

EFFECT OF CHLORIDE SALINITY AND BORON ON GERMINATION, GROWTH AND MINERAL COMPOSITION OF CHICKPEA (*CICER ARIETINUM* L.)

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ABSTRACT

In a pot culture experiment on a loamy sand, chickpea germination, dry matter yield and mineral composition at six weeks were observed as a function of increasing soil boron (0.6, 2.3, 4.3, 6.2 and 8.1 ppm) at five salinity levels (.4, 2.5, 4.3, 6.2 and 8.5 dSm⁻¹ ECe). Increasing levels of salinity inhibited germination upto 65% and delayed it by 10 days. With increase in salinity from 1.4 to 8.5 dSm⁻¹ the dry matter yield decreased from 5.12 to 1.55 g/pot. Concentration of Ca, Mg and Na in tissues increased and that of K and B decreased with increased soil salinity. Application of boron also inhibited germination and decreased dry matter yield. At 0.6 and 8.1 ppm soil boron, the per cent germination and dry matter yield were 78 and 61%; 4.91 and 1.78 g/pot, respectively. Soil boron resulted in luxury consumption of Na and thereby reduced K uptake. The saline soils with higher amounts of boron were found more harmful to germination and growth of chickpea than saline soils with lower amounts of boron.

INTRODUCTION

In south-western Haryana and the adjoining areas of Rajasthan and U. P., underground waters, mostly brackish, are being largely used for irrigation. Such waters, having dominant chloride and sulphate anions and also variable amounts of boron, build up high levels of salts in the root zone. Chlorides affect germination and plant growth more adversely than sulphates (Manchanda 1980; Manchanda and Singh, 1982 and Yadav et al., 1985). This study reports the effect of different levels of chloride salinity and boron on germination, growth and mineral composition of chickpea.

MATERIAL AND METHODS

A pot culture experiment was conducted during 1983-84 using a non-calcareous, loamy sand (89% sand, 7% silt and 4% clay) soil in cement pots (30x30x40 cm³) at the Haryana Agricultural University Regional Research Station, Bawal. The soil was typical Camborthid according to 7th approximation. The pH (1:2), ECe, C.E.C. and hot water soluble (h.w.s.) boron of experimental soil were 8.55, 1.4 dS m⁻¹, 8.4 me/100 g soil and 0.55 ppm, respectively. Five levels of salinity (0, 20, 40, 60 and 80 me/l of satura-

tion extract) and five boron levels (0, 2, 4, 6 and 8 ppm B) at each salinity level were replicated thrice in a completely randomised design. The salinity levels were created by adding different amounts of NaCl, Na₂SO₄, CaCl₂ and Mg Cl₂.6H₂O in 19 kg soil in such proportion so as to obtain 80 and 20 per cent of chloride and sulphate salts, respectively. The proportion of the salts of sodium, calcium and magnesium was 2:1:1, respectively. Boron was applied through boric acid. Each pot was also supplied with 10, 20, 5 and 5 ppm of N, P₂O₅, Fe and Zn, respectively. The soil was then mixed and filled in pots and packed to a uniform density of 1.5 g/cm³. The soil was analysed for ECe and h.w.s. boron as per the method of Richards (1954). The observed salinity (ECe) was 1.4, 2.5, 4.3, 6.2 and 8.5 dSm⁻¹ and hot water soluble boron was 0.55, 2.30, 4.30, 6.20 and 8.10 ppm in different treatments. In each pot, ten seeds of chickpea (*Cicer arietinum*, L.) cv Gaurav were sown on 30 October, 1983 and, after completion of germination, two plants were allowed to grow in each pot. Recommended cultural practices were followed throughout the growth season. The crop was harvested at flowering stage (42 d.a.s.). For dry matter (shoot) yield, the plants were washed, dried in an oven at 70°C and weighed. For analysis, the plant samples were ground finely. Boron was assayed by using the Hatcher and Wilcox (1950) technique. From each sample 0.5 g material was digested in a diacid mixture (HNO₃:HCO₄::4: 1) and analysed for Na, K, Ca and Mg by using the procedures outlined in USDA Hand Book No. 60 (Richards, 1954).

RESULTS AND DISCUSSION

With increasing levels of salinity, germination not only delayed but also reduced significantly (Fig. 1). At 1.4 dSm⁻¹ of soil salinity (control), germination was completed on the 10th day whereas at dSm⁻¹ it completed on the 20th day after sowing.

Increasing concentration of salinity and boron in the soil decreased seedling emergence and dry matter yield of chickpea (Table 1 and 2). Germination and dry matter yield decreased significantly at and above 4.3 dSm⁻¹ level of salinity. The adverse effect of salinity on plant growth may be due to: (a) the osmotic effect of rooting medium (b) the accumulation of toxic ions (Cl⁻ and Na⁺) in plant tissues

Table 1. Effect of salinity and boron levels on per cent germination of chickpea

Salinity ECe (dSm ⁻¹)	Boron (ppm)				
	0.55	2.30	4.30	6.20	8.10
1.4	97	96	97	93	87
2.5	90	93	96	93	87
4.3	92	90	87	77	70
6.2	63	63	53	47	40
8.5	47	33	32	28	23
Mean	78	75	72	67	61

CD (5%) : main effect 8.1; interaction 18. 1

(Hayward and Wadleigh, 1958; Bernstein, 1962 and Allison, 1964). Significant reduction in germination and dry matter yield was observed at and above 6.2 and 4.3 ppm of soil boron, respectively (Tables 1 and 2). It indicates that chickpea tolerance to boron decreases with advancing crop growth stage. Such a trend in chickpea was also indicated by Manchanda and Yadav (1978).

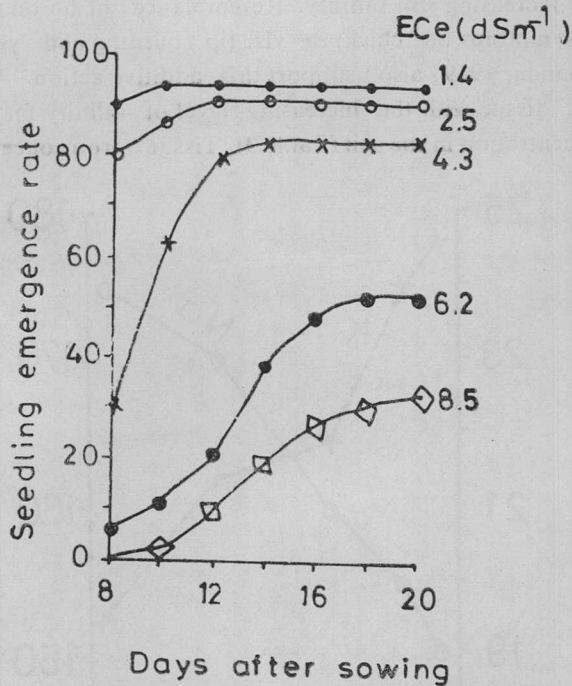


Fig. 1. Seedling emergence rate as affected by electrical conductivity of saturation extract (ECe)

Saline soils with higher amounts of boron are more harmful to germination and growth of chickpea than saline soils with lower amounts of boron (Table 1 and 2). This may be attributed to more absorption of Na at higher levels of salinity in presence

Table 2. Effect of salinity and boron levels on dry matter yield (g/2 plant) in chickpea

Salinity ECe (dSm ⁻¹)	Applied boron level (ppm)				
	0.55	2.10	4.30	6.20	8.10
1.4	6.43	6.03	4.83	4.27	4.03
2.5	6.33	5.97	4.77	3.20	2.37
4.3	5.07	4.40	3.77	3.00	1.57
6.2	3.80	3.00	2.10	1.40	0.63
8.5	2.83	2.03	1.37	0.93	0.30
Mean	4.91	4.26	3.37	2.56	1.78

CD (5%) Main effect 0.74; interaction 1.66

of boron. Concentration of sodium increased while that of potassium decreased almost linearly with increasing salinity and boron application in soil (Table 3, Fig. 2). Thus it appears that boron reduces specificity of plant to K uptake to encourage Na accumulation to toxic amounts. Increased absorption of Na may also be due to the formation of sodium borate which is the most soluble salt of boron. Additive action of soil salinity and boron on Na accumulation in plant is evidently one of the indirect reasons for increasing soil salinity. Resemblance of boron toxicity symptoms and Na toxicity symptoms on chickpea viz. tip burning and yellowing of leaves (Yadav and Manchanda, 1979) also support this additive action. An increase in Ca and Mg contents of tissue with the increasing level of salinity may be attributed to their increased concentration in the soil (Table 3). Tissue boron concentration increased

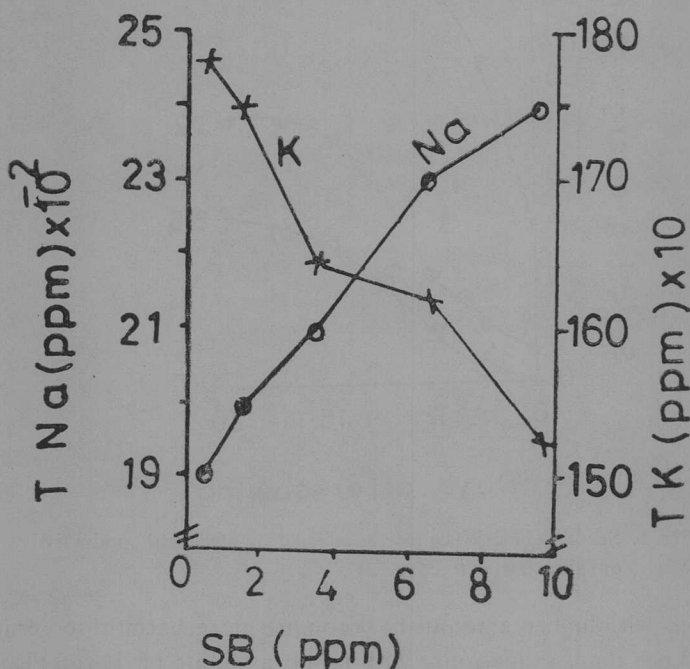


Fig. 2. Tissue sodium (TNa) and tissue potassium (TK) as affected by soil boron (SB).

Table 3. Tissue composition of chickpea as affected by soil salinity

Salinity level ECe (dSm ⁻¹)	Tissue Composition (%)			
	Ca	Mg	Na	K
1.4	1.04	0.38	0.08	1.71
2.5	1.84	0.45	0.11	1.75
4.3	2.02	0.52	0.10	1.68
6.2	2.15	0.60	0.27	1.60
8.5	2.38	0.73	0.42	1.57

with boron application and decreased with increase in soil salinity (Table 4). Similar results were reported by Manchanda (1980) while working with barley on non-saline sandy soils of Australia. Boron concentration in plants decreased with increasing soil salinity (Table 4) as a result of antagonistic effect of increasing chloride with increasing soil salinity.

Table 4. Effect of salinity and boron levels on tissue B content (ppm) in chickpea

Salinity	Applied boron level (ppm)				
ECe (dSm ⁻¹)	0.55	2.30	4.30	6.20	8.10
1.4	48.0	136.6	299.6	498.3	690.0
2.5	47.3	128.3	279.6	483.0	658.6
4.3	47.6	116.3	255.6	457.6	587.6
6.2	45.0	101.0	248.0	430.0	567.7
8.5	42.3	97.6	243.3	400.0	516.6
Mean	46.0	116.0	265.2	453.8	604.1

CD (5%) ; Main effect 31.9; interaction 71.3

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