CHAPT ER 6

DISCUSSION OF EXPERIMENTAL RESULT

6.1 Effect of phosphorous fertilizer on exchangeable Al^{3+}, available phosphorous and soil pH

Soil on the experimental site is poor in chemical properties, especially available phosphorous is 3.39 ppm (Table 10). Poor available phosphorous content is probably result of low soil pH (4.24), high exchangeable aluminum and iron considered as main cause. According to Sanchez (1976) aluminum toxicity is the most common cause of acid soil infertility. Also, Sanyal and de Datta (1991) revealed that in acid soil, phosphorous adsorption by soil is generally attributed to hydrous oxides of iron (Fe) and aluminum (Al), and to (1:1) layer lattic clays, particularly in tropical soils with low pH.

Result of liming 1300 kg ha^{-1} increased soil pH and available phosphorous from 4.24, 3.39 ppm in original soil (Table 10) to 5.55, 3.86 ppm respectively whereas exchangeable Al^{3+} was remarkably reduced from 0.76 meq/100g soil down to 3.38meq/100g soil (Figure 5.1). Sanchez (1976) reported that aluminum toxicity can be corrected by liming to pH 5.5 to 6.0, to precipitate the exchangeable aluminum as aluminum hydroxide. Rate of available phosphorous increase became more rapid when phosphorous fertilizer was applied (Figure 5.1). As a result, available phosphorous increased from 3.86 ppm when no phosphorous fertilizer applied to 6.5, 16 and 16.7 ppm when 54, 75, and 112 kg P_2O_5 ha^{-1} were applied respectively. According to Sanyal and de Datta, (1991) soil pH from 5.5 to 6 can improve situation of available phosphorous in the soil better, simultaneously Mn^{2+} and Al^{3+} toxicity could be reduced. In this study, results demonstrate that when phosphorous fertilizer was applied at amount greater than 75 kg P_2O_5 ha^{-1}, increasing availability of phosphorous become remarkably slow. This result was similar to those reported by many authors in which this reduction was concern to formation of insoluble Ca-P compounds when soil pH is beyond 5.5-6.0 (Naidu *et al.*, 1990 cited by Sanyal and de Datta, 1991). Experimental soil pH was 5.9 which was obtained at 75 kg P_2O_5 ha^{-1}, the highest rate of available phosphorous increase was also obtained at this fertilizer level. Thereafter, the rate of available phosphorous increase was strongly declined at 112 kg P_2O_5 ha^{-1} and correspondent pH was 5.97 (Appendix 9). Figure 5.1 also indicate that soil pH slightly increased when phosphorous fertilizer was added due to high CaO content included in FMP fertilizer.

6.2 Response of mungbean growth, yield, and yield components to phosphorous fertilizer

6.2.1 Plant height

Plant height showed positive response to phosphorous fertilizer application. Average height of V 41-52 is the highest among varieties studied at all growth stages and it responded more strongly to phosphorous than the other varieties. This variety also gave the highest seed yield. Ability of increasing plant height after flowering (R4 and R6) of V41-52 (Figure 5.5) is better than other varieties. Relationship between seed yield and plant height was reported by Na LamPang *et al.*, (1988) correlation between yield and plant height at harvest appear significantly and are highly significant for plant height increase after flowering. Figure 5.5 indicate plant height increase of V 41-52 at R4 and R6 is greater than other varieties. The fact is that the highest seed yield was also found in V 41-52. Similarly, it is clearly explained in the case of VC 27-68A in which it also gave the second high seed yield, and the second plant height increase.

6.2.2 Nodulation

Results of the experiment shown that significant lower number of nodule per plant in treatments without phosphorous fertilizer application (Table 17). General speaking, nodule number increased strongly at 56 and 75kg P_2O_5 ha^{-1} (Figure 5.3). Turkhede and Giri (1982) cited by Fageria *et al.*, (1991) revealed that there were increase of nodule number and nodule weight and increase rate of nitrogen fixation in the number of leguminous crops when phosphorous fertilizer was applied. Phosphorous is a limiting factor for the establishment of nodulation and /or nitrogen fixation (Luyindula and Haque, 1988). Besides, soil acidity affected both nodulation and growth of plant soil acidity factor including low pH, low Ca^{2+}, high Al^{3+} and Mn^{2+} have been considered as inhibitor for legumes nodulation (Munns, 1980). Effect of acid soil on nodulation of mungbean was similar to conclusion of Munns (1980); Borker and Sfredo (1994) also revealed that low soil pH often relates to high exchangeable aluminum, Mn^{2+} that cause toxicity to plant, and especially to activity of *Rhizobium* bacteria. The symbiosis is particularly sensitive to Al^{3+} and Mn^{2+} toxicity. Syer and Craswell (1995) reported that P addition increase plant growth and nitrogen fixation legume, enhance of the quantity and quality of crop residues.

Table 17 and figure 5.3 shown different responses of nodule number in various varieties. Among them, V 41-52 and VC 27-68A were shown better performances than Lang and V 87-13. According to Miller and Fernandez, (1988) there is different in nodulation from mungbean variety to variety and that lack of understanding of complexity of nitrogen fixation, assimilation, translocation and partitioning to various plant parts. The latter are very complex processes and not necessarily related to the amount of N_2-fixation by a plant.

6.2.3 Dry matters

Dry matters including above dry matter and root dry weight gave significantly positive responses when phosphorous fertilizer was applied. Especially, the response was high when phosphorous fertilizer was applied at 56 and 75kg P_2O_5 ha^{-1} (Table12 and 15). Generally dry matters were significantly increased through increasing of plant height and number of nodule as discussed above. Because of dry matter production in plant is derived from solar radiation through the photosynthesis process, temperature and soil fertility governs the speed of development (Mc Cloud *et al.*, 1990). Although there were similar response of mungbean varieties in dry matters to increasing of phosphorous fertilizer levels, VC 27-68A and V41-52 always shown their dry weights better than Lang and V 87-13 (Figure 5.2, Table 13 and 16). The group with higher dry matters is also the group with higher seed yield which is VC 27-68A and V 41-52. According to Na LamPang *et al.*, (1988) correlation between total plant dry matters and seed yield is highly significant while harvest index with total dry matters shown no relation. Sahrawat and Islam, (1988) revealed that phosphorous requirement varies not only from crop to crop but also among cultivates of the same crop leads to accumulation of dry matter was difference from variety to variety.

6.2.4 Yield components

Yield components of mungbean i.e. pod number per plant, 100-seed weight, number of seed per pod also increased significantly by increasing phosphorous fertilizer application rates. Fageria *et al.*, (1991) stated that variation in yield components is related to varieties, spacing, fertilizer and climatic. This is particularly true for the relationship between phosphorous deficiency and a decrease in the number of flowers and delay in flower initiation that effect on pod number and filled pod number in mungbean (Bould, 1978 cited by Marschner, 1986). Actually, there is close correlation between yield components and seed yield in the experiment. Increase of 100-seed weight, number pod per plant, number seed per pod occurred correspondingly in relation to seed yield (Figure 5.5, 5.6, 5.7).

6.2.5 Seed yield

Experimental result show that phosphorous fertilizer application increased average seed yield from 16% to 34% more than average control (without P fertilizer). The highest rate of average seed yield increase was obtained at 75 kg P_2O_5 ha^{-1} for all varieties (Figure 5.8). This rate is relevant to the highest rate of available phosphorous increase in the soil at the same phosphorous fertilizer application rate (Figure 5.1). As a result, this demonstrated that the role of phosphorous fertilizer application might be important to improve seed yield of mungbean in the hilly zone. However, Figure 5.8 displays the different dynamics of seed yield from various varieties to phosphorous fertilizer applied. Seed yield of VC 27-68A and V 41-52 were better than remaining varieties (Figure 5.8). According to Sahrawat and Islam, (1988); Claimon *et al.*, (1988); that seed yield response of legumes in general, mungbean in particular to phosphorous fertilizer is different from variety to variety.

The increasing of seed yield was generally due to enhancing of dry matters, nodule number, and yield components of mungbean when phosphorous fertilizer application rate was increased.

6.2.6 Potassium, nitrogen and phosphorous concentration of YFEL in V4

Phosphorous and nitrogen concentration in YFEL significantly increased when phosphorous fertilizer was added at every phosphorous fertilizer levels. Results of this study show that the mungbean in control treatments (no phosphorous fertilizer) had phosphorous deficiency. Phosphorous concentration of YFEL in V4 ranged from 0.31% to 0.42%. The highest concentration of phosphorous and nitrogen in YFEL was obtained at 75 kg P_2O_5 ha^{-1}. Correspondingly, it was also observed that the highest soil available phosphorous of 16.03 ppm at 75 kg P_2O_5 ha^{-1} as compared with 3.86 ppm at 0 kg P_2O_5 ha^{-1}. The great increase of phosphorous and nitrogen concentration of YFEL at 75 kg P_2O_5 ha^{-1} in which this level of phosphorous fertilizer is probably considered as suitable phosphorous fertilizer level for high yielding. It has been found that there is an optimum concentration of phosphorous in soil solution associated with maximum crop growth and yield (Sanchez, 1976). According Tiaranan *et al.* (1985); and Claimon (1988) soil available phosphorous of 8 ppm was critical value for maximum mungbean yield, meanwhile available phosphorous in the experimental soil was only 6.5 ppm at 56 kg P_2O_5 ha^{-1} which was not enough phosphorous for maximum yield of mungbean. Therefore, high increase of phosphorous concentration in YFEL at 75 kg P_2O_5 ha^{-1} had close correlation to the high increase of seed yield and yield components at the same level.

In terms of varieties, there were significant differences between two groups of variety in phosphorous concentration and nitrogen concentration of YFEL (Table 20 and Figure 5.9). This is also similar to results of seed yield, yield components and dry matters. Lang and V 87-13 shown poor response to available phosphorous in the soil at 56 kg P_2O_5 ha^{-1} while VC 27-68A and V 41-52 shown the better response. Sanchez, (1976) shown that high aluminum levels in soil solution do direct harm to roots and decrease of root growth and translocation of root calcium and phosphorous to the tops. He also said that tolerant low phosphorous ability of each species or/and variety is different, and little is known about nature of such differences in most tropical crops. As a result of low pH in experimental soil (4.24) (Table 10), it is probably that tolerant low phosphorous ability of Lang and V 87-13 is less than VC 27-68A and V 41-52. However, all varieties shown good ability to adsorb available phosphorous, nitrogen in the soil at higher phosphorous fertilizer levels (Table 21 and Figure 5.9).

Significant increase of nitrogen concentration in YFEL was recognized when phosphorous fertilizer was added as mentioned above. This is probably result of the better symbiotic ability of *Rhizobium* bacteria and host (mungbean) in treatments with additional phosphorous fertilizer application. Symbiosis is a biological process, which depends on many factors. Symbiosis development is sensitive to soil conditions. Because symbiosis is particularly sensitive to the Al^{3+} and Mn^{2+} toxicities and Ca^{2+}, available phosphorous deficiency associated with soil acidity (Munns and Franco, 1982 cited by Craswell *et al.*, 1987). Original soil of this study is low in pH, available phosphorous, Ca^{2+} and Mg^{2+} which are 4.24, 3.39 ppm, 4.8 meq/100 g and 1.6 meq/100g respectively. Whereas, Al^{3+} is quite high (0.76 meq/100g). Such soil condition limited symbiosis process development. As a result, ability of nitrogen in the soil become deficit in treatments without phosphorous fertilizer application.

In terms of potassium concentration of YFEL, Table 22 shown significant difference between treatments with phosphorous fertilizer and without it. However, there was no significant difference among treatments with different phosphorous fertilizer levels. This means that there is no relation or a little relation between phosphorous fertilizer application and potassium concentration of YFEL.

6. 3 Economic consideration

Table 23 indicate that phosphorous fertilizer application at 112 kg P_2O_5 ha^{-1} did not give significant increase in gross margin as compared to gross margin at 75 kg P_2O_5 ha^{-1}. This is understood that additional variable cost, which is mainly from additional P fertilizer cost, is not relevant to additional seed yield or gross revenue. Moreover, there is considerable decrease in return to capital for all varieties compared with gross margin at 75 kg P_2O_5 ha^{-1}. This indicates that phosphorous fertilizer application at 112 kg P_2O_5 ha^{-1} is not economically sound. High increase rate in gross margin at 75 kg P_2O_5 ha^{-1} was found in VC 27-68A and V 41-52. This is due to result of high increase rate of seed yield of these varicties at 75 kg P_2C_5 ha^{-1}. Besides, increasing variable cost from 56 to 75 kg P_2O_5 ha^{-1} is not much when compared with increasing gross revenue between these two levels (Table 24). As a result, return to labor has high rate of increase at this level, 75 kg P_2O_5 ha^{-1}. In terms of return to capital, high increase of gross margin at 75 kg P_2O_5 ha^{-1} especially in V 41-52 kept return to capital high.

Together with economic consideration of different treatments in this study, experimental average seed yield was higher than the average seed yield obtained in field survey, even local variety. Average yield of mungbean in both two villages is 520 kg ha^{-1} which is lower than 1535 kg ha^{-1} of variety Lang with application at 75 kg P_2O_5 ha^{-1} in the experiment (Figure 5.8). This is considered as a fertilizer application gap in general and phosphorous fertilizer and lime application gap in particular. Obviously, even application of lime and other chemical fertilizers excepting phosphorous fertilizer will give higher in seed yield than average seed yield in field survey (Table 5 and Figure 5.8). Therefore, there are some selections to invest fertilizer application by different levels of capital. To moderate and poor farmers, it is recommended to apply phosphorous fertilizer at 56 kg P_2O_5 ha^{-1} including other chemical fertilizers for high mungbean yield. To better-off farmers, it is recommended to apply at 75 kg P_2O_5 ha^{-1}. However, at such the phosphorous fertilizer application i.e. 56 and 75 kg P_2O_5 ha^{-1} using VC 27-68A and V 41-52 is necessary to get high benefit.