤ 0.05)	11.064	0.3775	4.40	2.5772	102.55
Application Time (Days after transplantion)					
20	109.2	1.53	16.25	55.03	495.06b
30	105.08	1.46	14.77	54.73	589.53a
40	107.33	1.46	15.87	54.99	466.62b
LSD value (P ≤ 0.05)	NS	NS	NS	NS	91.621
Interaction	NS	NS	NS	NS	NS

Means followed by different letters in respective columns are significantly different from each other at P≤0.05.

Among various concentrations of maleic hydrazide, the application of 1000 ppm resulted in the highest chlorophyll content (57.51 SPAD) while chlorophyll content was reduced to the minimum (53.24 SPAD) in plants treated with 1200 ppm maleic hydroxide that was statistically similar to the effect of 0, 600 and 800 ppm respectively.

The chlorophyll content of leaf is an important physiological factor as it determines the photosynthetic efficacy of a plant (Hikosaka, 2004). Dry matter production is the indicator of metabolic efficiency of plant that utilizes the absorbed photosynthetically active radiations (Kannan et al., 2016). The plants growth inhibitors are reported to reduce the elongation of stem and increase the chlorophyll contents in leaves as well as change the growth of roots (Fletcher et al., 2000; Carvalho et al., 2014). In current experiment maleic hydrazide when applied at 1000 ppm resulted in enhanced chlorophyll content in leaf, that might be due to the reason that the same concentration caused more number of branches and leaf area (Table 1) with an extended and open canopy to capture more light (Daughtry et al., 2000). Maleic hydrazide as growth retardant, assist the plant to develop tolerance against abiotic stresses because of its effects on plant metabolism (Fletcher et al., 2000; Elansary& Salem, 2015; Etemadi et al., 2015; thereby indirectly enhances the photosynthetic efficiency of a plant with an increase in chlorophyll content due to resistance against abiotic stresses and diseases (Spinelli et al., 2010).

Leaf area plant^{-1} (cm^2)

Data pertaining leaf area plant^{-1} are placed in Table 1. The statistical analysis showed that maleic hydrazide and application time significantly affected leaf area plant^{-1}, while interaction between maleic hydrazide concentrations and application time was noted non-significant. Data regarding application of maleic hydrazide at different concentration showed that maximum leaf area plant^{-1} (637.60 cm^2) was observed when plants were treated with maleic hydrazide at 1000 ppm. While minimum leaf area plant^{-1} (441.70 cm^2) was recorded with the application of maleic hydrazide at 600 ppm which is statistically at par with the effect of 0 and 1200 ppm. Mean data pertaining to application time revealed that foliar spray of maleic hydrazide after 30 days of transplantation resulted in maximum leaf area plant^{-1} (589.53cm^2) followed by leaf area (495.06cm^2) recorded in plants treated with maleic hydrazide, 20 days after transplantation which is statistically similar to the leaf area (466.62cm^2) observed in plants sprayed with maleic hydrazide after 40 days of transplantation.

It is evident from the findings that leaf area was significantly increased with the spray of maleic hydrazide. Increase in leaf area might be due to the role of maleic hydrazide that suppresses the apical dominance and increases leaf number and area of the leaf (Jadhav et al., 2005). It may also be due to increase in number of layers in palisade tissue, chlorophyll and starch contents in spongy cells (Reddy et al. 1999). Similar results were observed by Jadhav et al.,(2015) in heliconia and Suryawanshi et al.,(2017) in mustard.

Days to flowering

The statistical analysis of the data showed that maleic hydrazide significantly influenced days to flowering, while application time and interaction between maleic hydrazide concentrations and application time had no significant effect on days to flowering. Data regarding different concentrations of maleic hydriazide showed that plants of local dahlia treated with distilled water (control) took maximum days to flowering (98.56) while minimum days to flowering (83.89) were noted in plants treated with maleic hydrazide at 1000 ppm.

The application of maleic hydrazide at 1000 ppm resulted in early flowering in local dahlia as compared to other treatments. It might be due to its inhibitory role on certain growth promoters such as auxin and gibberellins as a result plant experienced a sort of stress and hence caused early flowering (Sharma et al.1995; Meher et al.,1999; Navale et al.,2010). Early flowering had been observed with the application of maleic hydrazide due to its effects as growth retardant (Dutta and Ramdas, 1998; Navale et al., 2010).

Number of flowers plant^{-1}

The average data concerning number of flowers plant^{-1} are presented in Table 2. The statistical analysis showed that number of flowers plant^{-1} was significantly affected by maleic hydrazide concentrations, while application time and interaction between maleic hydrazide concentrations and time of application was found non-significant. Mean data relating to maleic hydrazide concentrations showed that maximum number of flowers plant^{-1} (55.776) were observed with the application of maleic hydrazide at 1000 ppm while minimum number of flowers plant^{-1} (40.31) were recorded with the application of 1200 ppm maleic hydroxide that was statistically similar to the effect of 0, 600 and 800 ppm respectively.

Maleic hydrazide resulted in reduction in plant height by suppressing the role of auxin and gibberillin which ultimately increased the number of main and secondary branches, thereby increased flowers yield (Sharma et al.1995; Dutta and Ramdas, 1998; Meher et al.,1999 ; Navale et al.,2010).

Flower diameter (mm)

The mean data concerning flower diameter are placed in Table 2. The analysis of data showed that flower diameter was significantly affected by maleic hydrazide concentrations and application time, whereas the interaction between maleic hydrazide concentrations and time of application was non-significant. Data of maleic hydrazide concentrations showed maximum flower diameter (119.86 mm) was recorded in plants sprayed with maleic hydrazide at 1000 ppm. Control plants (treated with distilled water) were having minimum flower diameter (109.72) which was statistically at par with flower diameter recorded in plants treated with maleic hydrazide at 800 ppm. Mean data for application time revealed that foliar spray when applied after 20 days of transplantation resulted in maximum flower diameter (115.72 mm). However minimum flower diameter (110.38mm) was observed when foliar spray of maleic hydrazide was done 40 days after transplantation.

Maleic Hydrazide treatment caused increase in flower size due to availability of more carbohydrates during the development of buds. Increased flower diameter might be due to transverse cell expansion and division (Sachs and Kofranek, 1963). Maleic hydrazide resulted in an increase in leaf chlorophyll content and leaf area (Table 1) with enhanced photosynthesis due to control on abiotic stresses (Elansary & Salem, 2015; Etemadi et al., 2015) and diseases (Spinelli et al., 2010). Moreover, the food reserves might have been diverted mainly to flowers and resulted in an increase in flower size when plants were treated with maleic hydrazide (Gupta and Dutta, 2000; Padampriya and Chezhiyan, 2002; Singhrot et al., 2003; Moond et al.,2006) . Similar findings were recorded by Singh et al., (2017) in dahlia who reported maximum flower diameter in dahlia with treatment of maleic hydrazide.

Fresh flower weight (g)

The mean data concerning fresh weight of flower are presented in Table 2. The statistical analysis showed that maleic hydrazide significantly influenced fresh flower weight, while application time and the interaction between maleic hydrazide concentrations and application time had non-significant effect on fresh flower weight of local dahlia. Data regarding application of maleic hydrazide at different concentrations showed that fresh flower weight was increased to maximum (31.74 g) in plants that received maleic hydrazide at 1000 ppm. Minimum fresh flower weight (23.81g) was found in plants treated with 600 ppm of maleic hydrazide.

Table 2.Days to flowering, No. of flowers plant-1, Flower diameter, Fresh flower weight and Dry flower weight as affected by Maleic hydrazide concentration and Application time.

Treatment	Days to flowering	No. of flowers plant-1	Flower diameter (mm)	Fresh flower weight (gm)	Dry Flower weight (gm)
Maleic hydrazide (ppm)					
0	98.56a	41.51b	109.72b	25.49bc	2.52bc
600	97.89a	48.87ab	113.38ab	23.81c	2.22c
800	97.89a	45.07b	109.79b	25.58bc	2.36c
1000	83.89b	55.776a	119.86a	31.74a	3.18a
1200	97.22a	40.31b	115.28ab	29.38ab	2.81b
LSD value (P ≤ 0.05)	7.4481	9.0682	5.2774	4.1394	0.3257
Application Time (Days after transplantion)					
20	97.33	45.99	115.72a	28.43	2.61
30	92.93	47.03	114.73ab	27.15	2.73
40	95.00	45.89	110.38b	26.02	2.51
LSD value (P ≤ 0.05)	NS	NS	8.70752	NS	NS
Interaction	NS	NS	NS	NS	NS

Means followed by different letters in respective columns are significantly different from each other at P≤0.05.

Dry flower weight (g)

The analysed data showed that maleic hydrazide significantly affected dry flower weight, while application time and the interaction between maleic hydrazide concentrations and application time had non-significant effect on dry flower weight of local dahlia (Table 2). Data regarding application of maleic hydrazide at different concentrations showed that maximum dry flower weight (3.18 g) was observed in plants treated with maleic hydrazide at 1000 ppm as compared to other treatments. However, the dry flower weight was minimum (2.22 g) in plants treated with maleic hydrazide at 600 ppm.

It is clear from the findings that both fresh and dry flower weight was increased with the treatment of maleic hydrazide at 1000 pppm. Maleic hydrazide caused decrease in plant height with an increase in leaf area and chlorophyll content as well as flower diameter (Table 1 and Table 2) and resulted in an increase in flower weight. It might be due to accumulation of more metabolites and availability of reserve food for the reproductive growth. The results are in agreement with the findings of Arshid, (2009) and Haque et al., (2007) who found a significant increase in fresh and dry flower weight respectively in chrysanthemum with the application of growth retardants.

CONCLUSION

Based on the present research work, it is concluded that maleic hydrazide at 1000 ppm improved the vegetative and floral variables; decreased the plant height to the minimum with an increase in flower size and numbers of flowers in local dahlia. Though, time of application for most of the parameters was non-significant. However maleic hydrazide applied 20 days after transplantation increased flower diameter while application of maleic hydrazide 30 days after transplanting increased leaf area.

Recommendation

Maleic hydrazide at 1000 ppm could be recommended for reasonable plant height and better flower production in local dahlia.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

All the authors have contributed: The main idea/theme of the experiment was given by MA (Masood Ahmad). He designed the experiment and supervised the whole research from start till completion and wrote this manuscript. SA executed the experiment, did data collection, data analysis and provided assistance in writing of the manuscript. SAJ, MA (Mehboob Alam) and AR helped in the interpretation of data and technical writing of the manuscript. IHK and GAK helped in statistical analysis and its interpretation. HA assisted in field data collection, soil analysis and in write up of the manuscript. All authors read and approved the final version.

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