CHAPTER - V

DISCUSSION

The results of the experiments on "Planting methods and nutritional management in kharif urdbean (Vigna mungo L. Hepper) and their effect on productivity potential of succeeding wheat (Triticum aestivum L.) in Vertisols of Chhattisgarh plains" have been presented in the earlier chapter. In continuation with this, an effort has been made to interpret and discuss the results with figures and facts from the important observations and cause and effect relationship along with established scientific views of national and international research workers.

5.1 Weather effect

The growth and production potential of any genotypes is influenced by the prevailing weather condition and agro resource management practices. The agro resources can be managed, but the weather conditions are difficult to control. However, the reduction in grain yield of a crop can be minimized to some extent by the manipulation in crop management techniques according to prevailing weather conditions. The prevailing meteorological parameters and weather conditions like precipitation, humidity, temperature,
solar radiation, evapo-transpiration etc. govern the physiology of the crop and ultimate effect is exhibited through its production.

The urdbean crop received 504.4 mm and 1039.9 mm of rainfall during kharif 2002 and 2003, respectively. The rainfall during both the years were well distributed throughout the crop life cycle which favourably affected the urdbean crop. The solar radiation, humidity and other weather parameters were favourable for urdbean crop (Appendix I, II and Fig. 3.3 and 3.4). The urdbean cv. TAU-2 was used as the test crop. It has a short life spell and categorized as early crop, which matures within 75 days therefore, the yield performance was least affected, due to weather fluctuations during both the kharif seasons. The high water retaining capacity of the experimental soil further helped to system.

The wheat crop needs cool and dry weather conditions for its growth, development and better yield attributes and yield. However, occurrence of light showers additional to residual soil moisture and irrigation at critical stages favour the growth and yield parameters of wheat. The 43.7 and 75.7 mm winter precipitation was received by the wheat during rabi 2001-02 and 2002-03, respectively, which slightly favoured the growth and yield of wheat. The maximum
and minimum temperature ranged between 34.7°C- 6.6°C and 39.8°C-9.3°C during 2002-03 and 2003-04, respectively, which were quite favourable for growth and development of wheat crop. The lower range of minimum temperature and higher relative humidity 89%-93% during third week enhanced the germination and initial growth of wheat by condensing maximum dews. The reduced mean evaporation of 2.9 mm and 1.8 mm day\(^{-1}\) at different growth stage of the crop during 2002-03 and 2003-04, respectively, further assisted in maintenance of stored soil moisture for longer period.

5.2 Effect on urdbean

5.2.1 Growth, yield attributes and yield

Urdbean cv. TAU-2 was grown during kharif 2002 and 2003 under three methods of planting viz., ridge planting, paired method of planting and flat method of planting; and four nutrients levels i.e. 100% RDF, 75% RDF, 50% RDF and \textit{Rhizobium} inoculation treatments. The findings of the present investigation are discussed in light of available data supported with literature available on this aspect.

It is evident from data that the grain yield of urdbean under different planting method was comparable to each other. The similar results were also noted in previous studies conducted at Raipur (Anonymous, 2003). It is due to sloppy land supported with proper drainage system and well
distributed rainfall during the season. Being an early maturing crop, urdbean was not affected very much due to abbreviations in rainfall distribution. Urdbean seeded under different nutrient levels showed significant variation in seed yield. The nutrient dose of 100% RDF produced the maximum grain yield of 7.95 q ha\(^{-1}\) and 8.98 q ha\(^{-1}\) during the years 2002 and 2003, respectively (Table 4.12). The maximum response due to use of 100% RDF was also reported by Singh and Bajpai (1993), Rajendran et al. (1974a) and Shivram and Ahlawat (2000b) for nitrogen; Thakur and Negi (1985), Singh et al. (1986), Kushwaha (1993), Rao et al. (1990) for P\(_2\)O\(_5\); George et al. (1981), Saxena et al. (1996) for K\(_2\)O and Lal and Jaiswal (1979), Ghosh et al. (1996) for sulphur in urdbean. The higher yield under 100% RDF was due to higher yield attributes \textit{viz.}, pods plant\(^{-1}\), seeds pod\(^{-1}\), seeds plant\(^{-1}\), 100-seed weight (Table 4.10 and 4.11) under ridge planting method and nutrient level of 100% RDF. It was found significantly superior over other treatments, during both the years. The similar findings were also obtained by Samiullah et al. (1981), George et al. (1981), Salam and Nair (1982), Thakur and Negi (1985), Singh et al. (1986), Mahmud et al. (1997) and Ramamoorthy et al. (1997) in urdbean.

The proper and uniform density of plant stand plays the key role to increase the growth, yield attributes and grain
yield of urdbean. However, plant population was noted to be
not influenced significantly by the different treatments. Only
comparative increase in population was recorded under ridge
method of planting and 100% RDF than the rest of the
treatment.

The higher yield of urdbean under 100% RDF
treatment can be ascribed due to higher value for growth
parameters like plant height, dry biomass of plant, number of
branches plant\(^{-1}\), root length, root weight, LAI, LAD, DMA,
CGR, RGR, nodule number and weight at most of the
observation schedules. The use of nitrogen in pulses promote
Rhizobial growth for nitrogen fixation and also to meet initial
requirement of seedlings of urdbean and recommended dose of
N certainly beneficial to the crop to produce maximum nodule
number and other growth parameters of crop. Bhalu et al.
(1995) reported that the application of recommended nitrogen
as starter dose helped in the establishment of the crop, which
ultimately led to the extensive development of root nodule and
bacteria present in them fulfilling the need of the crop for
nitrogen. It was observed that during both the years the better
performance was noted under ridge method of planting and
100% RDF of nutrient level. The above findings clearly suggest
that higher nutrient doses and ridge method enhanced the
growth parameters, which ultimately increased grain yield.

The increased LAI under ridge method of planting and under higher level of nutrition i.e. 100% RDF increased the net assimilation rate and resulted in increased dry matter accumulation thereby grain yield (Table 4.5 and 4.6). The CGR and RGR were also higher under ridge planting method and higher nutrient level 100% RDF due to increased assimilation rate (Fig. 4.2 and 4.3). The significant positive correlation between LAI and DMA confirmed the higher CGR and RGR (George et al., 1981, Saxena et al., 1996 and Singh, 2000).

Harvest index (HI) under different nutrient levels was significantly maximum under 100% RDF which was comparable to 75% RDF and Rhizobium inoculation treatment during first year of experimentation, but during second year and on mean basis, it was comparable only to Rhizobium inoculation. The similar findings were also reported by George et al. (1981) and Saxena et al. (1996).
5.2.2 **Content and uptake of N, P, K and content and yield of protein**

Higher concentration of N, P and K and protein in seed and stover of urdbean was noted under 100% RDF followed by 75% RDF and *Rhizobium inoculation* in both the years. The minimum concentration of these nutrients was noted in 50% RDF. The nitrogen content in seed and stover and in their total was significantly the highest under 100% RDF during both the years and on mean basis (Table 4.13). P and K contents in seed, stover and in their total (Table 4.14 and 4.15) were significantly affected by different nutrient management treatments. The 100% RDF accumulated more nutrient in seed as well as stover in both the years. Increased application of nutrients improved the nutritional environment of the soil solution leading to higher availability of nutrients to plants. Further, improved synchrony between supply and plant demand, the better root proliferation, greater nodulation and leaf area enhanced the mobilization of nutrients towards the sink alongwith photosynthates of plant. Higher N, P and K concentration might have favoured greater source-sink relation at appropriate period of pod development stage resulting in higher yield. On the contrary, the planting methods were found to exhibit non-significant response of NPK content (Table 4.13, 4.14 and 4.15). Above findings are in
agreement with Sahu (1973), Kadwe and Bhade (1973) and Namdeo and Ghatge (1976) for N content and Khandkar and Shinde (1991) for P and Kadwe and Bhade (1973) and Namdeo and Ghatge (1976) for P and K in urdbean.

Similarly, the significantly higher uptake of N, P and K by seed and stover and in their total, protein content and protein yield was recorded under 100% RDF followed by 75% RDF and Rhizobium inoculation. Significantly higher nutrient uptake and protein yield in these treatments might be due to higher content of nutrients and the yields of seed and stover under these treatments (Sahu, 1973, Kadwe and Bhade, 1973 and Namdeo and Ghatge, 1976).

5.2.3 Available soil nutrients

There was no significant difference in available soil nutrients due to different planting methods. Under different nutrient management practices, significantly maximum quantity of available soil N, P and K was found under 100% RDF (Table 4.17). Increased availability of N, P and K might be due to reduced N losses by formation of organo-mineral complexes through exchange reaction (Singh, 1997, Sharma and Mitra, 1991 and Prasad and Singh, 1992). Biological immobilization of NH$_4$ ion also might have been a cause of reduced N loss (Prasad and Singh, 1992). Rao and Singh
(1991), Chaudhary and Das (1996) and Shrivastava et al. (2003) reported the similar findings.

5.2.4 Productivity rating index, energy and economics

The productivity rating index and production efficiency under ridge method of planting showed higher values than other methods of planting (Fig. 4.4). In case of nutrient management, maximum values of productivity rating index and production efficiency were found under 100% RDF, whereas, the minimum values were noted under 50% RDF. The higher values under above treatments are in accordance with higher seed yields under these treatment.

The energy studies in urdbean clearly indicate that the highest energy output, energy use efficiency and energy output-input ratio were obtained under ridge method of planting (Table 4.18). However, it was mostly comparable with flat method of planting. In case of nutrient management, energy output was found maximum under 100% RDF, but energy use efficiency and energy output-input ratio were maximum under Rhizobium inoculation treatment. The total energy output was remarkably higher under 100% RDF higher total energy input due to more fertilizer input under this treatment, the energy use efficiency and output-input ratio were low. Whereas, in case of Rhizobium inoculation, the
energy input was less and comparatively higher seed and stover yield, the energy use efficiency and energy output-input ratio were high.

The economic analysis showed that the gross and net returns were significantly higher under ridge method of planting compared to other methods (Table 4.20). The increased productivity under this treatment due to less effect of continuous rains. Under ridge method of planting, the rain water did not stagnate anytime in the field. But, benefit cost ratio was maximum under flat method of planting, it is due to less cost involved in flat method of sowing. Under different nutrient management practices, significantly higher gross return, net return and benefit cost ratio were obtained under 100% RDF treatment. The increased productivity under this treatment could cover up the additional cost of production, which resulted in higher benefit cost ratio. This signifies further the superiority of higher fertilizer level to increase productivity of urdbean. Trivedi (1996) also reported similar findings.

5.3 **Effect on wheat**

5.3.1 **Growth, yield attributes and yield**

Wheat was grown in rabi after urdbean to assess the residual effect of kharif treatments as well as direct effect of two levels of recommended fertilizers i.e. 100% and 75% RDF.
The results revealed that the residual effect of *kharif* treatments were beneficial to increase the grain yield of wheat during both the years (Table 4.27). Grain and straw yields of wheat under flat method + 100% RDF was found maximum during first year of experimentation, while, during second year, it was observed under ridge + 100% RDF. However, it was found at par with paired + 100% RDF. It is clear that the planting method of urdbean has not very much influenced on wheat yield, but the residual effect of fertilizer applied in urdbean had significant influence on succeeding wheat crop.

The beneficial residual effect of fertilizer on wheat crop can be explained through the fact that certain portion of the nutrient applied to a crop may remain unutilized due to time required for the slow decomposable fraction to release its nutrients for crop utilization. Urdbean is already a short duration crop unable to utilized whole quantity of fertilizers and some quantity of fertilizers immobilized in soil, which, mineralize in later period during wheat growing season, which is ultimately available for the growth and development of the succeeding crop wheat.

In the present study, application of 100% RDF to urdbean enriched the soil with N, P and K (Table 4.31), which facilitate the higher N P and K content and their uptake by urdbean (Table 4.28, 4.29 and 4.30). The availability of more
N, P and K in higher doses increased the growth parameters such as plant height (Table 4.20), number of tillers (Table 4.21), dry matter accumulation (Table 4.22), root volume and weight (Table 4.23), LAI (Table 4.24) and LAD (Fig. 4.5). These parameters might have favoured more of nutrient uptake and photosynthesis leading to accumulation of higher amount of dry matter and production of more of yield attributes i.e. ear m⁻¹ row length, length of ears (Table 4.25), grains earhead⁻¹, grain weight earhead⁻¹, 1000-grain weight (Table 4.26) and ultimately grain yield of wheat. The results corroborates with the earlier findings of Mahadkar and Saraf (1988a), Mahadkar and Saraf (1988b), Thakur (1995), Singh et al. (1995), Shivram and Ahlawat (2000b), Ahmed et al. (2001) and Patra (2001).

The direct effect of fertilizer dose to wheat was also studied. 100% RDF significantly increased grain and straw yields of wheat (Table 4.27). The increase in yield of wheat might be due to proper and sufficient supply of N, P and K during entire growth period of wheat. Similar findings were also reported by Rana et al. (1982), Singh and Singh (1984), Duhan et al. (1988), Singh and Singh (1991), Lathwal et al. (1992), Shrivastava et al. (1995) and Nayak et al. (1997).

Higher yield of wheat under 100% RDF attributed to significantly higher plant height, number of tillers plant⁻¹, dry
matter accumulation at 30, 60, 90 DAS and at harvest, root volume at late tillering and milking stage, root dry weight plant⁻¹, leaf area index, leaf area duration, ears m⁻¹ row length, length of ears, grains earhead⁻¹, grain weight earhead⁻¹ and 1000-grain weight. Similar findings in response to higher level of nutrients have been also reported by Singh et al. (1982), Singh et al. (1987), Awasthi et al. (1993), Ajit et al. (2001), Shrivastava et al. (1995). The role of nutrients in wheat growth and yield is well known.

5.3.2 N uptake and use efficiency

Nitrogen, phosphorus and potash uptake in grain and straw were significantly higher under residual effect of 100% RDF applied in urdbean irrespective of method of sowing. This might be due to residual effect of nutrients available which are not utilized by the preceding crops. These results are in close conformity with the earlier findings of Shivram and Ahlawat (2000a), Patra (2001) and Ahmed et al. (2001). Similarly, direct application of 100% RDF registered significantly higher N composition and uptake in grain, straw and in their total. This corroborates the earlier findings of Oscarson et al. (1995), Lee et al. (1995), Banga et al. (1996), Singh et al. (1996) and Singh (1997).
5.3.3 Available soil nutrients

The residual effect of *kharif* treatment imposed on urdbean crop could not give significant differences on available N, P and K content of soil. Whereas, direct application of fertilizer to wheat possess a significant difference on available N, P and K content of soil. The application of 100% RDF showed higher N, P and K content of soil as compared to 75% RDF. Chaudhary and Das (1996) found that the application of fertilizer in *kharif* legume attributed the improvement in physico-chemical properties of soil. Rao and Singh (1991) found that inclusion of greengram in cropping sequence increased the available nitrogen status significantly. Shrivastava *et al.* (2003) also reported improvement in the soil nutrient status due to legume and fertilizer application.

5.3.4 Productivity rating index, energy and economics

The productivity rating index and production efficiency of wheat were significantly influenced by residual effect of *kharif* treatments. The maximum productivity rating index and production efficiency was recorded under 100% RDF irrespective of methods of sowing (Fig. 4.8). The higher values are in accordance with higher grain yields under these treatments. Similarly in case of direct application of nutrients,
100% RDF showed higher values of productivity rating index and production efficiency over 75% RDF.

The energy studies in wheat clearly indicated that the energy output, energy use efficiency and energy output-input ratio were maximum under the residual effect of 100% RDF under all the three methods of sowing. Similarly, direct application of 100% RDF to wheat also possess the higher energy output, energy use efficiency and energy output-input ratio over 75% RDF (Table 4.32). The higher grain and straw yields under this treatment might be the possible reason for such increase.

The economic analysis indicated that the gross and net returns were significantly higher under the residual and direct effects of 100% RDF as compared to other treatments (Table 4.33). The increased productivity under this treatment could cover up the additional cost of production, which resulted in higher benefit cost ratio. Singh and Bajpai (1993), Basak and Shah (1993) and Shivram and Ahlawat (2000a) also reported the similar findings.

5.4 Effect of urdbean-wheat cropping system

The total productivity and net income of the cropping system were observed maximum under application of 100% RDF followed by 75% RDF (Table 4.34). This is obviously due
to higher yield of component crops of the system under these treatments. Balance sheet of available N, P and K was prepared by taking the cropping system into consideration (Table 4.35, 4.36 and 4.37). The findings showed the less depletion of these nutrients from soil under 100% RDF which signifies higher total productivity and increment in productivity over low recommended dose of fertilizer. This might be due to greater exchange of nutrients from unavailable to available pool and build up of soil humus due to leguminous crop, which might have resulted in higher CEC and also favoured more nutrient retention in soil (Bellakki et al., 1998). Yadav (1990), Rao and Singh (1991), Singh and Bajpai (1993) and Shivram and Ahlawat (2000b) reported only 32% of applied N and 15-13% of applied P are recorded by the crop to which these are applied. There was significant residual effect of applied N (Prasad and Subbiah, 1982), P (Tandon, 1984) and K (Grewal and Sharma, 1981) on the succeeding crops. Shrivastava et al. (2003) reported that the blackgram-wheat cropping sequence maintains sustainable level of soil fertility without impairing any adverse effect on soil and their productivity.