CHAPTER V
DISCUSSION

1. Yield

1.1 Growth

It was found from the experiment that phosphorus had a positive influence on growth of the studied sugarcane cultivars, i.e. K 90-112, K 86-161 and Phil 66-07. Without phosphorus application, dry matter, crop growth rates and leaf area index of the three cultivars were low as compared to those applied with phosphorus at three various rates. The result supports the work of Martin *et al.* (1997a) who reported that sugarcane dry matter and leaf area index increased whenever more available phosphorus was present in soil. Thus sugarcane crop without phosphorus application had lower leaf area index as compared to the one with phosphorus application. The reason for this could be because leaf area is the photosynthetic apparatus of plant, playing an important role in productivity (Perumal, 1995a).

Reduction of leaf area index resulted in reduction of crop photosynthesis, and hence the productivity. Furthermore, dry matter and crop growth rate of sugarcane declined when there was no phosphorus.

Phosphorus plays an important role in growth and metabolism processes. Phosphorus deficiency leads to reduced metabolism rate and photosynthesis (Terry and Ulrich, 1973). Phosphorus is also an important composition of cell, therefore phosphorus deficiency reduces cell division and growth (Sooksathan, 1976).

With application of 25, 35 and 45 kg of TSP per rai, it was found that leaf area indices were higher than control (without phosphorus treatment). Consequently, there was more leaf area for photosynthesis and growth.

The response of phosphorus in the three cultivars studied was similar. Out of the three cultivars, Phil 66-07 had highest growth rate and dry matter, followed by K 86-161 and K 90-112, even though there were no differences in leaf area indices. This may imply that Phil 66-07 was more efficient in photosynthesis.

When plant is deficient in phosphorus, leaf area duration is reduced. Phosphorus is a mobile nutrient normally translocating from mature leaves to young leaves under phosphorus deficiency. Therefore, leaf area duration is less and had shortened time of photosynthesis. With higher leaf area duration, leaf can photosynthesize at higher rate, producing more products from photosynthesis resulting in more dry matter and higher growth rate.

Even though the three cultivars had similar patterns of changes in growth rate, dry matter accumulation, leaf area index and leaf area duration with time, Phil 66-07 had maximum value for the above characters and was followed by K 86-161 and K 90-112. Such results could be mainly due to genetic variability existing among the cultivars.

To determine phosphorus deficiency, the third leaf was sampled and analysed for phosphorus content which then was compared to critical value. It was found that phosphorus contents in the third leaves of the three cultivars during 60, 80 and 100 days were found to increase with phosphorus application. Control treatments were found to have very low phosphorus contents in the third leaves varying from 0.11 to 0.13%, whereas the level of phosphorus in the treated plants ranged from 0.24 to 0.31% of dry matter. The sampling period was the period of maximum phosphorus accumulation after basal application and 70 days after planting, moreover there was high phosphorus content in leaves. The obtained results are similar to the report of Clement (1980) who used leaf sheath as index tissue for determining phosphorus level and found that phosphorus content in leaf sheath increased when more phosphorus was applied.

There was a reduction of phosphorus content as the cane matured. However, phosphorus content in index tissue of treatments with phosphorus application was still higher than the control. Phosphorus content in the third leaf is directly related to sugarcane growth i.e. during 3 – 4 months to 4 – 5 months after planting, there was high phosphorus in the third leaf and at the same period of time crop growth rate was also high. Phil 66-07 and K 86-161 at the age of 3, 4 and 5 months had phosphorus content between 0.18 – 0.22, 0.15 – 0.21 and 0.15 – 0.17%, respectively. According to Anderson and Bowen (1990), the optimum phosphorus at the age of 3 – 9 months was 0.19 – 0.32%. Lower phosphorus content than the mentioned rate would reduce the growth rate of sugarcane. From this experiment, Phil 66-07 and K 86-161 had higher growth rate and higher phosphorus content in the third leaves than K 90-112 at 3, 4 and 5 months.

1.2 Yield Components

There is a positive relationship between tillering and stalk height with phosphorus application. In control (no phosphorus), number of tillers and stalk height was significantly lower than the cane applied with phosphorus. The main reason being that deficiency of phosphorus reduces tillering ability and elongation of internodes, therefore the cane is stunted (Humbert, 1968). This is in agreement with Rahman *et al.* (1992) who reported that phosphorus application increased number of tillers, compared to cane without phosphorus application.

Effect of phosphorus to stalk height obtained from the study is similar to investigation of Tiwari *et al.* (1997) and Rattanarak *et al.* (1990) who reported that stalk height increased significantly after applying phosphorus fertilizer. Furthermore, Clement (1980) and Humbert (1968) also noted that application of phosphorus increased phosphorus content in meristematic tissue as these nutrients had the role in cell division and elongation.

There was no difference in tillering among the three cultivars. However, with application of phosphorus, K 86-161 had the highest stalks followed by Phil 66-07 and K 90-112. The effect of phosphorus to tillering and crop growth leads to number of millable stalks at harvesting. More tillers and better growth of cane result in more millable stalks to be harvested.

From the investigation, it was also found that sugarcane with phosphorus application had more number of tillers and thus number of millable stalks, compared to non phosphorus treatments. Cane with phosphorus deficiency produces less number of tillers which also mostly die before shooting above the ground (King *et al.*, 1995). Humbert (1968), Rattanarak *et al.* (1990) and Rahman *et al.* (1992) achieved the same result in their works, i.e. phosphorus application enhanced tillering and thus number of stalks and yield.

Furthermore, phosphorus has a direct effect on the growth of stalks. As discussed earlier, phosphorus plays an important role in photosynthesis. Therefore phosphorus does not only enhance tillering but also growth, as measured by dry weight accumulation of each stalk. The results from the study illustrated that stalk weight of all three cultivars increased when phosphorus was applied. The increase of stalk weight with phosphorus levels had similar pattern to those of growth, dry matter and leaf area index. The results also supports the findings of Rattanarak *et al.* (1990) and Rahman *et al.* (1992) who showed that cane stalks were heavier with increase in phosphorus application rates.

In general, cane yield is directly related to growth of cane, tillering, millable cane and stalk weight. Therefore, when phosphorus deficiency reduced cane growth, tillering, millable cane and stalk weight, as a consequence the cane yield also reduced. Cane yield is directly related to number of stalks harvested and stalk weight. This result is supported by Prasad (1976) Rattanarak *et al.* (1990) and Rahman *et al.* (1992) who reported that phosphorus had influence on cane yield, i.e. as more phosphorus was applied to sugarcane, higher yield was obtained.

1.3 Cane Quality

For the cane harvested at 10 months after planting, CCS of cane under phosphorus application was found to be higher than CCS of cane without application of phosphorus. Phosphorus is important in photosynthesis process of leaves (source) and the product, sucrose, is translocated and stored in stalks (sink). Therefore, phosphorus deficient cane has lower CCS than the normal cane. The finding of this study was supported by Rahman *et al.* (1992) and Perumal (1995b) who showed that sugarcane responded to phosphorus by having higher CCS. However, the results from the study is in contrast to the report of Prajoubmao *et al.* (1990) who showed no differences in CCS of cane with and without phosphorus application although there was a tendency of sugarcane to have higher CCS when phosphorus was applied.

The result of this study shows that sugar yields of the three cultivars were lower when phosphorus was not applied. As sugar yield is a product of cane yield and CCS, sugarcane from the control treatment having low CCS always produced low sugar yields as compared to the phosphorus treated plants. Among the three cultivars, Phil 66-07 had highest yield and CCS and consequently produced higher sugar yield and this was followed by K 86-161 and K 90-112.

Similarly, Anderson *et al.* (1996) reported that sugar yield was positively related to phosphorus application. Rahman *et al.* (1992) also reported that phosphorus application increased sugar yield significantly.

Phosphorus content in cane juice plays an important role in the process of clarification during sugar production in the factory. That is phosphate in cane juice is essential for good clarification. It has been found that the optimum requirement of phosphate is 300 – 400 ppm (Mathur, 1975).

Application of phosphorus increased phosphorus content in sugarcane juice during the course of study in all cultivars. The cultivar with highest average phosphorus in juice was Phil 66-07, followed by K 86-161 and K 90-112. Increased phosphate in juice could be due to higher application of phosphate fertilizer. This finding is similar to the reports of Perumal (1995b) who found that applying foliar phosphorus fertilizer increased the phosphorus content of cane juice significantly from 292 to 392 ppm, and Sundara (1996) reported that phosphorus content in sugarcane juice increased as available phosphorus in soil increased.

2. Nutrients in Sugarcane Parts at Harvest

From the study of phosphorus application in three sugarcane cultivars, it was found that there was no difference in content of nitrogen and potassium in leaf, leaf sheath, dry leaf and stalk from treatments with and without Phosphorus application. Application of phosphorus only increased phosphorus content in leaf, leaf sheath, dry leaf and stalk without interfering with nitrogen and potassium contents in tissues. Clement (1980) also reported that phosphorus content in leaf, leaf sheath and dry leaf increased as more phosphorus was applied. Furthermore, Perumal (1995b) also reported that spraying of phosphorus fertilizer to sugarcane leaves increased phosphorus content in leaf sheath as compared to control.