Pak. J. Bot. 9 (2): 163—166, 1977

EFFECT OF SALINITY ON GERMINATION, SEEDLING GROWTH AND α—AMYLASE ACTIVITY IN WHEAT. [1,2]

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Abstract

Studies on wheat seed germination, shoot growth and α-amylase activity showed that H-68 was comparatively more salt tolerant and Mexi-Pak most sensitive amongst the various cultivars tested. Seeds of H-68 and Mexi-Pak contained identical amounts of α-amylase. However, the enzyme activity in Mexi-Pak seeds decreased with increase in salinity. An enhancement in the enzyme activity in presence of gibberellic acid has been observed in both the cultivars.

Introduction

There is considerable evidence that increase in salinity reduces seed germination and growth in many crop plants. Although several studies have been carried out but very little effort has actually been directed towards discerning the effect of salinity on early developmental stages which may be responsible for the subsequent growth inhibition. It has been shown that induction of water stress, by increasing salt concentration, reduces seed germination (Wahhab, 1961; Claridi & Wiebe, 1968; Younis & Hatata, 1971) and increasing osmotic pressure, using mannitol or polyethylene glycol (PEG), depresses α amylase synthesis (Jones, 1969; Jones & Armstrong, 1971). Therefore the present work, concerns itself with the effect of salinity on seed germination, seedling growth and the activity of the enzyme α amylase in order to screen out tolerant and sensitive cultivars for further studies.

Materials and Methods

Healthy seeds of *Triticum aestivum* L. cv. H-68, C-591, Pak-70, Mexi-Pak-65, Sonora-64, Lerma-66 and Norteno were washed and soaked in saline solutions (0.0, 0.5 and 1.0% of NaCl) for 5 hours. Twenty seeds per treatment were planted in beakers containing 0.75% agar-gel made out of the respective salt solutions. The seeds were planted, grooved side down, on the salt-agar-gel surface and the beakers were covered and placed in the germinator. After 120 hrs. in complete darkness, the beakers were taken out of the germinator and germination counts as well as seedlings height was recorded. For α amylase determination, seeds of H-68 and Mexi Pak were used and the method of Jones & Varner (1967) was followed.

Unless otherwise indicated the above experiments were carried out at 25±1°C and were replicated three times. Analysis of variance was used to evaluate the data statistically.

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1. This research has been financed in part by a grant (FG-Pa-147) made by the United States Department of Agriculture under PL-480 research programe to SMN.

2. Contribution number 71 of the Atomic Energy Agricultural Research Centre Tandojam

Results

Effect of salinity on germination and shoot growth.

Seeds of seven wheat cultivars of local and Mexican origin, germinated on salt-agar-gel media, showed no significant effect on germination. All seeds were considered germinated when the length of root and/or shoot measured more than 2-3 millimeter. However, salinity did depress shoot gorwth. The data, compiled in order of tolerance, revealed that H-68 was comparatively more and Mexi-Pak the least tolerant (Table 1). Statistical analysis of the data showed significant differences amongst the cultivars (except between Inia and Mexi-Pak) and salinity. There was no interaction between cultivar and salinity.

Effect of salinity on α-amylase activity.

The data presented in Table 2 indicates that H-68 and Mexi-Pak contained similar amounts of α-amylase under control conditions (no salinity or GA). However, when the salinity of the growth media was increased from 0.5—1.0 % NaCl there was a corresponding decrease in the enzyme activity in Mexi-Pak but not in H-68. When gibberellic acid (10μM) was supplemented an enhancement of the enzyme activity was observed in H-68 as well as in Mexi-Pak. In this case salinity reduced the enzyme activity of both the cultivars. It is quite possible that different concentratins of GA may be required to counter the effect of salinity or probably some other enzyme(s) may have become a limiting factor.

TABLE 1. Effect of salinity on wheat shoot growth (cm).

Cultivars	Salinity levels		
	0	0.5	1.0
H-68	9.55	5.83	2.39
C-591	9.74	5.96	2.07
Pak-70	8.17	4.16	2.06
Sonora-64	8.23	4.32	1.64
Norteno	7.89	2.83	1.40
Inia-66	8.17	3.74	1.16
Mexi-Pak-65	8.23	3.38	1.12

S.D. Salts = 5% = 0.17, 1% = 0.22 Cultivar 5% = 0.28, 1% = 0.34

TABLE 2. Effect of NaCl salinity on α-amylase (μg/10 seeds) in wheat seeds.

Cultivars	Treatments	Salinity level (%)		
		0.0	0.5	1.0
H—68	+ GA	4.36	2.65	1.49
	— GA	1.35	1.40	1.24
Mexi-Pak	+ GA	2.31	0.76	0.55
	— GA	1.52	0.55	0.44

L.S.D. GA & Cultivars 5% = 0.23, 1% = 0.33 Salinity 5% = 0.80, 1% = 1.13

Discussion

Under the experimental condition the wheat cultivars tested did not show significant reduction in seed germination due to increase in salinity. These observations thus agree with those reported for wheat where similar salt concentrations were used (Chaudhuri & Wiebe, 1968; Younis & Hatata, 1971) but it differs from our earlier report (Naqvi *et al*, 1975). The difference may, however, be explained on the basis of the media used for planting the seeds. In the present studies agar-gel was used while in the previous one we had used filter papers. It is interesting to note that Rehwaldt (1968) has reported that filter papers used to germinate seeds of *Arabidopsis thaliana* had an inhibitory effect. Similarly Younis & Hatata (1971) experienced irregular and inconsistent results when they used filter papers to study the effect of salinity on wheat seed germination. Therefore, it is obvious that the differences in our two studies can also be explained on the basis of the difference in the two media rather than the effect of salt *per se*. Studies to delineate the differences between the two media are underway and will be reported elsewhere. It is however, difficult to compare our results with some others (Wahhab, 1961; Khan *et al.*, 1970; Khan & Patel 1972) because of two reasons. Firstly, very few of the workers have defined the criteria for germination and therefore, take different standards for their measurements and secondly they have used soil, sand or filter papers and/or higher salt concentrations.

The data presented in Table 1 shows that increase in salinity of the media reduces shoot growth in all the cultivars tested. Comparing the cultivars, on the degrees of their tolerance, it is observed that cultivars of local origin were comparatively more tolerant than their Mexican counter parts. It can further be observed that H-68 occupied most tolerant and Mexi-Pak the most sensitive position. Though Mexi-Pak shoots were initially shorter than H-68 the percent reduction in length due to increase in salinity was more than H-68. In case of H-68 increasing salinity from 0.0 to 0.5% reduced the shoot length by 39% while in Mexi-Pak it was 59%. Similarly when the salinity level was further raised to 1.0% the reduction in H-68 was observed to be 75% while it was 86% in Mexi-Pak. These observations further corroborate the reported effect of salinity on shoot growth of wheat (Khan & Patel, 1972; Naqvi *et al.*, 1975) and of maize (Naqvi, 1972). It is interesting to note that

Nieman & Poulsen (1971) using bean reported that in the absence of light, salinity did not affect plant growth. However, from the present studies it is clear that salinity reduced shoot growth even under dark conditions.

The α-amylase activity of Mexi-Pak was adversely affected with increase in salinity level. This reduction in activity may have been due to the osmotic (Jones, 1969; Jones & Armstrong, 1971) or ionic effect on the mechanism by which GA enhances the enzyme synthesis. Khan & Patel (1972) have also reported a reduction in α-amylase production in two wheat cultivars (C-591 and Mexi Pak) but they did not compare them on the basis of their salt tolerance and the enzyme production. The production of α-amylase was observed to be enhanced due to the presence of GA in control as well as at various salinity levels. But the response in Mexi-Pak was much less than in H-68. In our further studies, to be reported elsewhere, we have observed that external supply of GA enhances plant growth under saline conditions. Therefore, the results presented here are suggestive of a relationship between α-amylase production and the induction of salt tolerance in wheat to a certain extent.

Indication of good salt tolerance at early stages may not mean that plants will retain this advantage throughout its whole life cycle. However, in another experiment, when H-68 and Mexi-Pak were grown till maturity, the former retained its superiority. Hence tolerance at early developmental stages may serve as an index of plant growth at later stages. Therefore, for a systematic approach to the problem it is essential to proceed from germination upto the maturity stages and find ways and means to counter or minimise the effect of salinity on plant growth.

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