5. **GENERAL DISCUSSION**

The effects of variety, plant density and phosphorus on growth, development, yield and nutrient uptake of pigeon pea and their after effects on the succeeding wheat crop have been discussed in this chapter.

5.1 **Variety**

Growth parameters viz., plant height, branches and dry matter accumulation per plant in shorter duration pigeon pea variety 'Prabhat' (116 days) recorded comparatively lower values as compared with 'Type-21' and 'Manak' (146 days).

'Manak' had tallest plants among the three varieties indicating its expression of genetic character under iso-nutritional and moisture conditions. Maximum plant growth in terms of number of branches and dry matter production per plant (Tables 4 and 5), as observed in variety 'Type-21, might have resulted in higher stalk yield (Table11).

Varietal behaviour to differing plant densities at 40 and 100 day stage revealed that at low population density, the 'Type-21' had highest dry matter production compared with 'Manak' and 'Prabhat' (Table 5a and b), were non-significant (Table 6) Among the three varieties, 'Prabhat' was of shortest duration taking 116 days to mature (Table7). While 'Manak'21, and 'Type-21' were
of medium duration (145 days). The early maturity of 'Prabhat' has also been reported by Saxena et al. (1974), Ahlawat (1976) and Singh (1978). 'Type-21' in general, produced more number and weight of pods/plant and bolder seeds with higher grain weight per pod than 'Prabhat' and 'Manak' (Tables 8 and 9). However, the length of pod was almost identical in the three varieties (Table 9). The number of grains per pod were more in 'Manak' than 'Type' and 'prabhat' in 1992. Number of pods per plant in pigeon pea is the most important single yield attribute determining the yield potentiality and always positively correlated with the grain yield. (Ahlawat, 1967 and Singh, 1978). 'Type-21' possessing the character of bearing more pods in addition to bolder seeds, therefore, yielded higher than other two varieties namely, 'Manak' and 'Prabhat' in the present investigation.

Varieties and plant population interacted significantly in respect of number of number and weight of pods per plant. Variety 'Prabhat' suffered increasingly more inter-plant competition with increasing plant density which finally resulted in reduced number and weight of pods per plant. Inter-Plant competition in 'Prabhat' reduced the test weight also.
In both years, 'Prabhat' remained the lowest yielder. As indicated earlier 'Prabhat' is a short duration variety than 'Manak' and 'Type-21'. The crop duration plays an important role in its productivity. Generally the longer the duration, the higher would be the yielding ability. The same observations have been reflected by these cultivars. The results obtained by Singh (1973) and Ahlawat (1976) also corroborate the above observations.

'Type-21' exhibited maximum harvest index followed by 'Manak' and 'Prabhat'. It is an indicative of better yield potentiality coupled with other desirable yield components of an ideal plant type. The harvest index speaks of the conversion efficiency of non-grains into grain portion by turning up nutrient uptake as well as utilization.

Studies on nutrient uptake brought out that 'Type-21' on an average, removed as much as 102 kg N and 20 kg P/ha. The respective nutrient uptake values in 'Prabhat' (short duration variety) were 66 and 14 kg/ha. The total uptake by a crop is by and large related to its dry matter (grain+ non-grain parts) and, therefore, the varietal behaviour in respect of nutrients (N and P) uptake was almost identical to that of dry matter production. The nutrient removal by pigeon pea clearly suggested that balanced fertilization is essential to harness the yield potential of high yielding varieties. Similar results were reported by Singh (1973) and Ahlawat (1976).
5.2. **Plant density**

Increased plant density results in enhanced competition among the plants for nutrients, water, light, oxygen and CO$_2$. Two types of relationship between the plant population and the crop yield have been described by Holliday (1969b). One is an 'asymptotic' where with increase in density, the yield rises to maximum and then relatively constant at high densities, the other is 'Parabolic' where, Yield rises to a maximum but then declines at higher densities.

It is observed that increasing plant densities reduce branching and dry matter accumulation per plant. Because the increased density limits the space availability per plant and hence the root configuration and plant productivity. But the plant height increased with the increase in Plant density. The increase in population resulted in more of mutual shading leading to more elongation of meristematic cells than that under competition free conditions. Similar observations were reported by Wilsie (1935) and Manjhi (1971).

The inverse relationship of plant population to branches and dry matter production per plant was also noticed by Singh (1975), Chauhan and Singh (1981). Increased plant height at high population densities was also recorded at Akola under AICRP in 1977-78. The total crop dry
matter was higher at high population densities resulting in more stalk yield per hectare. This substantiates the 'asymptotic' relationship enunciated earlier.

Yield components viz., number and weight of pods per plant, grains per pod, grain yield per plant and test weight recorded higher values at low density. But this improvement was not reflected by the grain yield per ha since medium and high densities outyielded the low density. It is attributable to the fact that the improvement in aforesaid yield attributes failed to compensate for the low number of plants per unit area. Per hectare yield was higher at medium density followed by high and low densities. Very truly proving the 'Parabolic' relationship between the plant density and yield, described by Holliday (1960b). Higher grain yield of pigeon pea with higher plant populations were also obtained by Saxena (1968), Manjhi (1971), Ahlawat et al. (1975a) and Ahlawat (1976).

The reduction in grain yield per plant at higher plant densities might have been due to comparatively poorer growth of individual plant because of competition for light, water and nutrients. The results obtained by Wiggins (1939), Reynolds (1950), Wiklund (1954), Harvey et al. (1958), Holliday (1963), Donald (1963) and Weber et al. (1966), corroborate the present results. Grain yield per plant generally decreased with an increase in plant density per high plant densities (subject to optimum) should be accommodated per unit area to push up total productivity
even at the cost of productivity of individual plants (Saxena, 1969 and Hammerton, 1971) because the grower is interested in higher yield per unit area rather than higher yield per plant.

5.3. **Phosphorus fertilization**

Phosphorus application, in general, increased plant height, number of branches, dry matter production per plant and also resulted in higher stalk yield per hectare. These findings are in agreement with those reported by Manjhi (1971), Rao (1975), Singh et al. (1976), Hegée (1977) and Singh (1978). The improvement in individual character like branching and dry matter production per plant was observed by Panwar and Yadav (1980) and Chauhan and Singh (1981). Increased dry matter accumulation due to phosphorus fertilization presumably led to boost stalk yield per hectare. It also improved the dry weight of nodules per plant at 70 day stage in 1993. The improvement in nodulation was probably responsible for better grain productivity because it might have resulted in more fixation of atmospheric nitrogen. Since increase in microbial population and activity (Acharya, 1953) has ascribed to phosphorus fertilization under controlled conditions and it results in pushing up N and organic carbon content of the soil. The deficiency of phosphorus would hold otherwise trend (Nichols, 1965).
Application of phosphorus increased the yield components, namely, number and weight of pods per plant, grain yield per plant and test weight. These beneficial effects of phosphorus on yield attributing characters showed increased grain yield. An economic optimum dose ranged between . This, in turn, confirmed the hypothesis regarding phosphorus needs of the pigeon pea. Thus the results of the present study are in agreement with those of Rathi et al. (1974), Singh et al. (1980) and Chauhan and Singh (1981). While Roy Sharma et al. (1979) obtained the response upto 100 Kg P2O5/ha

The adequacy of phosphorus induces vigorous Rhizobial activity and more effective fixation of nitrogen (Roberts and Olsen, 1944, Schuphan 1961 and Swaminathan et al. (1969). Thus the uptake of N and P was also improved by phosphorus fertilization. Phosphorus as discussed earlier significantly increased the grain as well as stalk yield of pigeon pea and therefore, the total uptake of these nutrients. Similar results were also reported by Manjhi (1971), Singh and Prasad (1976), Hegde (1977), Ahlawat (1977) and Dalal and Quilt (1977).

The various treatments namely different plant densities, P levels and different varieties of pigeon pea had marked effect on the productivity of succeeding wheat crop. The grain yield of wheat obtained following pigeon
pea variety 'Type-21' in general, was higher compared with other varieties. The superiority of 'Type-21' may be accounted to its relatively better nodulation and probably greater biomass left over in the soil for utilization by succeeding crop of wheat. Jeswani (1979) and Jeswani and Saini (1981) recommended the growing of short duration varieties like 'Prabhat' 'Type-21', 'Pant A-3' and 'Pant A-1' in arhar-wheat rotation. Similarly high plant population leaving behind larger root mass and more of leaf shedding per unit area, would have resulted in greater availability of nutrients to succeeding wheat crop.

The increase in wheat yield following P fertilized pigeon pea plots may be attributed to qualitative as well as quantitative improvement in root nodulation in pigeon pea. This characteristic improvement must have fixed more of atmospheric N and consequently higher fertility in respect of soil N which was reflected on succeeding cereal (wheat). Similar results were reported by Panwar and Yadav (1980) and Ahlawat et al. (1981).

The overall economic analysis of 'arhar (grown with various treatments) - wheat' rotation revealed that the total net returns obtained were almost in full agreement with the recommendations made for arhar in the present investigation. For instance, 'Type-21', which
gave highest yield also gave highest total net returns. The recommended plant density of 111, 111 plants/ha though recorded higher net profit in arhar but total net returns were marginally higher in case of 166, 666 plants/ha. The trend in net returns obtained with graded levels of phosphorus in arhar was almost identical to total net returns from the rotation. Anonymous (1971b) also found the 'arhar-wheat' rotation more profitable in economic terms. Same was also observed by Brar et al. (1976).