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VOL.13, NO.148 1986

Published By
Prof. Dr. A.M. Balba Group For Soil And Water Research
Registered Under No. 734, 1981
College of Agriculture, University of Alexandria
Alexandria, Egypt.
Tel. 5975405, 5866275

ALEXANDRIA SCIENCE EXCHANGE

Published By

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Registered Under No 734, 1981

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BIOLOGICAL NITROGEN FIXATION AND YIELD OF SOYBEAN AS AFFECTED BY VARIOUS GROWTH CONDITIONS.

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ABSTRACT

Soybean (Glycine max L.Merr.)variety "Columbus", inoculated or uninoculated grown on calcareous soil in pots was irrigated with tap water, tap water + 1500, +3000 and +6000 ppm NaCl + $CaCl_2$ and sprayed with Fullyfertile 0, 3 and 6 times during the growth season. Nodulation, nitrogenase activity of root, nitrogen content of the plant and yield of dry matter and grain were taken as criteria.

Salinity depressed differentially all of the tested characteristics. At 3000 and 6000 ppm salinity levels the depression in yield was relatively greater than that in biological nitrogen fixation factors. Grain yield decreased to 55.8, 12.4 and 0.4% of the control by the 1500, 3000 and 6000 ppm salts added to irrigation water respectively. Inoculation increased grain yield by 547%. Foliar fertilization with Fullyfertile 3 and 6 times during the season increased grain yield to 109.1 and to 116.4% of the control respectively.

Significant interaction effects of salinity X inoculation, salinity X foliar fertilization and salinity X inoculation X foliar fertilization were found. This indicated that inoculated sprayed plants were more affected by salinity than the uninoculated unsprayed.

INTRODUCTION

Agricultural expansion on calcareous soils has been achieved in Egypt to increase food production. Nutritional problems due to the high contents of calcium carbonates arise in such soils (Balba 1981). Secondary salinization due to inefficient drainage presents also another problem in these soils (El-Gabaly 1971 and Balba 1984).

Soybean crop proves potential for improving legume production (Hamdi 1982). Better yields were realized through inoculation with effective rhizobial cultures (Hamdi et al 1968), Abdel-Naim et al 1981, Abdel-Ghaffar 1982, El-Sherbeeny et al 1982, El-Essawi and Abadi 1983 and El-Shakweer et al 1984). Still better yields could be obtained through foliar fertilization (El-Shakweer et al 1982, El-Essawi and Abadi 1983 and El-Shakweer and Barakat 1984)

It is known that soybean plants are sensitive to salinity (Richards 1954, Abel and Mackenzie 1964, Shabassy et al 1972, and Ayers and Westcot 1976). But the interaction effect of these factors in calcareous soils received scarce attention. Therefore, this work aimed to study this interaction effect on soybean grown in calcareous soil.

MATERIALS AND METHODS

A pot experiment was carried out on soybean (Glycine max L.Merr.) variety "Columbus" under greenhouse conditions at the Soil Salinity Laboratory, Alexandria, Egypt. The pots were 23 cm in diameter and 36 cm deep with a hole at bottom for drainage. A nonsaline calcareous sandy loam soil sample taken from a surface layer (0-30 cm) at Maryout area (Northern Sector of Tahreer Province) was used in the experiment. The soil characteristics as determined according to Black et al(1965) were: calcium carbonates 26.2%, organic matter 0.48%, total nitrogen 0.05%, electrical conductivity of saturated soil-water extract 0.55 mmhos/cm at 25°C and pH of saturated soil-water paste 8.4.

Experimental factors involved were inoculated seeds at sowing against uninoculated, variable salinity levels in irrigation water (0,1500,3000 and 6000 ppm of NaCl + $CaCl_2$ equally added to tap water of about 200 ppm of

total soluble salts) and foliar spray with Fullyfertile fertilizer 0,3 and 6 times during the growth season; all were run in 6 replicates.

For inoculation, the seeds were treated with a specific rhizobial inoculum carried on arabic gum provided by the Department of Agricultural Microbiology of the Ministry of Agriculture, Egypt. Irrigation with the salinized water started after thinning each 3 days with the proper leaching requirements to avoid salt accumulation. Fullyfertile foliar fertilizer (22.0% nitrogen, 21.0% phosphorus, 17.0% potassium, 0.079% magnesium, 0.037% iron, 0.0061% zinc, 0.0395% manganese, 0.0033% boron, 0.005% molybdenum, 0.0076% cupper and 0.002% cobalt) was applied 4 weeks after sowing every 10 or 20 days to give a total of 3 or 6 sprays. The foliar solution contained 5 g of Fullyfertile/liter of distilled water.

Sowing was on 19/5/1984. Ten days later, each pot received 1 g of each of superphosphate and potassium sulphate as fertilizers. Four days later, the plants were thinned to 10 plants/pot. At maximum flowering stage (88 days old), 3 replicates were removed for effective nodule counting, root nitrogenase activity measurements (Hardy et al 1973) and total nitrogen determination (Cattenie 1980). The other 3 replicates remained to maturity (129 days age) for weighing the grain yield.

Data were statistically analysed according to Snedecor and Duncan (1967).

RESULTS AND DISCUSSIONS

General effects of the main variables of the experiment i.e. salinity, inoculation and Fullyfertile foliar sprays on nodulation, root nitrogenase activity, vegetative vigour, nitrogen content and grain yield of soybean plant are show in Table 1. Salinity depressed all of these characteristics but to variable extents as illustrated in Figure 1. Grain yield was the most affected while vegatative vigour, nodulation, N_2-ase activity and nitrogen content of the plant were almost equally the least. At a salinity of +1500 ppm, grain yield declined almost to half that of the control and at +6000 ppm no

yield was obtained. This is in fair agreement with previous work (Richards 1954, Abel and Mackenzie 1964, Shabassy et al 1972, Ayers and Westcot 1976) which rated soybean as a sensitive salinity crop. The salinity of 1500 ppm is common in most drainage waters which might be a source of irrigation in Egypt (Kaddah 1954 and Ismail et al 1978). inoculation greatly increased the tested plant characteristics i.e. nodulation, N_2Oase activity, vegetative vigour, nitrogen content and grain yield (Table 1). Grain yield, which is the outcome, with inoculation was 5 times as great as that without. Response od soybean to inoculation with effective rhizobia under Egyptian conditions has been reported by Hamdi et al (1968), Abdel-Naim et al (1981) Abdel-Ghaffar (1982), Hamdi (1982), El-Sherbeeny et al (1982), El-Essawi and Abadi (1983) and El-Shakweer et al (1984). Foliar spray also increased all (Table 1) grain yield increased 15% by applying 3 sprays and 33% by 6 sprays of Fully fertile. Foliar application of integrated fertilizer was reported to improve biiological nitrogen fixation and yield of faba bean (El-SHakweer et al 1982 and El-Shakweer and Barakat 1984) and of soybean (El-Essawi and Abadi 1983).

Interaction effects between salinity X inoculation and salinity X foliar spraying on nodulation, nitrogenase activity, nitrogen content, vegerative vigour and grain yield were found significant. In all casses,as salinity increased the difference between inoculated and uninoculated treatments, on one side, and between sprayed and unsprayed treatments on the other side, became wider. In other words, salinity depressed the inoculated plants more than the uninoculated and the sprayed more than the unsprayed, figures 2 and 3 . The second order interaction effect of salinity X inoculation X foliar spraying on nodulation, nitrogenase activity, nitrogen content, vegetative vigour and grain yield, also, significant. Accordingly it is concluded that inoculated sprayed plants were the most affected by salinity.

Table 1 : Mean values of nodulation , root nitrogenase activity , biomass dry weight and nitrogen content of soybean plant at maximum flowering (88 days age) and grain yield at maturity (129 days age) as affected by salinity of irrigation water , inoculation and foliar sprays .

Variable	Nodules / plant		N_2- ase activity, μmole C_2H_4 /root/hr.*	Dry weight of root + shoot , g./plant	Nitrogen content of root+shoot mg./plant	Grain yield g./plant
	Number	Dry weight, mg.				
Salinity (ppm) added to irrigation water : *						
0	8.84	150.9	3.25	9.72	211.5	2.83
1500	5.84	92.6	2.18	6.44	137.6	1.58
3000	3.87	46.4	1.32	4.55	90.2	0.35
6000	1.99	24.8	0.61	2.54	44.1	0.01
L.S.D. (5%)	0.39	9.1	0.26	0.34	4.6	0.09
Inoculation with rhizobia**:						
Uninoculated	0.04	0.0	0.11	4.25	83.3	0.32
Inoculated	10.24	157.3	3.70	6.87	158.4	2.07
L.S.D. (5%)	0.27	6.4	0.28	0.24	6.2	0.06
Fullyfertile foliar sprays***:						
0	4.47	64.3	1.60	4.90	104.2	1.10
3	5.06	79.7	1.91	5.59	119.6	1.20
6	5.88	92.1	2.21	6.20	138.7	1.28
L.S.D. (5%)	0.33	7.9	0.24	0.30	5.1	0.05

* Each value is a mean of 2 inoculation treatments X 3 foliar treatments X 3 replicates X 10 plants.

** Each value is a mean of 4 salinity treatments X 3 foliar treatments X 3 replicates X 10 plants .

*** Each value is a mean of 4 salinity treatments X 2 inoculation treatments X 3 replicates X 10 plants.

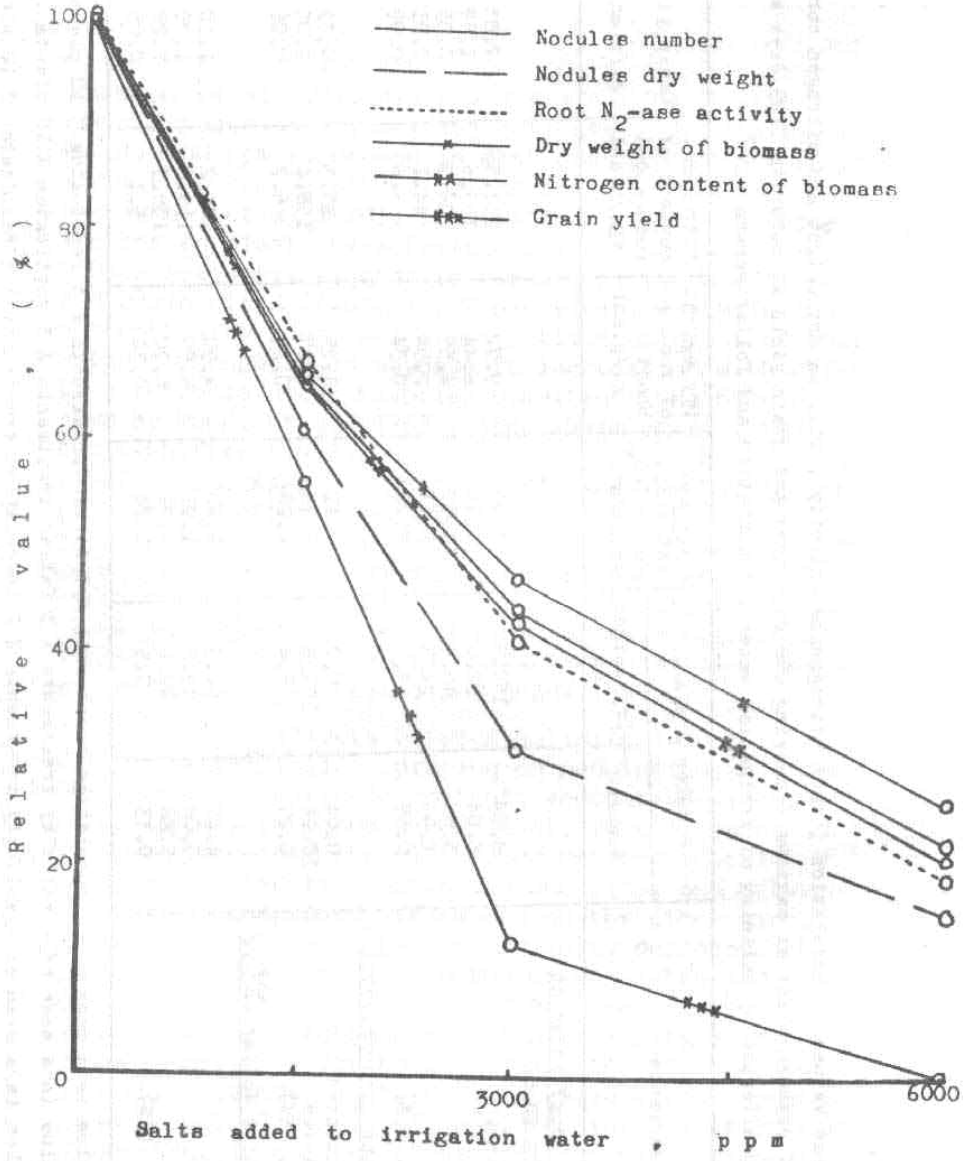

Figure 1 : Relative depression in number and dry weight of nodules , root N_2- ase activity , dry weight and nitrogen content of biomass and grain yield of soybean plant by salinity in irrigation water.

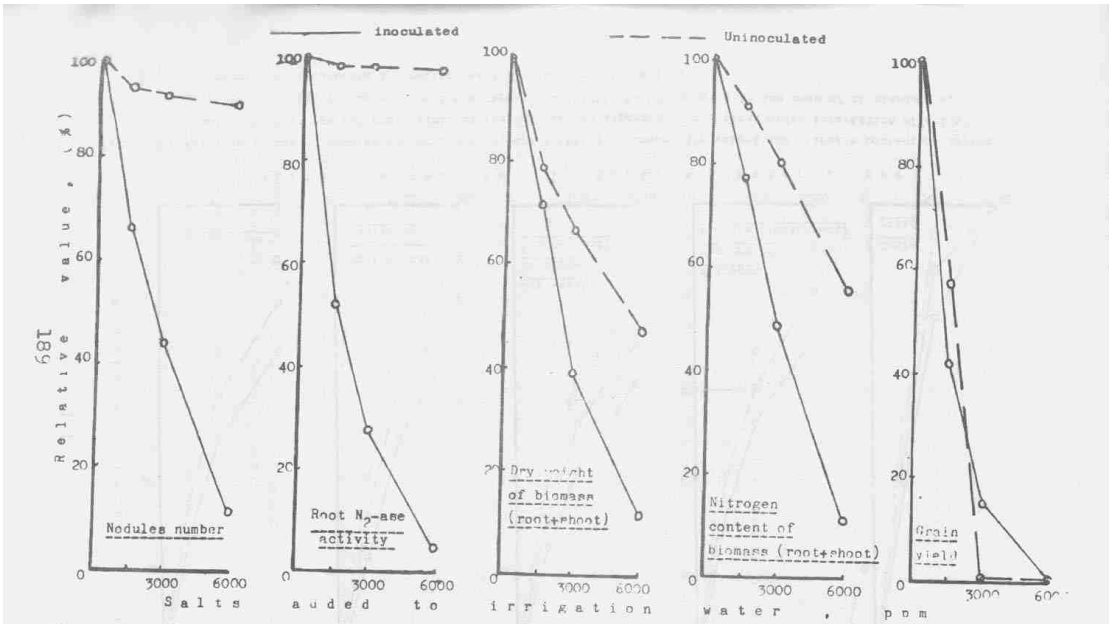

Figure 2 : Relative values of nodules number , root N_2-ase activity, biomass dry weight and nitrogen content of soybean plant at 88 days age and grain yield at 129 days age as affected by the first order interaction effect of salinity of irrigation water X inoculation with rhizobia . (Each value is the mean of 90 plants i.e. 3 foliar spray treatments X 3 replicates X 10 plants/replicate) .

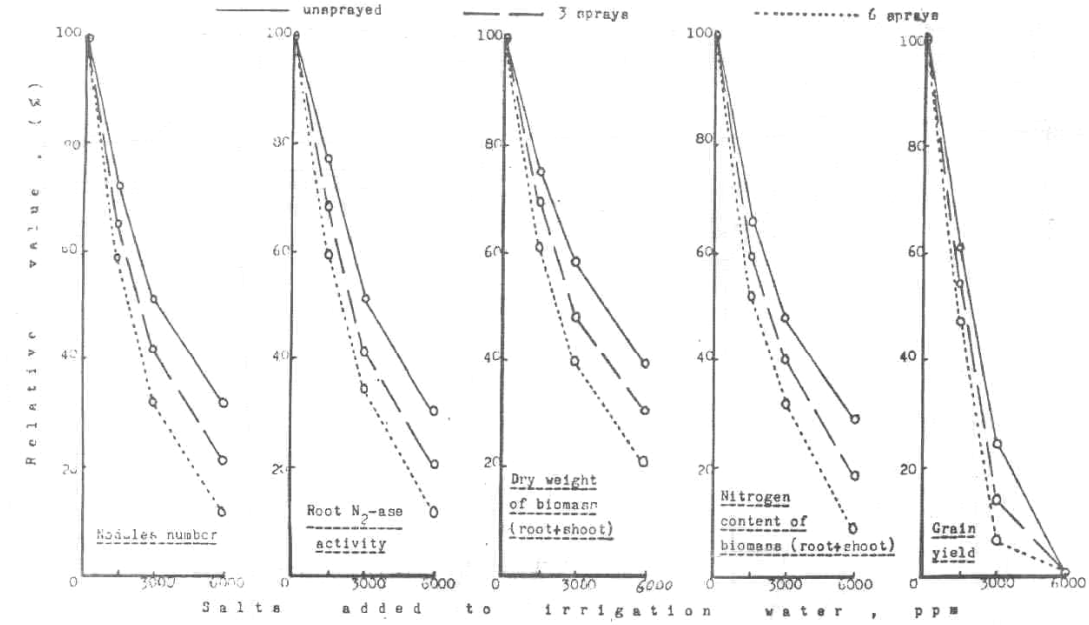

Figure 3 : Relative values of nodules number , root N_2-ase activity , biomass dry weight and nitrogen content of soybean plant at 88 days age and grain yield at 129 days age as affected by the first order interaction effect of salinity of irrigation water X foliar sprays of Fullyfortile. (Each value is the mean of 60 plants i.e. 2 inoculation treatments X 3 replicates X 10 plants/replicate) .

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