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# Mepiquat Chloride: An effective plant growth regulator to improve growth and productivity of rice in North-Western Himalayan region of India

S. K. YADAV*, D. K. SINGH, KIRTI SHARMA, PRATIMA ARYA, SUPRIYA TRIPATHI and YOGESH SHARMA

*Department of Agronomy, College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar-263145 (U. S. Nagar, Uttarakhand)*
**Corresponding author's email Id: santosh.yadav87@gmail.com*

**ABSTRACT:** The present investigation an effective plant growth regulator to improve growth and productivity of rice in North-Western Himalayan region of India was conducted at NEB Crop Research Centre of G. B. Pant University of Agriculture and Technology, Pantnagar. The eight treatment combinations *viz* Mepiquat Chloride 5% AS 50 g a.i./ha in 1000 mL/ha at MT ($T_1$), Mepiquat Chloride 5% AS 62.5 g a.i./ha in1250 mL/ha at MT ($T_2$), Mepiquat Chloride 5% AS 125g a.i./ha in2500 mL/ha at MT ($T_3$), Mepiquat Chloride 5% AS 50g a.i./ha in1000 mL/ha at PI ($T_4$),Mepiquat Chloride 5% AS 62.5g a.i./ha in1250 mL/ha at PI ($T_5$),Mepiquat Chloride 5% AS 125ga.i./ha in2500 mL/ha at PI ($T_6$),Mepiquat Chloride 5% AS 50ga.i./ha in1000 mL/ha at MT and PI($T_7$) and Untreated Control 100 RDF($T_8$) were evaluated with three replications under completely Randomized Block Design. The experiment was evaluated to see the effect of above treatments towards Growth, Yield and Productivity of Rice. The result of study revealed that treatment Mepiquat Chloride 5% AS 62.5 g a.i./ha in1250 mL/ha at MT stageresulted in significantly higher grain, straw and biological yield than all other treatments. Therefore, it was concluded that treatment Mepiquat Chloride 5% AS 62.5 g a.i./ha in1250 mL/ha at MT stage could be recommended for sustaining yield and productivity of rice under *tarai* conditions of Uttarakhand.

**Key words:** Growth, Mepiquat Chloride, Mid tillering, Panicle Initiation, *Oryza sativa*, productivity

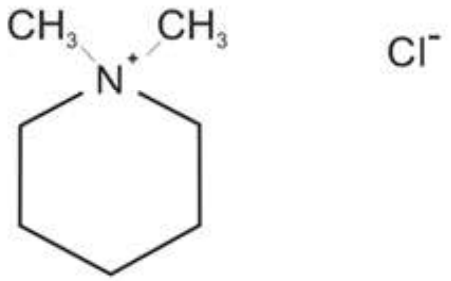
Rice (*Oryza sativa* L.) is the staple food of about 3 billion people and demand is expected to continue to grow as population increases. Globally rice is grown over an area of about 149 million ha with an annual production of 600 million tones. In India, rice is of cultivated round the year in one or the other part of the country, in diverse ecologies spread over 44.6 Mha with a production of 132 MT of rice and average productivity of 2.96 t/ha.

In India, rice is cultivated in both winter and summer seasons, West Bengal, Uttar Pradesh, Andhra Pradesh, Punjab, Tamilnadu, Bihar, Orissa, Assam, Karnataka and Haryana are ten major Rice producing states which account for more than 80% rice production in India.

Plant growth regulators play important roles in plant growth and development, but little is known about the roles of plant growth regulators in improving the yield components and yield of rice. Endogenous plant growth regulators determine many growths and development processes ultimately manifesting yield components and yield. Plant growth regulators are known to enhance the source-sink relationship and stimulate the translocation of photo-assimilates thereby helping in effective flower formation, fruit and seed development and ultimately enhance productivity of the crop. Growth regulators can improve the physiological efficiency including photosynthetic ability and can enhance the effective partitioning of accumulates from source to sink in the field crops (Solamani *et al.*, 2001). Use of growth regulators viz. mepiquat chloride and chlormequat chloride increases photosynthetic rate by increasing leaf chlorophyll content and mesophyll cell size which is due to more rapid exchange of $CO_2$into mesophyll cell by virtue of their large surface area (Dulizhao and Derrick. 2000).

Mepiquat Chloride (MC, 1, 1-dimethyl piperidinium chloride) is one of the most widely used as plant

growth retardants with structural formula as follows:




The mepiquat chloride is mostly absorbed by the green parts of the plant and can be included in the group of gibberellic acid biosynthesis inhibitor, which makes it an inhibitor of cell elongation (Lamas, 2001). It belongs to chemical group Quaternary Ammonia, which has the mode of action Quaternary Ammonia, characterized by the inhibition of branches growth (Wanderley *et al.*, 2011). The effects of mepiquat chloride on the overgrowth of plants is associated to the reduction stem extension, fewer nodes, shorter branches and decreased leaf area (Fernandez *et al.*, 1991). Regarding to the dose to be used, according Wallace *et al.* (1993), its subdivision has more marked effect compared to the single dose application on plant height, number of nodes and length of internodes. The definition of an appropriate dosage to be applied is one of the main difficulties in growth regulators recommendation (Athayde and Lamas, 1999), since the results expected using the recommended doses are not always achieved. The impact of mepiquat chloride on stem elongation and plant height are temperature dependent (Reddy *et al.*,1992) and at high temperatures higher PGR rates are needed to control plant growth (Rosolem *et al.,* 2013). Now a day the PGR management in crops has been a challenge for growers as weather instability has increased in recent years. Keeping the above fact in view an experiment was formulated and study was undertaken on effect of PGR's on Rice at NEB Crop Research Centre of G. B. Pant University of Agriculture and Technology, Pantnagarunder the investigation entitled "An effective plant growth regulator to improve growth and productivity of rice in North-Western Himalayan region of India"during *kharif* season of 2018 and 2019.

## MATERIALS AND METHODS

The experiment was conducted at NEB Crop Research Centre G. B. Pant University of Agriculture and Technology Pantnagar during *Kharif* 2018 and 2019. "An effective plant growth regulator to improve growth and productivity of rice in North-Western Himalayan region of India." Experiment was laid out in Randomized Block Design (RBD) with three replications. The rice variety HKR-47 tested under different plant growth regulator (Mepiquat Chloride 5% AS) doses at different stages i.e., at MT andPI. The treatment consist of eight treatment *viz.,* $T_1$(Mepiquat Chloride 5% AS 50 g a.i./ha in 1000 mL/ha at MT), $T_2$(Mepiquat Chloride 5% AS 62.5 g a.i./ha in1250 mL/ha at MT), $T_3$(Mepiquat Chloride 5% AS 125g a.i./ha in2500 mL/ha at MT), $T_4$(Mepiquat Chloride 5% AS 50g a.i./ha in1000 mL/ha at PI), $T_5$(Mepiquat Chloride 5% AS 62.5g a.i./ha in1250 mL/ha at PI), $T_6$(Mepiquat Chloride 5% AS 125ga.i./ha in2500 mL/ha at PI),$T_7$(Mepiquat Chloride 5% AS 50ga.i./ha in1000 mL/ha at MT and PI) and $T_8$(Untreated Control100% RDF) applied as plant growth regulator (Mepiquat Chloride 5% AS) at Mid-tillering and Panicle Initiation Stages by foliar application and observations were recorded as:

**Climate and Weather:** The belt falls under sub-humid and sub-tropical climate zone with hot dry summers and cool winters. Generally, south-west monsoon sets in the first week of June and continue up to end of September with its peak in August.

**Effect on plant attributes:**

i. Plant height at 0, 15, 30 days and at harvest after spray of 16 randomly selected plants in each replication/treatment.
ii. Number of tillers per plant at 0, 15, 30 days and at harvest after spray of 16 randomly selected plants in each replication/treatment.

**Effect on yield attributes:**

i. Average panicle length (cm)
ii. 1000 grain weight (g)

iii. Grain yield (t/ha)

**Site of Experiment:** The site of experiment is situated at an altitude of 243.84m above mean sea level, $29^0$ Latitude and $79.3^0$E longitude. It falls under foot hills of shivalik range of Himalayas as a narrow belt called "*Tarai*."

## RESULTS AND DISCUSSION

### Growth parameters

#### *Plant Height*

Plant height decreased due to application of Mepiquat Chloride 5% AS. However, the minimum plant height 15 days after application during 2018 was obtained in Mepiquat Chloride 5% @ 125 g a.i. /ha at Mid tillering 71 cm($T_3$) followed by Mepiquat Chloride 5% @ 62.5 g a.i. /ha at Mid tillering 73 cm ($T_2$) which were *at par* but differed significantly from rest of the treatments. However maximum plant height was recorded in untreated control (82 cm). Similar trend was noticed in 30 days after application and at harvest.

Plant height varied non significantly at 0 days after application and minimum plant height 15 days after application in 2019, was obtained in Mepiquat Chloride 5% @125 g a.i. /ha at Mid tillering 72 cm ($T_3$) followed by Mepiquat Chloride 5% @ 62.5 g a.i. /ha at Mid tillering 74.3 cm ($T_2$) which were *at par* but differed significantly from rest of the treatments. However maximum plant height was recorded in untreated control (83 cm). Similar trend was noticed in 30 days after application and at harvest (Table 1).

#### *No. of tillers per plant*

No. of tillers/$m^2$ varied non significantly at 0 days after application. The maximum no. of tillers/$m^2$at 15 days after application in 2018 was obtained in ($T_3$) Mepiquat Chloride 5% @ 125 g a.i. /ha at Mid tillering (162) followed by ($T_2$) Mepiquat Chloride 5% @ 62.5 g a.i. /ha at Mid tillering (159) which were *at par* but differed significantly from rest of the treatments. However, minimum number of tillers/ $m^2$ was recorded in untreated control (145). Similar trend was noticed in 30 days after application and at harvest.

**Table 1: Plant height (cm) of rice as influenced by different treatments during *Kharif*, 2018and 2019**

| Treatments | Plant height (cm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0 days after spray | | 15 days after spray | | 30 days after spray | | At final harvest | |
| | 2018 | 2019 | 2018 | 2019 | 2018 | 2019 | 2018 | 2019 |
| $T_1$: Mepiquat Chloride 5% @ 50 g a.i./ha at Mid tillering | 52 | 53.5 | 76 | 77.1 | 87 | 89.1 | 117 | 119.3 |
| $T_2$: Mepiquat Chloride 5% @ 62.5 g a.i./ha at Mid tillering | 53 | 54.6 | 73 | 74.3 | 84 | 86 | 111 | 113.4 |
| $T_3$: Mepiquat Chloride 5% @ 125 g a.i./ha at Mid tillering | 52 | 53.4 | 71 | 72 | 82 | 84.2 | 106 | 108.2 |
| $T_4$: Mepiquat Chloride 5% @ 50 g a.i./ha at Panicle initiation | 51 | 53 | 80 | 81.5 | 91 | 93.5 | 124 | 126.1 |
| $T_5$: Mepiquat Chloride 5% @ 62.5 g a.i./ha at Panicle initiation | 51 | 54 | 79 | 80.4 | 90 | 92 | 121 | 123 |
| $T_6$: Mepiquat Chloride 5% @ 125 g a.i./ha at Panicle initiation | 52 | 53.7 | 77 | 78.2 | 88 | 90 | 119 | 121.8 |
| $T_7$:Mepiquat Chloride 5% @ 50 g a.i./ha (Two spray 1st spray at Mid tillering stage followed by 2nd spray at Panicle initiation Stage | 53 | 53.4 | 75 | 76 | 86 | 88 | 114 | 116.4 |
| $T_8$: Untreated Control | 50 | 52.9 | 82 | 83 | 93 | 97 | 120 | 125 |
| $SE_m\pm$ | 1.5 | 1.3 | 1.3 | 1.06 | 1.26 | 1.17 | 1.58 | 2.59 |
| CD(p=0.05) | NS | NS | 3.89 | 3.17 | 3.77 | 3.51 | 4.73 | 7.77 |

No. of tillers/$m^2$ varied non significantly at 0 days after application and maximum no. of tillers/$m^2$ at 15 days after application in 2019, was obtained in ($T_3$)Mepiquat Chloride 5% @ 125 g a.i. /ha at Mid tillering (165) followed by ($T_2$) Mepiquat Chloride 5% @ 62.5 g a.i. /ha at Mid tillering (162) which were *at par* but differed significantly from rest of the treatments. However, minimum No. of tillers/ $m^2$ was recorded in untreated control (148). Similar trend was noticed in 30 days after application and at harvest (Table 2). This may be due to application of growth regulator enhanced the better root growth and nutrients uptake which leads to increased plant height and differentiation. The similar result was reported by different workers (Prakash *et al.*, 2006). It may be due to the application of growth regulator enhanced the better physiological phenomena and nutrients uptake which leads to increased number of branches (Prakash *et al.,* 2003).

## Yield Attributes of Rice

### *Number of Panicles / $m^2$*

No. of Panicles/$m^2$in 2018 (Table 3) was recorded maximum in Mepiquat Chloride 5% @ 125 g a.i./ha at Mid tillering 271($T_3$) followed by Mepiquat Chloride 5% @ 62.5 g a.i./ha at Mid tillering 270($T_2$) which were *at par* but differed significantly from rest of the treatments. However minimum No. of Panicles / $m^2$were recorded in untreated control (231). Similar trend was noticed in 2019.

### *Average Panicle Length (cm)*

Average Panicle Length (cm) in 2018 (Table 3) was maximum in Mepiquat Chloride 5% @ 125 g a.i./ha at Mid tillering 24.4cm($T_3$) followed by Mepiquat Chloride 5% @ 62.5 g a.i. /ha at Mid tillering 23.3cm($T_2$) which were *at par* but differed significantly from rest of the treatments. However minimum average Panicle Length (cm) was recorded in untreated control (14.1cm) similar trend was noticed in 2019.

### *1000 Grain weight (g)*

1000 Grain weight (g) in 2018 (Table 3) was maximum in Mepiquat Chloride 5% @ 125 g a.i./ha at Mid tillering 25.2g($T_3$) followed by Mepiquat

**Table 2: Number of Tillers/$m^2$ of rice as influenced by different treatments during *Kharif*, 2018 and 2019**

| Treatments | No. of Tillers/$m^2$ (cm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0 days after spray | | 15 days after spray | | 30 days after spray | | At final harvest | |
| | 2018 | 2019 | 2018 | 2019 | 2018 | 2019 | 2018 | 2019 |
| $T_1$: Mepiquat Chloride 5% @ 50 g a.i./ha at Mid tillering | 132 | 140 | 153 | 156 | 155 | 159 | 161 | 163 |
| $T_2$: Mepiquat Chloride 5% @ 62.5 g a.i./ha at Mid tillering | 135 | 142 | 159 | 162 | 162 | 166 | 168 | 170 |
| $T_3$: Mepiquat Chloride 5% @ 125 g a.i./ha at Mid tillering | 130 | 139 | 162 | 165 | 164 | 168 | 169 | 172 |
| $T_4$: Mepiquat Chloride 5% @ 50 g a.i./ha at Panicle initiation | 137 | 142 | 146 | 149 | 148 | 152 | 154 | 156 |
| $T_5$: Mepiquat Chloride 5% @ 62.5 g a.i./ha at Panicle initiation | 134 | 140 | 147 | 150 | 149 | 153 | 155 | 157 |
| $T_6$: Mepiquat Chloride 5% @ 125 g a.i./ha at Panicle initiation | 133 | 143 | 149 | 152 | 151 | 155 | 157 | 158 |
| $T_7$:Mepiquat Chloride 5% @ 50 g a.i./ha (Two spray 1st spray at Mid tillering stage followed by 2nd spray at Panicle initiation Stage | 136 | 141 | 155 | 158 | 158 | 162 | 164 | 165 |
| $T_8$: Untreated Control | 135 | 142 | 145 | 148 | 147 | 151 | 153 | 155 |
| $SE_m$± | - | - | 2.17 | 2.26 | 1.79 | 1.94 | 1.48 | 2.06 |
| CD(p=0.05) | NS | NS | 6.5 | 6.78 | 5.36 | 5.83 | 4.44 | 6.19 |

**Table 3: Yield attributes of rice as influenced by different treatments during *Kharif*, 2018 and 2019**

| Treatments | No. of Panicles/$m^2$ | | Average Panicle Length (cm) | | 1000 grain wt.(g) | |
|---|---|---|---|---|---|---|
| | 2018 | 2019 | 2018 | 2019 | 2018 | 2019 |
| $T_1$: Mepiquat Chloride 5% @ 50 g a.i./ha at Mid tillering | 261 | 259 | 20.3 | 17.8 | 21.8 | 22.9 |
| $T_2$: Mepiquat Chloride 5% @ 62.5 g a.i./ha at Mid tillering | 270 | 265 | 23.3 | 21.8 | 24.2 | 25.2 |
| $T_3$: Mepiquat Chloride 5% @ 125 g a.i./ha at Mid tillering | 271 | 267 | 24.4 | 23.2 | 25.2 | 26.3 |
| $T_4$: Mepiquat Chloride 5% @ 50 g a.i./ha at Panicle initiation | 255 | 243 | 20 | 16 | 19.9 | 20.9 |
| $T_5$: Mepiquat Chloride 5% @ 62.5 g a.i./ha at Panicle initiation | 258 | 248 | 21.2 | 16.1 | 20.1 | 21.3 |
| $T_6$: Mepiquat Chloride 5% @ 125 g a.i./ha at Panicle initiation | 261 | 259 | 21.4 | 17.9 | 21.2 | 22.4 |
| $T_7$:Mepiquat Chloride 5% @ 50 g a.i./ha (Two spray 1st spray at Mid tillering stage followed by 2nd spray at Panicle initiation Stage | 263 | 259 | 22 | 18.1 | 22.5 | 23.6 |
| $T_8$: Untreated Control | 231 | 239 | 14.1 | 15 | 16.6 | 18.6 |
| $SE_m \pm$ | 2.37 | 2.43 | 0.7 | 1.37 | 0.8 | 0.83 |
| CD(p=0.05) | 7.1 | 7.3 | 2.1 | 4.1 | 2.41 | 2.5 |

**Table 4: Yield attributes of rice as influenced by different treatments *Kharif* (2018 and 2019)**

| Treatments | Grain yield (kg/ha) | | Straw yield (kg/ha) | |
|---|---|---|---|---|
| | 2018 | 2019 | 2018 | 2019 |
| $T_1$: Mepiquat Chloride 5% @ 50 g a.i./ha at Mid tillering | 5390 | 5452 | 5186 | 5200 |
| $T_2$: Mepiquat Chloride 5% @ 62.5 g a.i./ha at Mid tillering | 5798 | 5898 | 5570 | 5616 |
| $T_3$: Mepiquat Chloride 5% @ 125 g a.i./ha at Mid tillering | 5839 | 5912 | 5604 | 5712 |
| $T_4$: Mepiquat Chloride 5% @ 50 g a.i./ha at Panicle initiation | 5381 | 5452 | 5116 | 5240 |
| $T_5$: Mepiquat Chloride 5% @ 62.5 g a.i./ha at Panicle initiation | 5423 | 5554 | 5218 | 5396 |
| $T_6$: Mepiquat Chloride 5% @ 125 g a.i./ha at Panicle initiation | 5564 | 5671 | 5332 | 5464 |
| $T_7$:Mepiquat Chloride 5% @ 50 g a.i./ha (Two spray 1st spray at Mid tillering stage followed by 2nd spray at Panicle initiation Stage | 5686 | 5735 | 5450 | 5576 |
| $T_8$: Untreated Control | 4892 | 4711 | 4554 | 4440 |
| $SE_m \pm$ | 50.37 | 58.4 | 51.04 | 44.81 |
| CD(p=0.05) | 151 | 175.2 | 153.11 | 134.44 |

Chloride 5% @ 62.5 g a.i./ha at Mid tillering 24.2g($T_2$) which were *at par* but differed significantly from rest of the treatments. However minimum 1000 Grain weight (g) was recorded in untreated controls (16.6g). Similar trend was noticed in 2019.This might be due to higher No. of Panicles / $m^2$ and test weight, the highest factor for the higher values of these parameters might be due to increased uptake of nutrients by crop by effective translocation of nutrients from source to sink (reproductive area of crop).

***Grain yield (Kg/ha)***

Grain yield (Kg/ha) in 2018 (Table 4) was maximum in Mepiquat Chloride 5% @ 125 g a.i./ha at Midtillering5839($T_3$) followed by Mepiquat Chloride 5% @ 62.5 g a.i./ha at Mid tillering 5798($T_2$) which were *at par* but differed significantly from rest of the treatments. However minimum Grain yield (Kg/ha) was recorded in untreated control (4892). Similar trend was noticed in 2019 (Table 5). Grain yield (Kg/ha) was maximum in Mepiquat Chloride 5% @ 125 g a.i. /ha at Mid tillering 5912($T_3$) followed by Mepiquat Chloride 5% @ 62.5 g a.i. /ha at Mid tillering 5898($T_2$) which were *at par* but differed significantly from rest of the treatments. However minimum Grain yield (Kg/ha) was recorded in untreated control (4711).

***Straw Yield (Kg/ha)***

Straw Yield (Kg/ha) in 2018 (Table 4) was maximum in Mepiquat Chloride 5% @ 125 g a.i. /ha at Mid tillering 5604($T_3$) followed by Mepiquat Chloride 5% @ 62.5 g a.i. /ha at Mid tillering 5570 ($T_2$) which were *at par* but differed significantly from rest of the treatments. However minimum Straw Yield (4554Kg/ha) was recorded in untreated control. Similar trend was noticed in 2019 (Table 5). Straw Yield (Kg/ha) was maximum in Mepiquat Chloride 5% @ 125 g a.i. /ha at Mid tillering 5712($T_3$) followed by Mepiquat Chloride 5% @ 62.5 g a.i. / ha at Mid tillering 5616($T_2$) which were at par but differed significantly from rest of the treatments. However minimum Straw Yield (Kg/ha) was recorded in untreated control (4440). This may be due to application of plant growth regulators at the initial stages might have been effectively absorbed and translocated to the pods resulting in more number of pods plant-1 in chickpea reported .

## CONCLUSION

It was concluded that Mepiquat Chloride 5% @ 62.5 g a.i./ha at Mid tillering showed very promising result for almost all the characters as compared to other treatments and increased the yield in rice.

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