Discussion
CHAPTER V

DISCUSSION

Field experiments were conducted at farmer’s field of S. Vadipatty village of Reddiarchatram block of Dindigul District of Tamil Nadu during the late season (April - May) of 1996-97 and 1997 - 1998 to study their effect of organic and inorganic sources of N on growth and productivity of sugarcane (cv. COC 90063). The results of previous chapter are discussed in this chapter.

5.1. Influence of season on cane productivity

Weather elements play an important role in exploiting the yield potential of crop. Sugarcane being a tropical plant thrives best in hot sunny areas where temperature, light and moisture are the main factors that influence the cane yield (Humbert, 1968). A long warm summer growing season with adequate rainfall is an ideal climate for sugarcane production (Manglesdrof, 1950). Temperature ranging from 20-35 °C is optimum for growth of sugarcane. The months of May - Feb of both years during which the experimental cane was raised, is found to be the ideal planting period for late season. Total rainfall of 856.7 and 919.6 mm was received in 51 and 52 rainy days respectively for the both crop seasons. Regular rains coupled with low evaporation during the 2 - 7th week after planting favoured better germination for both the years. Even though, there was not much rain during 1996-97 arid no rain during 1997-98 during the tillering phase (i.e. From 9 to 14th and 10th to 17th week), timely irrigation supported for better tillering. In these conditions, the green manure incorporated plots withstand the dry spell and the crop performance was better, compared to other treatments (M₁ and M₂). The
high and continuous rainfall during the grant growth stage favoured better growth and
development especially in the green manure incorporated plots during both the crop
seasons, which was reflected in the final yield.

The temperature during grand growth stage was 30-35 °C and sunshine hours
was also ranged from 7 to 8 hours per day, which was favourably acted upon the dry
matter production during both the years. The rainy season continued up to 36th week of
growth i.e. during maturity stage of the crop, therefore the quality parameters were
comparably better in period to the second season i.e., 1997-98. The rain was totally
absent beyond 34th week of crop growth during 1997-98. This dry weather with cool
night temperature favoured the sugar accumulation in cane during the second season.

5.2. Effect of organic and inorganic sources of N on cane growth characters

5.2.1. Germination

Germination is a critical process in the life of cane plant. Good and early
germination results in good start and provides healthy basis for an safe and higher
yielding crop.

In this study, better cane germination of 83 per cent was observed on completion
of germination phase. In general, the germination was not significantly influenced either
under green manure incorporation or under pure crop system. It clearly indicated that
intercrops did not affect the germination of cane and this was due to low intercrop canopy
during the early stages, not sufficient enough to obstruct the sprouting of cane buds.
Similar observations were made by Yadav *et al.* (1987) and Jayabal (1988).
Tillering is an important phase in the physiology of sugarcane. Synchronized production of appropriate number of tillers and greater survival is essential for obtaining required optimum number of millable cane at harvest (Fig. 3). Tiller production and its survival capacity indicate the degree of competition which an intercrop offers to the cane crop. In this study, among the organic manures, tiller production was higher under 100 per cent FYM (M₁) whereas the number of tillers got reduced under green manure intercropping system (M₃ and M₄).

Tiller reduction in intercropping system is more a function of light intensity. The apical dominance is controlled by auxins like indole - acetic acid moving towards lower buds. Under increased light intensities the down ward movement of growth regulating substances diminishes. Hence the rate of elongation of stem slow down and the degree of bud incubation decreases resulting in production of tillers. When light intensity is reduced the reverse reaction takes place. Ultimately, the production of tillers is reduced.

The survival capacity of tillers was much lower under 50 per cent FYM with sunnhemp intercropping. This may be due to the fact that increasing availability of sunlight after the incorporation of green manure at 45 DAP.

Higher and prolonged availability of N place a vital role in influencing the initiation, development and maintenance of tillers in sugarcane. As protein synthesis is more during this phase, N application provided congenial nutrient environment during the period. Number of tillers and survival capacity were more under 100 per cent N + Azospirillum. Increased and continued supply of N under this treatment paved the way
Fig. 3. Effect of organic and inorganic sources of nitrogen on tiller population
for a progressive build up of N availability in the soil and also facilitates increased innate capacity of plants for tillering and concomitant decrease in tiller mortality. This results are in accordance with the findings of Yadav (1991).

5.2.3. Plant height

Higher the plant height will be the individual cane weight and indicated a measure of final yield. The treatments involving 50 per cent FYM + Sunnhemp inter cropping and 100 per cent + *Azospirillum* produced taller canes at all the stages. This might be due to the addition of organics which improved the soil physical, biological conditions which would have facilitated for better availability and absorption of plant nutrients from the soil and also water retaining and favourable environment for root development, augmenting the absorption of nutrients by which it increased the plant height. Nambiar and Ghosh, 1984 and Buragohain (2000).

5.2.4. Leaf Area Index (LAI)

LAI is also the important factor influencing on the growth of the plants in terms of foliage production in relation to ground area coverage and is an indication of assimilation as well. Application of 50 per cent FYM + sunnhemp intercropping significantly increased LAI as compared to other organics. This could be ascribed to the fact that the cane crop was applied with sufficient quantity of nutrients to enable it to put forth its activities satisfactorily. This was in conformity with results obtained by Mahendran (1994).

Leaf Area is directly proportional to the amount of fertilizer N applied to sugarcane. Sundara (1985) reported that higher dose of N resulted in more leaf area due to enhanced tiller density and higher leaf number. This was also confirmed in the present
study, where higher LAI was associated with 100 per cent N as compared to 75 and 50 per cent N. The better utilization of N in the early stages resulted in higher leaf area and higher LAI (Panda and Rao, 1991). At the harvest, LAI was reduced in all the treatments due to the fact that translocation of the photosynthates for the growth of economic part.

5.2.5. Dry Matter Production (BMP)

Dry mater at harvest had a positive influence on cane yield. In this present investigation, the results revealed that higher DMP at harvest was observed under 50 per cent FYM + sunnhemp (Fig. 4). The increased DMP was contributed by the efficient assimilation and absorption of nutrients (Van Dillewijn, 1952).

Higher level of N enhanced the DMP in both the years of study. Increased N with split application and subsequent fixation of N by *Azospirillum* increased the N availability in the soil and was more efficiently utilized for the dry matter accumulation. Sundara (1985) and Stephen Arul (1992) also reported similar results.

5.3. Influence of organic and inorganic sources of N on growth analysis of sugarcane

Crop growth rate (CGR) and net assimilation rate (NAR) were at peak between 180-270 DAP while relative growth rate (RGR) was at the peak between 90-180 DAP. The treatments involving 50 per cent FYM + sunnhemp intercropping and incorporation and 100 per cent N + *Azospirillum* exerted a positive higher rate of growth, as this treatment recorded increased LAI, Plant height and DMP. This was in confirmation with the findings of Mahendran (1994).
Fig. 4. Effect of organic and inorganic sources of nitrogen on dry matter production
Millable cane production is an important yield attribute determining the ultimate cane yield in sugarcane. Survival of tillers to develop into millable canes had a greater influence for higher cane yield. The number of millable cane also had higher and positive correlation of 0.98 with the yield. The results from this study clearly indicated that 50 per cent FYM + sunnhemp intercropping increased the millable cane population to a maximum extend (Fig. 5). This was due to better and increased conversion of tillers into millable canes during both the years. Sathyavelu et al (1981) and Nasir Ahmed (1999) had observed that intercropping of sunnhemp as green manure in the standing crop of sugarcane had an adverse effect on tiller production but increased the number of millable cane which intum increased cane yield.

Higher dose of N combined with biofertilizers enhanced the millable cane population at harvest. This could be achieved by higher tiller population and better uptake and utilization of plant nutrient efficiently. Yadav et al. (1987) informed that higher N dose is beneficial for maintaining higher density of canes. Increasing number of millable cane population with increasing N level was reported by Sathyavelu et al. (1991).

The experimental findings also throws light on the subject that increased production of tillers need not necessarily result in increased number of millable canes. On the other hand, optimum level of tiller production is sufficient to give more millable canes at harvest due to less interplant competition and more survival capacity.
Fig. 5. Effect of organic and inorganic sources of nitrogen on millable cane
5.4.2. Millable cane length

Cane elongation was very much influenced by organic and inorganic sources of N. Longer millable canes were harvested from the plots supplied with 50 per cent FYM and sunnhemp intercropping and incorporation at 45 DAP. The increased cane length under sunnhemp and daincha would have been due to improved supply of plant nutrients particularly N from the decomposed organic matters and the N fixation by root nodules. The complementing competition during the early growth phase resulted in increased cane height which was sustained latter with less inter plant competition under increased plant nutrient availability. Similar increase in length of millable cane was also observed by Verma et al. (1981) under cane + garlic and cane + tobacco intercropping system.

Application of 100 per cent N + Azospirillum (S2) resulted increased millable cane length as compared to 75 per cent and 50 per cent N. This observation is in accordance with the finding of Yadav and Prasad (1986).

5.4.3. Individual cane weight

Individual cane weight is a function of leaf area, number of internodes and length of millable cane in addition to better assimilation rates. Sugarcane dry matter at formative and grand growth phase contribute to the individual cane weight at harvest.

The experimental results showed that individual cane weight increased under 50 per cent FYM + sunnhemp intercropping (M4) (Fig. 6). Increased cane weight under this treatment was the result of increased cane length and girth of the cane. It is also evident from correlation analysis that girth of sugarcane had shown higher positive correlation than length of cane. Intercropping of sunnhemp in sugarcane and incorporation produced
Fig. 6. Effect of organic and inorganic sources of nitrogen on individual cane weight
only optimum tillers which in turn helped to reduce the inter plant competition and thus created a congenial atmosphere for better utilization of available plant nutrients in an efficient manner. In addition, green manure also contributed sizable quantity of N through atmospheric N fixation. And also green manure intercropping and incorporation increased the available NPK during the critical phase of the crop and resulted in a vigourous stand which in turn helped to attain heavier canes at harvest.

Nitrogen had a greater influence in increasing cane weight in both the years. Application of 100 per cent N recorded spectacular difference in single cane weight over 75 and 50 per cent N. Application of 100 per cent N with *Azospirillum* facilitated several beneficial factors *viz.*., increase in crop growth, vigour, enhanced availability of N in the soil and consequent greater uptake, led to greater production of photosynthates and its mobilities into cane stalks. This is in line with the findings of Kannappan (1982) and Chavan *et al.* (1985),

5.5. Effect of organic and inorganic sources of N on cane and sugar yield

For sugarcane where the economic product is a green vegetative part, it is absolutely essential to have an optimum dose of N supply for higher productivity. In this study, application of 50 per cent FYM + sunnhemp intercropping and incorporation (M₄) resulted in significantly the highest cane yield in both the years (Fig. 7). Higher cane yield under green manure intercropping and incorporation on 45 DAP was mainly due to optimum tiller production and better survival capacity of tillers which resulted in more number of millable canes, increased cane length, girth and weight, Among different yield attributing characters number of millable cane ha⁻¹ had the highest correlation value. The better performance of cane yield attributes were due to the increased supply of plant
Fig. 7. Effect of organic and inorganic sources of nitrogen on cane yield
nutrients to the soil system by the incorporation of sunnhemp biomass which in turn enhanced the availability of N, P and IC in the soil system. Higher biomass accumulation by sunnhemp intercropping added more N to the plots. This condition increased the plant uptake was increased and resulted in the increased cane yield. This was in conformity with the earlier findings of Rao (1990) who reported that green manure application to cane crop increased the availability of NPK from the soil favouring more uptake by cane which in turn increased the cane yield.

The cane and sugar yield in 50 per cent FYM + vermicompost applied (M2) plots were comparatively lower than the green manure incorporated fields during both years. The reason for low yield may due to the use of very little quantity of vermicompost (1.5 t ha⁻¹) compared to other organic manures. This fact was in conformity with Kale et al. (1992) who informed that vermicompost should be used in bulk quantities like other manures for achieving fruitful results.

In the present investigation, the beneficial effect of recommended level of N with Azospirillum was well established. This treatment registered higher cane yield but comparable with 100 per cent N and 75 per cent N + Azospirillum. Nitrogen application at 100 per cent level along with Azospirillum provided a congenial environment which reflected on higher DMP, It also favoured the production of millable cane, cane weight which in turn resulted in cane yield. Similar effect of 100 per cent N increasing cane yield was reported by Rangiah et al. (1988), Rajaram and Srinivas (1986), Manoharan et al. (1991).
5.5.2. Sugar yield

Sugar yield is a function of cane yield and CCS per cent. Organic manures had a significant influence on sugar yield. Fifty per cent FYM + sunnhemp recorded the highest sugar yield of 16.49 and 16.93 t ha\(^{-1}\) during 1996-97 and 1997-98 respectively. The lower yield of sugar was obtained with 50 per cent FYM + vermicompost application (M\(_2\)) during both the years (Fig. 8). The results are in conformity with the findings of Nasir Ahmed (1999).

5.6. Effect of organic and inorganic sources of N on quality character of sugarcane

Climatic factor prevailed during maturity stage of the year 1997-98 with favourable weather condition influenced the quality of the second year crop towards the higher side. The cane quality parameters like brix per cent, sucrose per cent purity coefficient and commercial cane sugar per cent was not significantly influenced by various treatments during both years (Fig. 9). Similar findings were reported by Yadav et al., (1987), Mahendran (1994) Kumarasamy and Rajasekaran (1994) and Vijay Kumar et al (1999). However, numerically different values of the above said characters were registered. The highest sucrose, brix and CCS per cent were registered by 50 per cent FYM + sunnhemp incorporation (M\(_4\)) at 45 DAP during both the years.

Nitrogen is an important element deserving special focus for promoting the cane growth. The increased dose of mineral nitrogen in enhancing the tissue moisture status resulted in the reduction of quality parameters. In this study, the balanced and integrated use of N with biofertilizers could prove advantageous in maintaining the cane quality.
Fig. 8. Effect of organic and inorganic sources of nitrogen on sugar yield
Fig. 9. Effect of organic and inorganic sources of nitrogen on Juice quality
without any significant differences in the quality parameter like brix, sucrose, CCS per cent and purity co-efficient. The highest per cent of brix and sucrose were observed in 100 per cent N + *Azospirillum*.

The CCS per cent was also higher in the 50 per cent FYM + sunnhemp incorporated (M₄) plots during both the years. This might be due to the increased mean sucrose content of 19.61 and 19.73 in the juice with an increase in the level of organic manures (FYM + green manure) during 1996-97 and 1997-98 respectively.

This was in conformity with the findings of Ramalingaswamy *et al.* (1996) and Kathiresan and Manoharan (1999).

Sugar yield was significantly influenced by the N levels with and without *Azospirillum*. The higher sugar yield of 16.67 t ha⁻¹ recorded in 100 per cent N + *Azospirillum* (S₂) and lower sugar yield of 14.36 t ha⁻¹ was obtained in 50 per cent N without *Azospirillum* (S₅), during 1996-97. The 100 per cent N without *Azospirillum* (S₁), 75 per cent N without *Azospirillum* (S₃) and 75 per cent N with *Azospirillum* (S₄) were on par with one another. The same trend was observed in 1997-98 also. However, the highest sugar yield of 17.71 and the lowest yield of 14.70 t ha⁻¹ was recorded in S₂ and S₅ respectively. This result was in line with findings of Kumar and Hunsigi (1997) and Navale *et al.* (1995).

5.8. Effect of organic and inorganic sources of N on plant nutrient uptake

The uptake of nutrients by the crop is greatly influenced by the form and availability of N in the soil apart from the favourable soil moisture condition. The increased nitrogen uptake of 235.27 kg ha⁻¹ with 50 per cent FYM + sunnhemp
incorporation at 45 DAP ($M_4$). This increase was 9.06 and 15.09 higher than the 100 per cent FYM alone ($M_i$) and 50 per cent FYM + vermicompost ($M_2$) applied plots respectively during 1996-97. The similar trend was also observed in N uptake during 1997-98. The highest N uptake of 237.26 kg ha$^{-1}$ was recorded in $M_4$ and the increase was 7.81 and 14.36 per cent more than $M_i$ and $M_2$ respectively. Both years the gap in uptake of N between 50 per cent FYM + daincha incorporation $M_3$ and $M_4$ was only meagre (i.e., 2 per cent during both the years) (Fig. 10).

This could be ascribed to the fact that incorporation of sunnhemp increased the N availability continuously and steadily throughout the crop period without much losses, resulting in more uptake. This observation is similar to the findings of Shankaraiah et al. (1999) and Jayapaul et al. (2000).

Similar trend in phosphorus uptake also observed during both the years. The higher uptake 75.36 and 77.16 kg ha$^{-1}$ of phosphorus was recorded in 50 per cent FYM + sunnhemp ($M_4$) during 1996-97 and 1997-98 respectively. The lowest uptake of phosphorus was observed in 50 per cent FYM + vermicompost ($M_2$) during both the years.

In N levels with and without Azospirillum 100 per cent N + Azospirillum (S2) recorded the highest uptake of phosphorus during both the years. The uptake in 100 per cent N alone ($S_1$), 75 per cent N alone ($S_3$) and 75 per cent N + Azospirillum ($S_4$) were on par with $S_2$. 
Fig. 10. Effect of organic and inorganic sources of nitrogen on NPK uptake
The highest physical quantity of uptake among the major nutrients was recorded in potassium. The highest quantity of 405.95, 404.92 kg ha\(^{-1}\) were estimated in the 50 per cent FYM + sunnhemp incorporated (M\(_4\)) plots during 1996-97 and 1997-98 respectively. Followed by M\(_4\), the 50 per cent FYM + daincha incorporation (M\(_3\)) registered the next higher potassium uptake during the year. The 100 per cent FYM (Mi) plot and 50 per cent FYM + vermicompost (M\(_2\)) plots showed on par status in the potassium uptake during both the years. The differences in the potassium uptake was significant during both the years.

Among the N levels and *Azospirillum* application, the 100 per cent N + *Azospirillum* (S\(_2\)) had significantly higher potassium uptake followed by 75 per cent N + *Azospirillum* (S\(_4\)). They are significantly on par during both the years.

5.9. Effect of organic and inorganic sources of N on post harvest soil sample

The organic manures did not much influence the soil pH and EC during both the years. However, significant change was observed in soil N, P and K availability after harvest during both the years. The highest N and K availability was observed in 50 per cent FYM + sunnhemp where as the highest P availability was noticed in 50 per cent FYM + vermicompost application followed 50 per cent FYM + daincha during 1996-97 and 50 per cent FYM + daincha in 1997-98 (Fig. 11). Similar findings were made out by Singh (1964), Jadhav (1996), Yadav (1984) and Nasir Ahmed (1999).

The inorganic nitrogen with and without *Azospirillum* did not much influence the N and P content after harvest. However, the K availability had significant difference in the soil after harvest during both the years.
1996-97

1997-98

Fig. 11. Effect of organic and inorganic sources of nitrogen on post harvest NPK
5.10. Effect of organic and inorganic sources of N on economic analysis

Intercropping and incorporation of sunnhemp at 45 DAP in sugarcane with addition of 50 per cent of the recommended FYM recorded a higher gross and net income as compared to the same quantity and method of application of daincha, 1.5 t of vermicompost with 50 per cent FYM and 100 per cent FYM. The yield and the reduced cost on transport etc., were main reasons for the higher returns obtained in this treatment (Fig. 12 and 13). Higher cane yield under 100 per cent recommended N with *Azospirillum* did not reflect on economics. Applications of 50 per cent FYM + sunnhemp and 100 per cent N + *Azospirillum* though produced higher cane yield not reflected in B: C ratio as 75 per cent N + *Azospirillum* registered higher B: C ratio. This may be due to saving in N at this level resulted in higher net return and B:C ratio.
Fig. 12. Economics of sugarcane production during 1996-97
Fig. 13. Economics of sugarcane production during 1997-98