SUMMARY AND CONCLUSION

A field experiment entitled "Integrated nutrient management in field pea and its effect on productivity of fodder sorghum" was conducted in rabi and kharif seasons of 2002-03 and 2003-04 to study the effect levels and sources of phosphorus and biofertilizers at the Research Farm of A.S. (P.G.) College, Bulandshahr, U.P. The experiment was conducted in a split plot design with three P levels (0, 20 and 40 kg P$_2$O$_5$/ha) and two sources (DAP and MRP) as main plot treatments and four biofertilizers (no biofertilizer, Rhizobium PSB and Rhizobium + PSB) as sub-plot treatments replicated thrice. The soil of the experimental plot was sandy loam in nature with moderate fertility and slightly alkaline. The rabi crop was planted on 30$^{th}$ September and 10$^{th}$ September and fodder sorghum was planted on 7$^{th}$ and 9$^{th}$ June respectively during 2002-2003 and 2003-2004. Performance of pea crop was better in 2002-03 while the performance of fodder sorghum was better in 2004.

6.1. Pea

6.1.1. Response of P

Growth attributes and root nodulation

(i) Application of 40 kg P$_2$O$_5$/ha produced the tallest plants with the highest dry matter yield, root nodulation, and LAI at pod-filling stage.
(ii) CGR and NAR between various growth stages improved significantly up to 40 kg P$_2$O$_5$/ha.

(iii) RGR and RLGR were adversely affected following P application.

Yield attributes

(i) Number of pods/plant and grains/pod increased with increasing rates of P$_2$O$_5$ up to 40 kg/ha.

(ii) P application produced bolder seeds in one 2003-2004 out of the two seasons.

Yields

(i) Grain and straw yields and harvest index markedly increased up to 40 kg P$_2$O$_5$/ha.

(ii) The nature of response of pea to applied P was linear up to 40 kg P$_2$O$_5$/ha.

Nutrient uptake

(i) Addition of 40 kg P$_2$O$_5$/ha improved both N and P uptake by crop over 20 kg P$_2$O$_5$/ha and no phosphorus in case of N, and over no P only in case of P.

(ii) Nitrate reductase activity increased significantly up to 40 kg P$_2$O$_5$/ha.

Nutrient status of soil

Increasing levels of P up to 40 kg P$_2$O$_5$/ha resulted in improved status of available N and P in soil at harvest of pea crop.
**Microbiological parameters**

(i) Nitrogenase activity at flowering increased significantly up to 40 kg P₂O₅/ha. Specific nitrogenase activity in root nodules increased up to 40 kg P₂O₅/ha in 2002-03 only.

(ii) Bacterial populations in the rhizosphere at flowering proliferated markedly with the applied P₂O₅ up to 40 kg/ha.

**Economics**

Addition of 40 kg P₂O₅/ha fetched the highest net return and net return/rupee invested on cost being Rs. 15880/ha and Rs. 2.72 respectively.

**6.1.2. Response of Sources of phosphorus**

**Growth attributes and root nodulation**

(i) Plant height, dry matter yield, LAI and nodulation (number and dry weight) were favourably affected by sources of phosphorus.

(ii) Phosphorus sources enhanced CGR between various growth stages in 2002-03 only whereas NAR was higher between pre-flowering and flowering stages only in the same season.

**Yield attributes**

Sources of phosphorus application produced more pods/plant in both the seasons and bolder seeds in 2002-03 only.

**Yields**

Addition of DAP brought about significant increase in grain and straw yields in 2002-03 only.
Nutrient uptake

N uptake and NR activity significantly increased following sources of phosphorus in 2002-03 only.

Nutrient status of soil

Addition of DAP improved soil status in terms of available N and P after pea crop.

Microbiological parameters

(i) Activity of nitrogenase enzyme at flowering enhanced markedly by DAP.

(ii) Bacterial population in the rhizosphere at flowering was significant higher with DAP.

Economics

An additional mean net return of Rs. 153.20/ha only was obtained by DAP. Mean net return/rupee invested, however, decreased with DAP.

6.1.3. Response of biofertilizers

(i) Combined inoculation of Rhizobium and PSB, in general, improved all the growth attributes and root nodulation over their individual inoculations and no inoculation. Single inoculations, however, recorded identical values of these attributes but higher than no inoculation.

Yield attributes

(i) Dual inoculation with Rhizobium and PSB improved number of pods/plant over their single inoculations and no inoculation.
(ii) Grains/pod and 1,000-grain weight showed perceptible increase with dual and single inoculations over no inoculation in 2002-03 only.

(iii) Rhizobium and PSB as separate inoculations recorded higher values of yield attributes over no inoculation in 2002-03 only.

**Yields**

(i) Grain and straw yields markedly increased with dual and single inoculations with Rhizobium and PSB over no inoculation. Dual inoculation increased the grain yield by 17% compared with no inoculation.

**Nutrient uptake**

(i) N uptake and NR activity markedly increased by dual and single inoculations with Rhizobium and PSB.

(ii) P uptake increased by single and dual inoculations in 2002-03 only.

**Nutrient status of soil**

(i) Available N and P status of soil after pea improved by dual inoculation and inoculation with PSB.

(ii) Rhizobium inoculation improved N availability in 2003-04 and P availability in 2002-03 over no inoculation.

**Microbiological parameters**

(i) Activity of nitrogenase in root nodules, and bacterial population in the rhizosphere at flowering increased by dual and single inoculations over no inoculation. Single inoculations with
Rhizobium and PSB had, however, identical influence on nitrogenase activity and bacterial count.

**Economics**

Combined inoculation of Rhizobium and PSB recorded maximum mean net return (Rs. 18440/ha) and mean net return/rupee invested (Rs. 2.14).

6.2. **Fodder sorghum**

6.2.1. **Phosphorus**

6.2.1.1. **Growth and development**

Residual effect of 40 kg P$_2$O$_5$/ha improved all growth attributes of sorghum as compared to 20 kg P$_2$O$_5$/ha.

6.2.1.2. **Fodder and dry matter yield/ha**

Residual effect of 40 kg P$_2$O$_5$/ha recorded higher fodder and dry matter yield/ha over 20 kg P$_2$O$_5$/ha during both the years.

6.2.1.3. **Nutrient content and uptake**

Residual effect of 40 kg P$_2$O$_5$/ha improved N and P content and uptake in sorghum crop over 30 kg P$_2$O$_5$/ha during both the years.

6.2.1.4. **Economic returns**

Residual effect of 40 kg P$_2$O$_5$/ha recorded higher net returns/ha and per rupee invested (Rs. 1231 and 0.42) over control.
6.2.2. Sources of phosphorus

6.2.2.1. Growth and development

Application of MRP recorded an increase in plant height, stem diameter, leaves/plant, dry weight of fodder/plant over DAP during both the years.

6.2.2.2. Fodder and dry matter yield/ha

MRP application improved fodder and dry matter yield/ha as compared to DAP during both the seasons.

6.2.2.3. Nutrient content and uptake

MRP was found better than DAP in influencing the N and P content of fodder and their uptake during both the years.

6.2.2.4. Economic returns

MRP produced higher returns over DAP source of P application. The increase in MRP was Rs. 143.20 in net returns and Rs. 0.42 net returns/rupee invested in over DAP.

6.2.3. Biofertilizers

6.2.3.1. Growth and development

Application of biofertilizer had significant effect on growth attributes viz. plant height, stem diameter, number of leaves/plant and dry matter of accumulation/plant where combined application of rhizobium and PSB recorded higher values as compared rhizobium and PSB alone and no inoculation during both the years.
6.2.3.2. Fodder and dry matter yield/ha

Fodder and dry matter yield/ha were increased by rhizobium and PSB and dual application rhizobium + PSB over no inoculation. Combined application of rhizobium + PSB recorded higher yield over rhizobium and PSB alone.

6.2.3.3. Nutrient content and uptake

Combined application of rhizobium + PSB improved N and P content in fodder sorghum and N and P uptakes over single application of rhizobium, PSB and no inoculation during both the years. Rhizobium and PSB application also recorded higher values in this respect over no inoculation.

6.2.3.4. Economic returns

Combined application of rhizobium + PSB produced an increase in net returns/ha (Rs. 4175.19) and per rupee invested (Rs. 0.48) over no inoculation.

CONCLUSIONS

Following conclusions were drawn from the present trial conducted on pea and its residual effect on fodder sorghum:

1. Higher grain yield and net returns/ha can be obtained by the application of 40 kg P₂O₅/ha applied through DAP and seed inoculation with rhizobium + PSB in pea crop.

2. Available nitrogen and phosphorus in soil can be improved by raising pea crop during rabi season when 40 kg P₂O₅/ha was applied through DAP/VRP with rhizobium + PSB inoculation.
3. Higher yields and net returns/ha in pea fodder sorghum crop sequence can be obtained by the application of 40 kg P$_2$O$_5$/ha applied through DAP/MRP and seed inoculation with rhizobium + PSB in pea and fodder sorghum.