CHAPTER - VI

SUMMARY AND CONCLUSION

The experiment entitled "nitrogen, phosphorus and water requirement of soybean (Glycine max (L) Merr.) crop in black soil under rainfed condition" was carried out at Research farm, IGKV, Raipur during the "kharif" season of 1987 and 1988. The main objectives of the experiment were to study the effects of nitrogen and phosphorus on growth, development, yield and quality of soybean. Additional studies for its water requirement, water use efficiency and drought pattern at different growth stages were also made. Thus, two separate sets of experiments were conducted.

In the first trial, four levels of nitrogen at 0, 15, 30 and 45 kg/ha and four levels of phosphorus at 0, 30, 60 and 90 kg/ha were taken. The studies on evapotranspiration (or water requirement) were carried out by two sets of gravimetric lysimeters installed adjoining the experimental area representing identical environment. Soybean variety "Gaurav", being the most popular variety in this region, was taken. The soil of the experimental field was clayey in texture locally called "kanhar". The soil was low in available nitrogen and phosphorus and high in potash. The climate of Raipur comes under moist sub-humid according to Thornthwaite's moisture regime based climatic classification, with an average annual rainfall of 1400 mm on normal years.
The salient features of the experimental findings are summarized below:

6.1 Growth pattern

The plant height and dry matter production showed increasing trend linearly upto pod filling stage while, the number and size of leaves and leaf area index increased gradually reaching to its maximum towards pod formation stage and decreased thereafter.

The crop growth rate (CGR) increased upto pod filling stage and relative growth rate (RGR) increased upto flowering stage. The peak rate of CGR and RGR was observed from vegetative to flowering stage which indicated maximum assimilation rate of dry matter. The CGR and RGR values showed negative trend between pod filling to maturity stage due to shedding of older leaves.

The nitrogen levels had favourable effect on all the growth parameters. An increasing trend in growth parameters was observed with increasing nitrogen levels, however the plant height between the lower dose of nitrogen and control was more or less similar. The leaf area index and dry matter production increased significantly with increasing nitrogen levels during most of the crop growth stages.

Phosphorus application did not show much variation on growth parameters like plant height, number and size of leaves at most of the crop growth stages. But, the leaf area index (LAI) and dry matter production increased appreciably with phosphorus
application. The effects of lower dose of phosphorus was equivalent to control at most of the crop growth stages. Similarly, the effects of medium and higher doses of phosphorus were alike except for LAI at seedling stage in 1988 and dry matter at seedling, pod filling and maturity stages in 1987 and dry matter at seedling stage in 1988.

6.2 Yield attributes

The yield attributing characters like number of pods per plant, seeds per pod and 100 seed weight increased with increasing nitrogen levels. However, the lower dose of nitrogen was similar to control except for the number of pods per plant in 1988. In case of harvest index, higher nitrogen dose showed lower harvest index. Nitrogen levels had no significant effect on number of branches per plant in both the years.

The different levels of phosphorus did not affect the number of branches per plant and number of seeds per pod during both the years, while, the number of pods per plant increased considerably with phosphorus application. The weight of 100 seeds increased significantly at higher doses in 1987, but remained unaffected in 1988. Unlike the nitrogen levels, the different levels of phosphorus had non-significant effect on harvest index.

6.3 Yields

In both the years the seed, straw and total yields increased significantly with increasing levels of nitrogen. The lower dose
of nitrogen was comparable with control for straw and total biomass in 1988. The highest seed yield of 18.45 and 19.86 q/ha was obtained under higher dose of nitrogen N45 in 1987 and 1988 respectively.

Application of phosphorus significantly increased the seed, straw and total yields of soybean. But, the lower and medium doses of phosphorus were identical for seed yield in both the years and for straw and total yields in second year. The medium and higher doses of phosphorus were alike for straw and total yield in 1988. Higher dose of phosphorus (P90) recorded higher seed yield in both the years (17.07 and 18.65 q/ha in 1987 and 1988 respectively).

6.4 Uptake studies

Since the nutrient uptake is directly associated with the biomass production, the uptake of nitrogen and phosphorus increased appreciably with increasing nitrogen and phosphorus doses. The lower dose of nitrogen was at par with control for nitrogen uptake by straw in second year. The lower and medium doses of phosphorus were similar for nitrogen uptake by seed in both the years and by straw and total uptake in 1988. Similarly the medium and higher doses of phosphorus were comparable for nitrogen uptake by seed in 1987 and by straw and total nitrogen uptake in 1988.
Phosphorus uptake by seed, straw and total biomass increased significantly with nitrogen levels, however the lower dose of nitrogen was identical with control for phosphorus uptake by seed in 1988. Similarly, the phosphorus doses increased the phosphorus uptake by seed, straw and total uptake in both the years, though the difference between lower and medium dose of phosphorus was at par in 1987.

6.5 Seed quality

The protein content of seed increased and oil content decreased with increasing nitrogen levels. But the per hectare yields of protein and oil increased significantly with increase in nitrogen doses, though the oil yield was similar due to medium and higher doses of nitrogen in 1987 and due to lower dose and control in 1988.

There were no significant effects of phosphorus fertilization on oil content of seed in both the years and protein content in first year. In 1988, the medium and higher doses of phosphorus significantly increased the protein content of seed over control. The protein production increased significantly with phosphorus application, though the lower and medium doses of phosphorus were comparable. The oil yield did not increase significantly with each increment in phosphorus levels. The lower dose of phosphorus was comparable with medium dose while the medium dose was comparable with higher dose.
6.6 Correlation studies

All the growth and yield attributing characters like plant height, number and size of leaves, LAI, dry matter production, branches per plant, pod per plant, seeds per pod, and 100 seed weight were significantly associated with the seed yield. The harvest index was negatively associated with seed yield.

6.7 Evapotranspiration (ET) and open pan evaporations (EO)

The evapotranspiration (ET) losses during the crop season were 665.8 mm as against the 417.9 mm of EO in 1987. While in 1988, they were 645.3 mm as against the 390.5 mm of EO. The average ET was 665.4 mm during the crop season. On an average the ET values during seedling, vegetative, reproductive and maturity stages were 74.2, 104.1, 121.7 and 98.8 mm respectively.

The crop coefficients (ET/EO) for different growth stages i.e. seedling, vegetative, reproductive and maturity stages were 0.9, 1.8, 2.2 and 1.2 respectively.

6.7.1 Water use efficiency (WUE)

The water use efficiency was higher in 1988 (2.86 kg/ha/mm of ET) as compared to 1987 (2.50 kg/ha/mm of ET). The average was worked out to be 2.68 kg/ha/mm.
6.8. Water balance

In the water balance studies it was observed that the estimated ET losses either by climatic methods or by soil moisture depletion method were much lower than the actually measured ET losses through lysimeter. This may be due to the factor that due to luxuriant vegetative growth in the field, the transpiration losses might have been much higher. It is, therefore, necessary to modify the existing equations for estimation of ET by incorporating physiological parameters like LAI, stomatal density etc.

6.9. Drought pattern

Based on the agricultural drought pattern, water stress was observed at vegetative stage in 1988 for a few days, but it not at all affected the yield adversely. But no drought was observed through systems analysis approach for estimation of drought as the evapotranspiration (ET) values were higher than the potential evapotranspiration (PE) values. This shows that the crop did not experience water stress during the growth period as compared to the estimated values.

6.10. Relation between ET with meteorological parameters.

Among the different meteorological parameters only minimum temperature was significantly associated with ET losses.
Based on the findings of the two year experiments the following conclusions can be drawn

1. Soybean is a leguminous crop but initial booster dose of nitrogen is essential to accelerate initial vegetative growth. Application of nitrogen upto 45 kg/ha is needed for increasing its production and productivity.

2. Phosphorous application is essential for obtaining economically sustainable grain yield in clayey soil of this region. Increasing dose of phosphorous upto 90 kg/ha gives significant increase in yield.

3. Balance application of nitrogen and phosphorus at the rate of 45 kg N/ha and 90 kg P2O5/ha is essential to get optimised return on the black clayey soil, instead of keeping it either fallow or utilizing for other traditional crops.

4. As regards water losses, the ET rate of soybean crop is higher during peak vegetative and reproductive stages due to higher LAI. However, with an average water loss of about 665 mm, soybean crop can be grown successfully even under severe drought conditions in traditional rice growing area.

5. Analysis of drought either through water balance or through system analysis shows no signs of water stress either in 1987 or 1988, the two successive severe drought years of this region. This very well indicates the drought tolerance capacity of soybean for stabilized production.