



Asian Journal of Plant Sciences

ISSN 1682-3974

science
alert

ANSI*net*
an open access publisher
<http://ansinet.com>

Contribution of Mepiquat Chloride in Drought Tolerance in Cotton Seedlings

¹Muhammad Iqbal, ²Nazia Nisar, ¹Rao Sohail Ahmed Khan and ¹Khezir Hayat

¹Cotton Research Station, Multan, Pakistan

²Department of Plant Breeding and Genetics, University College of Agriculture,
Bahaudin Zikriya University, Multan, Pakistan

Abstract: The objective of this study was to observe water stress tolerance in cotton seeds, when mepiquat chloride is used as seed treatment. Increasing drought resistance of cotton seedlings by accelerating root growth is an important practical implication. The study was conducted on effects of mepiquat chloride (1, 1-dimethyl peperidinum chloride) on drought resistance of cotton seedling. The cotton seeds were soaked for night in mepiquat chloride solution i.e. 0, 500, 1000, 1500 and 2000 ml L⁻¹. Water stress was given after thirty days after sowing, for nine days and data were collected for root length, shoot length, fresh weight and dry weight. Firstly, mepiquat chloride seed treated plants were well irrigated and subjected to severe stress. It indicated that petiole length and shoot length decreased, while root length, fresh weight and dry weight increased with high concentration of mepiquat chloride. Cotton seeds treated with high dose of mepiquat chloride may elongate the days taken to emerge first true leaves. With the withdrawal irrigation, mepiquat chloride treated seedlings at all concentration maintained higher root growth, shorter stem length more fresh and dry weight than non-treated seedlings.

Key words: Mepiquat chloride, drought, cotton, seed treatment

INTRODUCTION

The development of drought tolerant crops has hindered by lack of knowledge of precise physiological parameters that are diagnostic of genetic potential for improved productivity under water deficit conditions. Cotton is especially interesting to study genetic potential for adaptation to water deficit. Cotton originated from perennial plants adapted to semiarid, subtropical environment, which experience periodic drought and temperature extremes^[1]. Adequate emergence and uniform distribution of seedlings are important factors for cotton yield. In many areas, the surface layer of soil becomes dry after cotton seed are sown because of rapid soil water evaporation^[2]. Some seed cannot germinate; some emerged seedlings stop growth or die because their roots cannot reach water in deeper soil layer. The root system is vital for plants to grow and develop well and the lateral roots are very important for the initiation and development of roots^[3]. This will surely contribute to raising strong seedling and enhanced the resistance of plant to adverse conditions like lower temperature and water stress. It is reported that the initiation and growth of cotton roots are interrupted when the soil temperature decreases below 14.5°C^[4]. Therefore, increasing drought resistance of cotton seedling by accelerating root growth has important implication.

Recently much attention has been devoted to modify the root system to reduce water stress and increase water use efficiency^[5,6]. These approaches mainly included breeding or selecting new varieties, modifying the soil environment, altering crop management and changing plant growth.

Mepiquat chloride is a plant growth retardant that has been used worldwide on cotton fields to harmonize vegetative growth and enhance lint yield. It is also reported to promote initiation and viability of lateral roots but its mechanism is unclear yet. Wendt *et al.*^[7] found that the application of mepiquat chloride increased water potential of leaves and transpiration rate. Unwiller and Oosterhuis^[8] reported that foliar or root application of mepiquat chloride has tendency to increase cotton seedling drought resistance and survival under severe water stress and to determine the effect of mepiquat chloride on growth.

MATERIALS AND METHODS

The experiment was conducted at Cotton Research Station, Multan. The purpose of the experiment was to evaluate the effect of mepiquat chloride on cotton seedling. The cotton seeds of CIM-499 were soaked in mepiquat chloride solutions of 0, 500, 1000, 1500 and 2000 ml L⁻¹ concentration in deionized water, for a night.

The cotton seeds were grown in pots in green houses in Complete Randomized Design with three replications. The temperature during the experiment was maintained at 31/21°C day/night and humidity at 60-70%. The pots were filled with equal amount of sandy loam soil to maintain the homogeneity of replications. The soil of these pots was sterilized by formaldehyde to kill the soil microbes. Thirty days after sowing, the cotton seedlings were put under water stress by giving the water to pots after 9 days in each treatment.

The data were recorded for petiol length (1st true leaf 2nd true leaf and 3rd true leaf), root length, shoot length, fresh weight and dry weight. Before the emergence of true leaves, the data were recorded after every three days. After the emergence of true leaves, the irrigation was stopped for nine days and the data of root length, shoot length, fresh weight and dry weight were taken after nine days. Then the data statistically analysed^[9].

RESULTS AND DISCUSSION

From Table 1, it is evident that the significant difference exist among the treatment for all traits that studied upto three leaves emergence under normal irrigation. The petiol length of the 1st, 2nd and 3rd true leaves decreases significantly with the application of mepiquat chloride and maximum decrease in petiol length was 1.6 mm at the mepiquat chloride application at the rate of 2000 ml L⁻¹ of water as compared to 3.1 mm in the plants of without mepiquat chloride treatment. It indicted that the petiol length of leaves shorten with application of mepiquat chloride when applied through seed treatment. Root length of plant increased significantly with the application dose (Table 2). The shoot length of the plant decreases significantly with the application of mepiquat chloride as compared to normal sowing and decrease was gradual with the increase of mepiquat chloride dose

(Table 2). It was also observed that days required to emerge true leaves in mepiquat chloride treatment as compared to normal plants are more and maximum 12 days were taken to emerge 1st true leave in mepiquat chloride application at the rate of 2000 ml L⁻¹. The fresh and dry weight also increased significantly from normal plants and maximum fresh and dry weighs were recorded in high dose treatment of mepiquat chloride, but the difference among T₄ and T₅ was non-significant (Table 2).

Table 3 showed that significant difference exists among treatments for root length, shoot length, fresh weight and dry weight after giving the water stress. The root length increased significantly with the increase of mepiquat chloride application but the difference was non-significant between T₄ and T₅ and T₃ and T₄, which indicated that under water stress, mepiquat chloride application induced the deeper growth to absorb more water stress, mepiquat chloride accelerated root growth under drought by the treatments. The treatment which mepiquat chloride accelerated inhibited stem elongation that changed in petiol length (Table 2). Mepiquat chloride treated plants were shorter and more compact than the control. The appearance of new leaves after germination also delayed by mepiquat chloride treatment, but difference between control and treated roots was small with time. The influence of mepiquat chloride on shoot length, fresh weight and dry weight varied with the concentration. There was no significant difference in shoot length between 500 ml L⁻¹ mepiquat chloride treated and control seedlings after germination. The same general growth pattern was observed for 1000, 1500 and 2000 ml L⁻¹ mepiquat chloride treated seedling (Table 4). Measurement of fresh weight and dry weight than the control plants. But the differences were non-significant among the mepiquat chloride treated seedlings at the rate of 1500 and 2000 ml L⁻¹ for fresh and dry weight (Table 4).

Table 1: Mean squares of mepiquat chloride treated cotton seedling characters before water stress

SOV	df	Petiol length (mm)			Root lengths (cm)	Shoot length (cm)	Fresh weight (g)	Dry weight (g)
		1st true leaf	2nd true leaf	3rd true leaf				
Treatments	4	1.01*	1.17*	1.38*	0.74*	1.67*	0.023-	0.00063*
Errors	10	0.05	0.04	0.03	0.13	0.07	0.0004	0.00006

*=Significant

Table 2: Average effect of mepiquat chloride treated cotton seedling characters before water stress

Treatments (ml L ⁻¹)	Petiol length (mm)			Root lengths (cm)	Shoot length (cm)	Fresh weight (g)	Dry weight (g)
	1st true leaf	2nd true leaf	3rd true leaf				
0	3.1	2.9	2.2	2.03	5.50	0.38	0.043
500	2.5	2.2	1.6	2.73	5.03	0.46	0.049
1000	2.1	1.7	1.1	3.26	4.83	0.50	0.056
1500	1.9	1.6	0.8	3.33	4.81	0.58	0.073
2000	1.6	1.3	0.5	3.40	4.60	0.60	0.076
Cd _{0.05}	0.4	0.36	0.31	0.65	0.48	0.036	0.014

Table 3: Mean squares of mepiquat chloride treated cotton seedling characters after water stress

SOV	df	Root length (cm)	Shoot length (cm)	Fresh weight (g)	Dry weight (g)
Treatments	4	1.35*	1.19*	0.235*	0.029*
Errors	10	0.04	0.04	0.0004	0.0004

* = Significant

Table 4: Average effect of mepiquat chloride treated cotton seedling characters after water stress

Treatments (ml L ⁻¹)	Root length (cm)	Shoot length (cm)	Fresh weight (g)	Dry weight (g)
0	4.4	5.8	0.72	0.46
500	4.8	5.6	0.86	0.49
1000	4.8	5.1	1.03	0.55
1500	6.0	4.4	1.43	0.67
2000	6.1	4.3	1.45	0.69
Cd _{0.05}	0.36	0.36	0.036	0.036

From this study, it was observed that after withdrawal of irrigation, mepiquat chloride treated seedlings at all concentration maintained higher root growth, water extraction from deep soil layers and inhibited the true leaf emergence at very beginning with maintaining more fresh and dry weight, deep root system and high fresh weight and dry weight are characteristics of drought resistant plants. It suggested that mepiquat chloride treated seedlings were able to produce more phytosynthates, which enhanced seedling survival under water stress. Guasman *et al.*^[10], Huang and Guasman^[11] soaked cotton seeds in 25-100 mg kg⁻¹ mepiquat chloride solution for 8 h but they observed the effect of mepiquat chloride on radical growth only. Abdel-Al and Eid^[12] treated cotton seeds with mepiquat chloride and found no effect on yield, probably because of low concentration they used. Fan^[13] soaked the seeds with mepiquat chloride (1000 mg kg⁻¹) for 24 h and observed the inhibition of short growth even five month after emergence. Present results showed that is real possibility for the use of mepiquat chloride to modified root pattern and increased drought resistance of cotton seedlings. The soaling of cotton seeds in mepiquat chloride was effective in modifying root growth, fresh weight and dry weight for the seedling survival under water stress. It is still further needed to conduct experiment in field environment to determine weather for water stress. The responses of different cotton varieties to mepiquat treatment should be also studied.

REFERENCES

1. Kohel, R.J., 1974. Influence of certain morphological character on yield. *Cotton Growing Rev.*, 51:281-292.
2. Munro, J.M., 1987. *Cotton*. 2nd Edn., Longman Scientific and Techninal. Essex, England.
3. He, Z.P., X.J. Min and P.M. Li, 1998. Physiological effect of plant growth retardant DPC on roots activity of cotton. *J. Beijing Agric. Univ.*, 14: 224-235.
4. Jackson, M.B., 1986. *New Root Formation in Plants and Cuttings*. Horticultural Science and Plant Biotechnology Group (Hortic. 420). Martinus Nijhoff Publisher, pp: 1-200.
5. Jordan, W.R., J.E. Quisenberry and B. Roark, 1981. Contribution of Heat Tolerance and Root Growth Potential in Drought Resistance. In: Brown, J.M., (Ed.), *Proc. Belt. Wide Cotton Proc. Res. Conf.*, Memphis, TN. National Cotton Council, Memphis, TN., pp: 40-41.
6. Passioura, J.B., 1983. Roots and drought resistance. *Agric. Water Manage.*, 7: 265-280.
7. Wendt, C.W., V.R. Isbell, B.C. Stuarat and J.R. Abersathy, 1984. Effect of 1, 1-Diamethyl Piperidinium Piperidinium Chloride on Growth and Water Relations of Cotton in a Semi-arid Enveronment. In: Ory, R.L. and F.R. Ritting (Edn.), *Bioregulation*. DC., pp: 205-213.
8. Unwiller, M.J. and D.M. Oosterhuis, 1996. The effect of the growth regulators pix and IBA on cotton roots growth. *Arkansas Fram Res.*, 35: 5.
9. Steel, R.G.D. and J.H. Torrie, 1980. *Priciples and Procedures of Staistics: A Biological Approach*. 2nd Edn., Mcgrw Hill Book Co. New York.
10. Gausman, H.W., L.I. Dennis and J.D. Burd, 1984. Cotton seed germination as affected by mepiquat. *Plant Growth Regul. Bull.*, 12: 7-9.
11. Huang, S.Y. and H.W. Gausman, 1982. Effect of mepiquat chloride on cotton (*G. Hirsutum* L.) seed germination. *Plant Growth Regul. Soc. Am. Bull.*, 10: 7-8.
12. Abdel-Al, M.H. and E.T. Eid, 1985. Effect of growth retardants on growth, yield and some chemical consitution of cotton plant. *Ann. Agric. Sci., Moshtoho (Cairo)*, 23:41-58.
13. Fan, X.K., 1985. Restraining the growth of cotton seedling by soaking seeds in growth regulators. *Shanghai Agric. Sci. Technol.*, 1: 39-40.