SUMMARY

Systematic investigations were undertaken to study the uptake of major nutrients, viz. nitrogen, phosphorus and potash during the life cycle of bajra (Pennisetum typhoides (Burm) S & I) commonly known as pearl millet in the Divisions of Soil Science and Agricultural Chemistry; and Crop Physiology, U.P. Institute of Agricultural Sciences, Kanpur. The following aspects were studied.

I. Studies on the uptake of N, P and K by hybrid bajra at different phases of growth in four different soils of Uttar Pradesh.

II. Partial efficiency of nitrogen absorbed by hybrid bajra at different growth phases in relation to grain yield.

III. Investigations of foliar application of nitrogen to hybrid bajra and its effect on growth, chemical composition and yield.

As the bajra crop is grown under wide range of diversity in soil conditions, uptake studies were planned in pots by transporting soils from the four important bajra growing tracts of the state to Kanpur. These soils were

1. Alluvial (a) Ganga uplands sandy loam soils of Kanpur district (b) Ganga upland loamy sand soils of Allahabad district (c) Yamuna upland loamy sand soils of Agra district,
and (ii) Residual-grey to greyish brown sandy loam soils of Jhansi district. In order to minimize the losses of nitrogenous fertilizers and work out rentability and its relationship with partial efficiency of nitrogen absorbed by bajra at different phases of growth, in relation to grain yield, studies were projected on split application of fertilizers through soil. For the third studies foliar application of nitrogen was compared with soil application to assess the economic and efficient use of fertilizers and also for getting higher yields of better food value. The results obtained from these studies are briefly summarized below:

I. Uptake studies:

1. Dry matter accumulation appeared to be a function of time and continued to increase from seedling to harvest irrespective of treatmental or soil differentiations. The magnitude of dry matter production in various soil associations was due to differences in the parent materials, topography, texture, inherent fertility and environmental conditions under which these soils have developed.

2. Maximum dry matter accumulation in alluvial areas took place in Ganga upland sandy loam soils of Kanpur followed by loamy sand soils of Allahabad of the same origin but weathered to a higher degree. Third in order of dry matter production was the Yamuna upland loamy sandy soils from Agra district. Least amount of dry matter was produced in residual grey to greyish brown sandy loam soils of Jhansi district.
The soils developed on the upper stretches of watersheds of Ganga as in Kanpur district were different in fertility as compared to similar soils at the lower most stretches in the watershed of this river in Allahabad. Likewise the alluvial soils of Yamuna uplands of Agra district due to their intermitent adulterations with the wind blown soil materials of Aravali region in Rajasthan bore a different fertility. Grey to greyish brown soils of Jhansi being of residual origin were extremely poor in their fertility.

3. Dry matter accumulation proceeded at a slow rate at seedling, increased at tillering and flag leaf with a sudden spurt in its rate of increase at heading stages of plant growth. Subsequently the rate of dry matter production decreased at harvest.

4. The daily rate of dry matter accumulation was lowest at seedling, increased at tillering and decreased at flag leaf and was maximum at heading stages of bajra plant growth. Accordingly, two periods of dry matter production were observed, one at tillering when 9-12 percent accumulation took place and the second at heading where 63-70 percent of it was produced.

5. Of the three nutrients, nitrogen was found to be of maximum importance from the view point of dry matter production at every stage of plant growth in all the four soils. The application of phosphatic fertilizers influenced the accumulation of dry matter to a small extent in Agra and Jhansi.
soils. It was also observed that fertilized plants produced higher dry matter content at a faster rate than the unfertilized plants.

6. Generally, plants accumulated nitrogen in the early ontogeny of the growth. The differences in nitrogen contents due to treatments were also best exhibited at the early stages of plant growth. The phosphate and potash accumulation were also high at these stages of growth with none or little differences at subsequent stages. However, maximum amounts of these nutrients were marked at tiller development stage. As the growth advanced, nitrogen, phosphate and potash contents decreased as a result of increase in dry matter accumulation.

7. The uptake of nitrogen commenced slowly during the seedling phase with an increase at tiller development stage. This rate of nitrogen uptake was slowed down at flag leaf and again recorded a sudden increase at heading and was subsequently diminished. Thus, two efficiency periods of nitrogen uptake were noticed one at active tiller development; 30-35 days and the second at heading 65-68 days after sowing of the crop. On the other hand, the uptake of phosphate continued to increase regularly from initial stages to maturity. The uptake of potash increased almost steadily from seedling to heading. The differences in the magnitude of uptake were due to treatment and soil variations. Uptake of these nutrients were also a function of time and were more regulated according to the pattern of dry matter production.
8. The influence of treatments during various phases of growth on the magnitude of total uptake of nitrogen, phosphates and potash in the four soil types ranged according to variations in their inherent fertility and texture. The uptake of nitrogen increased progressively with the addition of every level of nitrogen fertilization in all the four soils. It was of a higher order in soils of Allahabad and Agra at the lowest level of 20 Kg. N/ha., while in residual soils of Jhansi such increases were marked from the level of 40 Kg. N/ha. The influence of phosphates and potash on the uptake of N was also marked at their higher rates of fertilization. On the contrary, the rates of phosphatic and potassic fertilizations did not influence their own uptake.

9. Nitrogen fertilization had a significant effect on the grain yield in all the four soils. Phosphatic or potassic fertilizers failed to have any marked effect on any of the soils except in the Yamuna upland alluvial loamy sand soil of Agra district. The loamy sand soils of Ganga uplands of Allahabad district were more responsive to nitrogenous fertilization where the lowest dose of 20 Kg N/ha. gave significant response of grain yield over unfertilized control. Correspondingly, the sandy loam soils of Kanpur district showed marked effects at 40 or 60 Kg. N/ha. levels over unfertilized ones. In both these alluvial Ganga upland soils the increases due to phosphatic or potassic fertilizers singly or combined with nitrogenous manuring did not influence the grain yields significantly.
10. Highly profound effects were observed among the various levels of nitrogen application on the yield of bajra grain in Yamuna upland loamy sand soils of Agra district. Similar significant responses were also observed due to individual, phosphatic and potassic manures and their combined applications of NK, NP, PK and NPK at every level of fertilization.

11. The sandy loam residual soils from Jhansi district showed statistical superiority due to application of nitrogenous fertilizers only. These soils being extremely poor in nutrient status were highly responsive to every level of nitrogen manuring whereas the application of phosphatic or potassic fertilizers singly or combined failed to influence the bajra grain yields significantly. However, numerical differences in yield were noticed due to P or K fertilization which were not statistically significant.

II. Partial efficiency studies:

12. Split application of nitrogenous manuring through soil at different rates and stages of plant growth improved nitrogen accumulation and its uptake at every stage of plant growth in all the three, lower, medium and higher, series of N fertilization irrespective of its time of application. The accumulation of N was more in plants receiving medium and higher levels (40 and 60 Kg. N/ha) of fertilizers.

13. The nitrogen content went on increasing from seedling to tiller development stage in treatments where nitrogen was supplied in divided instalments; half at sowing and the rest at tiller development in moderate and higher series. In lower series highest N content was observed at seedling stage in treatment where all N was supplied at the time of sowing. On the
contrary, nitrogen continued to accumulate till flag leaf in treatments where the dosages of nitrogen were given in split dressings; half at the time of sowing or tillering and the rest at flag leaf. At comparative levels of fertility, split dressings were more conducive to nitrogen accumulation than single application. Addition of nitrogenous fertilizers at tiller development in full or half at tillering and the rest at flag leaf resulted in comparatively lesser accumulation of nitrogen than where fertilizers were supplied in full or in part at the time of sowing.

14. Every increase in the rate of nitrogen application resulted into corresponding increase in dry matter accumulation irrespective of time of application. Dry matter accumulation was high at seedling where full dose of nitrogen was applied at the time of sowing in all the three series whereas maximum dry matter production was observed at the stage of tiller development where nitrogen was applied at tillering phase. From flag leaf to harvest stages highest dry matter accumulation took place in treatments where half of the nitrogen was applied at the time of sowing and rest at flag leaf in all the three series of nitrogen application.

15. Increasing levels of nitrogen were found to be associated with increased uptake of nitrogen. The application of full dose of nitrogen at tiller development or half at tillering and the other half at flag leaf showed lower N uptake at seedling in comparison to treatments where nitrogen was supplied wholly or partially at the time of sowing. The uptake was comparatively slow and lowest in the unfertilized plots.
The uptake of nitrogen was in larger proportion between flag leaf and heading stages in treatments where nitrogen was supplied in divided instalments particularly in M and H series.

16. In treatments where full dose of nitrogen was applied at the time of sowing, plants recovered 27, 43 and 54 percent N with the addition of 20, 40 and 60 Kg N/ha respectively. The corresponding recoveries in the three series were 17, 40 and 50 percent in the treatment where all N was given at tillering phase. Comparatively higher efficiency of N fertilizer was achieved when supplied in split dressings, half at sowing and the rest at tillering or flag leaf (T3 and T4) in all the three series; and between the two, T4 was best from percent N utilization point of view.

17. At lower rate, 20 Kg N/ha, best partial efficiency (36.5) could be obtained by applying full amount either at sowing or tillering while in medium and higher series better partial efficiency of N fertilizer for obtaining maximum grain yield could be achieved by supplying full dose in split applications. Observations on rentability were in line with those of partial efficiency where the mean effects of split dressings were superior to those recorded by the application of full dose at the time of sowing in medium and high series.

18. The application of nitrogenous fertilizers at any of the three rates showed marked increases in grain yields. Supplying full dose of nitrogen at sowing time gave statistically superior yields of bajra grain as over the application of similar dose at the time of tillering. Among the three methods of split
applications (T₃, T₄ and T₅) significantly highest grain yield was obtained by applying half nitrogen at the time of sowing and the rest at flag leaf. No such significant increases in fodder yields were noticed by supplying nitrogen in split applications. However, significant increases in fodder yield were noticed with every increase in nitrogenous fertilization.

19. Among the three doses of nitrogen, the application of 60 Kg. N/ha increased the grain yield by 69 percent while such increases were of the order of 21 and 45 percent at 20 and 40 Kg N/ha respectively over unfertilized plants. Of the various treatments, where N was supplied in divided instalments best responsiveness in all the three series, i.e. L, M, and H, was obtained by applying half nitrogen at the time of sowing and the rest at flag leaf. The increases in the fodder yield were 28, 51 and 66 percent in L, M and H series respectively.

III  Foliar fertilization studies:

20. In experiments where foliar fertilization of nitrogen was compared with soil application markedly superior grain yield of hybrid bajra was obtained by supplying 40 Kg N/ha, half through soil at the time of sowing and the rest in two foliar sprays, over all other treatments where corresponding dose of nitrogen was supplied singly either through soil or foliar sprays. Significant differences in number of panicles, test weight and fodder yields were also recorded in this treatment.

21. Highest protein content was observed in treatment where 40 Kg. N/ha was supplied in four equal sprays extending from tiller development to flag leaf stages in comparison to other treatments where equal dose of nitrogen was supplied in
full either through soil alone or half through soil and the rest through foliar sprays.

22. Highest fertilizer efficiency as also the net income for every rupee invested on fertilizer was obtained by supplying 20 Kg. N/ha all through foliar spray while its double dose, 40 Kg N/ha, all supplied through soil gave a lower efficiency and net return.