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SEED TREATMENTS FOR ALLEVIATING WATER STRESS ON GERMINATION OF SUNFLOWER.

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Abstract

Germination studies under 3 levels of water stress conditions, were conducted for the pre-soaked seeds subjected to drying treatments of different durations. Germination was significantly improved under all water potentials (Ψs) of pre-soaked seeds following 12 hours of drying. The pre-soaked seeds without subsequent drying treatment showed low percentage of germination; the same seed lot under -6 bar Ψ showed an improvement of dry weight of root and shoot. Soaking in water or solutions of ascorbic acid, $CaCl_2$, KH_2PO_4, KNO_3, NaCl, succinic acid and $ZnSO_4$, followed by drying of seeds, improved germination and early growth of seedlings under simulated water wtress conditions. The seed vigor was found to be associated with enhanced oxygen uptake, amylase activity and the efficiency of mobilizing nutrients from cotyledons to embryonic axis.

Introduction

Sunflower, an important oil crop, poses a serious problem of poor germination under dry conditions (Kathiresan and Ramaswamy 1978). Seed treatments, soaking in water or chemical solutions followed by drying, have been shown to accelerate germination in many crop species (Heydecker and Coolbear 1977). This work, therefore, was carried out to find whether the seed treatments of sunflower could solve the problem of poor germination under simulated water stress conditions.

Materials and Methods

Certified sunflower seeds (Helianthus annuus L. EC 68414) were treated by soaking in the following chemical solutions in the ratio of 1:2 seed weight/volume for 12 hours at 23°C and dried for 12 hours at 30°:water, ascorbic acid(200 mg/l),$CaCl_2$(50 mg/l), KH_2PO_4 (100 mg/l), KNO_3 (500 mg/l), NaCl (100 mg/l),succinic acid (150 mg/l) and $ZnSO_4$ (100 mg/l). Both unsoaked and water soaked controls were kept. Another set of seeds was dried for different durations of 0,2,12,24,48 hours, following soaking in water for 12 hours.

The seeds were germinated on filter paper moistened with polyethylene glycol solution (Molecular weight 6000) to give -3, -6 bars of Ψ. After 7 days of imbibition, the germinated seeds were analysed for percent germination, dry weight of root and shoot per seedling.

Seeds were also analysed for their respiratory oxygen uptake (Umbreit et al., 1972), amylase activity (Rudrapal and Basu 1979) and mobilization efficiency (Srivastava and Sareen 1974).

Results

Germination of pre-soaked, undried seeds was reduced at all water potentials (Ψs) (Table I). Germination was significantly improved at -6 bar in the pre-soaked seeds dried only for 2 hours. Further improvement to maximum germination under all the 3 Ψs was observed in the pre-soaked seeds dried after 12 hours (Table-I). Reduced dry weight of shoot and root was observed following pre-soaking when seeds were germinated at -3 bar (Figures 1,2). However, at -6 bar, root and shoot dry weights of the pre-soaked, undried seeds were improved despite the reduced percent germination (Table I, Figures 1,2). At -3 bar, root dry weight of the pre-soaked, 2 hours dried seeds was improved despite the reduced germination and shoot dry weight (Table I, Figures 1,2).

Table I: Effect of drying treatments of different durations following soaking for 12 hours on the subsequent germination of seeds under 3 water potentials (0, -3, -6).

Duration of drying (hrs)	Germination (%)		
	0	-3	-6
Control (unsoaked)	64	48	25
0	31	19	13
2	56	41	34*
12	78**	77**	67**
24	75**	69**	59**
48	71**	66**	55**

** - Significant at 1% level
* - Significant at 5% level

Chemical pretreatment of seeds significantly improved germination and early seedling growth under simulated water stress conditions (Table II). The seed lot pretreated with KNO_3 showed maximum percent germination and shoot dry weight per seedling in 0,-3,-6 bars of Ψ. The same treatment showed a maximum root dry weight per seedling under 0, -3 bars of Ψ. However, under -6 bar of Ψ, seed lot pretreated with $CaCl_2$ showed maximum root dry weight per seedling (Table II).

Table II: Performance of treated seeds under different water potentials (0, -3, -6).

Seed Treatment	Germination (%)			Shoot dry weight (mg/plant)			Root dry weight (mg/plant)		
	0	-3	-6	0	-3	-6	0	-3	-6
Control (untreated)	64	48	25	11.0	4.3	2.5	3.9	2.1	1.5
Water	80	80	69	11.6	4.4	3.5	5.2	2.9	2.2
Ascorbic acid	77	76	70	12.3	4.7	3.8	5.2	2.6	2.3
$CaCl_2$	88	80	68	12.2	5.0	3.8	5.4	2.7	2.6
KH_2PO_4	84	82	73	13.3	5.4	3.8	4.3	2.5	1.8
KNO_3	90	88	80	15.3	6.0	4.3	6.3	3.5	2.1
NaCl	80	71	70	12.0	5.0	3.1	6.0	3.0	1.6
Succinic acid	78	66	53	13.9	5.4	3.3	4.6	3.0	1.8
$ZnSO_4$	80	68	59	14.6	5.8	3.3	5.5	2.3	1.8
	F-Test			F-Test			F-Test		
Stress level	**			**			**		
Treatment	**			**			**		

** - Significant at 1% level

Oxygen uptake was appreciably greater in seeds pretreated with ascorbic acid (375 µl/g/h), $CaCl_2$ (300 µl/g/h), KNO_3 (297 µl/g/h) and succinic acid (286 µl/g/h)(Table III). Mobilization efficiency was significantly greater in all the pretreated seeds, especially when $CaCl_2$ (70%) and KNO_3 (66%) were used. Amylase activity was significantly greater in all the treated seeds especially in those subjected to KNO_3 and $CaCl_2$ (Table III).

Discussion

<u>Drying treatments & Germination</u>: The poor germination of pre-soaked, undried seeds was unlikely to be due to the leaching of essential nutrients as suggested by Eyster (1940) since germination of the pre-soaked seeds improved by drying treatments (Table I). This supports the results of Barton and McNab (1956) who found that the addition of nutrients to germination medium did not improve the germination of pre-soaked seeds. The

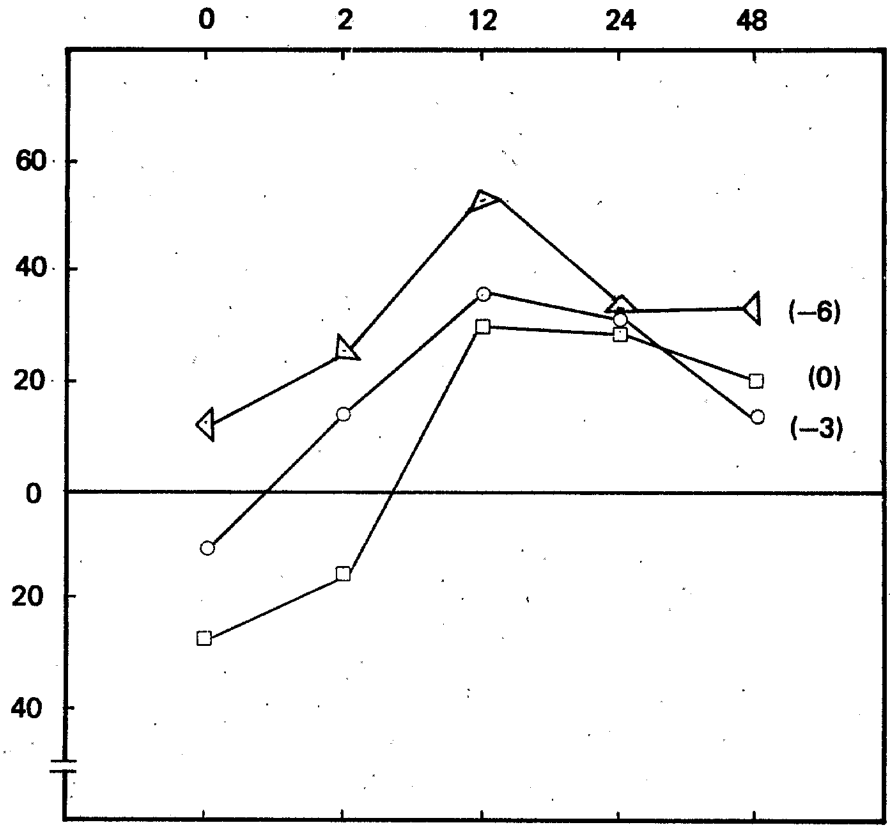
possibility of oxygen deficiency due to accumulation of water in the cavity between the cotyledons of seeds during soaking, was suggested by Orphanos and Heydecker (1972) as the cause of the poor germination of soaked *Phaseolus* seeds.

Table III: Effect of presowing seed treatments on some physiological processes of germination.

Seed treatment	Oxygen uptake ($\mu l\ O_2/g$ dry wt/h)	Mobilization efficiency (%)	Amylase activity (mg starch hydrolysed/ mg protein/h)
Control (untreated)	103	37	2.53
Water	192	48	6.73
Ascorbic acid	375	63	4.58
$CaCl_2$	300	66	13.52
KH_2PO_4	261	59	9.28
KNO_3	297	70	15.11
NaCl	241	58	8.30
Succinic acid	286	55	2.94
$ZnSO_4$	232	50	8.17
F-Test	**	**	**

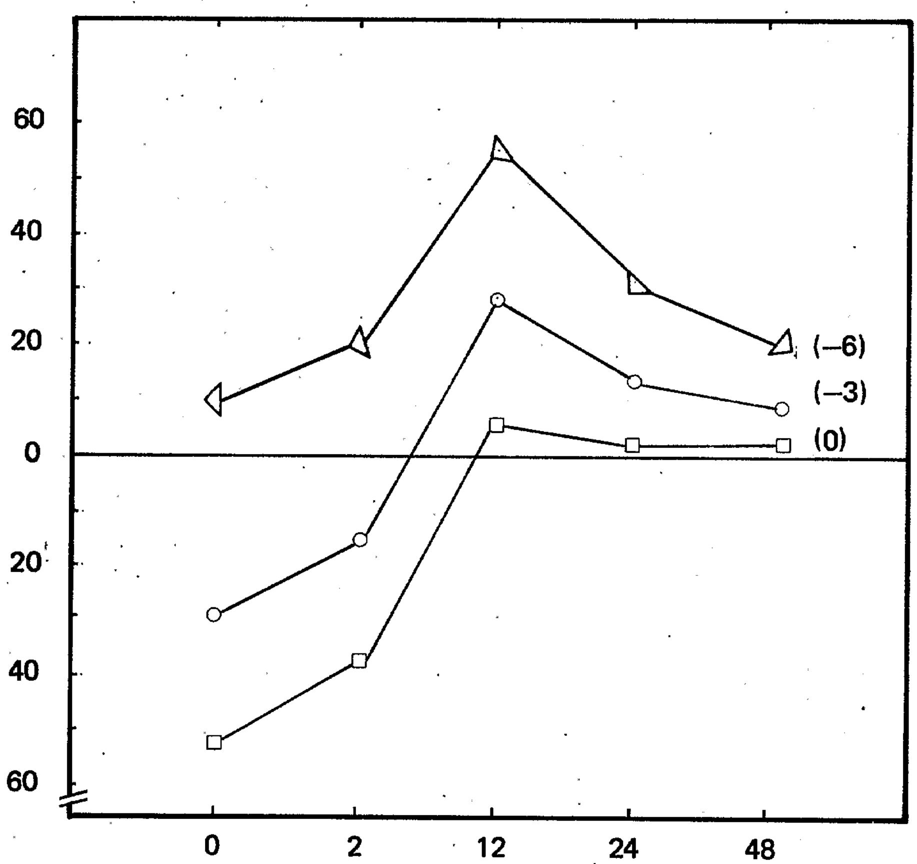
** - Significant at 1% level

Chemical treatments & germination: Beneficial effects of KNO_3 as in the present result (Table II) was also reported by Doyle et al. (1952) in wheat, oat, barley and flax; Ogawara and Ono (1961) in tobacco; Woodstock (1959) in tomato. Also, KNO_3 is used as a routine aid in breaking of post-harvest dormancy (ISTA 1976). Maximum root growth occurred in plants grown from seeds treated with $CaCl_2$ (Table II) which confirms the findings of Henckel (1964). Decrease in the Ψ of germination medium decreased germination of seeds (Table II). Parmar and Moore (1968) attributed the reduced germination to decreased water absorption by the seeds with decreasing Ψ in the germination medium. The present result shows the more adverse effect of decreased Ψ on shoot dry weight than root dry weight (Table II). This greater dependence of shoot growth on water uptake of seedlings, was also suggested by Parmar and Moore (1968).



Duration of drying (h) (after soaking for 12h)

Fig. 1



Duration of drying (h) (after soaking for 12h)

Fig. 2

The seed vigor is associated with enhanced oxygen uptake, increased amylase activity and the efficiency of mobilizing nutrients from the cotyledons to the embryonic axis (Table III). Thus, effects of chemicals on the metabolic activity of seeds reflected in germinability of seeds. This method of seed treatment using hypertonic solutions of salts is capable of commercial exploitation according to Darby and Salter (1970).

Acknowledgements

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