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Hydropriming and Osmopriming Effects on Cumin (*Cuminum Cyminum L.*) Seeds Germination

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***Abstract*—**In production of medicinal plants, seed germination is very important problem. The treated seeds (control, hydro priming and $ZnSO_4$) of Cumin (Cuminum cyminum L.) were evaluated at germination and seedling growth for tolerance to salt (NaCl and Na_2SO_4) conditions at the same water potentials of 0.0, -0.3, -0.6, -0.9 and -1.2MPa. Electrical conductivity (EC) values of the NaCl solutions were 0.0, 6.5, 12.7, 18.4 and 23.5 dSm^{-1}, respectively. The objective of the study was to determine factors responsible for germination and early seedling growth due to salt toxicity or osmotic effect and to optimize the best priming treatment for these stress conditions. Results revealed that germination delayed in both solutions, having variable germination with different priming treatments. Germination, shoot and weight, root and shoot length were higher but mean germination time and abnormal germination percentage were lower in NaCl than Na_2SO_4 at the same water potential. The root / shoot weight and R/S length increased with increase in osmotic potential in both NaCl and Na_2SO_4 solutions. NaCl had less inhibitor effect on seedling growth than the germination. It was concluded that inhibition of germination at the same water potential of NaCl and Na_2SO_4 resulted from salt toxicity rather than osmotic effect. Hydro priming increased germination and seedling growth under salt stress. This protocol has practical importance and could be recommended to farmers to achieve higher germination and uniform emergence under field conditions.

***Keywords*—**Priming, Germination, Nacl, $ZnSo_4$, Na_2So_4.

I. Introduction

CUMIN (*Cuminum cyminum L.*) is a member of Umbelliferae and annual plant which originated in the Iran, Egypt, Turkistan and East Mediterranean. But, it is widely cultivated in Iran, China, India, Morocco, South Russia, Japan, Indonesia, Algeria and Turkey; specially, in arid and semi-arid regions [33]. Iran is one of the most important cumin exporters in the world market [13]. Leaf shape, short leaves, color and surface cover of plant parts are representative adaptation of cumin to drought conditions [16]. Furthermore, the plant is relatively salt resistant and has no much needs of soil fertility [10]. But in production of medicinal plants, seed germination is very important problem. The seeds are occasionally sown in seedbeds having unfavorable moisture because of the lack of rainfall at sowing time [3], which results in poor and unsynchronized seedling emergence [22]. A major constraint to seed germination is soil salinity, a common problem in irrigated areas of Iran, with low rainfall [14]. Soil salinity may affect the germination of seeds either by creating an osmotic potential external to the seed preventing water uptake, or through the toxic effects of Na^+ and Cl^- ions on the germinating seed [15]. Salt and osmotic stresses are responsible for both inhibition or delayed seed germination and seedling establishment [2]. Under these stresses there is a decrease in water uptake during imbibitions and furthermore salt stress may cause excessive uptake of ions [21]. Seed priming has been successfully demonstrated to improve germination and emergence in seeds of many crops, particularly seeds of vegetables and small seeded grasses [4]. The beneficial effects of priming have also been demonstrated for many field crops such as wheat, sugar beet, maize, soybean and sunflower [23, 28, 15, 26]. [8] reported beneficial effect of a hydration-dehydration seed treatment on germination of sunflower. [24] reports that primed Brassica seeds may reduce the risk of poor stand establishment in cold and moist soils. However, [29] stress that KNO_3 effectively improved germination, seedling growth and seedling vigour index of the seeds of sunflower varieties with low germination. The aims of the present study were to determine factors responsible for failure of germination of cumin seeds under saline conditions due to the toxic effects of NaCl and Na_2SO_4 by comparing seed germination under a range of osmotic potentials due to NaCl and Na_2SO_4. Furthermore, the study examined the possibilities to overcome salt stress by seed treatments with hydro priming or treatment with $ZnSO_4$.

II. Materials and Methods

In order to determine the impact of different primes on germination of Cumin seeds, an experiment was conducted at Zabol University in 2008. Seeds were primed with various

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materials, including hydroprime seeds which were primed with distilled water, osmoprime seeds which were treated with different chemical factors as NaCl, Na_2SO_4, $ZnSo_4$. for produce solutions with various osmotic potential we used of Michel and Kaufmann (1973) and Money (1989). All three different osmopriming provide employed in order to osmotic levels of 0.0, -0.3, -0.6, -0.9, -1.2 MPa. Initially seeds were disinfected by Sodium hypochlorite (NaOCl) to disinpect the seeds. Seeds were in sodium hypochlorite (1.5 per) for one minute and then washed away with distilled water. After disinfecting seeds were put in disinfected petry dished. Each petry dish contained 25 seeds. After 24 hours of priming seeds were washed with distilled water and then dried and in kept laboratory room at temperature of 25°C for two hours. After dried seeds located in petry dishes and treated with distilled water at temperature of 25°C for seven days. The experimental design was randomized completely block design, with three replications. The differences between the means were compared using Duncan values ($P < 0.01$). Three replicates of 25 seeds were put between double layered rolled Anchor germination papers with 10 ml of test solutions. The papers were replaced every 2 days to prevent accumulation of salts. The rolled paper with seeds was put into sealed plastic bags to avoid moisture loss. Seeds were allowed to germinate at 25±1°C for 7 days. Germination was considered when the radicles were 2 mm long. Germination percentage was recorded every 24 h for 7 days. Root length, shoot length were measured after the 7th day.

III. Results

A significant three-way interaction (seed treatment, solution and stress) was found ($P < 0.01$, 60 df.) for all investigated characters. The germination rate and germinati- on percentage decreased by increasing in osmotic potential in both NaCl and Na_2SO_4 solution and maximum germination rate and percentage were obtained at NaCl and Na_2So_4 level providing 0 Mpa in hydropriming treatment (Table I).

TABLE I
Germination Rate

MPa	control (untreated) 1	control (untreated) 2	Hydropriming 1	Hydropriming 2	$ZnSO_4$ 1	$ZnSO_4$ 2
0	11.9	11.9	18.1	18.1	11	11
-0.3	10.6	9.2	16.3	12.5	10.47	8.7
-0.6	10.0	7.3	14.1	10.7	9.8	7.8
-0.9	8.8	6.8	13.9	8.6	9.6	6.0
-1.2	3.1	1.3	10.4	8.2	8.25	3.4

1: NaCl, 2: Na_2SO_4

The root length decreased by increasing in osmotic potential in both NaCl and Na_2So_4 in control but in Hydropriming and $ZnSo_4$ prime, Nacl and Na_2So_4 increased by increasing in osmotic potential until -0.3 Mpa and then decreased by increasing in osmotic potential. Best treatment in root length was NaCl -0.3 Mpa in hydropriming (Table II).

TABLE II
Germination Percentage

MPa	control (untreated) 1	control (untreated) 2	Hydropriming 1	Hydropriming 2	$ZnSO_4$ 1	$ZnSO_4$ 2
0	68	68	84	84	72	72
-0.3	62	56	80	80	71	69
-0.6	45	35	63	60	57	55
-0.9	34	11	54	23	44	19
-1.2	12	7	20	16	16	15

1: NaCl, 2: Na_2SO_4

The shoot length, root weight and shoot weight were decreased by increasing in osmotic potential and best treatment in three characters was NaCl and Na2So4 with 0 Mpa in hydropriming (Tables III, IV, V and VI).

TABLE III
Root Length (Cm)

MPa	control (untreated) 1	control (untreated) 2	Hydropriming 1	Hydropriming 2	$ZnSO_4$ 1	$ZnSO_4$ 2
0	2.2	2.2	2.1	2.1	1.8	1.8
-0.3	2.1	1.4	3.8	2.3	2.6	2.1
-0.6	1.4	1.4	2.5	1.9	2.2	1.7
-0.9	1.0	0.2	1.4	0.8	1.6	0.6
-1.2	0.7	0.0	1.1	0.0	0.9	0.0

1: NaCl, 2: Na_2SO_4

TABLE IV
Shoot Length (Cm)

MPa	control (untreated) 1	control (untreated) 2	Hydropriming 1	Hydropriming 2	$ZnSO_4$ 1	$ZnSO_4$ 2
0	1.8	1.8	2.2	2.2	1.9	1.9
-0.3	1.5	1.4	2.0	1.9	1.8	1.7
-0.6	0.9	0.9	1.9	1.8	1.7	1.2
-0.9	0.8	0.0	1.1	0.1	1.0	0.0
-1.2	0.0	0.0	0.7	0.0	0.4	0.0

1: NaCl, 2: Na_2SO_4

TABLE V
Root Weight (mg Plant^{-1})

MPa	control (untreated) 1	control (untreated) 2	Hydropriming 1	Hydropriming 2	$ZnSO_4$ 1	$ZnSO_4$ 2
0	2.3	2.3	2.5	2.5	2.4	2.4
-0.3	1.9	1.8	2.2	2.1	2.0	2.0
-0.6	1.4	1.4	1.9	1.8	1.7	1.7
-0.9	1.1	0.8	1.5	1.4	1.2	1.1
-1.2	0.4	0.3	0.9	0.9	0.5	0.4

1: NaCl, 2: Na_2SO_4

TABLE VI
Shoot Weight (mg Plant^{-1})

MPa	control (untreated) 1	control (untreated) 2	Hydropriming 1	Hydropriming 2	$ZnSO_4$ 1	$ZnSO_4$ 2
0	1.3	1.3	1.6	1.6	1.4	1.4
-0.3	0.9	0.9	1.3	1.2	1.1	1.0
-0.6	0.5	0.5	0.9	0.9	0.7	0.7
-0.9	0.2	0.2	0.5	0.7	0.7	0.3
-1.2	0.0	0.0	0.3	0.3	0.2	0.2

1: NaCl, 2: Na_2SO_4

The root/ shoot weight and R/S length increased with increase in osmotic potential until -0.9 Mpa but decreased in -1.2 Mpa both NaCl and Na_2SO_4 solution (Fig. 1).

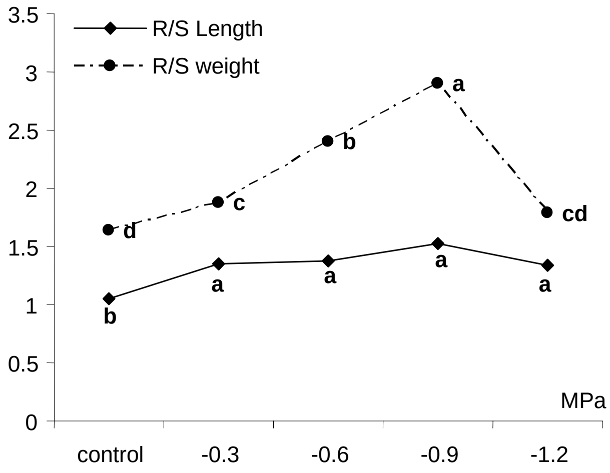

Fig. 1 Root/Shoot length (cm) and weight (mg) of cumin seedlings treated with Zn_2SO_4, hydropriming and control (untreated) at salt stress of NaCl and Na_2SO_4

IV. Discussion

Hydropriming clearly improved both rate of germinat- ion and mean germination time both under salt stress conditions. Furthermore, hydro priming resulted in increase of normal germination. The results are in line with the findings of [32] in Brassica and [30] in mustard. [12] indicated the beneficial effects of hydro priming on aged or unaged seeds with respect to germination and percentage of normal seedlings in cauliflower. Furthermore, [26] reported that increasing drought stress resulted in increasing abnormal seedlings in sugar beet. It is concluded that superiority of hydro priming on germination could be due to soaking time effects rather than Zn_2SO_4 treatment. Because, hydro primed seeds compared to Zn_2SO_4 treated seeds were allowed to imbibe water for a longer time and went through the first stage of germination without protrusion of radicle. [1] reported that higher duration of exposure to seed treatment resulted in higher cumulative germination in wild sunflower and [5] found that hydro priming was the most effective method for improving seed germination of onion, especially when the seeds were hydrated for 96 h compared to 48 h. The beneficial effects of Hydro priming on germination were found in this study. Zn_2SO_4 shortened MGT, however, final germination was higher from Hydro priming, suggesting toxicity of Zn_2SO_4 due to ion accumulation in the embryo [7]. Seeds always germinated better in NaCl than Na_2SO_4 at the equivalent water potential in line with earlier observations made for soybean by Khajeh[15]. This may be due to the uptake of Na^+ and Cl^- ions by the seed, maintaining a water potential gradient allowing water uptake during seed germination. Lower germination percentage obtained from Na_2SO_4 compared with NaCl at equivalent water potential in each priming method suggest that adverse effects of Na_2SO_4 on germination were due to specific ion accumulation rather than osmotic effect. These results agree with [21] in cowpea, [7] in watermelon, they affirmed that drought or salinity may influence germination by decreasing the water uptake and toxicity of ions. Under salt stress, Na^+, Cl^- and SO_4^- may be taken up by the seed and toxic effect of NaCl and Na_2SO_4 might appear. However, our findings at high salinity concentration of 23.5 dSm^{-1} showed that decrease in germination percentage was significant. The main effect of seed treatments was an increase in germination rate; however, post-germination growth was also increased. Hydro priming improved seedling fresh weight under osmotic stress. Considering both seed treatments, it was concluded that hydro priming improved root growth and gave the highest root length in both solutions. [11]reports that root and shoot growth significantly decreased by osmotic stress at -0.6MPa and above induced by PEG 6000. [21] found that seedling growth of cowpea was inhibited by both NaCl and PEG, but higher inhibition occurred due to PEG. [31] proposed that emergence force and seedling growth were strengthened by hydro priming in watermelon. Seedling growth severely diminished with increased drought stress and genetic differences were found in sugar beet [26].

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