ADAPTABILITY OF LEGUME CROPS UNDER DIFFERENT SALINITY LEVELS

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This thesis entitled, ADAPTABILITY OF LEGUME CROPS UNDER DIFFERENT SALINITY LEVELS, prepared and submitted by ARAK CHANTUMA in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE IN CROP SCIENCE (AGRONOMY), is hereby accepted.

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ABSTRACT

CHANTUMA, ARAK. Institute of Graduate Studies, Central Luzon State University, Muñoz, Nueva Ecija, Philippines, October, 1989. ADAPTABILITY OF LEGUME CROPS UNDER DIFFERENT SALINITY LEVELS.

Major Adviser: Lun G. Mateo

The study involved two experiments aimed to compare the performance of four field legumes soybean, mungbean, cowpea, and white bean grown under different salinity levels, 0, 3000, 6000, and 9000 ppm (experiment 1) and to determine the effect of chicken manure application on soybean and mungbean grown under different salinity levels, 0, 6000, and 9000 ppm (experiment 2). In both experiments, sodiun chloride was used as the source of salts. The experiments were conducted at the screenhouse of the Department of Soil Science, College of Agriculture, Central Luzon State University, Munoz, Nueva Ecija, Philippines from January to May 1989.

In experiment 1, the results showed that the germination, plant height, yield components, dry matter yield, and seedyield of all field legumes were

significantly affected by salinity levels. On the average, percent germination 15 DAP was in the order of cowpea > white bean > mungbean > soybean with means of 90.00, 70.42, 64.38, and 50.62 percent, respectively. The germination of mungbean, soybean, and white bean was significantly reduced at 6000 and 9000 ppm but not at 3000 ppm. In contrast, the germination of cowpea was not significantly affected even at the highest salinity level of 9000 ppm. However, based on visual score done 28 DAP, soybean and cowpea appeared to be more tolerant to salinity than mungbean and white bean. White bean seemed to be the least tolerant to salinity among the field legumes as indicated by the zero survival of the plants on all salinized soils 45 DAP. Among the field legumes, soybean yielded the highest followed by cowpea, mungbean, and white bean with seedyield of 19.80, 15.10, 4.45, and 1.16 g/plot, respectively. At salinity level of 6000 ppm, the reduction in yield was 31.70, 68.70, 86.40, and 100.00 percent for soybean, cowpea, mungbean, and white bean, respectively.

In experiment 2, results showed significant interaction between field legumes and salinity levels but not between salinity level and the application of

chicken manure. The results further indicated that application of chicken manure did not improve the germination, yield components, dry matter yield, and seedyield of soybean and mungbean when the soil was salinized with NaCl at 6,000 and 9,000 ppm.

LITERATURE CITED

Abel, G.H. and A.J. Mackenzie. 1964. Salt tolerance of soybean varieties (Glycine max. L. Merrill) during germination and later growth. Crop Sci. : 157-161.

Abel,G.H. 1969. Inheritance of the capacity for chloride inclusion and chloride exclusion by soybean. Crop Sci. 9 : 697-698.

Abrol, I.P. and D.R. Bhumbla. 1971. Saline soils in India - their occurence and management. World Soil Resource. Rep. 41 : 42-51 FAO. Rome.

Allison, L.A. and A.R. Lowell. 964. Salinity in relation to irrigation. Advace in Agronomy 16 : 139-180.

Aragon,M.L. 1985. Influence of soil salinity and irrigation water quality on cotton (Gossypium hirsutum L.) Philipp. J. Crop Sci. 10 : S 21.

Arunin, S. 1983. Chracteristic and management of salt affected soils in the northeast of Thailand. The international seminar on Ecology and Management of problems soils in Asia. paper No. 19 Bangkok, Thailand.

Bhumbla, D.R. and I.P. Abrol. 1978. Saline and sodic soils. Paper presented at the soil and rice symposium, Los Banos, Philippines, September 20-26, 1978.

Banerjee,N.K. and N.R. Dhar. 1972. Influence of organic matter on the reclamation of saline soils. Sheila Dhar Institute of Soil Science, Allahabad. Division of Soil Science and Agricultural Chemistry, I.A.R.I., New Delhi-12.

Boonpikum, N. 1982. Effect of organic amendments, drainage and mulching on the reclamation of salt-affected soil in northeast Thailand. Thesis desertation (unpublished), University of the Philippines at Los Banos. 138 .pp.

Brandy, N.C. 1984. The nature and properties of soils. 9th edition. Macmillan Publishing Company New York, London. 750 .pp.

Danahue, R.I., R.W. Miller and J.C. Shickluna. 1977. Soil : Introduction to soils and plant growth. 4th edition. Prentice -Hall, Inc.,Engle Cliffs, New Jersey. 626 .pp.

Das, S.K. and C.L. Mehortra. 1971 Salt tolerance of some agriculture crops during early growth stages. Indian. J. Agric. Sci. 4(10) : 882-888.

De Datta, S.K. 1980. Principles and pratices of rice production. A Wiley- Interscience Publication. John Wiley & Sons. New york, Chicester, Brisbane, Toronto, Singapore. 618 .pp.

El Karouri, M.O.H. 1979. Effects of soil salinity on broad bean (Vicia faba) in the Sudan. Expl. Agric. 15 : 59-63.

FAO, 1985. Gudelines : land evluation for irrigated agriculture. FAO Soil Bulletin 55. Food and Agriculture Organization of the United Nations. 218 .pp.

Greaves,J.E. 1916. The influence of salt on bacteria activity of the soil. Soil Sci., 2(5) pp. 433-480.

Gunn, R.H. and D.P. Richardson. 1979. The nature and posible origins of soluble salts in deeply weathered landscapes of eastern Australia. Aust. J. Soil Res. 17 : 197-215.

Hendry, G.W. 1918. Relative effect of sodium chloridenon the development of certain legumes. Jour. Amer. Soc. Agron., 10(6) pp. 246-249.

Kearney Foundation, 1985. Soil and plant interactions with salinity. Kearney foundation five-year report 1980-1985. Agriculture experiment station University of California, Division of Agriculture and Natural Resources, Special publication 3315. 138 .pp.

Khan, A.A. 1980. The physiology and biochemistry of seed dormancy and germination. North-Holland Publishing Company. Amsterdam, New York, Oxford. 447 .pp.

Levitt,J. 1972. Response of plants to environtal stress. Academic Press New York, San Francisco, London. 697 .pp.

Lipman, C.B., A.R. Davis and E.S. West. 1926. The tolerance of plants for NaCl. Soil Sci. 22(4) .pp 303-322.

Mangel, K. and E.A. Kirby. 1987. Principles of plant nutrition. International Potash Institute. P.O. Box, CH-3048 Worblaufen-Bern/Switzerland. 655 .pp.

Miflin,B.J. 1980. The biochemistry of plants : A comprehensive treatise., Amino acid and derivative. Academic Press New York, Sydney, San Francisco. 670 .pp.

Musell, H. and R,C. Staples. 1979. Stress physiology in crop plants. A Wiley- Interscience Publication, John Wiley & Sons. New york, Chicester, Brisbane , Toronto. 310.pp.

Norman, A.G. 1949. Plant growth on saline and alkali soils. Advances in Agronomy. Vol. 1. Academic Press Inc., Publishers. New York. 440.pp.

PCARR, 1977. The Philippines recommends for mungo 1977. the Philippines Council for Agriculture and Resource Research .pp 62.

PCAAR. 1978. The Philippines recommends for soil fertility management 1978. The Philippines Council for Agriculture and Resource Research. Buraue of Soils. Manila. 109 .pp.

PCARRD, 1986. The Philippines recommends for soybean. The Committee for soybean. The Philippines Council for Agriculture and Resource Research and Development, 1986. 111 p. Technical Bulletin Series No. 14 A.

Peck, A.J. 1978. Salinization of non-irrigated soils and associated streams : A review. Aust. J. Soil res. 16 : 157-168.

Ratner, E.E. 1935. The influence of exchangeable sodium in soilson the growth of plants and the physical properties of the soil. Khimizatziya Sotzialist Zemledelliya (Moscow) 3: 35-45.

Sigua, G.C. 1985. Soil classification of Central Luzon State University, Research Station, Muñoz, Nueva Ecija. Philippines.

Sharma, D.R. and S,S, Prihar. 1973. Effect of depth and salinity of ground water on evaporation and soil salinization. Indian J. Agric. Sci. 43 : 582-586.

Sharma, D.Z., S.S. Puntamkar, P.C. Mehta and S.P. Seth. 1971. Note on the effect of different common salt of sodium and calcium on the germination of green-gram (Phaseolus aureus Roxb.) varieties. Indian J.Agric. Sci. 41(1) : 636-638.

Sinuwong, S. and Y. Takaya. 1974. Saline soil in northeast Thailand their possible origin as deduced from field evidence. Southeast Asia Studies 12(1) : 105-120.

Yadav, N.K. and S.R. Vygas. 1971. Response of root-nodule rhizobium to saline, alkaline and acid conditions. Indian J. Agric. Sci. 41(10) : 875 - 881.

Zimmermann,U. 1978. Physics of turgor - and osmoregulation. Ann. Rev. Plant Physiol. 29 : 121-148.