SUMMARY
A field experiment "Nutritional Studies Under Varying Plant Density in Okra (Abelmoschus esculentus (L). Moench.)" was conducted during the rainy season of 1997 and 98 at the Horticulture Garden of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. The study comprised four levels of nitrogen (N₀ – control, N₁ – 80 Kg N/ha, N₂ – 120 Kg N/ha and N₃ – 140 Kg N/ha), three levels of phosphorus (P₀ – control, P₁ – 80 Kg P/ha and P₂ - 100 Kg P/ha) and two plant densities (S₁ – 50 x 30 cm and S₂ – 50 x 40 cm). There were, thus, 24 treatments in all replicated thrice in a Factorial Randomized Block Design.

The source of nitrogen was urea and half of it was applied as basal dressing and the remaining half as top dressing 30 days after sowing. Entire phosphorus was applied through single super phosphate before sowing as basal dressing according to schedule of experiment. Recommended dose of potash i.e. 50 Kg per hectare was applied uniformly through muriate of potash as basal dressing. Cultural practices i.e. weeding, hoeing and irrigation were done timely and plant protection measures were adopted to protect the crop from insect pest and diseases.

All the vegetative growth parameters were affected significantly due to nitrogen nutrition. The plant growth was improved right from the initial stages. Application of 140 Kg N/ha recorded the maximum plant height (152.36 and 153.18 cm) greater than control (117.91 and 118.26 cm) and 120 kg N/ha per hectare (144.25 and 144.65 cm) during both the years. The number of nodes (20.38 and 19.66), leaf area per plant (2684.14 and 2706.59 sq cm) and diameter of main shoot (2.61 and 2.68 cm) were also registered maximum under the highest dose of nitrogen (140 Kg/ha) followed by 120 kg dose. Unlike the other
growth attributes, the number of green leaves per plant was found to be the maximum under 120 Kg N per hectare (21.37 and 21.49), though it did not differ significantly with the treatment of 140 Kg N per hectare during both the years of investigations.

The developmental parameters showed significant response during both the years of investigations. Increasing levels of nitrogen nutrition hastened the period required for flowering (44.55 and 45.52 days) and fruiting (45.94 and 46.91 days). Application of 140 Kg dose of nitrogen proved significantly effective in minimizing the period required for both the parameters.

Nitrogen applied @ 80 Kg/ha was noted to be significantly at par with control with respect to first fruit set during both the years.

The yield and yield contributory components were improved significantly with additional supply of nitrogen. The number (12.10 and 12.34) and weight of fruits per plant (187.68 and 188.29 g), their size i.e. length (16.82 and 16.85) and diameter (2.11 and 2.18 cm) were improved to the maximum under 140 Kg N/ha followed by 120 Kg N/ha. Application of 80 Kg N/ha also improved these attributes significantly when compared with control.

The yield of green pods/ha was increased progressively with increasing levels of nitrogen fertilization and the highest i.e. 109.04 and 109.38 q/ha yields were recorded under 140 Kg N/ha against the minimum i.e. 90.04 and 89.94 q/ha registered under control during first and second years of investigations respectively. However, the harvest under N₂ and N₃ remained statistically at par in the first year of investigation.

The nutritional status of pods and plants as judged by the contents of their minerals and metabolites were improved significantly under the influence of increasing levels of nitrogen doses. Dry matter, protein, nitrogen and
phosphorus contents of both okra leaves and pods and ash contents of pods were registered significantly greater when the plants were fertilized with 140 Kg N per hectare followed by 120 Kg N per hectare dose. However, both the doses i.e. 120 and 140 Kg did not differ significantly when compared between themselves with respect to dry matter contents of pods during both the years of study.

All the growth parameters of okra plants were influenced by increasing levels of P<sub>2</sub>O<sub>5</sub> significantly during both the years of study. The height of plants increased progressively and correspondingly with increasing levels of P<sub>2</sub>O<sub>5</sub>. Tallest plants (150.81 and 151.55 cm) having greater number of leaves (21.64 and 21.79) and maximum number of nodes (22.85 and 20.87) were noted when the plants received P<sub>2</sub>O<sub>5</sub> @ 100 Kg per hectare against the control revealing 122.85, 123.15 cm; 16.38, 16.52 and 12.83 and 12.56 values under the above attributes during both the years. The diameter of main shoot was also affected significantly due to phosphorus fertilization registering 2.31 and 2.37 cm values against 1.96 and 2.00 cm noted under control during first and second years of study respectively. The leaf area per plant was significantly greater under 100 Kg P<sub>2</sub>O<sub>5</sub> (2559.55 and 2565.15 sq cm) followed by 80 Kg P<sub>2</sub>O<sub>5</sub> (2255.15 and 2264.46 sq cm) treatment. The former was, however, significantly superior than the latter during both the years of study.

Among the phenological parameters i.e. days required for first flowering and fruiting, the former remained unaltered, whereas, the latter i.e. days required for first fruiting was affected significantly with the increasing levels of phosphorus fertilization. Application of 100 Kg P<sub>2</sub>O<sub>5</sub> required 46.79 and 47.73 days against 47.45 and 48.37 days under control during first and second year of study respectively.

All the yield attributory parameters i.e. number and weight of fruit per plant, volume and size of fruit increased significantly and progressively with
doses of phosphorus barring volume during second year of study. Application of 100 Kg $P_2O_5$ followed by its 80 Kg dose proved beneficial for improving these traits and the former produced significantly longer (16.76 and 16.75 cm) and thicker pods (2.18 and 2.22 cm) during the corresponding years of study. The yield of green pods was significantly maximum (104.33 and 105.18 q/ha) under 100 Kg $P_2O_5$ followed 80 Kg dose (100.91 and 100.99 q/ha) whereas, the minimum harvests (96.96 and 97.06 q/ha) were recorded under control during the corresponding years of study.

The chemical composition and metabolites of leaves and pods varied correspondingly and significantly with increasing levels of $P_2O_5$. Dry matter, protein, nitrogen and phosphorus contents of okra leaves and pods and ash contents in pods were registered significantly greater during both the years when the plants were fertilized with 100 Kg phosphorus per hectare. Phosphorus at 80 Kg level being significantly superior to control expressed statistically lesser ingredients than 100 Kg dose during both the years. The intra-row spacing i.e., plant geometry affected the vegetative growth of okra plants and significantly greater plant height (141.04 and 155.68 cm), diameter of main shoot (2.19 and 2.23 cm), number of nodes (18.00 and 17.36), number of leaves (21.09 and 21.23) and leaf area per plant (2475.56 and 2497.98 sq cm) were noted under wider spacing (50 x 40 cm). Both the phenological parameters i.e. flowering and fruiting were influenced favourably under low plant density and minimum period being statistically at par with high density were required for the same.

Plant geometry at 50 x 40 cm proved significantly effective in increasing fresh weight (177.88 and 178.25 g), diameter (2.06 and 2.08 cm) and volume of pods (21.10 and 21.25 cc) when compared with 50 x 30 cm during both the years of investigations. The number of pods per plant being significantly higher under 50 x 40 cm did not differ significantly with 50 x 30 cm spacing during second year of study.
The yield of green pods was significantly greater under higher plant density (112.95 and 113.03 q/ha) than the lower (88.52 and 89.12 q/ha) during both the years of study.

Lower plant density induced significantly greater nutrients and metabolites in the leaves and pods of okra and higher dry matter and phosphorus contents were noted under 50 x 40 cm plant geometry during both the years of study. Lower plant density expressed significantly greater protein and nitrogen contents in the pods during first year but in the leaves during both the years of investigations. The ash content estimated in pods revealed significantly greater values under low density cropping.

The first order interactive treatments though improved all the traits numerically but N3P2 (140 Kg N + 100 Kg P2O5/ha) interaction was significantly effective in improving the leaf area per plant and phosphorus content in leaves and pods during both the years, whereas, the height of main shoot and number of green leaves per plant were significantly maximum during first and second year of study respectively.

Application of 140 Kg N to low density cropping (N3S2) induced significantly higher ash content in the pods during both the years. The dry matter and protein contents of leaves were estimated significantly highest in first year.

Nitrogen @ 140 Kg applied to high density cropping (N3S1) remaining statistically at par in the first year produced significantly higher yield during second year of study. The nitrogen and dry matter contents in leaves increased significantly under P2S2 treatment during first and second year of investigations respectively.

Among the second order interactions, 140 Kg N in conjunction with 100 Kg P2O5 applied to low plant density crop (N3P2S2) improved all the
growth attributes, phenological traits, yield contributory components and chemical composition of leaves and pods numerically during both the years of study. The highest level of fertilizers applied together interacting with high plant density (N₃P₂S₁) produced relatively higher yield of green pods than the rest of interactive treatments during both the years of investigations.

The maximum net return of Rs. 22,727.00 and 23,234.40 with the cost/benefit ratio of 2.50 and 2.57 were obtained under N₃P₂S₁ (140 Kg N + 100 Kg P₂O₅/ha applied to high density crop) during first and second years of study respectively.

It can thus, be concluded that Kharif okra for commercial cultivation should be spaced at 50 x 30 cm and fertilized with 140 Kg N and 100 Kg P₂O₅/ha which can fetch on an average a net return of Rs. 22980.00 in the Northern Gangetic Plains of the country.