

EFFECT OF PHOSPHORUS AND POTASSIUM ON NODULATION AND YIELD OF SOYBEANS

K. SABESAN and C. SATHANANDA

*Department of Agronomy, Faculty of Agriculture,
Eastern University, Chenkalady.*

SUMMARY

Influence of different rates of P and K fertilizers on nodulation and on seed yield of soybeans was studied in regosols of the Eastern Province. Results showed that the greater the level of fertilizer P, the higher the rates of growth and development and higher the rate of nodulation. Application of K at the rate of 40 kg/ha tends to be more effective than 20 kg/ha, but its efficiency decreases when the rate is increased to 60 kg/ha. Results also indicate that optimum seed yield of soybeans under local conditions is possible with 70 kg/ha of P and 40 kg/ha of K.

INTRODUCTION

The importance of phosphorus and potassium in the growth and development of soybeans (*Glycine max* (L.) Merrill) is undisputed. The uptake pattern of P and K indicates that soybeans require an adequate supply of these elements throughout the growing season (Black, 1968; Hanway, 1976; Evans & Sorger, 1966; Ohlrogge & Kamprath, 1968). The relative concentration of P and K is also an important factor to be considered as it affects their uptake and consequently the seed yield (De Mooy, *et al* (1973). Moreover, it is believed that the process of symbiotic nitrogen fixation is largely associated with the availability of these elements in soils. This is particularly significant as P and K fertilization may fulfil the nitrogen requirement of soybeans to a certain extent. The available information indicates that P and K favourably affect nodulation and nitrogen fixation and ultimately increase the seed yield under various environmental conditions (Iswaran, 1969; Carbin, 1979; Bossier, 1979).

The present study was conducted to determine the rate of P and K fertilizers for maximum nodulation and optimum seed yield of soybeans in regosols of the Eastern Province.

MATERIALS AND METHODS

The experiment was carried out during January to April 1986 at the Eastern University, Chenkalady, situated in the dry low country of Sri Lanka. The soil type was typical sandy regosol (90.4% sand) with available phosphorus content of 0.02% and exchangeable potassium content of 0.71%.

Three levels of phosphorus and three levels of potassium were combined to form nine treatments in the experiment. The experimental design was a randomized factorial with three replicates. Each plot consisted of 7 rows 3 metres long, the spacing between rows being 45 cm.

A basal application of nitrogen at the rate of 30 kg/ha in the form of $(\text{NH}_4)_2\text{SO}_4$ was given to all plots. At the same time, phosphorus at the rates of 40, 70 and 100 kg P_2O_5 /ha and potassium at the rates of 20, 40 and 60 kg K_2O /ha in the form of triple superphosphate and muriate of potash respectively were given to appropriate plots. Variety Pb—1 was used and the seeds were inoculated with "Nitrogin-S" at the rate of 5 g/kg of seeds. Recommended management practices were adopted during the growing period.

Leaf area was estimated by automatic leaf area meter. Fresh nodules were counted from 10 plants of each plot and their dry weight was recorded. Plant samples were taken from each plot at harvesting to determine the yield components and the final seed yield was estimated by harvesting 5 central rows of each plot.

RESULTS AND DISCUSSION

Leaf area index

A significant increase in leaf area index was observed when the level of phosphorus was increased from 40 to 70 kg/ha and from 70 to 100 kg/ha (Table 1). There was also a trend to increase the leaf area index when the potassium level was increased from 20 to 40 kg/ha. But such an increase was not found when the level of potassium was further increased.

Dry matter accumulation

The effect of different levels of phosphorus and potassium on dry matter accumulation at different periods are shown in Table 2. It was found that the higher the level of added phosphorus, the greater the dry matter

EFFECT OF PHOSPHORUS AND POTASSIUM ON SOYBEAN

accumulation throughout the growing period. The increased rates of symbiotic nitrogen fixation at higher phosphorus levels also would have contributed to dry matter accumulation in these plots. The application of potassium fertilizer at rates greater than 20 kg/ha was not marked by any significant difference in dry matter accumulation.

Nodule number and dry weight

The rate of nodulation was significantly increased when the level of phosphorus was increased from 40 to 70 kg/ha thus suggesting favourable effect of phosphorus on nitrogen fixation (Table 3). However, when the phosphorus level was increased to 100 kg/ha, the increase in nodule number was significant only at 9 weeks. Table 4 shows that the increase in phosphorus level also corresponded with an increase in dry weight of the nodules. Results also indicate that potassium has no significant effect on nodulation.

Yield components and yield

The effect of treatments on seed yield of soybeans and its components are presented in Table 5. Of the yield components only the number of pods per plant was significantly influenced by the different rates of added phosphorus and potassium and this was reflected in seed yield confirming the fact that the pod number is the major determinant of seed yield of legumes. Neither seed number per pod nor 100 seed weight showed any significant variation due to the treatments.

As the yield components suggested, the maximum seed yield of 2950 kg/ha was obtained from the plot where 70 kg/ha of phosphorus and 40 kg/ha of potassium were applied. Phosphorus at the rate of 70 kg/ha was more effective on the seed yield than at 40 kg/ha. But its efficiency decreased when the rate was increased to 100 kg/ha. Although potassium tended to increase the seed yield, the difference was not significant. The absence of the effect of higher levels of potassium fertilizers is probably due to heavy leaching losses of potassium ions in sandy regosols. The lack of response may also be due to presence of sufficient potassium in the soil to meet plant requirements.

It can be concluded that phosphorus encourages the process of nitrogen fixation by increasing the rate of nodulation and increases the yield of soybeans but the effect of higher levels of potassium has been indifferent.

Table 1. Effect of treatments on LAI of the plant.

Treatment	Weeks after sowing		
	03	06	09
P ₃₀ K ₂₀	1.08	2.09	2.60
P ₄₀ K ₄₀	1.21	2.29	2.77
P ₆₀ K ₆₀	1.21	2.20	2.84
P ₇₀ K ₂₀	1.34	2.54	3.05
P ₇₀ K ₄₀	1.44	2.82	3.32
P ₇₀ K ₆₀	1.35	2.79	3.34
P ₁₀₀ K ₂₀	1.46	2.93	3.56
P ₁₀₀ K ₄₀	1.56	3.24	3.74
P ₁₀₀ K ₆₀	1.53	3.10	3.68
LSD (P=0.05)	0.12	0.23	0.18

Table 2. Effect of treatments on total dry matter accumulation, g / m²

Treatment	Weeks after sowing			
	03	06	09	12
P ₄₀ K ₂₀	63.5	165.0	313.2	273.8
P ₄₀ K ₄₀	71.1	182.8	332.9	290.2
P ₄₀ K ₆₀	72.9	170.9	325.9	281.4
P ₇₀ K ₂₀	80.4	200.3	362.5	316.5
P ₇₀ K ₄₀	87.5	231.1	395.7	348.0
P ₇₀ K ₆₀	81.8	223.1	378.7	334.7
P ₁₀₀ K ₂₀	92.4	239.4	397.6	351.2
P ₁₀₀ K ₄₀	98.2	272.6	425.5	382.3
P ₁₀₀ K ₆₀	109.5	256.9	410.2	367.0
LSD (P=0.05)	20.7	22.3	19.7	14.3

Table 3. Effect of treatments on nodule number per plant

Treatment	Weeks after sowing		
	3	6	9
P ₄₀ K ₂₀	7.2	13.8	21.4
P ₄₀ K ₄₀	7.7	14.4	24.3
P ₄₀ K ₆₀	7.3	13.0	24.3
P ₇₀ K ₂₀	11.4	18.3	25.7
P ₇₀ K ₄₀	10.6	18.9	29.5
P ₇₀ K ₆₀	11.2	17.2	27.9
P ₁₀₀ K ₂₀	13.8	19.6	30.8
P ₁₀₀ K ₄₀	13.8	18.1	35.6
P ₁₀₀ K ₇₀	12.9	16.8	32.4
LSD(0.05)	3.7	4.1	4.3

EFFECT OF PHOSPHORUS AND POTASSIUM ON SOYBEAN

Table 4. Effect of treatments on nodule dry weight per plant, mg.

<i>Treatment</i>	<i>Weeks after sowing</i>		
	3	6	9
P ₄₀ K ₂₀	129.0	248.3	394.0
P ₄₀ K ₄₀	146.0	270.0	461.6
P ₄₀ K ₆₀	139.0	240.3	423.3
P ₇₀ K ₂₀	228.0	352.7	529.6
P ₇₀ K ₄₀	222.0	374.3	614.0
P ₇₀ K ₆₀	235.0	332.3	519.6
P ₁₀₀ K ₂₀	311.0	421.0	668.3
P ₁₀₀ K ₄₀	325.0	403.7	694.6
P ₁₀₀ K ₆₀	302.0	369.7	653.0
LSD(0.05)	46.8	63.8	57.9

Table 5. Effect of treatments on yield components and final seed yield

<i>Treatment</i>	<i>Pod No / Plant</i>	<i>Seed No / Pod</i>	<i>Final</i>	
			<i>100 Seed Weight (g)</i>	<i>Seed yield . (100 kg/ha)</i>
P ₄₀ K ₂₀	22.4	1.67	13.9	21.0
P ₄₀ K ₄₀	24.8	1.76	13.9	23.9
P ₄₀ K ₆₀	23.3	1.76	13.9	22.4
P ₇₀ K ₂₀	27.5	1.81	14.2	26.1
P ₇₀ K ₄₀	30.6	1.82	14.4	29.5
P ₇₀ K ₆₀	28.6	1.78	14.2	28.0
P ₁₀₀ K ₂₀	25.3	1.70	13.7	24.5
P ₁₀₀ K ₄₀	26.8	1.74	13.9	26.7
P ₁₀₀ K ₆₀	26.0	1.69	13.7	25.2
LSD (P=0.05)	2.6	N.S	N.S	3.7

REFERENCES

- Black, C. A. (1968). Soil plant relationship. John Wiley & Sons, New York, London, Sydney 613 — 636.
- Bossier, E. E. (1978). Fertilizing for maximum yields. Crossby Lockwood & Sons Ltd., London.
- De Mooy, C. J., Pesek, J. T. and Paldon, E. S. (1973). Mineral nutrition, pp 267 — 352. In soybean : Improvement, production and uses. Edited by B. B. Caldwell, Amer. Soc. Agron, Madison, Wis.
- Evans, H. J. and Sorger, G. J. (1966). Role of mineral elements with emphasis on the univalent cations, *Arun. Rev. P I Physical* 17: 47 — 76.
- Carbin, T. Fredrick (1979). Studies on the growth of root system in leguminous crops. Agricultural Bulletin of Sage University. 43: 81 — 87.
- Hanway, J. J. (1976). Interrelated development and biochemical process in the growth of soybean plants. pp 5 — 15. In L. D. Hill (ed) World soybean research. The interstateprinters and Publishers. Inc, Danville, ILP, USA.
- Iswaran, V. (1969). Effect of pelleting soybean with lime and rock phosphate in its nodulation. *Mysore J. Agric. Sci.* 4: 469 — 470.
- Ohlrogge, A. J. and Kamprath, E. J. (1968). Fertilizer use in soybean. pp 273 — 295. In L. B. Nelson (ed) Changing patterns in fertilizer use.