CHAPTER VI

SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR FUTURE WORK
A field experiment on soybean (*Glycine max* linn) was conducted in Kharif 1989 and 1990 at Zonal Agricultural Research Station, Powarkheda, Hoshangabad (M.P.), to study the effect of S levels (10, 20, 30, 40, 50, 60 and 70 kg ha\(^{-1}\) through gypsum) and sources (gypsum, ammonium sulphate and single superphosphate @ 20 kg ha\(^{-1}\)) on plant height, number of root nodules, number of pods, biomass yield, concentration and uptake of N, P, K and S at different growth stages (30, 60, 90 DAS and at harvest), crude protein content, oil content, response of sulphur, utilization of S, economics of fertilizer S, optimum dose of S, balance sheet of S, harvest index and yard stick value.

The significant findings are presented below.

6.1 The plant height increased with increasing level of S upto 30 kg S ha\(^{-1}\) at 30 and 60 DAS and upto 40 kg S ha\(^{-1}\) at 90 DAS, but higher than that S level decreased the plant height. However, the successive significant increase of plant height was observed with 10 and 30 kg S ha\(^{-1}\) but the height decreased significantly at 70 kg S ha\(^{-1}\) at 30 DAS. Ammonium sulphate was also found significantly superior to single superphosphate to 30 DAS.

6.2 The number of root nodules increased with increasing
levels of S upto 20 kg ha\(^{-1}\) at 30 DAS, 40/30 kg ha\(^{-1}\) at 60/90 DAS but higher than that S levels decreased the number of root nodules. However, the number of root nodules significantly increased at 20 kg S ha\(^{-1}\) over control as well as at 70 kg S ha\(^{-1}\) 30 DAS. Gypsum produced significantly higher number of nodules than ammonium sulphate/single superphosphate. However, the nodules were successively and significantly increased with 10 and 30 kg S ha\(^{-1}\).

6.3 The number of pods per plant increased with increasing levels of S upto 40 and 50 kg ha\(^{-1}\) at 90 DAS and at harvest respectively but it decreased at higher than that S level. However, it significantly increased @ 20 kg S ha\(^{-1}\) at 90 DAS and successive and significantly higher with 20 and 50 kg S ha\(^{-1}\) at harvest.

6.4 The total dry matter yield at all the growth stages increased with increasing levels of S upto 40 kg S ha\(^{-1}\) except at harvest and stover at harvest in which the increasing trend was observed upto 60 kg S ha\(^{-1}\) but it decreased at higher than that S level. However, the successive significant increase of total dry matter yield was observed with 20 and 40 kg S ha\(^{-1}\) at 90 DAS; seed yield with 10 and 30 kg S ha\(^{-1}\) and stover yield with 10 and 60 kg S ha\(^{-1}\) but it significantly reduced @ 70 kg S ha\(^{-1}\) over at 40 kg S ha\(^{-1}\) at 90 DAS and at 30 kg S ha\(^{-1}\) in seed yield at harvest.

6.5 Application of graded doses of S upto 40 kg S ha\(^{-1}\)
increased the response to grain yield but the per unit response of S decreased with increasing level of S. Ammonium sulphate gave more response than gypsum and single superphosphate.

6.6 N content and uptake increased with increasing levels of S up to 40 kg ha\(^{-1}\) behind which a marginal reduction was observed. The N content increased up to 60 DAS period and its uptake up to 90 DAS then started declined at harvest. The N content significantly increased at 20 and 10 kg S ha\(^{-1}\) over control at 30 DAS and in stover respectively. N uptake successively and significantly increased at 90 DAS with 20 and 40 kg S ha\(^{-1}\) and by seed and seed + stover with 10 and 40 kg S ha\(^{-1}\) but it significantly decreased at 70 kg S ha\(^{-1}\) over at 40 kg S ha\(^{-1}\).

6.7 The P content and uptake increased with plant age as well as with increasing level of S up to 40 kg ha\(^{-1}\) at all growth stages, except at 30 DAS and 60 DAS in which the P content was increased up to 20 kg S ha\(^{-1}\) and P uptake up to 10 kg S ha\(^{-1}\). The P content significantly increased at 20 kg S ha\(^{-1}\) at all the growth stages except at 30 DAS in which the P content was found significant at 10 kg S ha\(^{-1}\) over control. The P uptake significantly increased at 60 DAS and 90 DAS @ 20 and 30 kg S ha\(^{-1}\) over control respectively. However, the P uptake by seed, stover as well as by seed + stover at harvest successively and significantly increased with 10 and
40 kg S ha-1. Ammonium sulphate was found significantly superior to single superphosphate for P content at 90 DAS and in seed and uptake at 60 DAS by seed, seed+stover. It was also superior to gypsum for P content and uptake by stover as well as by seed + stover.

6.8 The K content and uptake increased with increasing levels of S up to 40 kg S ha-1 at all the growth stages and decreased at higher than that S level. K content at 30 DAS and 90 DAS significantly increased @ 20 kg S ha-1 and at 60 DAS, in seed and stover @ 10 kg S ha-1 over control. However, the K content @ 40 kg S ha-1 was also found significantly higher than at 20 kg S ha-1 at 90 DAS and at 10 kg S ha-1 in seed and stover. K uptake at 30 DAS and 90 DAS was significantly higher @ 30 and 20 kg S ha-1 over control respectively. While the K uptake was found significant @ 10 kg S ha-1 at 60 DAS, by seed, stover and seed + stover. However, the K uptake @ 40 kg S ha-1 was also found significantly higher than that S level at 60 DAS, 90 DAS, by seed, stover and seed + stover at harvest.

6.9 Sulphur content and uptake increased with increasing levels of S up to 40 kg ha-1 at all growth stages except S content at 90 DAS which increased up to 20 kg S ha-1. S content significantly increased @ 10 kg S ha-1 at all the growth stages except seed in which the significant increase was observed at 20 kg S ha-1.

However, the S content at 30 DAS and in seed was also significantly higher @ 30 and 50 kg S ha-1 than that S levels. S uptake significantly increased @ 10 kg S ha-1 at
all growth stages over control except at 80 DAS and by seed in which the significant uptake was observed @ 20 kg S ha\(^{-1}\). However, the S uptake 40 kg S ha\(^{-1}\) was also found significantly higher than at 10 kg S ha\(^{-1}\) at 30 DAS, by seed and seed+stover. Ammonium sulphate was found significantly superior to single superphosphate for S content and uptake by seed as well as S uptake at 60 DAS.

6.10 Utilization of S decreased with increasing levels of S. The maximum 32.30% S was recovered at 10 kg S ha\(^{-1}\). The utilization was found more with ammonium sulphate than gypsum and single superphosphate at the same level of 20 kg S ha\(^{-1}\).

6.11 The balance of available S in soil decreased with increasing levels of S.

6.12 The nutrient availability (N, P, K & S) in soil at 0-15, 15-30, 30-45, and 45-60 cm soil depth increased with increasing levels of S up to 30/40 kg ha\(^{-1}\) at 30, 60, 90 DAS and at harvest during 1989 as well as in the post harvest soil samples during 1990. However, a little increase of pH and electrical conductivity was also observed in post harvest soil sample during 1990.

6.13 Crude protein content of soybean seed increased with increasing level of S up to 40 kg ha\(^{-1}\) but it decreased at higher than that S level. Ammonium sulphate proved superior to gypsum and single superphosphate for the protein content in seed.
6.14 Oil content and oil yield also increased with increasing levels of S up to 40 kg ha⁻¹ but it decreased at higher than that S level. The oil content significantly increased @ 20 kg S ha⁻¹ over control. Ammonium sulphate and gypsum were found significantly superior to single superphosphate for oil content at the same rate of 20 kg S ha⁻¹. However, the oil yield successively and significantly increased with 10 and 30 kg S ha⁻¹ but it significantly decreased @ 70 kg S ha⁻¹.

6.15 Harvest index increased with increasing levels of S up to 30 kg S ha⁻¹ but it decreased at higher than that S level. Ammonium sulphate gave the highest harvest index 36.97% amongst the S sources at the same level of 20 kg Sha⁻¹.

6.16 Yard stick value decreased with increasing levels of S. Ammonium sulphate gave the highest yard stick value 28.20% amongst the sources of S at the same level of S.

6.17 Application of increasing levels of S up to 30 kg ha⁻¹ increased the B:C ratio (1.68:1). Ammonium sulphate gave the highest B:C ratio (1.62:1) amongst the sources of S.

6.18 The optimum level of S was found 38 kg ha⁻¹ for maximum 2500 kg ha⁻¹ soybean giving the response of 12.55 kg seed and B:C ratio 1.67:1 with net return of Rs 14315.38.

CONCLUSION

From the above observations, it can be concluded that the growth and the yield attributing characters (height,
nodules, pods and drymatter yield), nutrient content and uptake (N, P, K & S) at various growth stages, protein and oil content, oil yield, response to grain yield and B:C ratio were found maximum between 30 to 40 kg S ha⁻¹ but the S level higher than 40 kg ha⁻¹ decreased the above values. The level 30/40 kg S ha⁻¹ was also found significant over lower level (10/20 kg ha⁻¹) as well as higher S level (70 kg ha⁻¹) at various growth stages. So the level of S should be between 30 and 40 kg S ha⁻¹ in the Vertisol having low S status. For this type of soil, the optimum dose of S was found 38 kg ha⁻¹.

Amongst the sources of S studied, ammonium sulphate was found superior to single superphosphate or gypsum and giving the highest values in most of the observations studied. The ammonium sulphate also significantly increased the P and S content and uptake by seed as well as oil content than single superphosphate / gypsum. Therefore, ammonium sulphate was found the best source of S for the Vertisol in the present investigation. From this study the S dose 38 kg ha⁻¹ should be applied through ammonium sulphate in the Vertisol of Tawa command area for maximum soybean production.

SUGGESTION FOR THE FUTURE WORK

Sulphur nutrition of crops grown on Vertisol provide useful information on the contribution of applied and soil nutrients to meet the nutritional requirements by
crops. Hence, this study could be extended on the following lines:

1. A study on the other high yielding cultivars of pulses, cereals and oil seed crops on various soil types of Madhya Pradesh.

2. To evaluate the relative availability of the various S forms in M.P. soils employing ion exchange equilibrium techniques.

3. To study the transformation of S in soil and its meaningful assimilation within plants parts.

4. To study the influence of S on the rate of N fixation by legumes.

5. Determination of S containing compounds such as vitamins, fatty acid etc. should be done with various levels of sulphur to elucidate the response of S on their metabolism as well.