The field investigation entitled "Integrated nitrogen management in wheat-maize cropping system" was conducted during rabi and kharif seasons of 2005-06 and 2006-07 to evaluate the response of biofertilizers along with fertilizer nitrogen on yield and nutrient uptake in wheat and their residual effect on succeeding maize and soil properties. The treatments comprised of three biofertilizers (No inoculation, Rhizobacteria and Azotobacter) three rates of N to wheat (0, 60 and 90 kg/ha and three rates of N to maize 0, 60 and 120 kg/ha). The experiment was laid out with three replications in factorial and split plot design. A summary of the findings follows:

6.1. WHEAT
6.1.1. Biofertilizers
1. Seed inoculation with both of Rhizobacteria and Azotobacter had similar favourable effects on growth and yield attributes (plant height, tillers/plant, leaf area index, dry matter accumulation and spike length) over uninoculated control during both the years.

2. The biofertilizer inoculation increased the mean grain yield of wheat by 5.96 to 7.55% over no inoculation treatment.
3. Biofertilizer inoculation increased N content and uptake in grain and straw as compared to no inoculation.

4. N-use efficiency, apparent N recovery, physiological efficiency and nitrogen harvest index of wheat was more under uninoculated control plots than *Azotobacter* and *Rhizobacteria* during both the seasons.

5. Biofertilizer application caused improvement in organic carbon and total N content of soil after wheat over its initial status, whereas they decreased when no N was applied.

6. *Rhizobacteria* inoculation fetched higher mean net returns of Rs. 32540/ha in wheat cultivation. The corresponding values of net returns were Rs. 31810 and Rs. 29655/ha under *Azotobacter* and control, respectively.

6.1.2. Nitrogen levels

1. The growth and yield attributes of wheat (plant height, leaf area index, number of tillers/plant, dry matter accumulation and length of spike) were significantly increased with N application up to 120 kg/ha. However, both the N levels (60 and 120 kg/ha) did not differ significantly in most of the plant attributes.

2. Nitrogen application enhanced grain and straw yields and harvest index of wheat up to 120 kg/ha. However, the differences between 60 and 120 kg N/ha were not significant.
3. The economic optimum dose was 100.10 and 100.67 kg N/ha with yield levels of 43.49 and 47.09 q/ha in 2005-06 and 2006-07, respectively.

4. The nitrogen content in plant, grain and straw increased by N-fertilization. However, nitrogen application beyond 60 kg/ha did not cause further increase in N content. The magnitude of increase in N uptake through grain as well as straw was more between 0 and 60 kg N/ha. Recovery of applied N and N-use efficiency in wheat were also the maximum with 60 kg N/ha followed by 120 kg N/ha.

5. All the fertilizer N rates either maintained or increased the organic carbon content of soil after wheat harvest over its initial status. The maximum organic carbon was recorded at 120 kg N/ha.

6. Application of 120 kg N/ha fetched the maximum net return of Rs. 38088/ha.

6.2. MAIZE

6.2.1. Residual Fertility

1. Plant population did not show any response to residual fertility either through biofertilizer or N-fertilization. The residual fertility left behind by biofertilizers had also no significant influence on grain or stover yields of maize.

2. Significant differences were observed in the growth and yield attributes of maize viz., plant height, leaf area index, cob length and girth, number of grains/cob and test weight
due to residual effect of higher level of 120 kg N/ha over no nitrogen.

3. Residual effect of 120 kg N/ha was marked on the grain and stover yields of succeeding maize when compared with no N. Mean grain yields of 37.13, 38.30 and 39.88 q/ha with their corresponding stover yields of 64.69, 66.21 and 68.21 q/ha with 0, 60 and 120 kg N/ha, respectively were obtained.

4. The residual effect of biofertilizer or N-fertilization failed to affect the N content in maize grain and stover. However, significant improvement in N uptake in grain and stover was noted only at higher level of 120 kg N/ha over control.

5. Protein yield of maize was favourably improved at 120 kg N/ha when compared with no nitrogen applied to preceding crop.

6. The effect of 120 kg residual N/ha was more pronounced than 60 kg residual N/ha in most of plant attributes.

6.2.2. Direct applied N

1. Nitrogen application increased almost all the growth and yield attributes (plant height, leaf area index, cob length and girth, grains/cob and test weight) up to 120 kg/ha. However, both the levels of 60 and 120 kg N/ha proved significantly better than no nitrogen.
2. Grain yield of maize significantly increased with the increase in N level up to 120 kg N/ha.

3. Direct applied N to maize significantly increased N content and N uptake up to 120 kg N/ha. However, N-use efficiency and apparent N recovery of applied N decreased with an increase in level of N.

4. Total soil N gradually decreased after each crop when no N was applied. However, both the levels of N (60 and 120 kg/ha) maintained the soil at higher level of total N when compared with its initial soil status.

5. Nitrogen application at 120 kg/ha fetched the highest mean net return of Rs. 18012/ha as against Rs. 9981/ha in plots where nitrogen was not applied.

6. Maize fertilized with nitrogen (60 and 120 kg/ha) recorded higher protein yield than maize grown without N.

7. The highest productivity and profitability of wheat-maize sequence could be sustained when both the crops were fertilized individually with 120 kg N/ha.

CONCLUSIONS

The findings of the present investigations led to draw the following conclusions.

1. Biofertilizer (Rhizobacteria or Azotobacter) inoculation and N application at 120 kg N/ha gave higher yield and net returns. However, the economic optimum dose about 100 kg N/ha.
For realizing higher productivity and net returns, inoculation of wheat with Rhizobacteria or Azotobacter should receive 120 kg N/ha in addition to seed sequence. It may thus be concluded that both crops in wheat-maize returns.

2. The maize crop responded favorably to 120 kg residual