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Short Communication

Productivity Enhancement by Putrescine in Wheat *(Triticum aestivum L.)*

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The effect of exogenously applied putrescine was studied in two wheat varieties namely, C-306 (drought tolerant) and HD-2329 (widely cultivated) under non stressed and water stressed conditions. Putrescine (10^{-5}M) was applied as seed treatment (ST), spray (SP) and combination of seed treatment and spray (ST+SP). Putrescine increased grain yield, biological yield and seed weight index under all the conditions. Among physiological attributes chlorophyll content and transpiration rate increased and leaf temperature decreased by putrescine. The results suggest that physiological effects of putrescine are similar to cytokinins.

Polyamines, a group of polycationic, low molecular weight aliphatic nitrogenous compounds are ubiquitously distributed in all living cells and known to play important regulatory role in plant growth and development (Slocum *et al.*, 1984; Bonchereau *et al.*, 1999). The physiological significance of these compounds have been reviewed comprehensively (Rajam, 1997; Sharma, 1999; Martin-Tanguy, 2001). Increased polyamine titre in stressed plants was found adaptive significance because of its involvement in regulation of cellular ionic environment, maintenance of membrane integrity, prevention of chlorophyll loss and stimulation of biosynthesis of proteins, nucleic acid and protective alkaloids (Evans and Malmberg, 1989; Kumar *et al.*, 1993).

Wheat is known to employ drought avoidance through water spending mechanisms (Jat *et al.*, 1991). The selection pressure and high cultivation of wheat appears to be responsible for water spending type of drought avoidance. Among other attributes of drought tolerance plant water relation parameters namely, stomatal conductance, transpiration, leaf to air temperature gradient and membrane stability have been correlated with the performance under water limiting conditons (Singh *et al.*, 1992). Investigations pertaining to the use of PGRs and other chemicals have shown that enhancement in drought tolerance is mediated through the modulation of these physiological attributes (Yadava *et al.*, 1994; Gupta *et al.*, 2000). However, information is almost lacking on the role of polyamines especially the putrescine on productivity acceleration under optimal and suboptimal environment. Currently, this group of bio-regulants is being viewed as an important chemical software for modulating crop responses under limiting and non-limiting environments.

Exogenous application of polyamines increased the productivity of a number of crops (Rugini and Mencuccini, 1985; Yang *et al.*, 1996; Sharma and Ali, 1998). However, very little information is available on the effect of exogenous application of polyamines in wheat particularly under water limiting conditions. Therefore, present investigation has been undertaken to study the effect of putrescine on some physiological parameters and productivity of wheat crop under water limiting conditions.

MATERIAL AND METHODS

A pot experiment was conducted to study the effect of putrescine on wheat productivity under water limiting conditions. The seeds were sown in well prepared pots containing sandy loam soil and recommended doses of fertilizers. Two varieties of wheat namely C-306 (drought tolerant) and HD-2329 (widely cultivated) were used under non-stressed and water stressed conditions. Putrescine dihydrochloride was dissolved in water and neutralized with traces of 1 M NaOH to pH 7.0. The treatments were comprised as seed treatment (ST), foliar spray (SP) and a combination of seed treatment

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and foliar spray (ST+SP). For seed treatment, the seeds were soaked in putrescine dihydrochloride (10^{-5} M) for 12 hours under dark before sowing. The foliar spray of putrescine with same concentration was carried out at anthesis stage for spray treatment. Similarly in case of ST+SP treatments, both seed soaking and spraying were done. Teepol, a wetting agent was mixed with the spray solution @ 0.5 ml l^{-1}. In control plants distilled water was used in place of putrescine.

The stress conditions were created by withholding the number of irrigations half as compared to control. Ten seeds were sown in each pot and after thinning two plants were maintained in each pot. Recommended doses of manures, fertilizers and other inputs were provided at appropriate time. Observation on physiological parameters were recorded at the time of anthesis.

The transpiration rate was measured directly by steady state porometer (LiCor-1600, Lincoln, USA) on the upper most fully expanded leaf. It represents the sum of the adaxial and abaxial sufaces. The leaf temperature was measured by the thermocouple of the steady state porometer pressed against the adaxial and abaxial sufaces of the same leaf (Gupta *et al.*, 2001). The total chlorophyll content was estimated using the method of Arnon (1949). Plants were harvested at maturity and observations on plant height, grain yield, biological yield per plant and seed weight index were recorded. All the observations were recorded in triplicates and data were analyzed using factorial randomized block design.

RESULTS AND DISCUSSION

Moisture stress decreased the grain yield and biological yield in both the genotypes (Table I). The grain yield was higher in cv C-306 than HD-2329 under non stressed and water stressed conditions. Putrescine increased the grain yield in all the three modes of applications namely seed treatment (ST), spray (SP) and combinations of seed treatment + spray (ST+ SP). The increase in grain yield was more pronounced in spray treatment (SP) under non stress conditions whereas under stress conditions the combination of seed teatment + spray proved better than other treatments. Seeds weight index also followed similar trend (Table I).

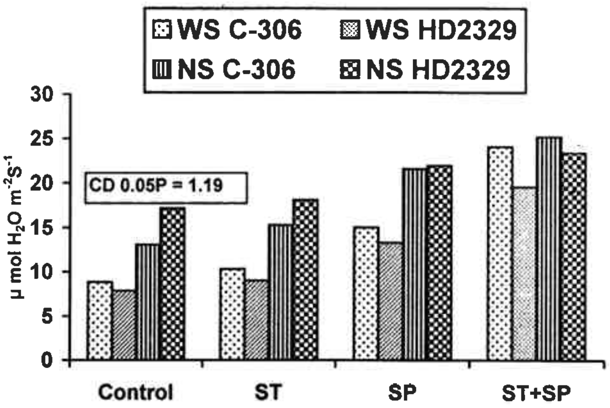

Figure 1 : Effect of putrescine treatments on transpiration rates of two wheat genotypes. WS and NS denotes water stress and non stress conditions.

Table I. Effect of putrescine on plant height and yield characters in wheat under water stress conditions.

Treatment	Variety (cm)	Plant height (cm)		Grain yield (g)		Biological yield (g)		Seed weight index	
		Non stress	Water stress	Non stress	Water stress	Non stress	Water stress	Non stress	Water stress
Control	C-306	50.00	48.60	1.10	0.83	3.28	3.07	41.46	34.25
	HD-2329	50.80	48.00	0.96	0.81	2.95	2.78	40.53	31.26
Seed treatment	C-306	54.60	47.60	1.21	0.95	3.07	2.96	43.42	35.36
	HD-2329	52.80	48.00	0.99	0.85	2.91	2.78	42.32	38.00
Spray	C-306	55.00	49.60	1.25	1.00	3.22	3.08	43.04	35.91
	HD-2329	55.60	46.80	1.05	0.84	3.18	3.00	42.00	32.12
Seed treatment + Spray	C-306	57.00	49.60	1.20	1.05	3.32	3.08	45.60	39.07
	HD-2329	56.60	50.00	0.93	0.86	3.39	3.15	44.17	39.71
CD 0.05P		2.308		0.051		0.070		1.435	

Table II. Effect of putrescine on leaf temperature and chlorophyll content in wheat under water stress conditions.

Treatment	Variety	Leaf temperature Adaxial (°C)		Leaf temperature Abaxial (°C)		Total chlorophyll (mg.g^{-1} fresh wt.)	
		Non stress	Water stress	Non stress	Water stress	Non stress	Water stress
Control	C-306	25.90	27.60	25.00	27.35	1.324	1.67
	HD-2329	28.20	28.80	27.30	29.05	1.381	0.890
Seed treatment	C-306	22.35	22.70	22.15	22.95	1.882	1.511
	HD-2329	22.85	24.20	22.70	24.40	1.634	1.270
Spray	C-306	25.15	25.45	24.65	25.15	1.888	1.536
	HD-2329	25.75	26.30	24.90	25.25	1.495	1.093
Seed treatment + Spray	C-306	24.30	25.05	24.25	24.75	2.220	1.636
	HD-2329	25.25	25.30	24.20	24.65	2.980	1.318
CD 0.05P		0.464		0.443		1.114	

Biological yield was also higher in C-306 than HD-2329 under both the conditions. Although putrescine application exhibited increase in biological yield but the effect was non significant in most of the cases. Plant height significantly increased and was maximum in SP + ST followed by SP and ST alone (Table I). The information on the effect of polyamines on the growth and productivity of wheat is almost lacking. Sharma and Ali (1998) reported exogenously applied polyamines induced increase in grain yield and 100 seed weight in soybean. Prakash and Prathapsenan (1988) observed alternating effect of putrescine on growth and yield of rice under saline conditions. The improvement in yield by putrescine application has been attributed to increase in endogenous polyamines remained for the normal development of reproductive structures (Cohen *et al.*, 1982).

The use of putrescine in all the three modes enhanced chlorophyll content in both the genotypes under both the conditions. The increase was maximum in ST+SP followed by remaining two treatments (Table II). Role of polyamines has already been implicated in prevention of chlorophyll degradation (Yordanov and Goltsev, 1990; Sharma, 2001).

The increased transpiration rate with putrescine application also exhibited a mutual reciprocacity suggesting that the changes were regulated by stomatal movements (Srivastava and Kumar, 1994). Putrescine increased the transpiration rate in all the three modes of application (Fig. 1). It is suggested that higher chlorophyll content alongwith optimized stomatal opening by putrescine might have resulted in enhanced productivity of wheat under both the conditions (Kumar *et al.*, 1993). Polyamines are known to mobilize K^+ (Krishnamurthy, 1991). Liu *et al.* (2000) suggested that polyamines target KAT 1 like inward K^+ channel in guard cells and modulate stomatal movement, providing a link between stress conditions, polyamine levels and stomatal regulation. This property may be linked to the increased transpiration rate and stomatal conductance caused by polyamine application in wheat. The lowering of leaf temperature by polyamine application implies that foliar cooling is caused by increase in transpiration rate and may be by enhanced stomatal conductance.

Thus, On the basis of these observations it can be concluded that polyamines can increase grain yield by adjusting the physiological attributes like chlorophyll content, leaf temperature and rate of transpiration. The effects are comparable to that of 6-benzyleadenine (Gupta *et al.*, 1998, 2000).

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