J. Cotton Res. Dev. **38**(2), 193-197 (July, 2024) **ISSN No. 0972-8619**

Evaluation of Osmo Protectants Application in *Bt* Cotton under different Moisture Regimes

KARMAL SINGH MALIK*, SHIWANI MANDHANIA, PRIYANKA DEVI, SWETA MALIK, MEENA SEHWAG, ANITA KUMARI AND JITENDER KUMAR

Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar-125004

**Email : Karmalsingh@gmail.com*

Abstract : A field experiment was carried out at the Cotton Research Area, CCS Haryana Agricultural University, Hisar, during the *kharif*, 2019 and 2020 to study abiotic stress management in *Bt* cotton hybrids through different osmoprotectants. The experiment was conducted under a split plot design with three treatments in main plots S1 (no water stress/control), S2 (No water after irrigation other than rainfall) and S3 (Limited water supply), whereas eight treatments imposed 60–80 DAS in subplots M1: Control (water spray), M2: Foliar application of 2 per cent urea-spray at weekly intervals, M3: Foliar application of 2 per cent KNO3-4 spray at weekly intervals, M4:Foliar application of 1 per cent thiourea, single spray, M5: Foliar application of Salicylic acid at 50 ppm, Single spray, M6: Foliar application of Glycine Betaine @ 100 ppm, Single spray, M7: Foliar application of Salicylic acid @ 100 ppm in a single spray and M8: Foliar application of PFRM @1 per cent three spray at ten day interval with three replications. The application of PPFM at 1 per cent significantly improved the bolls/square meter, boll weight, and seed cotton yield compared to all other management practices except control. The assimilation rate, stomatal conductance, and transpiration rate show significantly higher values at two stress levels than in the case of no water stress treatment.

Key words: : *Bt* cotton, glycine betaine, PPFM, salicylic acid.

Cotton (*Gossypium hirsutum* L.) is a vital fiber crop cultivated under diverse climatic conditions across the globe. The demand for cotton and its by products is increasing day by day due to more consumption of this fiber in the textile industry and the utilization of cotton seed as a source of edible oil. However, the average seed cotton yield in the world is below that of the potential yield of cultivars. The factors responsible for low yields include a shortage of approved seed, pest and disease attacks, weed infestation, unwise use of nutrients, and abiotic stresses (including drought, heat, and salinity). Among these, abiotic stresses are a single major factor responsible for reducing yield and will affect cotton productivity in the future. In India, cotton cultivation was revolutionized after Bt's introduction. Currently, only *Bt* transgenic hybrids or hybrids, are mostly grown. As a result, post *Bt* productivity was exaggerated from 303 kg/ha in 2001–2002 to 526 kg lint/ha in 2008–2009 (Venugopalan *et al.*, 2009); after that, again, there was a decline in cotton productivity, which is still low due to abiotic constraints. Cotton productivity in India is 400 kg/ha (AICRP, Cotton Annual Report, 2022–2023). The growth of cotton plants is strongly influenced by drought and saline environments with osmo protectants. Osmo protectants are enormously proficient and compatible solutes. Plants efficiently use their components and energy to defend against various stresses. Earlier studies have shown that physiological processes are more prone to variable degrees of regulation under adverse conditions (Cramer *et al.*, 2013). Considering this, the experiment was framed to evaluate osmo protectants under three levels of moisture regimes at Hisar.

Table 1: Physiological parameters as affected by different treatments

Treatments	Assimilation rate (umol m^{-2} sec^{-1})		Stomatal conductance (umol m^{-2} sec^{-1})		Transpiration rate (mmol m^{-2} sec^{-1})	
	2019	2020	2019	2020	2019	2020
No water stress/Control/	5.49	4.79	0.18	0.32	3.82	12.62
No water after first irrigation	6.94	4.75	0.23	0.28	4.70	14.74
Limited water supply	6.06	5.23	0.19	0.23	4.72	13.47
CD (p=0.05)	1.06	0.38	0.04	0.03	0.43	NS
Control	5.39	4.24	0.18	0.21	4.34	10.46
Spray 2%	5.23	4.38	0.19	0.25	3.89	12.80
KNo3 (2%)	6.82	4.35	0.21	0.25	4.31	12.79
Thio urea (1%)	4.94	4.82	0.16	0.28	3.63	13.21
Salicylic acid @50 ppm	5.37	5.04	0.18	0.28	4.33	15.90
Glycine Betaine @100 ppm	5.99	5.54	0.22	0.31	4.36	13.23
Salicylic acid @ @ 100 ppm-	7.43	5.50	0.22	0.30	5.34	14.72
PPFM (@1%)	8.14	5.41	0.22	0.32	4.88	15.78
CD at (p-0.05)	1.31	0.51	NS	0.04	0.82	1.50

MATERIALS AND METHODS

The study was conducted on *Bt* cotton hybrid (RCH 650) at the Cotton Research Area, CCS Haryana Agricultural University, Hisar. There were 24 treatment combinations. Sowing was done by dibbling method on the well prepared bed with row to row spacing of 100 cm and plant to plant spacing of 45 cm. Thinning was done to keep the excellent crop standing. Sandy loam with pH (7.91), soil EC (0.12 dSm-1), organic carbon (0.46 %), available N: 247, P2O5: 24.6, and K2O: 297 in kg/ha.

Sowing was done on May 5th, 2019 and April 21st, 2020. All the recommended practices were followed to raise a healthy crop. Observations were recorded as per standard procedures. The height of five tagged plants in each plot was measured at harvest. It was measured from the main stem to the tip of the fully opened leaf at the top and expressed in cm. Data of yield attributing characters was recorded from each plot's five tagged plants, and each plot's seed cotton yield was recorded and converted into kg ha. Data on physiological parameters was recorded using an IRGA (Infrared Gas Analyzer) one week after applying osmo protectants on a fully sunny day. The treatments' economics was calculated on actual expenses, including the rental value, and the production rate was the market rate. Total rainfall during the crop season was 770.2 mm and 384.1 mm. during 2019 and 2020, respectively. The experiment was conducted in a split-plot design along with three replications.

RESULTS AND DISCUSSION

The conditions of water stress and the spraying of different osmo protectants did not caused considerable differences in the data for physiological. Nonetheless, there was no discernible relationship between the state of water stress and the exogenous osmo protectant administration. When the crop treated with pink pigmented facultative methylobacteria (PPFM) @ 1 per cent and salicylic acid was averaged throughout all water stress treatments, their assimilation and transpiration were larger than that of the crop treated with other chemicals and the untreated control (Table 1). The current study's findings concur with those of Umebese *et al.*, (2009), who found when amaranth plants were experiencing a water deficit, the SA spray improved proline synthesis. Consequently, it is clear that spraying the cotton crop enhanced antioxidant activity levels by reducing oxidative stress and raising proline and ascorbic acid contents. Ali *et al.*, (2007) found that two maize cultivars' growth and photosynthetic capability

Table 2: Growth characters and seed cotton yield (kg/ha) as influenced by levels of stress and management

Treatments	Control	Urea spray (@2%)	KNO_3 (@2%)	Thio urea (@1%)	Salicylic acid @50 ppm	Glycine Betaine @100 ppm	Salicylic acid @100 ppm-	PPFM (@1%)	**Mean**	ANOVA	CD at (p=0.5)	SEd
Plant height (cm) at harvest												
No water stress/ Control/	215	202	208	211	210	213	218	214	**211**	Stress	NS	2.59
No water after first irrigation	217	210	206	214	214	210	212	214	**212**	Mgt	NS	3.54
Limited water supply	206	209	201	202	202	204	207	213	**205**	S x M	NS	6.13
Mean	**213**	**207**	**205**	**209**	**209**	**209**	**212**	**214**				
Sympodia at harvest												
No water stress/ Control/	19.84	19.41	22.39	20.49	20.32	19.19	22.34	20.33	**20.54**	Stress	0.70	0.25
No water after first irrigation	20	18.79	18.6	18.61	18.47	19.18	20.03	19.46	**19.14**	Mgt	NS	0.71
Limited water supply	18.5	20.18	18.49	17.98	18	19.34	18.19	18.69	**18.67**	S x M	NS	1.23
Mean	**19.45**	**19.46**	**19.83**	**19.03**	**18.93**	**19.23**	**20.19**	**19.49**				
Bolls/squaremetre												
No water stress/ Control/	75	70	72	74	73	73	78	73	**73**	Stress	NS	2.03
No water after first irrigation	75	66	66	66	71	63	75	75	**70**	Mgt	NS	2.50
Limited water supply	70	72	65	64	61	65	63	70	**66**	S x M	NS	4.33
Mean	73	69	67	68	68	67	72	73				
Boll weight (g)												
No water stress/ Control/	4.25	4.19	4.18	4.12	4.32	4.31	4.33	4.36	**4.26**	Stress	NS	0.06
No water after first irrigation	4.36	4.18	4.14	4.04	4.12	4.22	4.42	4.46	**4.23**	Mgt	0.16	0.08
Limited water supply	4.24	4.12	3.92	3.95	4.06	4.27	4.20	4.60	**4.12**	S x M	NS	0.14
Mean	**4.29**	**4.16**	**4.08**	**4.04**	**4.13**	**4.27**	**4.32**	**4.47**				
Seed cotton yield(kg/ha)												
No water stress/ Control/	3178	2511	2903	3178	2807	2919	2637	3400	**2942**	Stress	NS	173.64
No water after first irrigation	3089	2237	2252	2481	3104	3045	3044	3230	**2810**	Mgt	413.74	204.30
Limited water supply	3452	2430	2741	2504	2245	2763	2822	3333	**2786**	S x M	NS	353.85
	3239	2393	2632	2721	2719	2909	2835	3321				

were decreased when water stress equal to 60 per cent of field capacity was applied. Nevertheless, the negative consequences of water stress were mitigated by the exogenous administration of proline (30 mm).

Mean data (*kharif* 2019 and 2020) for plant height and number of sympodial ranches at harvest revealed that different stress management treatments did not influence both parameters. A significantly higher sympodial

Table 3: Economics as influenced by levels of stress and management

Treatments	Control	Urea spray (2%)	KNo_3 (2%)	Thio urea (1%)	Salicylic acid @ 50 ppm	Glycine Betaine @ 100 ppm	Salicylic acid @ @100 ppm-	PPFM (@1%)	**Mean**
Cost of cultivation (Rs/ha)									
No water stress/Control/	147840	134090	143173	149340	140758	143258	136423	155340	**143778**
No water after first irrigation	141340	123423	124008	129173	142923	141590	141090	147008	**136319**
Limited water supply	152508	130758	138008	132673	126590	138258	139090	152340	**138778**
Mean	147229	129424	135063	137062	136757	141035	138868	151563	
Gross returns (Rs/ha)									
No water stress/Control/	174778	138111	159704	174778	154407	160519	145037	187000	**161792**
No water after first irrigation	169889	123037	123852	136481	170704	167444	167444	177630	**154560**
Limited water supply	189852	133630	150741	137704	123444	151963	155222	183333	**153236**
Mean	178173	131592	144765	149654	149518	159975	155901	18265	
Net returns (Rs/ha)									
No water stress/Control/	26938	4021	16531	25438	13649	17261	8614	31660	**18014**
No water after first irrigation	28549	-386	-156	7308	27781	25854	26354	30622	**18241**
Limited water supply	37344	2872	12733	5031	-3146	13705	16132	30993	**14458**
Mean	30944	2169	9703	12592	12761	18940	17033	31092	
B : C									
No water stress/Control/	1.18	1.03	1.12	1.17	1.10	1.12	1.06	1.20	**1.12**
No water after first irrigation	1.20	1.00	1.00	1.06	1.19	1.18	1.19	1.21	**1.13**
Limited water supply	1.24	1.02	1.09	1.04	0.98	1.10	1.12	1.20	**1.10**
Mean	1.21	1.02	1.07	1.09	1.09	1.13	1.12	1.20	

branches/plant (20.33) were recorded under no water stress conditions as compared to no water after first irrigation (19.46) and limited water supply (18.69) as shown in Table 2. With the ontogeny of plant species, growth is a gradual function of differentiation, cell division, and development. Osmo protectant leaf spraying increased the chemicals' accumulation in the plant system and encouraged physiological and developmental processes linked to growth. The similar results have been reported in canola (Athar *et al.*, 2015). Moisture levels or stress management treatments did not influence the bolls/plant, which is a yield attributing characteristic during both crop seasons. Boll weight (gm) was significantly higher when (PPFM) @ (1%) was sprayed for stress management compared to all other treatments except the foliar application of salicylic acid @100 ppm. Seed cotton yield was significantly higher with application of PPFM @(1%) (3321 kg/ha) compared to all other treatments except control and application of salicylic acid @ 50 ppm (2909 kg/ha) depicted in Table 2. Other researchers have also reported on the growth promoting and protective effects of proline, glycine betaine, and salicylic acid (Bandurska, 2013; Kurepin *et al.*, 2015; Wutipraditkul *et al.*, 2015).

The highest value of the cost of cultivation, gross return, and net returns were computed under no water stress compared to other treatments during both crop seasons. In stress management treatments, the cost of cultivation (Rs. 151563/ha) and net returns (Rs. 31092/-) with foliar application of PPFM @ (1%) were recorded as highest, followed by control (Table 3). According to previous research (Ashraf *et al.*, 2011; Chen and Murata, 2011; Bandurska, 2013), the economic analysis showed that foliar spraying of osmo protectants is the potentially useful, economical, and value for money approach to produce cotton crop successfully under low water availability. The study's findings indicate that exogenous salicylic acid administration at a rate of 100 mg L-1 may be able to maintain cotton crop productivity in situations when there is water stress. Because cotton producers are already quite acclimated to spraying cotton crops to control insect pests during the season, the foliar application of salicylic acid is more economical and value for money. By applying foliar sprays of salicylic acid, glycinebetaine, and proline to cotton crops, farmers might earn a sizable profit.

REFERENCES

AICRP, "Annual Report" 2022-2023. Department of Agriculture Cooperation and Farmer Welfare.

Ali, Q., Ashraf, M. and Athar, H.U.R 2007. Exogenous applied proline at different growth stages enhances growth of two maize cultivars grown under water deficit conditions. *Pak. J. Bot.*, **39**: 1133-44.

Athar, H.-u.-R., Zafar, Z.U. and Ashraf, M. 2015. Glycinebetaine improved photosynthesis in canola under salt stress: Evaluation of chlorophyll fluorescence parameters as potential indicators. *J. Agron. Crop Sci.*, **201**: 428-42.

Ashraf, M., Akram, N.A., Al-Qurainy F. and Foolad, M.R. 2011. Drought tolerance: roles of organic osmolytes, growth regulators, and mineral nutrients. In: Adv. Agron. (Ed.): *Donald, L.S. Academic Press*, pp. 249-96.

Bandurska, H. 2013. Salicylic acid: an update on biosynthesis and action in plant response to water deficit and performance under drought. In: Salicylic Acid: Plant growth and development. (Eds.): Hayat, S., A. Ahmad and M.N. Alyemeni. *Springer Netherlands*, The Netherlands, pp. 1-14.

Cramer, G. R., Van Sluyter, S. C., Hopper, D. W., Pascovici, D., Keighley, T., and Haynes, P. A. 2013. Proteomic analysis indicates massive changes in metabolism prior to the inhibition of growth and photosynthesis of grapevine (*Vitis vinifera* L.) in response to water deficit. BMC *Plant Biology*, **13**: 1-22.

Chen, T.H. and Murata, N. 2011. Glycinebetaine protects plants against abiotic stress: mechanisms and biotechnological applications. *Plant, Cell Environ.*, **34**: 1-20.

Kurepin, L., Ivanov, A., Zaman, M., Pharis, R., Allakhverdiev, S., Hurry, V. and Hüner, N.A. 2015. Stress-related hormones and glycinebetaine interplay in protection of photosynthesis under abiotic stress conditions. *Photosynthesis Res.*, **126**: 221-35.

Venugopalan, M. V., Sankaranarayanan, K., Blaise, D., Nalayini, P., Prahraj, C. S., and Gangaiah, B. 2009. *Bt* cotton (*Gossypium* sp.) in India and its agronomic requirements–a review. *Indian J. Agro.*, **54**: 343-60.

Wutipraditkul, N., Wongwean, P. and Buaboocha, T. 2015. Alleviation of salt-induced oxidative stress in rice seedlings by proline and/or glycinebetaine. *Biol. Plant.*, **59**: 547-53.

Umebese. C.E., Olatimilehin, T.O. and Ogunsusi, T.A. 2009. Salicyclic acid protects nitrate reductase activity, growth and proline in amaranth and tomato plants during water deficit. *Amer. J. Agric. Biol. Sci.*, **4**: 224-29.

Received for publication : January 22, 2024
Accepted for publication : March 16, 2024