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EFFECT OF MEPIQUAT CHLORIDE ON VEGETATIVE GROWTH, FLOWERING AND YIELD OF PUMPKIN (*CUCURBITA MOSCHATA* DUCH. EX. POIR)

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ABSTRACT

The field experiment was conducted to determine the effect of Mepiquat chloride on growth, flowering and yield attributes of pumpkin cv. 'Kashi Harit' during *Kharif* season 2018. The experiment was laid out in randomized block design with eight treatments and three replications each. Three concentrations of mepiquat chloride *viz.,* 50 g a.i. ha^{-1}, 62.5 g a.i. ha^{-1} and 125 g a.i. ha^{-1} were applied at three growth stages namely i) at flower initiation, ii) at 15 days after flower initiation and iii) at vegetative stage followed by flower initiation stage of pumpkin. The results revealed that the application of Mepiquat chloride 5% AS @ 50 g a.i. ha^{-1} at vegetative stage followed by flower initiation stage significantly enhanced the number of leaves (40.80), leaf area (351.28 cm^2) and primary branches per vine (5.67) and reduction in vine length (5.90 m), days taken to male (37.67 days) and female (43.00 days) flower anthesis and the node at which first male (4.00) and female (15.00) flower appeared over control. Foliar application of Mepiquat chloride @ 62.5 g a.i. ha^{-1} was found more effective in increasing the number of female flowers/vine (4.85) and fruit yield (21.40 t/ha), number of fruits/vine (1.93), fruit length (12.41 cm), fruit girth (8.93 cm), fruit weight (1.93 kg) and number of seed/fruit (200.33). Whereas, number of male flowers/vine (60.38), sex ratio (12.44), days to 50 % flowering (45.33 days) was reduced by its all application as compared to control.

Keywords **:** Mepiquat chloride, randomized block design, pumpkin, flowering, sex ratio, yield

Introduction

Pumpkin, (*Cucurbita moschata* Duch. ex. Poir) is one of the most important crops belonging to cucurbits, grown mainly in tropical and sub-tropical parts of India. Pumpkin is grown during *Kharif* and summer season for its immature and tender fruits (Reddy 2015). Pumpkin is a rich source of carbohydrates, proteins, vitamins, minerals and contains beta carotene which acts as the precursor of vitamin A (Pandey *et al.,* 2008, Kumar *et al.,* 2015). It provides valuable sources of phytonutrients and functional components like zeaxanthin, carotenoids, ascorbic acids, phytosterols, vitamin E, linoleic acid and selenium, which acts as an antioxidant in human nutrition (Ahmed and Khan 2019). Omega-3 and 6 essential fatty acids are found in its seeds which are essential nutrients for normal mental health (Singh 2013).

Pumpkin flower biology and sex expression are the two important traits which plays an important role in obtaining higher production (Sakthinathan *et al.,* 2017). Such traits can be improved with the adoption of technologies like use of growth regulators. Different plant growth regulators are known to have an effect on early flowering, yield, sex ratio of flower, number and weight of fruit which plays an important role in plant morphology, growth and development (Gedam *et al.,* 1998). Mepiquat Chloride is widely used plant growth retardant which can prevent plant overgrowth by declining the activity of gibberellin acid synthesis (Khursheed 2010). It has wide application in cotton in inhibiting extreme vegetative growth, overcome water

stress levels, promote root growth and minimize losses (Chen *et al.,* 2018). Devaraju *et al.,* (2002) recorded delayed number of days for male flower initiation and promote earliness in the female flower initiation, number of female flowers and fruit/vine by the application of Mepiquat chloride in gherkin. Increase in various growth and yield parameters by its application was observed by Laddha *et al.,* (2018) in brinjal and Pal *et al.,* (2017) in onion.

However, no such information was available on the effect of Mepiquat Chloride on different growth behaviour and yield of pumpkin. Therefore, present investigations were planned to investigate the potential effect of Mepiquat chloride on crop growth and yield of pumpkin which help in better growth habit, fruiting and seed yield combined with better quality of the crop.

Materials and Methods

Present investigations on effect of Mepiquat chloride on pumpkin were undertaken at Vegetable Research Farm, Department of Horticulture, Institute of Agriculture Sciences, Banaras Hindu University, Varanasi during *Kharif* season 2018. Sowing of crop was done during first week of July in 2018 using 'Kashi Harit' variety in a plot of 5×5 m^2, maintaining row to row and plant to plant spacing of 1.5 x 0.6 m^2, respectively. Total number of plots was 24 (Figure 1). All the recommended agronomic practices such as weeding, irrigation, pesticide application were followed in raising the crop.

The experiment was laid out in randomized bock design having eight treatments comprising different concentrations of Mepiquat chloride 5% AS with three replications each. Different concentration of Mepiquat chloride 5% AS were T_1, T_4, T_7 (@ 50 g a.i. ha^{-1}), T_2, T_5 (@ 62.5 g a.i. ha^{-1}), T_3, T_6 (@ 125 g a.i. ha^{-1}) and T_8 water spray (untreated control). These treatments were applied at different stages of plant growth as, T_1, T_2, T_3 at flower initiation, T_4, T_5, T_6 at fifteen days after flower initiation and T_7 twice, first spraying at vegetative growth stage followed by second spraying at flower initiation stage. Observations were recorded by randomly selecting three plants from each plot (Figure 2). Data obtained on various parameters of growth, flowering and yield were subjected to statistical analysis, SPAR-II developed by IASRI, New Delhi.

Results and Discussion

Vegetative growth

Mepiquat chloride has significantly enhanced the vegetative growth of pumpkin (Table 1). The number of leaves was observed 0, at 15 and 30 days after sowing. The maximum number of leaves/plant (14.47) at 0 DAS was recorded in control (T_8) followed by treatment T_3 (14.00), and treatment T_6 (13.67) while at 15 DAS it was maximum with treatment T_7 @ 50 g a.i. /ha followed by treatment T_2 (62.5 g a.i. ha^{-1}) and treatment T_3 (125 g a.i. ha^{-1}) with their corresponding values 26.33, 25.33 and 24.80 respectively. At 30 DAS, number of leaves per plant was maximum (40.80) in treatment T_7 followed by treatment T_2 (39.27) and Treatment T_1 (38.43). Whereas, minimum number of leaves at 0, 15 and 30 DAS was observed in T_1 (13.20), T_5 (20.80) and T_8 control (33.73) respectively. The results obtained in present studies are in line to the findings of Pal *et al.* (2017) in onion, Laddha *et al.* (2018) in brinjal.

Leaf area recorded at 15 and 30 DAS, was found maximum in treatment T_7 (50 g a.i.ha^{-1}) with values of 284.01 cm^2 and 351.28 cm^2, respectively, whereas the minimum leaf area *i.e.* 260.87 and 301.45 cm^2 was observed in T_8 (control) at 15 and 30 DAS, respectively. Similar findings was recorded by Chandrababu *et al.,* (1995) and Laddha *et al.* (2018) who reported that foliar application of Mepiquat chloride increased the leaf area in groundnut and brinjal, respectively. Maximum number of primary branches per plant (5.67) was noted in treatment T_7 (50 g a.i. ha^{-1}) followed by treatment T_2, T_3 and T_1, whereas the minimum number of primary branches/ plant (3.67) recorded with control. The increase in the number of branches might be due to suppression of apical dominance by Mepiquat chloride which leads to increase in branching. Laddha *et al.* (2018) and Paikra *et al.,* (2018) also reported the same in brinjal and soybean, respectively. Vine length reduced significantly and found shortest (5.90 m) in treatment T_7 (50 g a.i. ha^{-1}) followed by T_2 and T_5 while longest vine length (6.77 m) was observed in control. Reduction in vine length may be attributed to the effect of Mepiquat chloride which inhibits the production of gibberellins which is responsible for cell elongation in plants. Results obtained in present investigation were also recorded by Mohamed (2015) in grapes.

Flowering attributes

Mepiquat chloride influenced the flowering and sex ratio in pumpkin and reduced the node number at which flowers appeared (Table. 2, Figure 3 and 4). Minimum number of days taken to first male flower anthesis (37.67 days) was observed in case of treatment T_7 whereas maximum days (41.33 days) was noted in treatment T_8 (control). In case of female flower anthesis, minimum days (43.00) was recorded by treatment T_7 followed by T_2 (43.33 days), while maximum by T_8 control (45.33 days). From this, it

might be concluded that application Mepiquat chloride 5% AS promoted the earliness in the number of days for the appearance of male and female flowers as compared to control. Similar findings were also recorded by Devaraju *et al.* (2002) in gherkin and Babu *et al.* (2009) in Jatropha.

Application of Mepiquat chloride resulted in the appearance of flowers at lower nodes in comparison to control. The lowest node number at which first male (4.00) and female (15.00) flower appeared was found in treatment T_7 and highest in control with values of 6.33 and 20.00, respectively. The results are in conformity to the findings of Devaraju *et al.,* (2002) who recorded the decrease in node number for female flower in gherkin. Significant variation in the number of days to 50% flowering was recorded among the various treatments. Treatment T_2 resulted in minimum days (45.33 days) for 50 % female flowering followed by T_7 (46.00 days) and maximum days (49.00) noticed in control. The result of the present study is in agreement with Babu *et al.,* (2009) who reported similar findings in Jatropha.

Sex ratio (ratio of male to female flowers) was reduced by the application of Mepiquat chloride which might be due to the increase in the number of female flowers per vine and reduction in male flowers. Application of Mepiquat chloride @ 62.5 g a.i. h^{-1}at flowering stage resulted in the minimum value of sex ratio (12.44) in treatment T_2 followed by T_7 and T_5, whereas maximum sex ratio was found in T_8 control (18.59). Also, the minimum (60.38) and maximum (4.85) number of male and female flowers were observed in same concentration, respectively. These results are in conformity to the findings of Jeyakumar and Thangaraj (1996), Devaraju *et al.* (2002) in gherkin and Babu *et al.* (2009) in Jatropha.

Yield attributes

Number of fruits/vine was significantly increased with Mepiquat chloride (Figure 5). The maximum number of fruits (1.93) was obtained with treatment T_2 (62.5 g a.i. ha^{-1}) followed by T_7 (1.83), T_1 (1.77) and T_4 (1.70), while the minimum (1.40) was obtained in control. It might be due to the reason that Mepiquat chloride diverts the energy from vegetative growth and directs it towards the production of flowers and thus increasing number of fruits per vine. Significant increase in the number of fruits by application of Mepiquat chloride was also recorded by Devaraju *et al.* (2002) in gherkin, Sridhar *et al.* (2009) in bell pepper, Mohamed (2015) in grapes and Laddha *et al.* (2018) in brinjal.

Fruit length was recorded maximum in treatment T_2 (12.41 cm) followed by T_7 (12.19 cm), T_3 (11.70) and T_4 (11.45 cm) and minimum value (10.70) corresponding to T_8 (control). Average fruit girth increased due to the application of Mepiquat chloride which in different treatments ranged from 6.05 to 8.93 cm. The maximum fruit girth was noted in treatment T_2 i.e. 8.93 cm followed by T_7, T_3, T_1, T_4 & T_5, T_6 and T_8 with mean values 8.36, 7.47, 7.46, 7.37, 7.33 and 6.05 cm, respectively. Minimum fruit girth was observed in control (T8). The increase in fruit length and girth in present investigation derives support from the findings of Kakroo *et al.* (2005), Mohan *et al.* (2016) and Laddha *et al.* (2018) who recorded the same in bottle gourd, cucumber and brinjal, respectively.

Mepiquat chloride application significantly increased the fruit weight which was recorded maximum i.e., 1.93 kg in T_2 (62.5 g a.i. /ha) followed by T_7 (1.90 kg) and minimum (1.36 kg) was noticed in control (T_8). Increase in weight of fruit by the application of Mepiquat chloride derives support from the findings of Laddha *et al.* (2018) who recorded the same in brinjal.

Number of seeds/fruits was recorded maximum in treatment T_2 (200.33) followed by T_7 (199.33), T_5 (182.33) and T_1 (179.00), while minimum in control T_8 (Table 1, Figure 6). This finding was in line with the observation recorded by Sridhar *et al.,* (2009) in bell pepper, Paikra *et al.,* (2018) in soybean. Similar results were obtained by Kim *et al.,* (2011) in flax.

Conclusion

Based on present study, it has been observed that the foliar sprays of 5% aqueous solution of Mepiquat chloride significantly affected the plant growth, flowering and yield parameters in pumpkin. It was observed that most of the plant growth and yield parameters were significantly improved with the application of Mepiquat chloride @ 50.0 and 62.5 g a.i./ha (Treatment T_7 and T_2). Thus, from the present study it may be recommended that the foliar spray of 5% Mepiquat chloride is beneficial in pumpkin production, as it improved most of the growth and yield traits of pumpkin.

Table 1 : Effect of Mepiquat Chloride on vegetative and yield attributes of pumpkin

Treatment	Number of leaves per vine		Leaf area (cm^2)		Number of primary branches per vine	Vine length (m)	Number of fruits per vine	Average Fruit length (cm)	Average Fruit girth (cm)	Fruit weight per vine (kg)	Number of Seeds per fruits
	15 DAS	30 DAS	15 DAS	30 DAS							
T_1	24.27	38.43	268.04	336.97	5.00	6.43	1.77	10.64	7.46	1.65	179.00
T_2	25.33	39.27	275.62	340.21	5.33	6.17	1.93	12.41	8.93	1.93	200.33
T_3	24.80	38.03	270.71	331.31	5.00	6.53	1.60	11.70	7.47	1.64	171.67
T_4	23.47	37.23	269.06	301.81	4.67	6.50	1.70	11.45	7.37	1.66	173.00
T_5	20.80	38.13	266.71	303.63	4.33	6.33	1.77	10.17	7.77	1.69	182.33
T_6	23.07	35.83	266.38	304.95	4.00	6.75	1.50	10.69	7.33	1.47	140.33
T_7	26.33	40.80	284.01	351.28	5.67	5.90	1.83	12.19	8.36	1.90	199.33
T_8 (untreated control)	23.67	33.73	260.87	301.45	3.67	6.77	1.40	10.70	6.05	1.36	139.33
CD (P=0.05)	2.80	3.72	13.58	25.96	1.01	0.51	0.24	1.14	0.56	0.27	3.76
SE.m±	0.93	1.24	4.53	8.	0.36	0.17	0.08	0.38	0.19	0.09	1.25

DAS: Days After Sowing

Table 2 : Effect of Mepiquat Chloride 5% AS on flowering of pumpkin

Treatment	Days to first male flower anthesis	Days to first female flower anthesis	Node at which first male flower appeared	Node at which first female flower appeared	Days to 50% female flowering	Number of male flowers per vine	Number of female flowers per vine	Sex ratio
T_1	39.33	43.67	5.00	16.00	47.33	69.65	4.80	14.51
T_2	38.00	43.33	4.33	16.70	45.33	60.38	4.85	12.44
T_3	40.33	45.00	5.00	16.00	48.67	77.64	4.63	16.76
T_4	39.67	44.33	5.67	17.67	48.33	71.60	4.67	15.34
T_5	38.67	44.33	4.67	16.33	48.33	66.98	4.67	14.37
T_6	41.00	45.00	6.00	18.00	48.00	79.49	4.50	17.63
T_7	37.67	43.00	4.00	15.00	46.00	64.07	4.81	13.07
T_8 (Untreated control)	41.33	45.33	6.33	20.00	49.00	77.84	4.20	18.59
CD (P=0.05)	0.78	0.90	1.12	1.27	1.09	10.72	0.35	2.39
SE.m.±	0.26	0.30	0.38	0.42	0.36	3.58	0.12	0.78

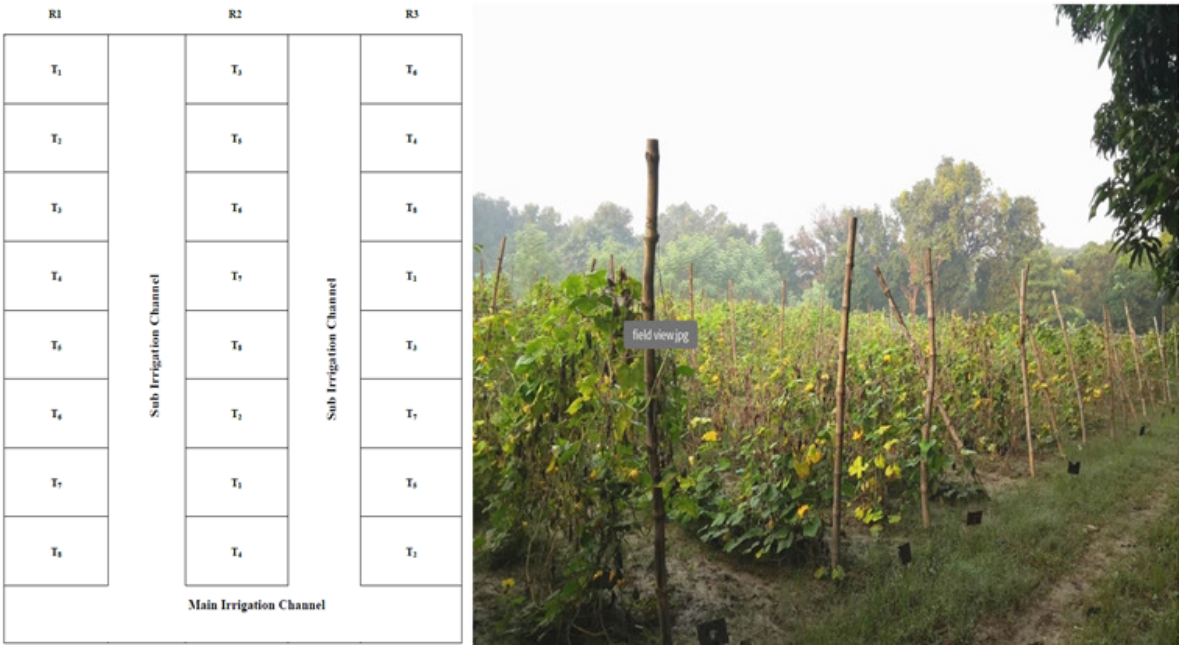

Fig. 1: View of the experimental field

Fig. 2: Tagged plants

Fig. 3: Male flower of pumpkin

Fig. 4: Female flower of pumpkin

Fig. 5: Pumpkin fruit

Fig. 6: Extracted seeds from the pumpkin fruit

Conflict of interest: The authors declare no conflict of interest.

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