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Effect of mepiquat chloride on growth and yield of pumpkin (*Cucurbita moschata* L.) variety Arka Suryamukhi

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Abstract
A field trial was conducted at Department of Horticulture, College of Agriculture, University of Agricultural Sciences, GKVK, Bangalore during the year 2019-2020 to study effect of mepiquat chloride on growth and yield of Pumpkin (*Cucurbita moschata* L.) variety Arka Suryamukhi. The experiment was laid out with ten treatments and three replications in a randomized block design. Different concentrations of mepiquat chloride (MC) (50, 75 and 100 g a.i. ha^{-1}) were sprayed at different growth stages (At initiation of shooting, at initiation of flowering and at 15 days after initiation of flowering) of crop. Growth parameters observations were recorded at45 and 60 days after sowing. Significant results were obtained in T_3in growth and yield parameters compare to other treatments and control. Reduced vegetative growth, higher yield and good quality fruits were recorded in treatment T_3 compare to other treatments.

Keywords: Pumpkin, mepiquat chloride, vine length, leaf area, growth, yield

Introduction
Pumpkin (*Cucurbita moschata* L.) is one of the popular and important vegetable among cucurbits and native to Central America (Ahmad and Khan, 2019) [1]. It is a climbing or creeping monoecious annual plant. The leaves have 3-5 rounded or obtuse apiculate lobules, the central one is higher than lateral ones. Stem is slightly angulated with 3-5 forked tendrils. Flowers are pentamerous, solitary and axillary. The fruit vary greatly in shape and size and it is soft and generally not fibrous. The flesh is sweet with numerous seeds. (Ntui *et al*., 2017) [9].
It is famous for its fruits and its edible seeds. The most important part is fruit and the second most important part is low-fat and protein-rich seeds. Fruit flesh contains 559 kCal of energy, 28% of water, 4g of fat, 2g of fibre and 24mg of Ca, 475mg of P, 175mg of Fe, 1mg of Na, 340mg of K, 7g of total carbohydrate, 2,8g of Sugar, 1g of Protein and is free of cholesterol (Devi *et al*., 2018) [3].
The main pumpkin producing countries are China, India, Russia, Ukraine, the United States of America and Mexico. The area and production of pumpkin in India was 94,000 ha and 2030,000 MT respectively. It is widely cultivated in states such as Orissa, Uttar Pradesh, Madya Pradesh, Chhattisgarh, Karnataka, Haryana, Kerala and Tamil Nadu. The highest production was 532820 tons in Madhya Pradesh, whereas in Karnataka it is 78610 ton (Anon., 2022) [2].
Pumpkin is considered a high value vegetable crop due to its high nutritional content, market value, storability and long-term availability with improved transport potential. There is therefore a need to increase the yield. The exogenous application of a plant growth retardant may have the potential to control both the morphology and physiology of plants without changing any development.
Mepiquat chloride is an anti-gibberellin compound that controls vegetative growth and accelerates the development of reproductive parts by reducing the length of the vine and the spread of the plant, thus reducing the distance between the source and the sink in order to improve the translocation of photo syntheses to fruit development (Rademacher, 2000) [11].
Therefore, the objectives of the experiment were
1. To study the effect of mepiquat chloride on growth of pumpkin.
2. To study the effect of mepiquat chloride on yield of pumpkin.

Materials and Method

The field experiment was conducted during the Kharif season (June to November) 2019 at the Department of Horticulture, College of Agriculture, UAS, GKVK Bengaluru. The area is at 12o 58' North latitude and 77o 35' East longitude, at an altitude of 830 m above Mean Sea Level (MSL). The experimental site nutrient status was 325.46 kg ha^{-1}, 142.3 kg ha^{-1} and 34.4 kg ha^{-1} nitrogen, phosphorus and phosphorus.

Land preparation/Experimental design

The total experimental area (478.5m^2) was thoroughly ploughed to a depth of 30 meters and the soil was brought to a fine tilth. Farm Yard Manure (FYM) at a rate of 25 tons per hectare applied 2-3 weeks prior to sowing. The raised beds, 30 cm in height, 23 m in length and 100 cm in width, were prepared leaving a space of 45 cm between two beds as a path for easy cultural operations. Drip irrigation laterals were laid after field preparation while at bed preparation, a basal dose of 30 kg of nitrogen and phosphorus per hectare and 60 kg of potash per hectare was added and well mixed in the soil. After preparation of beds, a bicolored polythene sheet of 30 micron size used as a mulching sheet to control weeds. Arka Suryamukhi seeds were obtained from the Indian Institute of Horticulture Research, Bengaluru (IIHR) and planted at a distance of 2.2m x 1.2m and the experimental seed was produced in Randomized Complete Block Design (RCBD) with 10 treatments and 3 replicates.

Treatment details of experiment

The experiment consisted of 10 treatments replicated three times. Mepiquat chloride was taken at three concentrations of 50, 75 and 100g a.i. Ha^{-1}, which was used at the three growing stages of the crop, namely the initiation of shooting (T_1, T_2 and T_3), the initiation of flowering (T_4, T_5 and T_6) and the 15 days following the initiation of flowering (T_7, T_8 and T_9) and the control of T_{10}.

Data collected

The data pertaining to various vegetative growth (45 and 60 Days After Sowing), yield and yield attributing parameters from five randomly selected and labelled plants in each replication of the treatment.

Growth parameters

1. Vine length (cm): The length of the vine of five labelled plants was recorded three times (45 and 60 days after sowing). The length of the vine was measured from the ground level to the tip using the meter scale and the mean was calculated and expressed in centimetres.

2. Leaf area (cm^2): The leaf area was measured 45 and 60 days after sowing using a leaf area meter. Five matured leaves were collected from the selected plants of all treatments and placed on the area meter of the leaf and averaged and expressed in cm^2 were recorded.

3. Chlorophyll content (SPAD value): Leaf chlorophyll content was measured using SPAD meter, all SPAD values were recorded from plants 45 and 60 days after each treatment and averaged to make an appropriate estimate of the chlorophyll content of the leaf.

4. Internodal length: The length of the internodal was measured from the 10th to the 15th node and at the 20th leaf expansion stage in centi-meters from each labelled plant at 45 and 60 days after sowing and the mean internodal length was calculated.

Yield and Yield attributing parameters

1. Number of fruits/plant: The number of fruits from all five tagged plants were counted and average was calculated and recorded as number of fruits per plant.

2. Average fruit weight (kg): Average fruit weight was calculated by taking individual fruit weight of each plant in each treatment and averaged.

3. Fruit yield/ha: Total weight of fruits harvested from the tagged plants in each replication was recorded till final harvest and the total yield of fruits per hectare under different treatments was computed in tonnes per hectare.

4. Fruit diameter (cm): - Fruit diameter was measured with the help of measuring scale after cutting of fruit into two equal halves and mean was calculated.

Data analysis

Data was collected and subjected to analysis of variance and significant means using XLSTAT software, then they were separated using least significant difference (LSD) at 5 per cent level of probability.

Results and Discussion

Effect of mepiquat chloride on growth parameters

There was marked variations in the vine length, leaf area, chlorophyll and inter nodal length at different stages of growth due to different treatments.

1. Effect of mepiquat chloride on vine length

The information on the length of the vine presented in Table 1 clearly shows that all the treatments significantly reduced the length of the vine compared to the control. The highest reduction in the length of the vine was observed in T_3 with an application of 100 g a.i. Ha^{-1} mepiquat chloride at the start of the shooting (early vegetative growth).

Table 1: Effect of mepiquat chloride on vine length (cm)on pumpkin (*Cucurbita moschata* L.) variety Arka Suryamukhi

Treatments	45 DAS	60 DAS
T_1-50 g a.i. ha^{-1} MC at initiation of shooting	183.62	301.54
T_2-75 g a.i. ha^{-1} MC at initiation of shooting	172.39	283.23
T_3-100 g a.i. ha^{-1} MC at initiation of shooting	163.39	255.13
T_4-50 g a.i. ha^{-1} MC at initiation of flowering	186.71	307.09
T_5-75 g a.i. ha^{-1} MC at initiation of flowering	177.43	293.12
T_6-100 g a.i. ha^{-1} MC at initiation of flowering	169.00	272.03
T_7-50 g a.i. ha^{-1} MC at 15 days after initiation of flowering	204.37	315.73

T_8-75 g a.i. ha^{-1} MC at 15 days after initiation of flowering	196.11	297.27
T_9-100 g a.i. ha^{-1} MC at 15 days after initiation of flowering	192.59	290.72
T_{10}-Control	222.30	351.72
F test	*	*
Mean	186.79	296.76
S. Em±	3.45	4.27
CD at 5%	10.27	12.70

*Significant @5% level.
MC: Mepiquat chloride.
a.i.: Active ingredient.
DAS: Days after sowing.

2. Effect of mepiquat chloride on internodal length

The analysis of the internaldal length data presented in Table 2 clearly shows that all treatments significantly reduced the internaldal length compared to the control. The highest reduction in internaldal length was observed in T_3 with the application of 100 g a.i. Ha^{-1} mepiquat chloride at the start of the shooting (early vegetative growth).

Table 2: Effect of mepiquat chloride on internodal length (cm)on pumpkin (*Cucurbita moschata* L.) variety Arka Suryamukhi

Treatments	45 DAS	60 DAS
T_1-50 g a.i. ha^{-1} MC at initiation of shooting	9.21	10.53
T_2-75 g a.i. ha^{-1} MC at initiation of shooting	9.20	10.47
T_3-100 g a.i. ha^{-1} MC at initiation of shooting	7.77	8.90
T_4-50 g a.i. ha^{-1} MC at initiation of flowering	11.04	13.31
T_5-75 g a.i. ha^{-1} MC at initiation of flowering	10.86	13.04
T_6-100 g a.i. ha^{-1} MC at initiation of flowering	10.50	12.26
T_7-50 g a.i. ha^{-1} MC at 15 days after initiation of flowering	13.82	15.82
T_8-75 g a.i. ha^{-1} MC at 15 days after initiation of flowering	13.92	15.54
T_9-100 g a.i. ha^{-1} MC at 15 days after initiation of flowering	13.53	14.79
T_{10}-Control	14.43	19.67
F test	*	*
Mean	11.43	13.43
S. Em±	0.12	0.07
CD at 5%	0.38	0.23

*Significant @ 5% level.
MC: Mepiquat chloride.
a.i.: Active ingredient.
DAS: Days after sowing.

3. Effect of mepiquat chloride on leaf area

The leaf area data as influenced by mepiquat chloride foliar spray recorded at 45 and 60 days after sowing (DAS) and presented in Table 3 show a significant difference in all treatments compared to control and a maximum reduction in leaf area was observed by the use of mepiquat chloride 100g a.i./ha at early vegetative growth (T_3: initiation of shooting) compared to other treatments.

Table 3: Effect of mepiquat chloride on leaf area (cm^2) on pumpkin (*Cucurbita moschata* L.) variety Arka Suryamukhi

Treatments	45 DAS	60 DAS
T_1-50 g a.i. ha^{-1} MC at initiation of shooting	369.57	425.00
T_2-75 g a.i. ha^{-1} MC at initiation of shooting	336.74	381.34
T_3-100 g a.i. ha^{-1} MC at initiation of shooting	319.72	359.68
T_4-50 g a.i. ha^{-1} MC at initiation of flowering	375.63	443.41
T_5-75 g a.i. ha^{-1} MC at initiation of flowering	354.42	393.23
T_6-100 g a.i. ha^{-1} MC at initiation of flowering	328.95	372.46
T_7-50 g a.i. ha^{-1} MC at 15 days after initiation of flowering	389.63	464.63
T_8-75 g a.i. ha^{-1} MC at 15 days after initiation of flowering	396.22	420.64
T_9-100 g a.i. ha^{-1} MC at 15 days after initiation of flowering	384.85	395.83
T_{10}-Control	394.65	478.83
F test	*	*
Mean	361.75	405.36
S. Em±	3.62	4.43
CD at 5%	10.49	13.17

*Significant @ 5% level.
MC: Mepiquat chloride.
a.i.: Active ingredient.
DAS: Days after sowing.

4. Effect of mepiquat chloride on chlorophyll content

The data recorded on the chlorophyll content as influenced by the mepiquat chloride foliar spray recorded 45 and 60 days after sowing (DAS) and presented in Table 4 show a

significant difference in all treatments compared to control and the maximum chlorophyll content was observed when mepiquat chloride was applied 100g a.i./ha at early vegetative growth (T_3: Initiation of shooting) compared to control.

Table 4: Effect of mepiquat chloride on chlorophyll content (SPAD-values) on pumpkin (*Cucurbita moschata* L.) variety Arka Suryamukhi

Treatments	45 DAS	60 DAS
T_1-50 g a.i. ha^{-1} MC at initiation of shooting	28.81	29.36
T_2-75 g a.i. ha^{-1} MC at initiation of shooting	29.40	29.86
T_3-100 g a.i. ha^{-1} MC at initiation of shooting	31.44	32.20
T_4-50 g a.i. ha^{-1} MC at initiation of flowering	27.8	28.16
T_5-75 g a.i. ha^{-1} MC at initiation of flowering	29.14	29.63
T_6-100 g a.i. ha^{-1} MC at initiation of flowering	30.27	30.90
T_7-50 g a.i. ha^{-1} MC at 15 days after initiation of flowering	26.33	27.00
T_8-75 g a.i. ha^{-1} MC at 15 days after initiation of flowering	26.94	27.91
T_9-100 g a.i. ha^{-1} MC at 15 days after initiation of flowering	26.57	28.97
T_{10}-Control	25.92	26.22
F test	*	*
Mean	28.27	29.02
S. Em±	0.38	0.40
CD at 5%	1.15	1.21

*Significant @ 5% level.
MC: Mepiquat chloride.
a.i.: Active ingredient.
DAS: Days after sowing.

5. Effect of mepiquat chloride on yield and yield parameters

Influence of mepiquat chloride on yield and yield attributing parameters such as number of fruits per plant, average fruit weight, fruit yield per hectare and fruit diameter are shown in Fig 1 which shows a significant difference between different treatments. The maximum number of fruits per plant, average fruit yield, fruit yield per hectare and fruit diameter was recorded in treatment T_3 (application of 100 g a.i at initiation of shooting).

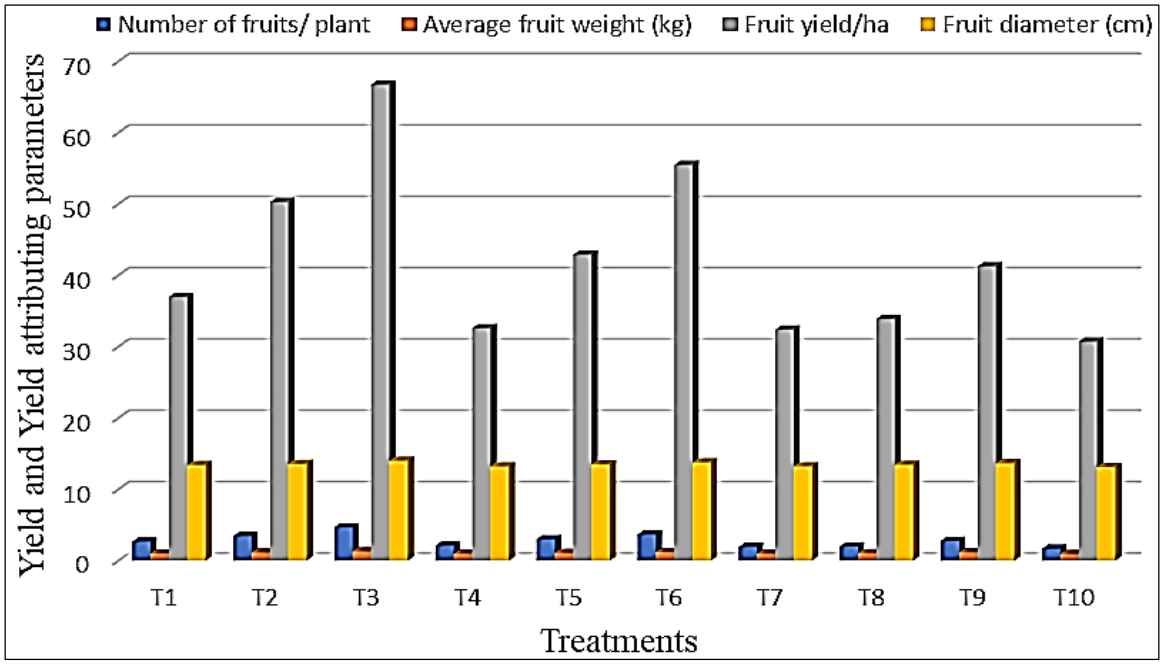

Fig 1: Effect of mepiquat chloride on number of fruits/plant, average fruit weight (kg), fruit yield/ha and fruit diameter on pumpkin (*Cucurbita moschata* L.) variety Arka Suryamukhi

Discussion

The results of the study showed that the highest reduction in the length of the vine and the internal length of the plant was observed in treatment T_3 followed by T_6 and T_2. A study conducted by Ozgur (2011) [10] in cucumber and Kumar *et al.* (2018) [6] in okra reported that the reduction in vine length was due to the anti-gibberellin effect of mepiquat chloride, which reduces the inner concentration of gibberellin.

Based on the data recorded, it was known that there was a significant reduction in the leaf area by increasing the concentrations of mepiquat chloride applied at the early vegetative growth stage of the crop. This may be due to reduced cell size in the cortical region and inhibits cell expansion. A comparable study was conducted by Sheng (2011) [12] in cucumber and Flores *et al.* (2018) [4] in cucurbits.

The application of growth retardant at a high concentration significantly increases the chlorophyll content of the leaves. It

is due to inhibition of the chlorophyllase synthesis of the enzyme involved in the degradation of chlorophyll and also induces grana cell synthesis and chloroplast synthesis. Similar results were reported in a study conducted by Sheng (2011) [12] in cucumber.

The highest number of fruits per plant by application of plant growth retardant is due to an increase in the number of branches with the highest number of pistillate flowers and also to a successful pollination. Mir *et al*. (2019) [7] recorded similar results in cucumber.

The maximum average fruit weight, fruit yield per ha and fruit diameter might be due to improved physiological activity like photosynthesis and translocation of food material that supports better fruit development which in turn increase the weight and size of the fruit thereby fruit yield per hectare and fruit diameter increased. A comparable study was done by Hidayatullah *et al.* (2009) [5] in cucumber and Mir *et al.* (2019) [7] in cucumber.

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