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EFFECT OF CERTAIN SALTS AND THEIR INTERACTION ON GERMINATION AND SEEDLING DEVELOPMENT OF BARREL MEDIC SEEDS

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ABSTRACT

Inhibitory effects of various levels of sodium chloride, magnesium chloride, potassium sulfate (singly and in combination) and mannitol at equal osmotic pressures on germination and seedling development of Barrel medic seeds (*Medicago truncatula* L.) were studied. The reductions in germination and total seedling length were, in general, greater by salts, particularly at higher osmotic pressure, than by mannitol. At equal osmotic pressures, potassium sulfate and magnesium chloride reduced germination and total seedling length more than sodium chloride. On the basis of recovery of ungerminated seeds from the single salt treatments with equal osmotic concentrations, magnesium chloride was the most toxic. When the chlorides of sodium and magnesium were combined with potassium sulfate, the inhibitory effect of single salt was eliminated and a sort of synergistic action was developed.

INTRODUCTION

Recently attempts have been made to more effectively utilize saline lands by the introduction of appropriate forage species (Roundy, 1985). Cultivation of forage legumes on abandoned semi-arid land preserves soil and maintains its productivity, against water and wind erosion. In Iraq, demand for increased fodder production has necessitated to bring salt affected areas for pasture production rather than leaving the lands fallow. Basic research on salt tolerance of forage plants is, therefore, necessary to choose the suitable crops for such lands.

Barrel medic (*Medicago truncatula* L.) is a forage legume recommended under rainfed conditions of the Jezira area in northern Iraq in salt affected soils. Therefore, germination percentage and early seedling growth of Barrel medic was studied at increasing levels (osmotic pressures) of some chloride and sulfate salts that are dominant in Iraqi soils.

MATERIAL AND METHODS

Seeds of barrel medic were obtained from the Legumes and Fodder Crop Department, Ministry of Agriculture and Agrarian Reform, Abu-Ghraib, Iraq. The seeds were germinated in 9 cm dia glass petri dishes lined with a disc of filter paper (Whatman No. 30) and 10 ml of the test solution was added to each dish. Solutions of mannitol and three salts viz., NaCl, $MgCl_2$ and K_2SO_4, used singly and in combination at six levels of osmotic pressures (1, 3, 6, 9, 12 and 15 atm), were the treatments against the control (distilled water). The concentrations of the solutions in treatment lots were checked by freezing point determination methods. Four replications, of 25 seeds each, were maintained for all lots. Petri dishes were incubated under uniform conditions in an illuminated incubator (Sicherheifoki IDIN 12880 Schtzart JP 20 DIN 40050) at a constant temperature of 15°C.

Germination counts were made on alternate days upto 10 days when the final germination count and the total seedling length of 15 seedlings selected at random per treatment were recorded. Data on the final germination were subjected to statistical analysis.

A recovery experiment was also conducted to see if ungerminated seeds could recover. The ungerminated seeds were washed with water and transferred to petri dishes lined with filter paper and moistened with 10 ml distilled water and incubated for germination for 7 days. The final germination was recorded and reported as recovery of the ungerminated seeds.

Germination of Barrel medic seeds in distilled water was only 70 to 80% and, therefore, germinations in different treatments were expressed as percentage of the mean germination in distilled water (control).

RESULTS AND DISCUSSION

Single Salt Treatments

Seeds of barrel medic did not germinate at osmotic pressure of 15 atm in all the three salt solutions. When the seeds were exposed to 1 atm of NaCl solution the germination rate dropped to 81% of the control (Fig. 1). When the osmotic level of salt was increased, the germination reduced significantly to about 76% at 3 atm. At 15 atm the seeds failed to germinate.

Germination of barrel medic seeds was reduced sharply by $MgCl_2$ and K_2SO_4 (Table 1). In $MgCl_2$ solution, the germination decreased significantly to 76% even at 1 atm and dropped sharply to about 30%, 14% and 7% of control at 6, 9 and 12 atm, respectively. Barrel medic seeds were very sensitive to K_2SO_4 even at the lowest level

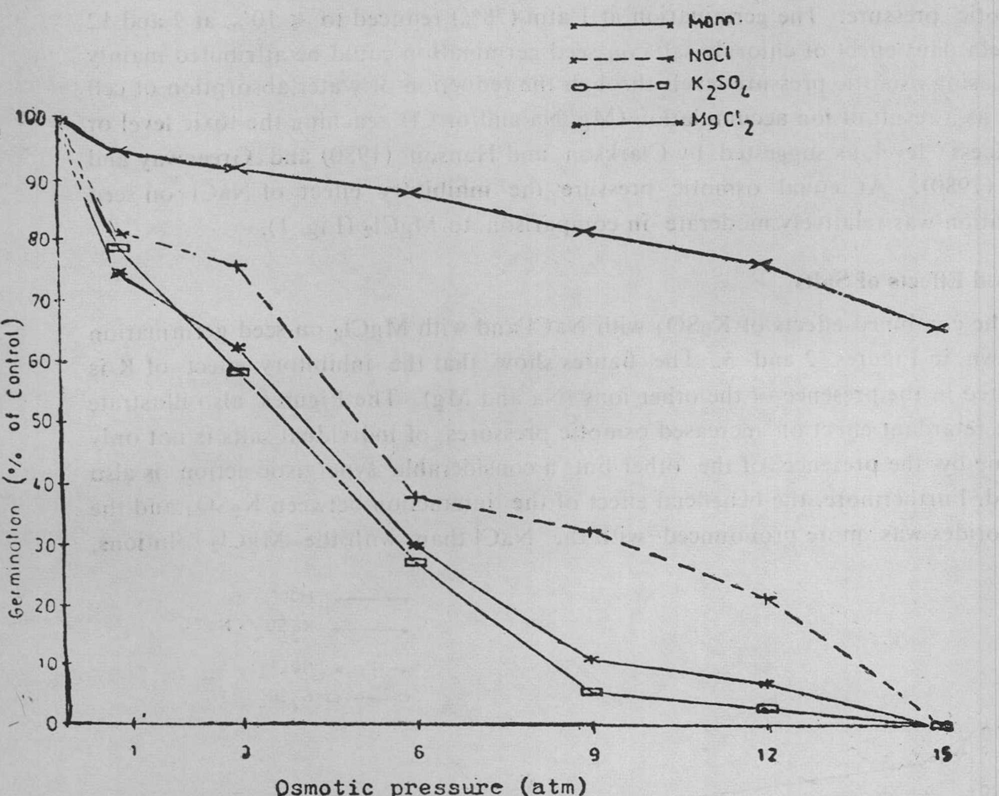

Fig. 1. Germination of barrel medic seeds as affected by various concentrations of sodium chloride, magnesium chloride, potassium sulfate and mannitol

Table 1. Per cent failure in germination and recovery of treated seeds of barrel medic in high salt concentrations (±SE).

	Osmotic pressure (atm) of initial treatment							
	6		9		12		15	
Substrate	Seeds not germinated	seeds recovered	Seeds not germinated	seeds recovered	Seeds not germinated	seeds recovered	Seeds not germinated	seeds recovered
NaCl	62.1	34.8 ±5.8	67.1	40.0 ±1.3	78.4	34.5 ±1.9	100	16.2 ±1.3
$MgCl_2$	70.3	21.1 ±1.2	86.2	21.6 ±1.8	93.0	23.2 ±1.4	100	6.7 ±0.8
K_2SO_4	72.9	37.0 ±5 8	94.6	48.5 ±2.7	97.9	36.1 ±1.1	100	20.3 ±1.9
Mannitol	12.2	77.7 ±3.5	18.3	85.7 ±6.1	24.3	77.7 ±1.2	55.2	76.3 ±1.9

of osmotic pressure. The germination at 1 atm (78%) reduced to < 10% at 9 and 12 atm. Retardant effect of chloride salts on seed germination could be attributed mainly to increasing osmotic pressure levels through the reduction of water absorption of cell tissues, as a result of ion accumulation (Mg, Na and/or Cl) reaching the toxic level or "ion excess" level, as suggested by Clarkson and Hanson (1980) and Greenway and Munns (1980). At equal osmotic pressure the inhibitory effect of NaCl on seed germination was relatively moderate in comparison to $MgCl_2$ (Fig. 1).

Combined Effects of Salts

The combined effects of K_2SO_4 with NaCl and with $MgCl_2$ on seed germination are shown in Figures 2 and 3. The figures show that the inhibitory effect of K is eliminated in the presence of the other ions (Na and Mg). The Figures also illustrate that the retardant effect of increased osmotic pressures of individual salts is not only overcome by the presence of the other but a considerable synergistic action is also recorded. Furthermore, the beneficial effect of the interaction between K_2SO_4 and the two chlorides was more pronounced with the NaCl than with the $MgCl_2$ solutions,

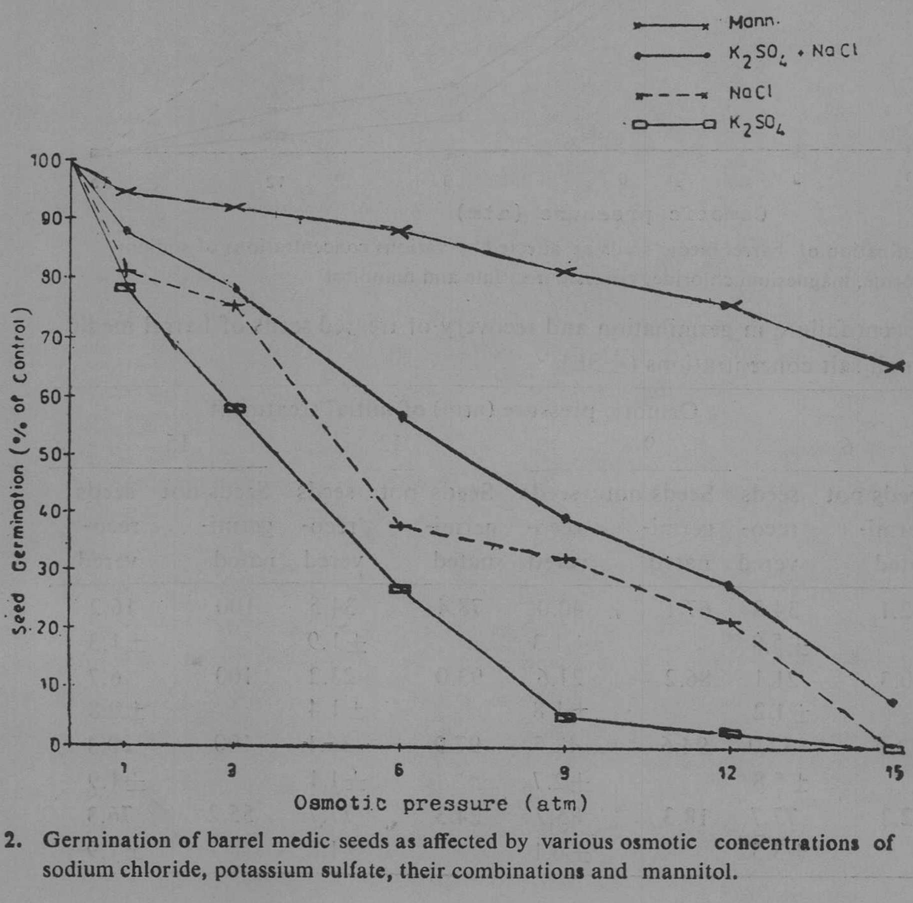

Fig. 2. Germination of barrel medic seeds as affected by various osmotic concentrations of sodium chloride, potassium sulfate, their combinations and mannitol.

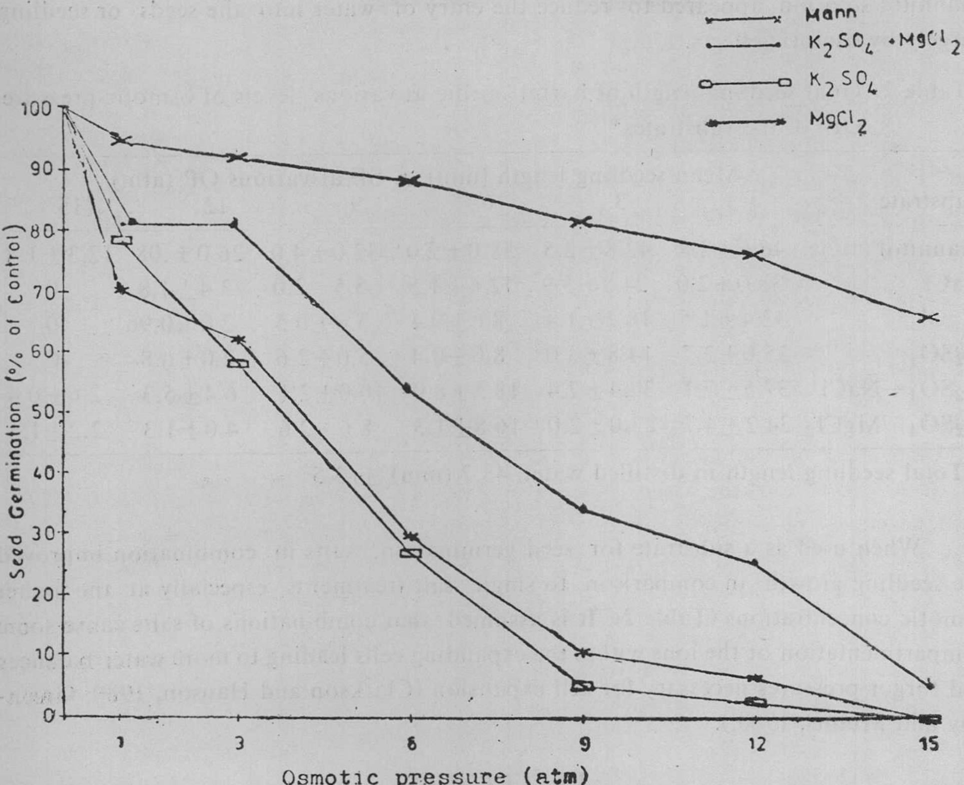

Fig. 3. Germinatian of barrel medic seeds as affected by various osmotic concentrations of magnesium chloride, potassium sulfate, their combinations and mannitol

especially at higher salinity levels. The possible explanation for these observations is that sodium and magnesium ions reduce the uptake of potassium or accumulation of potassium in the cell may be compensated by the presence of sodium and magnesium ions in the cytoplasm (Greenway and Osmond, 1972).

Seedling Development

The total seedling length of the untreated seeds of Barrel medic (48.5 mm) was reduced to 37.3, 32.4 and 35 mm when treated with 1 atm of NaCl, $MgCl_2$, and K_2SO_4, respectively (Table 2). The reduction continued to increase with the increase in concentrations up to 9 and 12 atm osmotic pressure. Seedling growth of Barrel Medic seeds as more sensitive to $MgCl_2$ and K_2SO_4 than to NaCl especially at higher concentrations. The inhibitory effect on seedling growth appeared to be mainly due to ionic action. With increase in the concentration of the medium, water absorption and cell expansion also tend to decrease (Kylin and Quatrano, 1975).

Total seedling length was not much affected by the various osmotic levels of mannitol as compared to single salts (Table 2). Increasing the osmotic pressure of mannitol solution appeared to reduce the entry of water into the seeds or seedlings largely by osmotic effects.

Table 2. Total seedling length of barrel medic at various levels of osmotic pressure (OP) of the substrates*

Substrate	Mean seedling length (mm) ± SE at various OP (atm) 1	3	6	9	12	15
Mannitol	46.6±2.8	42.8±2.5	38.0±2.0	32.0±4.0	26.0+.08	12.3±1.4
NaCl	38.0±2.0	24.8±3.9	12.6±1.5	5.5 ± 2.0	3.4±1.8	0
$MgCl_2$	32.4±1.5	18 2±1.4	8.6±0.4	3.6±0.5	2.0±0.96	0
K_2SO_4	35.0±2.7	14.8±3 0	8.0±0.4	5.0±2.6	2.0±0.8	0
K_2SO_4+NaCl	37.5±7.1	30.4±7.4	18.5±8.0	10 0±2.1	6.4±5.3	2.6±0.4
K_2SO_4+$MgCl_2$	34.2±4 7	22.0±2.0	16.8±1.3	8.6±2.6	4.0±1.3	2.2±1.4

* Total seedling length in distilled water 48.7 (mm) ± 3.5

When used as a substrate for seed germination, salts in combination improved the seedling growth in comparison to single salt treatments especially at the higher osmotic concentrations (Table 2). It is assumed that combinations of salts cause some compartmentation of the ions within the expanding cells leading to more water balances and turgor pressures necessary for cell expansion (Clarkson and Hanson, 1980; Greenway and Munns, 1980.).

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