http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences, 1 (4): 399-401, 1998 Research Article

Rainy Season Soybean (*Glycine max* L.) as Influenced by Nitrogen and Potassium Fertilisers Grown on Oxic Paleustults Soil in Northeast Thailand

A. Suksri
Department of Agronomy, Khon Kaen University, Khon Kaen 40002, Thailand

Abstract

Oxic Paleustults soil required the additional amounts of both dolomite and chemical fertilisers annually from crop to crop due to high rate of leaching and some amounts of nutrients have been taken up by roots of the soybean plants. An increase in N revels consistently increased total shoot dry weights, stern plus petiole dry weights, leaf dry weights, and pod dry weights of the soybean plants but the differences were relatively small and not statistically significance. Potassium increased top growth, seed yields and seed sizes only up to the second level and then a decline. The levels of K were relatively too high for N to encounter. The differences between the fertiliser treated plants and the untreated plants were large and statistically significance. Oxic Paleustults soil requires the lowest rates of both N and K fertilisers but higher K levels should be adjusted to attain N:K ratio of 1:1.5, Nitrogen is needed for soybean plants even though rhizobium *Japonicum* is available in soil from the previous soybean experiments. Seed yields of soybean plants increased with an increase in N levels but slightly depressed by higher K levels. Seed sizes of the soybean plants increased by the second level of K and higher K levels depressed it. There were some significant relationships between seed yields and total shoot dry weights, seed yields and leaf areas, seed yields and leaf area indices and a slightly positive relationships between seed yields and levels of N but with lesser extent with higher K levels.

Key words: Chemical fertilisers, rhizobium, canopies, vegetative growth, leaf area indices. seepage and percolation

Introduction

To pursue high seed yield of soybeans in most farming systems, seeds of soybean crop must be inoculated with rhizobium at the time of sowing if the soil has not been previously received some amount of rhizobium. The inoculation of bacteria is considerably to be the best technique for growers to attain some additional amount of nitrogen to the soil by the use of nitrogen fixing bacteria i.e. nitrogen is symbiotically fixed by roots as root nodules of the soybean plants while growing. Vangnai and Niamsrichand (1979), Vangnai (1980) and Suksri (1992) stated that the growth of stern plus petioles and !eaves and also seed yields of soybean plants were much higher for the inoculated plants than those without. These workers have carried out their experiments with the use of *Japonicum* rhizobium strain. They have suggested that in order to reduce some considerable amount of inputs, growers could not do away without rhizobium inoculation. With this work, it has been anticipated that if the soil has already been deposited with some amount of bacteria (*Japonicum*) from the previous experiments then should it be possessed still some outstanding results with the additional levels of both nitrogen and potassium added to the soil by the application of chemical fertilisers particularly the effects due to nitrogen. Nevertheless, potassium also has its significant effect on growth and seed yields of the soybean plants as stated by Suksri (1998). Therefore, it is of tangible value to carry out soybean experiment on Oxic Paleustults soil with respect to different levels of both nitrogen and potassium fertilisers.

Materials and Methods

This rain-fed experiment was carried out on Oxic Paleustults soil (Yasothon soil series) at Khon Kaen University experimental Farm, Khon Kaen, Thailand during August to November 1997 to investigate the effect of nitrogen and potassium chemical fertilisers upon growth and seed yields of KKU1 soybean cultivar. The experiment was laid in a factorial design with four replications. The sources of nitrogen (N) and potassium (K) were urea ($CO(NH_2)_2$, 46 % N) and potassium chloride (KCl, 60% K_2O). Nitrogen levels were: 0, 50, 100 and 150 kg N/ha and 0, 75, 150, and 225 kg K_2O/ha for potassium levels, hence the experiment was altogether consisted of 16 treatments. The combinations of treatments between N and K_2O were as follows: 0 kg N/ha plus 0 kg K_2O/ha (T1), 0 kg N/ha plus 75 kg K_2O/ha (T2). 0 kg N/ha plus 150 kg K_2O/ha (T3), 0 kg N/ha plus 225 kg K_2O/ha (T4), 50 kg N/ha plus 0 kg K_2O/ha (T5). 50 kg N/ha plus 75 kg K_2O/ha (T6), 50 kg N/ha plus 150 kg K_2O/ha (T7), 50 kg N/ha plus 225 kg K_2O/ha (T8). 100 kg N/ha plus 0 kg K_2O/ha (T9), 100 kg N/ha plus 75 kg K_2O/ha (T10), 100 kg N/ha plus 150 kg K_2O/ha (T11). 100 kg N/ha plus 225 kg K_2O/ha (T12), 150 kg N/ha plus 0 kg K_2O)/ha (T13), 150 kg N/ha plus 75 kg K_2O/ha (T14). 150 kg N/ha plus 150 kg K_2O/ha (T15), and urea at the rate of 150 kg N/ha plus 225 kg K_2O/ha (T16). The land area was ploughed twice followed by harrowing once. Three weeks before land preparation, dolomite at the rate of 1875 kg/ha was applied to the soil. The plot sizes being used were a 5 × 3 m and they were altogether 64 plots. The plots were separated from each other by a 1.5 m path. Seeds of soybean variety KKU1 obtained from Dr. Sanit Luadtong, one of the plant breeders of Khon Kaen University, were sown directly into the soil by hand at the rate of 3.4 seeds per hill with the spacing between rows and within the row of 30 x 20 cm, respectively. Right after sowing, a spraying of Lasso herbicide was carried out to control the germination of weed seeds. Two weeks after emergence, thinning of seedlings was carried out leaving only one seedling per hill. At this age, chemical fertilisers both N and K were applied once to their respective treatments by banding along the rows of the crop plants. Weeding was carried out by hand three weeks after emergence. Soil samples from each plot were taken before added dolomite and also after the harvest of the final seed yield and they were used for soil pH and organic matter determinations. Eight plant samples from each plot were taken at day 63 after emergence and they were used for dry weight and leaf area determinations. Dry weights per plant of stem plus petioles and leaves were determined by the use of a forced drought oven at 90°C for four days and then weighed out (Sestak *et at.*, 1971). Leaf areas per plant were measured by the use of Leaf Area Metre, Model No. AAC-400, Hayashi, Denko Co., Ltd., Japan. Seed yields were taken from samples of 40 plants of each replication and they were threshed out and dried under the sun for 5 days and then weighed out for dry weights. The data obtained were statistically calculated.

Results and Discussion

Soil pH: Mean values of the initial soil pH were ranging from 5.3 to 5.7 for T11 and T6, respectively while that of the final harvest, mean values of soil pH were much higher ranging from 6.1 to 6.5 for T9 and T7, respectively (Table 1). The mean percentages of soil organic matter were similar for both initial and final samplings i.e. the soil being used contented the percentages of organic matter between 0.6-0.8. The results indicated that the additional amount of dolomite has increased soil pH largely even though the crop plants have taken some large amount of calcium during the active growth period. It may be possible that during the active growth period, soil pH may have increased to some considerable level and soon declined when the plants advanced in age due to some amount of soluble calcium being taken up by roots and some portion being leached out by seepage and percolation. Thus soil nutrients may have been enormously leached away as stated by Cooke (1972) and Miller and Donahue (1990), the latter stated that the more the leaching, the more acidic the soil becomes, hence there is a great tendency for most soils in tropics to become more acidic. Therefore, the application of lime or dolomite and chemical fertilisers is obviously required from crop to crop in order to produce good crop yields in most tropical acid soils.

Top Growth and Leaf Area Index (L): With top growth, there were no statistical differences due to both N and K levels on total shoot dry weights, stem plus petiole dry weights, and leaf dry weights of the soybean plants, hence the data on these parametres are omitted. However, an increase in N levels increased total shoot dry weights, stem plus petiole dry weights, leaf dry weights, and pod dry weights of the soybean plants but K did only with the second level and then a decline. Higher K levels depressed growth of the soybean plants. This may be attributed to the imbalance between N and K levels i.e. N and K ratio should be at the ratio of 1:1.5 whilst higher K levels depressed growth of the crop plants. The effects due to N and K levels on leaf area indices were small arid not statistically significance. L values were ranging from 5.6 to 6.6. The results indicated that with this level of fertility of this soil type, only some small amounts of chemical fertilisers both N and K are required i.e. 50 kg N/ha and 75 kg K_2O/ha should he considerably adequate for the crop plants for optimum growth of tops. The results also showed that light interception among the crop canopies with these L values should be no lesser than 90 % (Suksri, 1993, 1998). The results also indicated that the planting distances between rows and within the row were presumably suitable for growth of the soybean plants.

Seed Yields and 100-Seed Weights: Seed yields of the soybean plants due to the effects of nitrogen levels were relatively cleared i.e. an increase in nitrogen levels consistently increased seed yields/ha of the soybean plants. Whilst that of K levels seed yields increased only up to the second level and then a decline (Table 2). However, the differences found among the fertiliser treated plants were relatively small and not statistically significance. On the contrary, the differences between the control and the fertliser treated plants were large and statistically significance. The results suggested that some amounts ef both N and K fertilisers must be applied to the soybean plants but not higher than 50 kg N/ha plus 75 kg K_2O/ha to obtain the ratio between N and K of 1:1.5. It is noticeable that higher level of K depressed top growth, seed yields and seed sizes. This may be attributed to the imbalance between N and K levels as previously discussed i.e. K levels could have been too high since the second level of K increased top growth, seed yields and seed sizes largely and the higher levels depressed it. To justify this, plant tissue analysis may be required as to compare the uptake of both N and K in the plant tissues. However, tissue analysis was not done with this experiment. With respect to N application, the results suggested that the application of N from chemical fertiliser must he required even though the soybean plants were able to fix some amount of nitrogen by rhizobium *Japonicum* that was already available in the soil from the previous experiments. Root nodules were developed well but not recorded with this experiment. With the calculations on margin profit out of the added N fertiliser (lowest level of both N and K) based on local price indices for soybean seeds and chemical fertilisers, the results revealed that the profit gained/ha was higher than 30 US Dollars, hence it is worthwhile to invest.

With 100-seed weights, the results showed that seed sizes being determined by weights were affected by levels of K fertilisers i.e. an increase in K levels increased seed sizes but only up to the second level while N had no effects. Seed sizes and seed yields were slightly lesser than that of Suksri (1998). The differences could possibly be attributed to the differences in total radiant energy from the sun received by sources (leaves) among the canopies that is greater in cold season than that of the rainy season as stated by Suksri (1992). Furthermore, the duration on growth during rainy season was much longer than that of the dry season due to presumably the differences in radiant energy received by crop canopies i.e. cloudy phenomena may have reduced the

Table 1: Mean soil pH values (1:2 water) of both initial and final soil samples of Oxic Paleustults soil of Northeast Thailand being used for soybean experiment with respect to nitrogen and potassium fertilisers.

Treatments	Initial pH	Final pH	Treatments	Initial pH	Final pH
T1	5.4	6.4	T9	5.5	6.1
12	5.6	6.3	T10	5.8	6.4
T3	5.8	6.2	T11	5.4	6.4
T4	5.5	6.3	T12	5.6	6.5
T5	5.6	6.2	T13	5.4	6.3
T6	5.7	6.2	T14	5.6	6.2
T7	5.4	6.5	T15	5.5	6.2
T8	5.4	6.4	T16	5.7	6.3

Table 2: Seed yields and 100-seed weights of the soybean plants as influenced by both nitrogen and potassium levels grown on Oxic Paleustults soil at Khon Kaen University, Thailand.

Nitrogen kg N/ha	Seed yield (kg/ha)	100-seed (g)	Potassium (kg K_2O/ha)	Seed yield (kg/ha)	100-seed (g)
0	3185b	16.68	0	3350	16.79
50	3428a	16.91	75	3526	17.16
100	3515a	16.96	150	3454	16.98
150	3579a	16.96	225	3477	16.57

in coming radiant energy from the sun in rainy season. Another reason for the lesser amount of top growth and seed yields could presumably be attributed to the imbalance between N and K ratio as previously discussed.

Seed Yields in Relation to Other Contributed Factors: There were some significant relationships between seed yields and total shoot dry weights (r^2 = 0.261*, y = 0.1309x + 19.158), seed yields and leaf areas (r^2 = 0.406**, y = 0.0183x + 2287.6), seed yields and leaf area indices (r^2 = 0.406**, y = 1.3714x + 17.157). There were some positive relationships between seed yields and N levels (r^2 = 0.901) but with lesser extent for K levels (r^2 = 0.417). The results indicated that total shoot dry weights, leaf areas, and leaf area indices have some significant effects on sinks (seeds) of the soybean plants. Therefore, to obtain high seed yield of the soybean plants then the plants must have attained some large amounts of top growth before filling stage of seeds begins. That is the vegetative phase must be extended or being prolonged for some considerable length of time and the higher levels of K must be reduced to make a good balance between N and K fertilisers. To justify this an experiment on the effects of organic matter and nitrogen levels in relation to K fertiliser may help in extending vegetative phase of the soybean plants by extending more vegetative growth. Nevertheless, it may be necessary to add some small amount of potassium to leaves by spraying or adding to the soil during the active period of seed filling stage as to obtain help from electron (e) transport in the photosynthetic e transport chain as stated by Overnell (1975) and Suksri (1998).

Acknowledgements

The author wishes to thank Mr. Preecha Mungprom for statistical calculations and Associate Professor Dr. Sanit Luadtong, the plant breeder for the new cultivar of soybean crop and also the Faculty of Agriculture, Khon Kaen University for facilities provided.

References

Cooke, G.W., 1972. Fertilizing for Maximum Yield. Hafner, London, ISBN: 9780258968406, Pages: 296.

Miller, W.M. and R.L. Donahue, 1990. Soils: An Introduction to Soils and Plant Growth. 6th Edn., Prentice Hall, Englewood, Cliffs NJ., ISBN: 9780138202262, Pages: 768.

Overnell, J., 1975. Potassium and photosynthesis in the marine diatom *Phaeodactylum tricornutum* as related to washes with sodium chloride. Physiologia Plantarum, 35: 217-224.

Sestak, Z., J. Catsky and P.G. Jarvis, 1971. Plant Photosynthetic Production: Manual of Methods. Junk, The Hague, Pages: 819.

Suksri, A., 1992. Effects of cattle manure, city garbage compost and inoculation upon growth and seed yield of soybean cultivars grown on Yasothon soil series. J. Agric., 8: 243-251.

Suksri, A., 1993. Effects of complete chemical fertilizers on growth and seed yield of eight-soybean cultivars grown on yasothon soil. Proceedings of the 30th Anniversary of the Department of Soil Science, August 19-20, 1993, Khon Kaen University, Thailand.

Suksri, A., 1998. Effects of dolomite on growth and seed yields of soybeans (*Glycine max* L.) grown on oxic paleustult soil in Northeast Thailand. Pak. J. Biol. Sci., 1: 215-218.

Vangnai, S. and P. Niamsrichand, 1979. Effects of organic manures and inoculation on growth and yield of off season soybean cultivars grown on an acid soil. Kasetsart J., 13: 1-7.

Vangnai, S., 1980. Research on the use of Rhizobium for improving soybean yield in Thailand. Kasetsart J., 14: 26-33.