Second, Conf., ARC, Giza 9-11 April, 1984.

NITROGEN FIXATION AND PHOSPHORUS, POTASSIUM AND WATER UPTAKE BY FABA BEAN AS AFFECTED BY SALINITY STRESSES.

El-Shakweer*, M.H.A. and M.A. Barakat**.

In a pot experiment, faba bean variety Giza 2 was raised in sand media on a free-nitrogen nutrient solution in which different amounts of salts up to + 6000 ppm were dissolved. Nodulation, nitrogenase activity and plant contents of nitrogen, phosphorus and potassium were determined twice during growth and at maturity. Yield was obtained and water transpried calculated.

Results showed that per plant all were depressed by increasing salinity, but a single nodule on average gained higher weight and nitrogenase activity in nitrogen fixation as plant proceeded to maturity. Phosphorus and potassium percentages were silghtly affected by salinity. The 25, 50 and 75% reduction in grain yield were reached at 1800,3800 and 7000 ppm in growth media. Water utilized per unit dry weight of plant was decreased by salinity.

---

* Associate Professor, Dept. Soils & Water Science, Fac. Agric., Cairo University., Fayoum, Egypt.

** Head of Researche, Soil Salinity and Alkalinity Laboratory (Alexandria), ARC.

NITROGEN FIXATION AND PHOSPHORUS, POTASSIUM AND WATER UPTAKE BY FABA BEAN AS AFFECTED BY SALINITY STRESSES

By

El-Shakweer*, M.H.A. and M.A. Barakat**

SUMMARY

In a pot experiment, faba bean variety Giza 2 was raised in sand media on a free-nitrogen nutrient solution in which different amounts of salts up to +6000 ppm were dissolved. Nodulation, nitrogenase activity and plant contents of nitrogen, phosphorus and potassium were determined twice during growth and at maturity. Yield was obtained and water transpired calculated.

Results showed that per plant all were depressed by increasing salinity, but a single nodule on average gained higher weight and nitrogenase activity in nitrogen fixation as plant proceeded to maturity. Phosphorus and potassium percentages were slightly affected by salinity. The 25, 50 and 75% reduction in grain yield were reached at 1800, 3800 and 7000 ppm in growth media. Water utilized per unit dry weight of plant was increased by salinity.

---

* Associate Professor, Department of Soil & Water Science, El-Fayoum Faculty of Agriculture (Cairo University), El-Fayoum, Egypt.

** Head Researchers, Soil Salinity and Alkalinity Laboratory (Alexandria), Agricultural Research Centre, Ministry of Agriculture, Egypt.

INTRODUCTION

Faba bean is a common grain legume under Egyptian agriculture that occupies annually about 320000 feddans during winter. It is often grown under sub-optimal production systems (Ibrahim et al., 1982). Of the major constraints is the slight to moderate soil salinity which dominates throughout the country (Elgabaly, 1971 and Balba et al., 1975).

The effect of salinity on legume crops has been extensively studied (Lagerwerrf and Eagle, 1961, Vincent, 1965, Abdel-Ghaffar et al. 1981, El-Shakweer and Barakat; 1981, Abdel-Ghaffar, 1982 and El-Shakweer et al. 1982). However, under salinity stresses, nitrogen fixation by legumes in general received but little attention.

The purpose of the present work is to study nodulation, nitrogen fixation, flowering and yield of faba bean and its consumptions of water, phosphorous and potassium under controlled salinized free nitrogen conditions.

MATERIALS AND METHODS

The pexperiment was conducted at El-Fayoum Faculty of Agriculture on 29/10/1982. Pots of diameter 33 cm, height 27 cm and a hole at the bottom for drainage were filled with salt-free sand and sown to faba bean (Vicia faba L.) variety Giza 2 at a rate of 3 pairs of plants/pot. Each 2 days of the first week after sowing, the pots were irrigated with Bond's modified Corne's free nitrogen solution (Allen, 1949). A local rhizobial strain inoculum (Okadin) was added to Bond's solution with the applications of the first week.

Eight days after sowing, the pots received irrigation solution having the following composition: Bond's solution

(control), Bond's solution + 500, +1000, +2000, +4000 and +6000 ppm of NaCl. Irrigation was applied each 3 days, the volume of which included proper leaching requirement in order to avoid salt accumulation. The volumes of irrigation and drainage solutions were recorded. Twelve replicates were used for each treatment, 4 of which were removed 6 weeks after sowing, 4 after 12 weeks (maximum flowering) and the last 4 were left to maturity (20 weeks after sowing). A set of 4 replicates of each irrigation treatment but without planting was used to determine the amount of evaporation.

After 6 and 12 weeks and at harvest (20 weeks from sowing), the plants were carefully uprooted and the roots were rinsed in tap water and then in distilled water, excised and subjected to nitrogenase activity measurement by the acetylene reduction technique (Hardy et al. 1973). The effective nodules of the root were counted and their dry weight (70°C) determined. At the 12-week age, flowers were also counted. At harvest, pods and grains number and dry weights were recorded. Dry weights of roots and shoots were taken and analysed for nitrogen, phosphorous and potassium (Cattenie, 1980). Evapotranspiration was determined in the cultivated pots as $\sum$volume of irrigation-$\sum$volume of leachate. Evaporation was determined from the uncultivated pots as $\sum$volume of irrigation-$\sum$volume of leachate. Transpiration is then evapotranspiration - Evaporation.

Statistical analyses was carried out according to Snedecor and Duncan (1967).

RESULTS AND DISCUSSION

Results are shown in Tables 1, 2 and 3. Table 1 shows the effect of salinity of Band's nutrient solution on nodulation (number and dry weight of nodules), nitrogenase activity, vegetative vigour (dry weight of shoot + root)

Table 1- Nodulation, nitrogenase activity, vegetative vigour and NPK contents of faba bean at different ages as affected by salinity of nutrient solution.

NaCl added to Bond's nutrient solution, ppm.	Nodules/plant		N_2-ase activity /μ mole C_2H_4/root per hr.	Nitrogen mg/plant	Phosphorus mg/plant	Potassium mg/plant	Vegetative vigour(Shoot +root dry wt g/plant)
	Number	Dry wt. g.					
			6 weeks				
0	47	98.1	7.5	427.1	58.2	150.2	11.5
500	45	91.4	7.0	418.2	52.4	142.7	10.4
1000	40	82.2	6.3	381.8	47.3	133.5	9.2
2000	32	61.1	5.0	326.4	39.7	117.4	7.6
4000	26	48.7	4.0	269.3	30.8	92.6	5.8
6000	19	32.3	2.9	157.5	22.2	75.3	4.9
L.S.D.$_{0.05}$	2.7	5.2	1.7	48.6	7.2	24.2	1.2
			12 weeks (maximum flowering)				
0	82	226.0	20.3	850.0	106.0	312.5	19.9
500	71	200.7	19.5	804.2	100.1	301.8	18.7
1000	60	170.3	17.1	732.3	91.2	270.7	15.8
2000	48	145.2	14.5	665.8	78.5	211.8	12.0
4000	35	127.7	11.7	590.6	53.3	162.3	9.6
6000	25	106.2	7.2	390.4	35.6	104.5	6.8
L.S.D.$_{0.05}$	4.2	5.0	2.2	42.5	6.8	18.8	1.6
			20 weeks (maturity)				
0	75	197.1	15.6	960.4	232.4	613.4	38.1
500	68	174.0	14.6	900.3	200.5	542.3	33.6
1000	59	145.2	13.9	810.2	175.8	485.5	26.9
2000	48	117.7	11.7	700.1	142.3	367.9	22.4
4000	36	102.3	9.8	580.7	101.4	254.0	18.0
6000	22	89.5	6.9	459.9	63.9	141.2	12.5
L.S.D.$_{0.05}$	4.0	4.6	1.9	44.0	8.4	20.8	1.7

Each value within the Table is the mean of 24 plants (6 plants/pot x 4 replicates).

Table 2- Yield and yield components of faba bean as affected by salinity of nutrient solution.

NaCl added to Bond's nutrient solution, ppm.	Maximum* number of flowers	Pods		Grains	
		Number per plant	Dry weight/ plant	Number per plant	Dry weight/ plant
0	45	14	16.3	39	12.3
500	40	14	14.3	37	10.3
1000	31	12	10.7	31	8.7
2000	22	9	9.9	25	7.0
4000	16	6	7.9	15	5.0
6000	10	3	5.0		3.2
$L.S.D._{0.05}$	1.5	1.4	1.5	1.5	1.0

Each value within the Table is the mean of 24 plants (6 plants/pot x 4 replicates).

* Accounted at 12 week age.

Table 3- Evapotranspiration, transpiration and transpiration ratio by faba bean plant (20 week age) as affected by salinity in nutrient solution.

NaCl added to Bond's nutrient solution, ppm	Evapotranspiration L./pot	Transpiration L./plant	Transpiration ratio $cm^3/g.$ dry wt.
0	69.6	5.68	149.1
500	64.5	4.91	146.1
1000	59.8	4.25	157.9
2000	52.0	3.12	139.3
4000	44.2	2.00	111.1
6000	37.9	1.13	90.4
		0.20	8.7
$L.S.D._{0.05}$	2.4	0.20	8.7

Each value within the Table is the mean of 24 plants (6 plants/pot x 4 replicates).

تثبيت الازوت والامتصاص الكلى للفوسفور والبوتاسيوم والماء في الفول البلدى تحت تأثير ضغوط ملحيـــــــة

محمد حماد عطية الشقوير * محمد عبد الفتاح بركات **

زرع الفول البلدى صنف جيزة ٢ فى تجربة اصص على مزرعة رملية باستخدام محلول مغذى خالى من الازوت ومذاب فيه كميات مختلفة من الاملاح حتى + ٦٠٠٠ جزء فى المليون. وقد قدر عدد العقد الجذرية ونشاط انزيم النيتروجينيز ومحتويات النبات من النيتروجين والفوسفور والبوتاسيوم مرتين خلال موسم النمو وعند النضج. وقدر المحصول وحسب ماء النتج.

وقد دلت النتائج على أنه بزيادة الملوحة فى الوسط الغذائى انخفضت جميع هذه الخواص المختبرة بالنسبة للنبات ولكن بالنسبة للعقدة الجذرية الواحدة زاد وزنها الجاف ونشاط انزيم النيتروجينيز فى تثبيت الازوت مع تقدم العمر. كما ان النسبة المئوية للفوسفور والبوتاسيوم لم تتأثر كثيرا بزيادة الملوحـــة. وكان ٢٥ ، ٥٠ ، ٧٥ ٪ من المحصول القياسى ينقص بازدياد ملوحة الوسط الى ١٨٠٠ ، ٣٨٠٠ ، ٧٠٠٠ جزء فى المليون. وكانت كمية المياه المستعملة لانتاج وحدة جافة من النبات تتناقص بازدياد الملوحـــة.

---

* استاذ مساعد - قسم الاراضى والمياه - كلية زراعة الفيوم (جامعة القاهرة) الفيوم - جمهورية مصر العربية.

** رئيس بحوث معمل بحوث الاراضى الملحية والقلوية بالاسكندرية - مركز البحوث الزراعية - وزارة الزراعة - جمهورية مصر العربية.

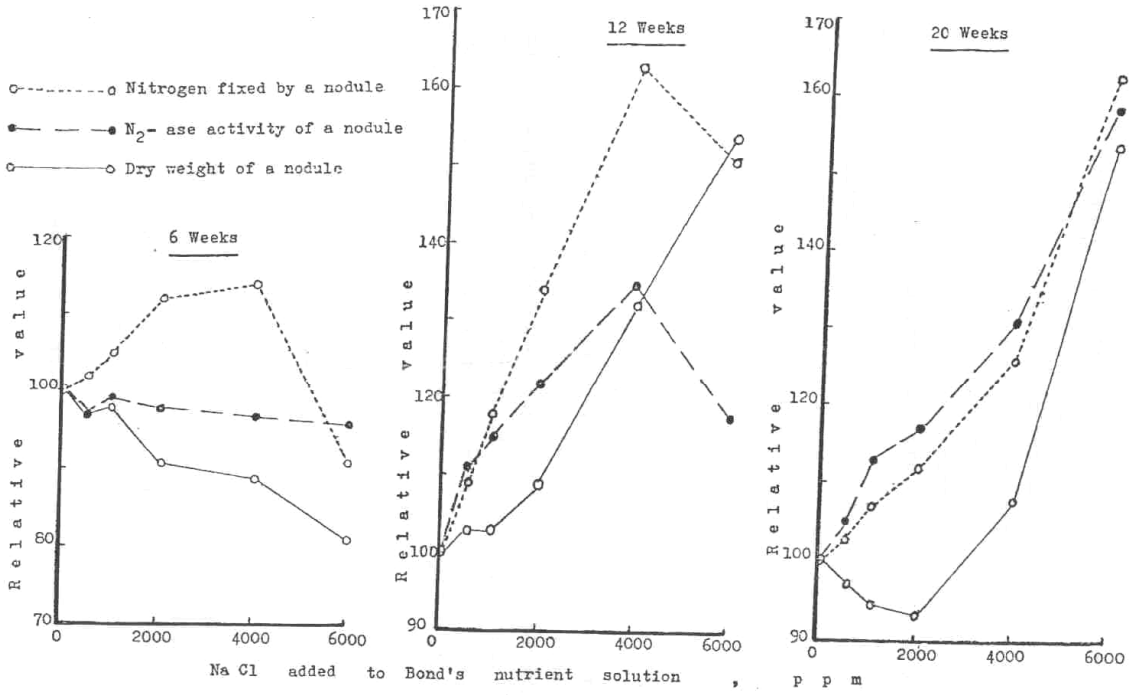

Figure 1 : Effect of salinity in Bond's nutrient solution on relative values of dry weight of a nodule , nitrogenase activity of a nodule and nitrogen fixed by a nodule in different growth stages of faba bean plant .

Table 2 shows the effect of salinity on flowers No.at maximum flowering stage and yield components. Flowering was very sensitive to salinity as it decreased to 22% of the control with the 6000 ppm salinity level. It is assumed that soil salinity increase the flowers drop due to the induced competition between flower formation and young vegetative parts on the allowed nutrients in the plant (El-Fouly, 1982). Pods number and its dry weight, grains number and its dry weight were decreased to 21, 31, 20 and 26% of the control respectively with raising salinity to 6000 ppm in the nutrient solution.

Figure 2 shows relative values of some of the tested characteristics of faba bean plant at harvest with salinity. With respect to grain yield and according to the applications of Ayers and Westcot (1976), the 25, 50 and 75% reduction in yield were effected by NaCl additions 800, 2800 and 6000 ppm respectively to Bond's solution which contained 1000 ppm of nutrients. In terms of electric conductivity, these values would correspond to 2.8, 5.9 and 10.9 millimhos/cm at 25°C respectively.

Table 3 shows the evapotranspiration, transpiration and transpiration ratio of faba bean plant at maturity as affected by salinity of nutrient solution. Evapotranspiration and transpiration were noticeably decreased with salinity being 54 and 20% of the control respectively with increasing salinity to the level of 6000 ppm. With the control, transpiration amounted to 8.2% of evapotranspiration while the corresponding values decreased with increasing salinity being only 3% with the 6000 ppm salinity level. Transpiration ratio of faba bean plant was not significantly affected with salinity up to 1000 ppm then decreased with salinity being 61% of the control with the 6000 ppm salinity treatment. It could be concluded that the decrease in transpiration ratio with salinity reflects higher water utilization under salinity stress.

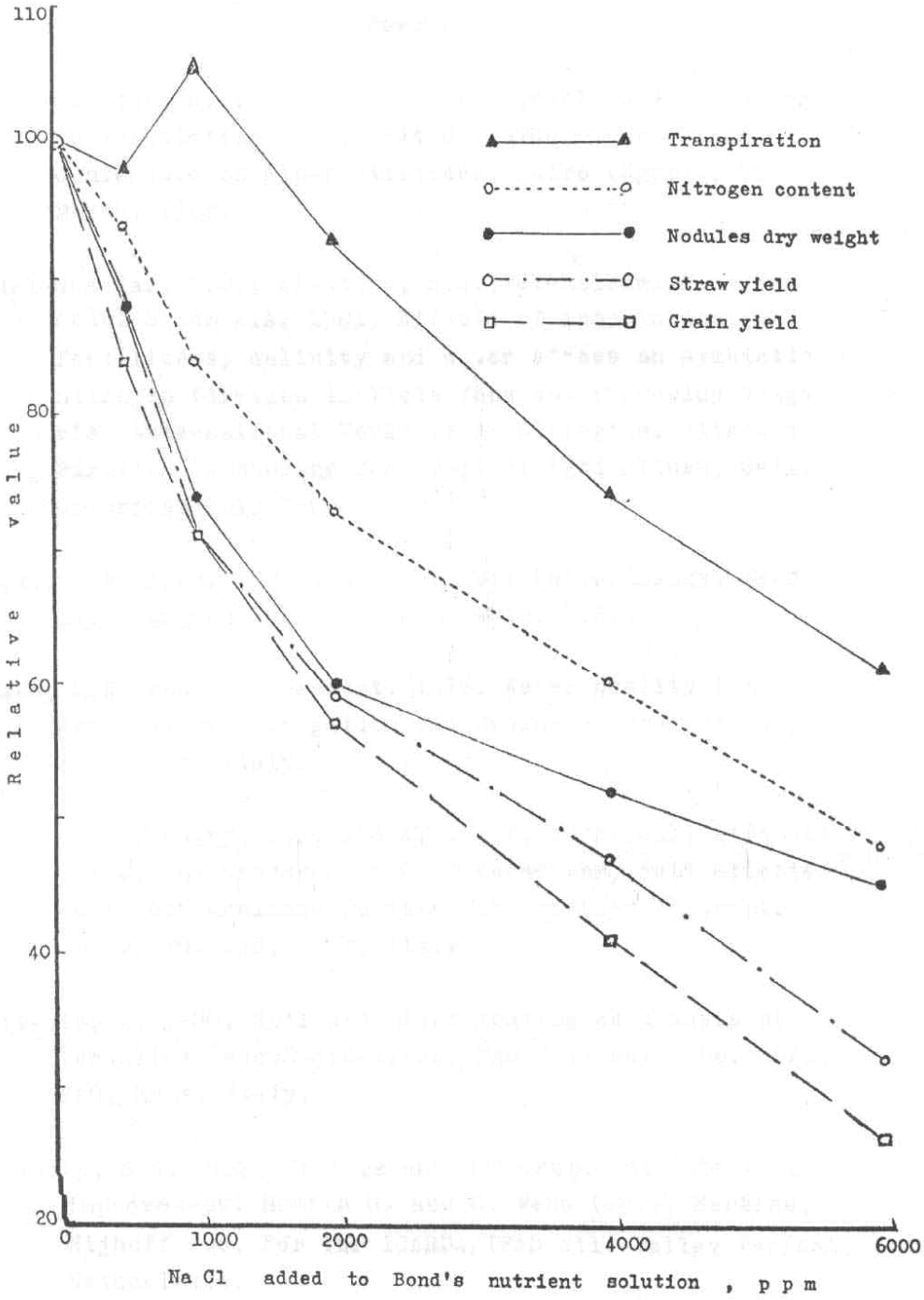

Figure 2 : Relative values of some characteristics of faba bean plant (20-week age) as affected by salinity of Bond's solution .

REFERENCES

Abdel-Ghaffar, A.S. 1982. Nodulation problems and response to inoculation. The first OAU/STRC. Inter-African Conference on Bio-fertilizers, Cairo (Egypt), 22-26 March, 1982.

Abdel-Ghaffar, A.S.; El-Attar, H.A.; El-Halfawi M.H. and Abdel-Salam A.A. 1981. Effects of inoculation, N-fertilizers, salinity and water stress on symbiotic nitrogen fixation in Vicia faba and Phaseolus vulgaris. International Workshop on Biological Nitrogen Fixation Technology For Tropical Agriculture, Cali, Colombia; 9-13 March, 1981.

Allen, O.N. 1949. Experiments in soil bacteriology. Page 119. Burgess Pub. Co., Minnesota, U.S.A.

Ayers, R.S. and D.W. Westcot. 1976. Water quality for Agriculture. Irrigation and Drainage Paper No. 29, FAO, Rome, Italy.

Balba, A.M., Kadry, L.T. and A. Taher, 1975. Salt affected soils. In: Research on Crop Water use, salt affected soils and drainage in the Arab Republic of Egypt. pp. 62-78. FAO, Rome, Italy.

Cattenie, A. 1980. Soil and plant testing as a basis of fertilizer recommendations. FAO Soil Bull. No. 38/2, FAO, Rome, Italy.

El-Fouly, M.M. 1982. Flowers and pod drop. In: Faba bean improvement. Hawtin G. and C. Webb (ed.), Martins, Nijhoff Pub. for the ICARDA/IFAD Nile Valley Project; Netherlands.

Elgabaly, M.M. 1971. Reclamation and management of salt affected soils. In: Salinity Seminar Baghdad. Irrigation and Drainage Paper No. 17, pp. 50-90, FAO, Rome, Italy.

El-Shakweer, M.H.A. and M.A. Barakat, 1981. Effect of chloride and sulphate salts on growth of peanut and cowpea. J. Agric. Res. Tanta Univ. (Egypt)7(2): 321-327.

El-Shakweer, M.H.A.; Farah, M.A. and M.A. Barakat, 1982. Effect of some integrated foliar fertilizers on nodulation, nitrogenase activity, nitrogen content and yield of Vicia faba plants in salinized calcareous soil. Annals of Agric. Sci.,,Ain Shams Univ. (Egypt), Bull. No. 1887, June, 1982.

Hamdi, Y.A. 1982. Application of nitrogen fixing systems in soil improvement and management. FAO Soil Bull. No. 49, FAO, Rome, Italy.

Hardy, R.W.F., Burns, R.C. and R.D. Holsten, 1973. Application of the acetylene-ethylene assay for measurements of nitrogen fixation. Soil Biol. Biochem. 5: 47-61.

Ibrahim, A.A. Nassib, A.M. and El-Sherbeeny, 1982. Faba bean agronomy in Egypt. In: Faba Bean Improvement Hawtin G. and C. Webb (ed.). pp. 109-116. Martins Nijhoff Pub. for the ICARDA/IFAD Nile Valley Project Netherlands.

Lagerwerrf, J.V. and H.E. Eagle, 1961. Osmotic and specific effects of excess salts on beans. Plant Physiol. 36: 472-477.

Snedecor, G.W. and E.N. Duncan, 1967. Statistical methods. The Iowa State Univ. Press, Iowa, U.S.A.

Vincent, J.M. 1965. Environmental factors in the fixation of nitrogen by legumes. In: Soil Nitrogen. Bartholomew, W.V. and F.E. Clark (ed.), pp. 384-435, Series No. 10 in Agron., Amer. Soc. Agron., Madison, Wisconsin, U.S.A.