Comparative Study of Methods of Planting, Varying Plant Densities, Graded Levels of Nitrogen and Maintenance of Tillers on the Growth, Yield and Quality of Seasonal Sugarcane (*Saccharum officinarum* Linn.) cv. Co. 740

By

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M. S. (U. S A.)

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for the degree of

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in

Agronomy

COLLEGE OF AGRICULTURE
KOLHAPUR 416005.
MAHARASHTRA, (INDIA)

1984

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Dedicated
to

Abasaheb Shinde

My late brother
whose blessings
have been an
eternal bliss
to me

CANDIDATE'S DECLARATION

I hereby declare that this thesis or part thereof has not been submitted by me or other person to any other University or Institute for degree or diploma

(Appasaheb G. Shinde)

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Dated : 18.10.1992

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CERTIFICATE

This is to certify that the thesis entitled, "Comparative study of methods of planting, varying plant densities, graded levels of nitrogen and maintenance of tillers on the growth, yield and quality of seasonal sugarcane (Saccharum officinarum Linn.) cv.CO.740", submitted to the Mahatma Phule Agricultural University, Rahuri, for the award of the degree of DOCTOR OF PHILOSOPHY in AGRONOMY, embodies the results of a bona fide research carried out by Shri Appasaheb G. Shinde under the guidance of Dr. N.K. Umrani, Chief Scientist, All India Co-ordinated Research Project for Dryland Agriculture, Solapur, Maharashtra State, and that no part of the thesis has been submitted for any other degree or diploma.

Kolhapur,
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(R.G. Patil)

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LIST OF ABBREVIATIONS

ha	.....	Hectare(s)
g	.....	Gramme(s)
kg	.....	Kilogramme(s)
t	.....	Tonne(s)
cm	.....	Centimetre(s)
dm	.....	Decimetre(s)
m	.....	Metre(s)
mm	.....	Millimetre (s)
l	.....	Litre(s)
°C	.....	Celsius
Rs.	.....	Rupees
%	.....	Percentage
@	.....	At the rate of
i.e.	.....	That is
e.g.	.....	For example
et al.	.....	And others
etc.	.....	And so forth
viz.	.....	Namely
Fig.	.....	Figure
F.Y.M.	.....	Farm yard manure
N	.....	Nitrogen
P_2O_5	.....	Phosphoric acid
K_2O	.....	Potash
L.A.I.	.....	Leaf area index
A.G.R.	.....	Absolute growth rate
C.C.S.	.....	Commercial cane sugar
N.R.	.....	Net rendiment
Sigt.	.....	Significant
N.S.	.....	Not significant
S.E.	.....	Standard error
C.D.	.....	Critical difference
Co.	.....	Coimbatore
cv.	.....	Cultivar

ABSTRACT

COMPARATIVE STUDY OF METHODS OF PLANTING, VARYING PLANT DENSITIES, GRADED LEVELS OF NITROGEN AND MAINTENANCE OF TILLERS ON THE GROWTH, YIELD AND QUALITY OF SEASONAL SUGARCANE (Saccharum officinarum Linn.) cv. CO. 740

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Research Guide : Dr. N.K. Umrani

An agronomic investigation was carried out at the Regional Sugarcane and Jaggery Research Station, Kolhapur, Maharashtra State (India) during the year 1979-80 and 1980-81 to find out the effects of methods of planting, plant densities, levels of nitrogen and maintenance of tillers on the growth, yield and quality of seasonal sugarcane. The experiment was laid out in confounding split plot design with two replications. The main plot treatments consisted of combinations due to three methods of planting, three plant densities and three levels of nitrogen. The sub-plot treatments were maintenance of tillers at light earthing. In the year 1981-82, the sub-plot treatment of maintaining tillers was modified and tillers were maintained beyond light earthing. The gross plot size of individual treatments was 12 x 5 m^2, while the net harvested plot size was 10 x 3 m^2. The soil of the experimental field was alluvial clay in texture, medium in total nitrogen, available P_2O_5 and K_2O; and was almost neutral in reaction during the period of experimentation. All the growth phases enjoyed congenial climatic conditions which helped in luxuriant growth, yield and quality of cane during the period of investigation.

The germination percentage at 8th week was the highest in single budded sett planting while the tillering ratio as well as number of shoots/ha was the highest in transplanting of settling. The leaf area and L.A.I. values so also the dry matter accumulation and growth rate was of higher order with the conventional method of

(Contd....)

three-budded sett planting during both the seasons. Similarly, important growth attributes like total and millable height, girth and number of internodes of cane were more in this system of planting. Shoot mortality recorded in this method was the lowest.

As a resultant effect, the per cane weight was highest in three-budded sett planting, exhibiting its superiority over the rest of the methods. Though the number of millable canes was the highest in settling planting than rest of the methods during both seasons, the single and three-budded sett planting methods surpassed the latter producing significantly more cane and sugar yield. Three-budded sett planting method also exhibited its superiority in periodical maturity studies viz., Brix, sucrose, purity and N.R. Similar was the trend of quality of juice at harvest.

The germination was found increased with decrease in plant density. Similarly the tillering ratio was wider in lower density and narrowed progressively with increase in the plant density. The shoot number increased progressively with increasing plant density. The leaf area and L.A.I values were higher in the lowest density during entire growth and at harvest stage so also the rate of dry matter accumulation and total dry matter per plant.

The plant height both the total and millable and the number of internodes increased with increase in plant density while the girth of cane exhibited reverse trend. The number of millable canes was found increased with increased plant densities, during both the years. The mortality of shoots was more in higher plant densities and the per cane weight was the highest in the lowest plant density. The yield of cane and sugar was found increased with increase in plant density and was the highest with 75 x 10^3 buds/ha (the highest density tried). The cane yield was 104.249 and 106.796 t/ha during first and second year of the experimentation, respectively. It was also the highest with the same plant density during third year (110.090 t/ha).

The values of Brix, sucrose and purity percentage in juice and N.R. were increased with increasing plant

(Contd....)

density during periodical maturity studies and at harvest. Similarly, the uptake of nitrogen was more with increasing level of plant densities.

The tillering ratio and number of shoots/ha progressively increased with increased levels of nitrogen so also leaf area and L.A.I. The total dry matter accumulation and A.G.R. in terms of dry matter at various stages of crop growth and at harvest, plant height both total and millable, girth of cane and number of internodes were increased with increase in the level of nitrogen. The differences in the shoot mortality were not conspicuous due to levels of nitrogen.

The individual cane weight also increased with the increase in the level of nitrogen and the same recorded with 250 kg N/ha (the highest nitrogen level tried) was the highest and significantly more than 150 kg N/ha. The number of millable canes was significantly more with the application of 200 and 250 kg N/ha than 150 kg N/ha during both the years of experimentation. The cane yield per hectare increased significantly with increasing levels of nitrogen during 1980-81 and when the data were pooled over seasons. While, the same was at par with 200 and 250 kg N/ha during 1979-80 and 1981-82, however, it was significantly more than 150 kg N/ha.

The periodical juice quality studies from 270 days onwards till harvest as judged in terms of Brix, sucrose and purity percentage of juice and N.R. indicated that increasing level of nitrogen lowered the values of these attributes. The removal of nitrogen was increased significantly with increasing level of nitrogen.

Uncontrolled treatment i.e. allowing all the tillers to develop was superior during both the years, in respect of tillering ratio and number of shoots, while the effects of maintenance of tillers were not conspicuous in the case of leaf area, L.A.I. values, dry matter accumulation, total and millable plant height and number of internodes.

Maintenance of tillers, however, by and large, increased girth of cane and individual cane weight. Though the shoot mortality was more in uncontrolled treatment

(Contd....)

during both the years, the ultimate number of millable canes was more resulting in significantly higher cane and sugar yield than the maintenance of tillers up to and beyond light earthing.

The quality parameters viz., Brix, sucrose and purity percentage of juice and N.R. recorded periodically and at harvest were found slightly favoured by controlling of tillers. The uptake of nitrogen and efficiency of utilization was more in uncontrolled treatment resulting in significantly higher number of millable canes and cane yield.

The simple economics of fertilizer use for sugarcane showed higher rate of profitability even at 250 kg/ha nitrogen level. The benefit cost ratio based on the valuation of production and cost of nitrogen worked out as 29.35, 23.21 and 19.87 at 150, 200 and 250 kg/ha nitrogen level, respectively.

Thus, three-budded sett planting with 75 x 10^3 buds/ha, application of 200 to 250 kg N/ha and maintaining all the tillers is beneficial package of practice for seasonal cane under flood prone conditions of Kolhapur region to obtain higher cane and sugar yield with reasonably higher quality juice.

INTRODUCTION

1. INTRODUCTION

Sugarcane (Saccharum officinarum Linn.) is the pride of Maharashtra State and plays a vital role in the agricultural economy of the state. In the year 1981-82, the area under sugarcane in India was 3.19 million hectares with cane production of 183.65 million tonnes and sugar 8.73 million tonnes. The corresponding figures for Maharashtra State were 0.30 million hectares area under sugarcane, 28.78 million tonnes of cane and 3.02 million tonnes of sugar. The average cane yield per hectare in Maharashtra is 92.15 tonnes as against 52.06 tonnes for India, with per cent recovery of 10.65 and 9.66, respectively, indicating that Maharashtra is important state in India, in respect of cane yield and recovery (Anonymous, 1983 a). The sugar industry has come to stay as the foremost agro industry in the state and stands second amongst the agro-based industries in the Indian Union. However, there is scope to increase the productivity per unit area when compared to other countries like Hawaii and Peru (220 and 150 tonnes per hectare, respectively). This indicates that the sugarcane crop has high yield potential and suggests that suitable agronomic techniques need to be developed to enhance the existing productivity level of this crop.

It has been estimated that the population of the

country will be around one billion by the turn of the century and the total sugarcane needed to provide sugar and jaggery needs of the population at the existing rate of growth, will be 300 million tonnes by 2000 A.D. (Thuljaram Rao, 1980). Considering also the need to increase production of other crops like oil seeds and pulses, there is a little scope to increase area under sugarcane. The way out, therefore, would be to maximise the productivity per unit area per unit time.

The appropriate methods of cultural practices leading to higher yields and better sugar contents in a cane variety are important factors. The industry has always looked for better quality while the growers for higher cane yield. It is difficult to combine these in a variety. The need for exploring alternative methods for improving both the yield and quality is, therefore, obvious.

Day by day, the cost of cultivation in sugarcane on increase due to the increase in seed, input and labour cost. In recent years, therefore, accent is given on reducing the cost of cultivation by way of economy in seed by the use of single bud either direct or transplanting thirty days old settlings. The method has been found to be successful. A new technique called STP (spaced transplanting) has been developed at I.I.S.R.,

Lucknow, which minimises the input levels and suits farmers with small holdings. This method enables the crop to make the best use of solar radiation. Substantial quantity of seed cane is being used in commercial cane crop. By this new technique there is considerable saving in seed material. The traditional method of sugarcane planting (three-budded setts) requires nearly eight tonnes of seed material as against 3 t/ha in STP. Thus, there is saving of more than five tonnes of seed material per hectare. Inter-plant competition and unevenly distributed solar radiation in conventionally raised sugarcane crop tends to reduce tillering and results in higher mortality, thereby adversely affecting stalk density and finally the cane yield. An improved crop geometry through proper spacing of plants by means of spaced planting or transplanting method is thus crucial for increase in productivity. Considering this, an amelioration technology "spaced planting or transplanting" technique for sugarcane crop has been developed and tested in the field. The trials conducted in the tropics included northern Karnataka and those in the sub-tropics included Haryana, Uttar Pradesh and Bihar. It has been reported that this technique minimises the input cost and is suited to farmers with relatively small holdings (Srivastava, et al., 1981). This new technology needs to be tested in comparison with conventional method (three-

budded setts) and single budded setts planting under flood prone area of Kolhapur region.

Several experiments have been conducted at all research stations, periodically and repeatedly on seed rate and spacing. Now, it is the time for economising cultivation expenses, using low cost technologies wherever possible without losing productivity. High seed rate is indicative of negligence on the part of the farmer to pay adequate attention in the selection of seed material. Low seed rate and optimum spacing between cane rows would lead to better utilization of sunlight by avoiding overcrowding and undue shading of leaves with more tillers and thicker canes per clump.

Sugarcane plants growing more closely in the row, under field conditions, develop keen competition. There is enough evidence to show that the widely spaced crop not uses sunlight efficiently. The wide spacing also results in better root training ultimately using the resources.

Manuring is one of the most potent factors to step up yields of sugarcane and forms a major item in its cost of cultivation. In cultivation of sugarcane, expenditure on manuring works to about 30 to 35 per cent of the total cost of cultivation. Of all fertilizer nutrients, weight for weight, nitrogen produces the highest yield response

to sugarcane. Perhaps this is the reason why average cultivator is tempted to use this fertilizer indiscriminately. Extensive research have been conducted on practically all aspects of nitrogen fertilization at the different state sugarcane research stations. As a result of these studies, fairly comprehensive recommendations about the use of nitrogen have been formulated and the extension agencies have taken up many of these recommendations suited for their respective regions leading to a considerable increase in the yield of sugarcane(Srivastava, 1971). There has been little realisation, however, that in extending such recommendations a more rational approach is needed in understanding the fertilizer needs of the crop so that maximum yield of cane and sugar results from the applied nitrogenous fertilizer.

Quality of the produce is as important as the yield and especially so in a crop like sugarcane, where the raw material has to be further processed into sugar and jaggery before final use. No doubt the sucrose content of cane is known to be mainly a varietal character but many other factors including nitrogen fertilization have also been observed to play a vital role in this respect (Singh and Singh, 1954). Recent trials have indicated that supply of nitrogen in small amounts results in lower cane and sugar yields per hectare, while the supply of more than the

required quantity results in poor juice quality. Hence proper balance is to be struck for nitrogen fertilization. A recommended nitrogen level for seasonal sugarcane crop in Kolhapur region is 250 kg/ha. However, it is felt essential to ascertain a level of nitrogen with new technique of planting and different plant densities by controlling tillers.

In sugarcane, tillering is an important phase in crop growth, not only in respect of contributing to stalk population at harvest, but also in affecting final yield and quality of the crop. Any deterrant to tillering is liable to affect the tonnage adversely. Basically, tillering is a function of genotype, nitrogen, water and radiation. Tillers in early formative growth phase may exceed 3 to 3.5 lakhs per hectare, but the ultimate number of stalks that come to harvest is never more than one lakh per hectare. Mortality under high seed rate and initial high population mean waste of inputs such as seed material, irrigation water and applied fertilizer.

Management techniques are considered equally important. Maintenance of population and allowing only specified tillers to develop into millable cane are to name a few. It is experienced that in sugarcane the tiller number increases enormously reaching ratio of 1:6 (eye bud:tiller). The ratio of millable cane to eye buds

planted is only 1.2:1. Thus, lot of resources are wasted by enormous tiller growth. It is considered essential to maintain a specified number of tillers, to develop into good millable cane.

A very high initial population only results in an unhealthy competition between the crowded sprouts. This struggle has a crippling effect even on the survivors and the survivors never completely recover from this initial set-back (Muthukrishnan, 1979).

Sugarcane tillers profusely and plant population reaches maximum by the time of final earthing, after which it starts dwindling down. Yield of cane depends very much upon the production and survival of early formed tillers. Higher survival of early formed tillers are able to develop fully during the following 'grand period' of growth which results in increased cane production. It is observed that most of the millable stalks are formed out of the mother shoots of the second order and the late formed shoots, principally composed of the third order shoots, mostly remain immature or die prematurely (Dillewijn, 1952 and Arakeri, 1956). Based on the above concept, it is necessary to study how far de-tillering is helpful in keeping down the late formed tillers at known and desired level and thereby increasing the cane yield and juice quality.

With these considerations in view, the present investigation was planned on comparative study of methods of planting, varying plant densities, graded levels of nitrogen and maintenance of tillers on growth, yield and quality of seasonal sugarcane variety Co.740, at the farm of Regional Sugarcane and Jaggery Research Station, Kolhapur (Maharashtra) during 1979-80 and repeated on similar lines for confirmation in 1980-81 and 1981-82. An account of the investigations carried out is presented in the following chapters.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

Sugarcane is an important cash crop in India in general, and Maharashtra in particular. Research on sugarcane dates back to more than 50 years in Maharashtra. Innovating farmers have also tried different systems, methods, etc. on their fields. Very high level of fertilizer is also adopted by some of the farmers. However, studies combining response to nitrogen levels with methods of planting, plant densities and maintenance of tillers, which are the important factors responsible for high yields are limited. Relevant literature on research work done on the effect of methods of planting, plant densities, levels of nitrogen and maintenance of tillers on growth, yield and quality of sugarcane, grown in different states of India and abroad has been reviewed in this chapter under appropriate headings.

2.1 Effect of methods of planting, plant densities and levels of nitrogen on germination of sugarcane

2.1.1 Effect of methods of planting and plant densities

With an objective of reducing the cost of cultivation, in recent times, accent has been given on use of single eye bud to reduce the cost of seed material. The experience dates back some 25 years.

Kale and Deshpande (1956) while working at Ugarkhurd (Karnataka), observed comparatively higher percentage of

mortality in case of single shoot and seedling setts than three-budded setts.

Gahlot (1957) working at Shahjahanpur (U.P.), reported that germination of cane was increased with decrease in the seed rate. About 60 x 10^3 buds/ha gave highest germination (43.9 %) as against 162 x 10^3 buds/ha (40 %).

Thakur and Jayaswal (1957) reported that the initial rate of germination was maximum in plots planted with single budded setts followed by six-budded and three-budded setts. However, the final germination count was maximum in three-budded setts and lowest germination was with the single budded setts.

Bains (1959) at Jalandhar (Punjab), observed that every increase in seed rate increased the germination, however, spacing did not exert any significant influence on germination.

Bhoj et al. (1960) observed that larger space available between setts within a row caused favourable influence on germination percentage in the normal seed rate as compared to increased seed rate.

Bhonsale and Tonapy (1962) reported that the crops with single shoot planting were not as vigorous as those

with the double shoot planting. They further observed that many gaps occurred in case of single shoot planting as against double shoot planting.

Singh and Singh (1967) stated that the germination per cent did not show any variation due to different seed rates in autumn planted crops but it exhibited significant variation in the spring planted cane. Both, medium (37×10^3) and high (53×10^3 setts/ha) seed rates showed significantly lower germination than lower (20×10^3 setts) seed rate. Anang Nath and Bajaj (1969) also reported similar results under Tarai conditions (U.P.).

Narayanan (1970) at Cuddalore (Tamil Nadu) revealed that increase in seed rate reduced the germination percentage in all the spacings. He further observed that two-budded sett planting gave comparatively less germination than that of three-budded sett.

Gupta and Lal (1975) at Shahjahanpur (U.P.), reported that reduction in seed rate and reduced distance between cane rows gave slightly better germination.

Krishnamurthy (1978) at Mandya (Karnataka),observed that the germination percentage and survival were higher to start with in spaced transplanting technique than planting of three budded sett.

Jothimoorthy et al. (1980) reported an increase of

5 per cent in germination of sugarcane with single budded sett over conventional method of two-budded sett planting.

Shanmugasundaram et al. (1981), Singh et al. (1981) and Anonymous (1982) observed that the germination per cent did not show any variation due to different seed rates. Similarly, Singh et al. (1982) also reported that the per cent germination in relation to row spacing and nitrogen treatments was not influenced.

Shinde et al. (1983) reported that the wider spacing of 90 cm in a row gave better germination as compared to shorter spacing of 30 cm.

2.1.2 Effect of levels of nitrogen

Kirti Kar and Anang Nath (1964) reported that germination percentage was significantly influenced up to (227 kg N/ha) beyond which it was adversely affected.

Patil et al. (1964) observed that the germination percentage increased with the increase in levels of nitrogen. Similarly, Patwardhan and Rege (1954) and Rege (1954) also observed beneficial effect of nitrogen on germination.

Mathur (1972) reported that the varying levels of nitrogen had no marked differences on germination per cent. Similar results were also reported by numerous workers viz., Singh and Gupta (1960), Kirti Kar et al. (1964), Hunsigi

et al. (1974), Singh (1974), Kirti Kar et al. (1975), Gill and Singh (1976), Panwar et al. (1980) and Salunkhe et al. (1980 and 1981).

Tripathi and Jaiswal (1974) observed that the germination was slightly suppressed due to application of full dose of 125 kg N/ha at planting.

Gupta and Lal (1975) working at Shahjahanpur, observed that germination was not affected due to basal application of nitrogen fertilizer up to 40 kg N/ha.

Nair (1979) is of the opinion that the cane germination was not affected due to basal application of nitrogenous fertilizer up to 40 kg N/ha.

Irfanuddin and Singh (1981) working at Kashipur (U.P.), observed an increase of 3.3 per cent in germination with the application of nitrogen than no nitrogen application.

At Kolhapur (Maharashtra), Shinde et al. (1981) while studying the response of early and mid-late varieties to rates of nitrogen fertilization, reported that the germination was improved by the rates of nitrogen from 0 to 375 kg N/ha in both the groups of early and mid-late varieties.

2.2 Effect of methods of planting, plant densities and levels of nitrogen on tillering of sugarcane

2.2.1 Effect of methods of planting and plant densities

Kharkar and Kulkarni (1957) observed that the single budded sett planting resulted into profuse tillering. Similar results were also observed at Kolhapur (Anonymous,1982).

Bains (1959) working at Jalandhar (Punjab), reported that the nitrogen and spacings influenced the production of tillering significantly, however, seed rates showed no effect on tiller production.

Bhoj et al. (1960) observed that the rate of tiller production per plant was higher with the normal seed rate (36×10^3 three-budded setts/ha) than with the increased seed rate (54×10^3 three-budded setts/ha).

The shoot production was found to increase with the increased seed rate and spacing (Anonymous, 1960-61, 1973 and 1979).

Singh and Singh (1967) while working at Shahjahanpur (U.P.), observed that the lowest seed rate i.e. 20.6×10^3 three-budded setts/ha resulted in the maximum production of tillers per plant than medium and high seed rates viz. 37.1 and 53.5×10^3 three-budded setts/ha. They further reported that autumn planting proved to be better in this regards than the spring planting. Similar results were also

reported by Mathur et al. (1968) and Anang Nath and Bajaj (1969).

Narayanan (1970) at Cuddalore, observed higher tillering with lower seed rate than with increased seed rate, depending upon the unit space available for each germinated shoot.

At Kolhapur and Padegaon (Maharashtra), transplanting of settling at the spacing of 30, 45 and 60 cm increased tillering ratio with the increased spacing (Anonymous, 1979).

Reddy (1981) working at Nizam Sugar Factory (Andhra Pradesh), observed more tiller production and higher percentage of tiller mortality in closer inter-row spacing treatments.

At Padegaon (Maharashtra), planting of 25 x 10^3 three-budded setts per hectare gave more number of tillers than 30, 35 and 40 x 10^3 three-budded setts (Anonymous, 1981 and 1982).

2.2.2 Effect of levels of nitrogen

Gahlot (1954) observed at Shahjahanpur (U.P.), that the highest number of tillers per plant was found under 227 kg additional nitrogen per hectare but the increase in tiller number per plant over the 114 kg level was not so marked.

Kirti Kar and Anang Nath (1964) observed that in Eastern U.P., increase in the levels of nitrogen from 0 to 227 kg/ha increased the number of tillers per plant and thereafter, there was a depression effect on tillering at higher level.

Patil et al. (1964) found erratic effect on tillering due to application of nitrogen alone at Mandya in Karnataka State.

Mathur (1972) working at Gorakhpur (U.P.), reported increased levels of nitrogen from 75 kg to 225 kg N/ha increased the tiller production.

Kirti Kar et al. (1975) in Rohilkhand region of U.P. observed that increasing the nitrogen dose from 100 to 200 kg/ha appreciably increased the number of tillers and millable canes per hectare.

Mathur and Tripathi (1975) observed that with the increase in levels of nitrogen from 100 to 250 kg/ha simultaneously increased the tiller production.

Naidu et al. (1982) working at Perumallapalle (A.P.), reported that the increasing level of nitrogen increased the number of tillers per plant. This is in agreement with Srinivasan and Mariakulandai (1969), Tripathi and Jaiswal (1974), Gill and Singh (1976), Sugumaran et al. (1976), Virendra Kumar (1976) and Narwal and Behl (1979).

2.3 Effect of methods of planting, plant densities, levels of nitrogen and maintenance of tillers on growth and development of sugarcane

2.3.1 Effect of methods of planting

Kale and Deshpande (1956) at Ugar Sugar Works Ltd., (Karnataka), observed that triple bud setts get early start and better conditions for vigorous growth and development of crop, resulting into higher yields of cane and sugar than that of transplanting of settlings.

Thakur and Jayaswal (1957) at Pusa Farm (Bihar), observed that the final plant height, the number of internodes and stand of crop in terms of number of matured canes from three-budded setts was maximum than single budded setts.

Sharma and Chauhan (1974) at Bagwai in Madhya Pradesh, stated that rayungan method of planting was better than normal method of planting in ridges and furrows (three-budded setts) for increasing plant height as well as the number of millable canes.

Singh (1975) observed that the single bud planting is definitely economical over sett planting. He further reported that this method is certainly advantageous for rapid multiplication of new varieties.

Krishnamurthy (1978) at the Malligere Farm of the Mysore Sugar Co. Ltd., Mandya (Karnataka), observed that

the length, number of internodes and the average weight of cane was increased in spaced transplanting method as compared to three-budded sett planting.

2.3.2 Effect of plant densities

Singh et al. (1940) working on quantity and quality of seed material had observed that the reduction in seed rate not only reduced the number of canes but also had harmful effect on growth and stand of crop, which consequently affected the cane yield.

Singh et al. (1970) reported that under Tarai conditions in Uttar Pradesh, the increasing levels of seed rate and nitrogen increased the plant height.

Panje (1973 a) observed consistent increase in millable stalk length, stalk size and weight per cane with increase in seed rate from 12 x 10^3 to 111 x 10^3 buds per hectare.

Irvine and Matherne (1978) reported that the row spacing of 61, 91 and 183 cm with single drill had no effect on leaf area and leaf area index. They further reported that leaf area reached a maximum in September, when the ratio of leaf to land area for 61 and 183 cm single drill spacings was 5.66 and 2.76, respectively.

Irvine and Benda (1980) in Louisiana (U.S.A.)

observed that the closely spaced sugarcane plant grows rapidly without pause for tillering and may grow slowly when conditions become limiting and at harvest plant has only one or two thin stalks which has characteristically fewer leaves per plant, less leaf area, less total plant weight and higher stalk fibre than do plants on wider spacing.

Reddy (1981) at Nizam Sugar Factory Ltd., Shakar-nagar in Andhra Pradesh, reported that the girth of cane showed a progressive increase with increased width of inter-row.

Shanmugasundaram et al. (1981) at Coimbatore in Tamil Nadu, while studying different seed rates namely 90, 135, 180, 270 and 360 x 10^3 buds per hectare observed that the variation in seed rate influenced the growth and yield contributory characters. They further reported the increasing trend in single cane weight and girth in corresponding lower plant densities.

At Padegaon (Maharashtra), the yield contributory characters such as cane girth, number of internodes, height of cane and per cane weight were not influenced due to varying seed rates from 25 to 45 x 10^3 three-budded setts per hectare (Anonymous, 1982).

2.3.3 Effect of nitrogen levels

Gahlot (1954) reported that at Shahjahanpur, increasing levels of nitrogen increased cane height and the maximum cane height was attained under 227 kg/ha additional nitrogen.

Sastry and Venkatachari (1960) while working at Rudrur in Andhra Pradesh, indicated that application of nitrogen had improved shoot population and height of cane plant over no nitrogen but the differences between (170 and 340 kg N/ha) were slight in both these attributes.

At Mandya in Karnataka, Patil et al. (1964) found slight increase in millable height and cane girth due to application of 340 kg nitrogen per hectare.

In Tamil Nadu, Srinivasan and Mariakulandai (1969) reported that the increasing doses of nitrogen from 170 to 340 kg/ha increased early vigour in terms of height, dry matter accumulation and cane attributes like length of millable cane, girth of cane and individual cane weight.

Cheema and Moolani (1970) found that application of nitrogen at both the rates (112 and 168 kg N/ha) significantly improved tillering at peak period, linear growth at all the stages, leaf area at peak period and millable cane length. They also observed the beneficial effect of nitrogen on length per internode and weight per cane.

Gill and Singh (1976) while studying the response of nitrogen application in Punjab, found that in the pre-monsoon period, nitrogen application increased the number of tillers per clump and observed maximum tiller production at 168 kg N/ha. Similar response of nitrogen was also observed with regards to millable cane height and number of millable canes.

Narwal and Behl (1979) and Narwal and Malik (1981) at Hissar (Haryana), observed that plant height and individual cane weight was increased significantly by the application of nitrogen up to 100 kg N/ha as compared to control. Further increase in nitrogen rates up to 200 kg did not prove beneficial. The thickness of sugarcane plants was increased significantly up to 150 kg N/ha over the control and 100 kg N/ha.

Mali et al. (1982) at Parbhani (Maharashtra), reported significant impact of graded doses of nitrogen from 0 to 300 kg N/ha on plant height, number of internodes and girth of cane. These growth attributes were influenced significantly by application of nitrogen at every stage of crop growth and each level of nitrogen was significantly superior to its lower.

2.3.4 Effect of maintenance of tillers

A very scanty work is reported on the maintenance

of tillers. Probably this aspect did not receive much attention.

Raheja and Azeez (1948) reported that most of the millable stalks were formed out of the mother shoots together with the shoots of the second order. Late formed shoots composed of the third order shoots, mostly remained immature or died prematurely.

Dillewijn (1952) observed that early formed tillers were able to develop fully during the following 'grand growth period' which resulted in increased yield of cane.

2.4 Effect of methods of planting, plant densities, levels of nitrogen and maintenance of tillers on number of millable canes and shoot mortality

2.4.1 Effect of methods of planting

Kale and Deshpande (1956) reported that at Ugar Sugar Factory in Karnataka, triple bud sett planting was found to be superior in respect of millable canes per hectare as compared to transplantation. They further observed that the percentage of dead canes was more in triple bud sett planting.

Kharkar and Kulkarni (1957) reported that in case of single bud sett planting, lesser shoot mortality was observed and finally number of millable canes was also not reduced.

At Lucknow (U.P.), the pregerminated setts planted vertically gave maximum shoots and millable cane stalks at harvest when compared with three-budded sett planting (Anonymous, 1972).

Sharma and Chauhan (1974) in their field trials in Madhya Pradesh, reported that the rayungan method of planting produced more number of millable canes compared to regular method of three-budded sett planting.

2.4.2 Effect of plant densities

Gahlot (1957) in his three-years trial conducted at Shahjahanpur (U.P.), concluded that the increasing levels of seed rate increased the number of millable canes per hectare and mortality percentage of tillers. The millable canes produced per hectare were 89.5, 108.2 and 114.7 x 10^3 under 62.5 x 10^3 (low), 112.5 x 10^3 (medium) and 162.5 x 10^3 (high) buds/ha, respectively.

Gill and Masood Alam (1967) at Lucknow, observed direct relationship between shoot and millable cane populations with the varying seed rates but the increases were not proportionate. More shoots were produced and survived per stubble-base and millable stalks were also heavier with lower seed rates than with higher seed rates.

Singh and Singh (1967) at Shahjahanpur, noticed the highest mortality of tillers with higher seed rate i.e.

53.5×10^3 three-budded setts per hectare, however, the number of millable canes per hectare was in increasing order with increased seed rate in autumn as well as spring planting seasons.

Anang Nath and Bajaj (1969) at Golagokarannath(U.P.), observed that the number of tillers and millable canes per hectare were highest under high seed rate followed by medium and low seed rate treatments. Similarly, they have reported highest mortality percentage of tillers in high seed rate treatments, where the number of tillers per hectare was the highest and the least in low seed rate treatment which had produced lowest number of tillers per hectare.

At Cuddalore in Tamil Nadu, Narayanan (1970) observed more number of millable canes with close spacing under all the seed rates, the maximum being 72.5×10^3 canes per hectare in 81 cm spacing with 62.5×10^3 two-budded setts.

At Lucknow, Singh et al. (1972) in their studies of effect of different methods of increasing the shoot population reported that increasing the seed rate without altering the row spacing was found to be of little consequence but increased density of planting, coupled with narrow spacing proved to be superior and holds promise for enhancing the stalk population.

Del Rosalio (1974) from Philippines, reported an

increase of 60 per cent in millable canes per hectare by reducing the furrow spacing from 1 metre to 0.75 metre despite a 20 per cent drop in the number of millable stalks per stool.

Matherne (1977) in Louisiana (U.S.A.), observed that the plant population increased per unit area with decreasing the inter-row spacing.

At Nizam Sugar Factory, Shakarnagar (A.P.), Reddy (1981) observed highest millable stalk population in closest spacing treatment. He further reported progressive decrease in tiller mortality with increase in the inter-row spacing.

Shinde et al. (1983) at Kolhapur (Maharashtra), reported that the linear spaced treatments (30 and 60 cm plant to plant spacing) produced more number of millable canes than that of 90 cm spacing.

2.4.3 Effect of nitrogen levels

Tanimoto and Burr (1959) reported that in Hawaii, the greater crowding of stalks due to high nitrogen fertilization did not result in a higher percentage of dead stalks at harvest. On the contrary, the highest nitrogen level tended to maintain better t o reduce cane mortality.

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Kakade (1972) in Maharashtra, observed the importance of nitrogen application during fairly early and formative phase of sugarcane crop for optimum millable plant population per hectare.

Mathur (1972) in his studies of response of N P K fertilization on sugarcane reported the association of the formation of millable canes with the increasing levels of N P K, however, profound effect was observed with nitrogen alone.

Dixit et al. (1975) in their studies on response of sugarcane to nitrogen in Tarai tract of U.P., observed that nitrogen application increased the cane population with the increase in nitrogen levels, while the mortality percentage decreased with higher nitrogen levels.

Gupta and Lal (1975) reported that at Shahjahanpur (U.P.), nitrogen application improved the survival of tillers and ultimate plant population. The increases obtained beyond 150 kg N/ha were only marginal.

In Rohilkhand region of U.P., Kirti Kar et al.(1975) observed that the increasing nitrogen dose from 100 to 200 kg/ha appreciably increased the number of millable canes per hectare.

Mathur and Tripathi (1975) while studying the

response of sugarcane to nitrogen fertilization observed appreciable increase in the formation of millable canes when nitrogen levels increased from 100 to 200 kg per hectare.

Virendra Kumar (1976) while reviewing the sugarcane manuring in U.P., reported that increasing doses of nitrogen gave progressive increases, both in the number of tillers and millable canes.

At Hissar in Haryana, Narwal and Behl (1979) found significant increase in the number of millable canes with graded doses of nitrogen from 50 to 150 kg per hectare over no nitrogen.

Irfanuddin and Singh (1981) in their fertilizer experiments on sugarcane at Kashipur in U.P., stated that the application of 150 kg nitrogen per hectare increased the production of millable canes by 18.69 per cent. Further, the combination of nitrogen with potassium (NK) and phosphorus and potassium (NPK) increased it to 21.03 and 25.39 per cent over no fertilizer application.

2.4.4 Effect of maintenance of tillers

In the studies of removing the extra shoots above the desired number in order to get greater percentage of survived canes at harvest, it was observed that the survival

of plants was similar in both the treatments of controlled and uncontrolled tillers. Further, it was seen that the competition between plants could not be controlled as the number of tillers also increased with the cutting of plants mechanically (Anonymous, 1956-57).

Kirti Kar et al. (1964) at Shahjahanpur, while studying how far different cultural practices such as reducing hoeings and de-tillering are helpful in keeping down the late formed tillers observed that the less number of tillers produced, resulted in lower number of millable canes by reducing normal hoeings from six to two. Further, they observed lowest mortality percentage where de-tillering was done.

2.5 Effect of methods of planting, plant densities, levels of nitrogen and maintenance of tillers on yield of cane and sugar

2.5.1 Effect of methods of planting

Kale and Deshpande (1956) reported that at Ugarkhurd in Karnataka, as regards cane yield, double seedling, single shoot and single seedling sett were found to be inferior to three-budded sett planting.

Kharkar and Kulkarni (1957) in the studies of single budded sett planting observed higher individual cane weight, however, the final yield of cane remained unaffected when compared with normal method of three-budded sett planting.

Bhonsale and Tonapy (1962) at Kolhapur (Maharashtra), observed beneficial effect of double shoot planting by rayungan method over single shoot planting on cane yield.

Although, rayungan method is cumbersome and involves additional expenditure in raising seedlings, the method was found equally beneficial to that of sett planting for getting optimum cane yield under Kolhapur conditions (Patwardhan and Patil, 1965).

Sharma and Chauhan (1974) in their trials conducted at Bagwai in Madhya Pradesh, shown that rayungan method of planting of sugarcane produced significantly higher yield of cane as compared to normal method of three-budded sett planting.

Transplanting either by single budded settling or scooped budded seedling does not give any beneficial effect on yield of cane and sugar in case of seasonal sugarcane as compared to conventional method of three-budded sett planting under Kolhapur conditions (Anonymous, 1980 d).

Lakhdive (1981) at Akola in Vidarbha region of Maharashtra, reported that the spaced transplanting showed significant reduction in cane and sugar yield when planted in February and March than the conventional method of three-budded sett planting and single budded sett planting. He further observed that the January planting had not

influenced the cane yield under all the three methods of planting.

Shinde et al. (1983) under Kolhapur conditions did not observe much variation in cane yield obtained from single budded and three-budded sett planting. They further reported the possibility of economising the seed material to the extent of $2/3^{rd}$ of the usual quantity used by adopting single budded sett planting with 30 cm spacing in a row.

2.5.2 Effect of plant densities

Gahlot (1957) at Shahjahanpur, observed that increased seed rate increased the cane and sugar yield. He further reported that medium and high (112.5 and 162.5 x 10^3 buds/ha) seed rates gave a significantly higher cane yield over low (62.5 x 10^3 buds/ha) seed rate; while the yield differences between high and medium seed rates were not significant.

At Kolhapur (Maharashtra), in three years studies on spacing-cum-manurial-cum-seed rates, it was observed that the spacing of one metre and 25 x 10^3 setts with 170 kg nitrogen per hectare found to be optimum for sugarcane variety CO.775 under seasonal planting (Anonymous, 1965 b).

Gill and Masood (1967) observed that at I.I.S.R., Lucknow, number of millable canes and yield per hectare did

not show any significant differences due to varying seed rates of 20 to 34 x 10^3 three-budded setts per hectare.

Singh and Singh (1967) while studying the effect of low, medium and high (20.6, 37.1 and 53.5 x 10^3 setts/ha) seed rates on yield of sugarcane under U.P. conditions found that medium and high seed rates gave significantly high yields than low seed rate.

In the studies on varying seed rates and seed material conducted at Kolhapur indicated that the yield of cane and sugar was in increasing order with increased number of buds per hectare as well as number of buds per sett (Anonymous, 1969).

Narayanan (1970) under Cuddalore conditions in Tamil Nadu, found that 81 cm spacing (4 links) with 100-125 x 10^3 buds per hectare either as two or three-budded setts was optimum for obtaining maximum cane and sugar yield.

Singh et al. (1970) concluded that under the conditions of Shahjahanpur in U.P., the yield of sugarcane was significantly influenced both by seed rates and nitrogen levels. Low (20.6 x 10^3 setts/ha) seed rate and lack of nitrogen ('0' kg N/ha) resulted in poor yield as compared to medium and high (37.0 and 53.5 x 10^3 setts/ha) seed rates and 112 and 224 kg nitrogen levels. They further reported that increase in seed rate by 1000 setts/ha

between low and medium seed rate resulted in an increase of 0.512 tonne cane yield, further increase of the same magnitude over medium seed rate increased the cane yield by 0.169 tonne.

At Lucknow, it was concluded that sugarcane cultivation after harvesting wheat, was profitable with the use of either pre-germinated setts or by increasing the normal seed rate and narrowing the space in between rows(Anonymous, 1972).

Panje (1973 a, and 1973 b) discussed the effects of plant densities on yield components in sugarcane. It was noted that the yield tended to increase at an average rate of about 0.28 tonne per cm increase in the linear spacing. The yield increase was due to increase in the weight of stalk. There was an indication that cane crop required 90 cm spacing between rows.

In Lousiana, U.S.A., Matherne (1977) observed that stalk population was closely related with yield. The closer row spacing on 0.9 metre rows on an average increased the stalk population by 62 per cent and cane yield by 39 per cent when compared with 1.8 metre row spacing. He, further reported that two drills on 1.8 metre spacing increased the stalk population by 60 per cent and cane yield by 23 per cent as against two drills on 2.1 metres, stalk population increased by 31 and cane yield 17 per cent in plant cane.

Thomas et al. (1977) at Weslaco in Texas (U.S.A.), while reducing row spacing from 182 to 122 cm observed an increase of 4.2 t/ha in cane yield.

At Coimbatore in Tamil Nadu, it was observed that the increase in the seed rate from 115 to 150 x 10^3 buds per hectare brought out significant improvement in cane yield to the extent of 8.0 tonnes per hectare (Anonymous, 1978 a).

Studies on the influence of planting dates and spacing on the early and mid-late varieties of sugarcane in Perambalur Sugar Factory area in Tamil Nadu, it was observed that the row spacing of 60 cm recorded the highest cane yield (117.5 t/ha) compared to 90 cm row spacing (106.0 t/ha) (Anonymous, 1980 a).

At Padegaon (Maharashtra), 30 x 10^3 three-budded setts per hectare found to be optimum seed rate for production of higher cane yield (Anonymous, 1980 c, 1981 and 1982).

Reddy (1981) while studying the effect of inter-row spacing on sugarcane yield in Nizam Sugar Factory area in Andhra Pradesh , reported that the cane yield was increased with increase in the inter-row spacing up to 120 cm only.

2.5.3 Effect of levels of nitrogen

Raheja and Azeez (1948) found that the initial high dose of nitrogen increased the tonnage of cane and sugar.

Kale et al. (1950) in their studies on yield and quality of sugarcane grown on the estate of Ugar Sugar Works Ltd., Mysore (Karnataka), observed that the higher doses of nitrogen than 336 kg N per hectare, lowered the yields of adsali sugarcane due to heavy lodging and consequent deadning of canes.

Mohan Rao and Narasimhan (1951) noticed no significant difference in sugarcane yield among the three levels of nitrogen (114, 170 and 228 kg/ha).

Singh et al. (1954) reported that at Gurdaspur in Punjab state, sugarcane variety CO. 312 gave good yields from nitrogen dose of 84 to 168 kg per hectare over the control.

Khan and Pattanayak (1956) observed that under Delhi conditions, a nitrogen dose of 90 kg per hectare was optimum for sugarcane.

Bains (1959) found that at Jalandhar (Punjab), application of 114 and 228 kg nitrogen per hectare increased the cane yield to the tune of 51.9 and 54.7 per cent in plant cane over no nitrogen. He further reported that in case of plant cane, 114 and 228 kg N/ha showed no significant difference in cane yield.

Kanwar and Singh (1960) observed that at Jalandhar, there were no significant differences in cane yield due to 112 and 224 kg N per hectare.

Arakeri et al. (1961) reported that at Sugarcane Liaison Farm, Hospet, in Karnataka, nitrogen at the rate of 280 kg per hectare as top dressing was optimum for the cane planted in January. This was applied in two equal doses at 6^{th} and 12^{th} week after planting.

Rege et al. (1963) in their fertilizer experiments on sugarcane in South India, observed that for plant crop, on an average, 224 kg N/ha recorded a significant increase of 5.46 tonnes of cane per hectare as compared to the lower dose of 168 kg N/ha.

Suryanarayana and Seetharamaiah (1963) reported that for Telangana tract of Andhra Pradesh, the optimum fertilizer dose of nitrogen for eksali crop is 252 kg N/ha which is to be given in two equal instalments, first half dose at 45 days after planting and the remaining half between 90 and 120 days after planting.

Jaisinghani and Jain (1964) in their simple fertilizer trials on sugarcane in Rajasthan, observed that there was the highest increase in yield due to application of 67.2 kg N, 24.8 kg P_2O_5 and 44.8 kg K_2O per hectare.

Joshi and Mahajan (1964) stated that on 'F' type of soil under Deccan Canal Area (Maharashtra), basal application of 9,000 kg compost or F.Y.M. and nitrogen top dressing with 336 kg per hectare in 4 doses was sufficient for 12 months January planted sugarcane.

Kirti Kar and Anang Nath (1964) while studying the response of nitrogen to sugarcane in eastern U.P.,observed that the significant response as regards cane and sugar yield was found up to 228 kg nitrogen dose per hectare.

Raja et al. (1964) observed that for economic returns from seasonal sugarcane crop, nitrogen dose of 224 to 280 kg per hectare was sufficient.

At Anakapalle in Andhra Pradesh, the treatment of 111 kg N/ha gave the maximum cane yield for sugarcane variety Co.419, a 12 months crop (Anonymous, 1965 a).

Srinivasan and Mariakulandai (1969) in their studies conducted in Tamil Nadu, indicated that the commercial cane sugar and cane yield in tonnes per hectare were found to be significantly higher under higher levels of nitrogen i.e. 284 and 340 kg per hectare. They further reported that 284 kg nitrogen and higher soil moisture status recorded 133.5 tonnes of cane and 15 tonnes of commercial cane sugar per hectare.

At Kolhapur (Maharashtra), increase in the level of nitrogen increased the cane and sugar yield significantly. Application of 340 kg nitrogen increased the cane yield by 12.95 per cent than 170 kg N per hectare (Anonymous, 1969).

At Anakapalle in Andhra Pradesh, there was a significant increase in cane yield with increasing level of nitrogen from 0 to 112 kg per hectare. With further increase in the level of nitrogen up to 336 kg per hectare, increase in cane yield was found to be negligible(Anonymous, 1969-70).

Cheema and Moolani (1970) reported that the application of nitrogen at the rate of 112 and 168 kg N/ha significantly produced higher yield of cane by 10.3 and 9.5 t/ha over the control (0 kg N/ha) corresponding to an increase of 21.8 and 20.2 per cent, respectively.

Prihar (1971) studied the nitrogen requirement of sugarcane grown under Rajasthan conditions. Based on the data collected for four seasons concluded that the optimum nitrogen requirement of sugarcane in northern, southern and east-southern regions in Rajasthan is 112 and 168 kg per hectare, respectively.

Srinivasan et al. (1971) observed that under Cauvery delta area (Tamil Nadu), application of nitrogen increased

the yield of cane for variety CO.419, a 12 months crop of sugarcane and optimum dose could be fixed at 280 kg N per hectare.

Mathur (1972) reported that at Gorakhpur in U.P. increase in the level of nitrogen from 75 kg to 225 kg per hectare had a consequent effect in accelerating the cane yield and the highest yield of cane was obtained in the treatment comprising of 225 kg N, 150 kg P_2O_5 and 150 kg K_2O per hectare.

Kirti Kar and Saroj (1974) observed marked improvement in yield of cane by application of nitrogen up to 200 kg per hectare but higher application was not found economical.

Ojha et al. (1974) summarised the long term manurial experiments at Shahjahanpur in U.P., and it was observed that the application of nitrogen at the rate of 224 kg/ha increased the yield of cane significantly.

Mathur and Tripathi (1975) reported that at Gorakhpur, in U.P., increase in the level of nitrogen from 100 to 250 kg/ha simultaneously increased the cane yield up to the treatment of 300 kg N/ha. The most economical yield, however, could be observed up to 250 kg N/ha. They further reported that higher sugar outturn was obtained under 200 kg N/ha.

Dixit and Saroj (1976) stated that at Kashipur under Tarai conditions of U.P., amongst the three levels of nitrogen (90, 150 and 210 kg N/ha), 150 kg/ha level registered the maximum cane yield.

Sugumaran et al. (1976) in their studies on response of promising varieties to nitrogen application in Tamil Nadu, reported that the application of 250 kg N/ha was found to be optimum and economical dose to get maximum returns, irrespective of the varieties of the region.

Ojha et al. (1977) reported that at Shahjahanpur, application of increasing doses of 150 and 250 kg N/ha increased the cane yield significantly over its lower doses and control.

Patil et al. (1977) observed that at Padegaon (Maharashtra) increasing levels of nitrogen fertilization increased the yield of sugarcane crop linearly and a dose of 300 kg N/ha for plant cane was found sufficient to increase the yield significantly.

Lal and Lal (1978) reported that under Tarai region of U.P., cane yield was increased with narrow spacing associated with 150 kg N/ha than wider spacing with higher dose of nitrogen.

Reddy et al. (1978) at Rajendranagar in Andhra Pradesh, observed an increase of 58.4 per cent in cane yield with 300 kg N/ha as compared to no nitrogen application.

Suresh Kumar et al. (1978) found that application of full dose of 250 kg N/ha at 90 days or tillering phase in the form of urea registered good response of cane in terms of yield for the variety CO.6304, recording 22.6 per cent enhanced yield than split application of nitrogen at 45 and 90 days after planting under Tamil Nadu conditions.

Narwal and Behl (1979) reported that at Samargopalpur (Rohtak), application of 100 kg N/ha increased sugarcane yields significantly over control (0 kg N/ha) and 50 kg N/ha.

Daniel and Sanjeevirayar (1980) reported that at Cuddalore in Tamil Nadu, among the different levels of nitrogen, 250 kg N/ha was found to be sufficient for obtaining optimum yield of cane and sugar.

Panwar et al. (1980) observed that at Jagadhri (Haryana), nitrogen application (75, 150 and 225 kg/ha) favourably influenced the cane yield.

Salunkhe et al. (1980 and 1981) reported that at

Kolhapur (Maharashtra), the highest cane yield was obtained with 337 kg nitrogen per hectare, but the economical yield was observed up to 252 kg N/ha. They further observed that application of nitrogen in two equal splits i.e. 50 % at the start of tillering and 50 % at earthing found to be optimum and economical for a 12 months crop of sugarcane.

Irfanuddin and Singh (1981) at Kashipur (Nainital), reported that on an average, 150 kg N/ha increased the yield of cane by 29.8 and of commercial cane sugar by 24.3 per cent over no nitrogen.

Kadian et al. (1981) observed that at Karnal in Haryana, increasing levels of nitrogen increased the cane yield, however, 200 kg N/ha was found to be optimum dose for sugarcane.

Shinde et al. (1981) reported that under Kolhapur conditions for a seasonal (12 months) crop of sugarcane 250 kg nitrogen per hectare is optimum dose for obtaining higher cane and sugar yield.

Singh et al. (1981) observed that under Delhi conditions, there was a linear increase in yield of sugarcane in all the varieties due to increased rates of nitrogen per hectare up to 200 kg.

Naidu et al. (1982) at Perumallapalle in Andhra

Pradesh, observed maximum cane yield of 86.91 tonnes and sugar yield of 12.5 tonnes/ha was recorded by application of 224 kg of nitrogen.

At Kolhapur, in the studies of promising early, mid-late and late varieties to nitrogen application, it was observed that the application of 375 kg N/ha gave significantly higher cane and sugar yield (136.38 and 18.61 t/ha, respectively) over lower dose of nitrogen (250 kg/ha) while 250 kg N/ha had its superiority (yield 126.19 and sugar 17.28 t/ha) over 125 kg and 0 kg N/ha indicated thereby the response of different varieties to higher levels of nitrogen (Anonymous, 1983 b).

2.5.4 Effect of maintenance of tillers

At Padegaon (Maharashtra) plant population control in sugarcane by removing the extra shoots above the desired number was not found beneficial as the yields of cane and sugar did not differ much in both the treatments of controlled and uncontrolled shoots (Anonymous, 1956-57).

Kirti Kar et al. (1964) at Shahjahanpur (U.P.), in their studies on the effect of controlling tillers by means of reduction in seed rate, reducing number of hoeings and de-tillering observed that the normal seed rate (111 x 10^3 buds/ha) and normal six hoeings with 33 per cent de-tillering had its superiority in respect of cane yield over 66

per cent reduction in seed rate and reduced number (two) of hoeings. They further reported that de-tillering gave the highest cane yield per hectare.

Muthukrishnan (1979) in the studies of family planning in sugarcane found that there is a net loss of Rs. 1,342.00 per hectare due to higher seed rate when the population at the end of germination stage exceeds 22.5 X 10^3 sprouts per hectare.

Shanmugasundaram and Venugopal (1979) reported that de-tillering and population control to the pre-determined levels (125 to 175 x 10^3 plants/ha) did not result in enhanced sugar yields and the concept of de-tillering and population control in the place of an optimum seed rate appears illconceived.

2.6 Effect of methods of planting, plant densities, levels of nitrogen and maintenance of tillers on juice quality of sugarcane

2.6.1 Effect of methods of planting

Holman et al. (1938) in their studies of double v/s single shoot planting observed no significant differences in juice quality, the sucrose content of cane and the glucose ratio.

Kale and Deshpande (1956) reported that the percentage of available sugar in cane, in the planting of shoot and seedling sett in general and double shoot sett in

particular, was appreciably higher than in triple bud sett planting.

In Louisiana, Recaud et al. (1978) in their studies on methods of planting of sugarcane, observed that the glucose per cent was not affected due to methods of planting and width of furrows.

2.6.2 Effect of plant densities and spacing

Bains (1960) at Jalandhar, among the various planting distances (30, 60 and 90 cm) observed that the wider spacing tended to improve the juice quality in terms of purity co-efficient and sucrose content of juice as compared to narrowly spaced rows. He, further reported that the low seed rate (62.5×10^3 two-budded setts/ha) showed better juice quality in the month of November.

Bhoj et al. (1960) in their trials conducted in central tract of U.P., observed slight improvement in juice quality of sugarcane with reduced inter-row spacing (from 1 to 0.75 m) as well as by increasing the seed rate from 36 to 54×10^3 three-budded setts per hectare.

At Golagokarannath (U.P.), it was found that increase in seed rate from 62.5 to 112.5×10^3 buds per hectare improved the juice quality of sugarcane (Anonymous, 1963-64).

Anang Nath and Bajaj (1969) under Tarai conditions in U.P., observed superior juice quality in high (162.5 x 10^3 buds/ha) seed rate over medium and low (112.5 and 62.5 x 10^3 buds/ha) seed rate treatments.

Narayanan (1970) at Cuddalore (Tamil Nadu) observed slight improvement in juice quality of cane with higher (62.5 x 10^3 two-budded setts/ha) seed rate when compared with 30 x 10^3 three-budded setts/ha.

Singh et al. (1970) reported that at Shahjahanpur, quality of cane juice was influenced by varying seed rates. Low (20.6 x 10^3 three-budded setts/ha) seed rate invariably showed adverse influence on sucrose content and purity co-efficient of cane juice.

Dixit and Saroj (1975) in Tarai tract of U.P., observed the highest juice sucrose content and purity co-efficient at the smallest row spacing (90 cm) and 150 kg nitrogen application per hectare.

Shanmugasundaram et al. (1975) reported that juice quality, particularly commercial cane sugar per cent in cane at 10 and 12 months crop age remained unaffected by the different seed rates.

Thomas et al. (1977) at Weslaco (Texas) in U.S.A., observed that reducing row spacing from 182 to 122 cm significantly increased percentage of pol and purity.

In Florida (U.S.A.), Gascho and Shih (1978) reported that the narrow spacing (0.5 m) gave greater yields of total sugar, pol and fibre than wider spaced (1.5 m) rows.

Reddy (1981) at Shakarnagar in A.P., observed no variation in juice quality due to various inter-row spacings from 90 to 180 cm.

Shinde et al. (1983) at Kolhapur (Maharashtra) observed that single budded sett planting at 30 cm distance in a row gave highest sucrose per cent in juice than wider spacing.

2.6.3 *Effect of levels of nitrogen*

The sugar outturn per hectare is closely linked up with the cane yield and juice quality. Several workers investigated on various aspects affecting the juice quality directly or indirectly.

Kale et al. (1950) reported that at Ugar Sugar Works Ltd. (Karnataka), the higher doses of nitrogen than the 336 kg N/ha comparatively lowered the quality of adsali cane as a result of heavy lodging and consequent deadening of canes.

Gahlot (1954) observed that at Shahjahanpur, application of nitrogen at the rate of 114 and 228 kg/ha decreased sucrose per cent juice and purity co-efficient.

Samuels and Landrau (1956) in their field experiments conducted at Puerto Rico, covering a wide range of varieties and soils, observed that the nitrogen application increased polarization and degree Brix significantly.

Du Toit (1959) observed lesser degree of depressing effect of nitrogen on the sucrose content of sugarcane when nitrogen was applied as an early top-dressing within 3 months.

Bains (1960) reported that the nitrogen application delayed and depressed the sucrose content and purity per cent juice significantly, both in the plant and ratoon crops. Such differences, however, narrowed down with an advancement in the season and were almost negligible after December.

Kanwar and Kochhar (1960) studied the effect of N P K fertilization on the juice quality of sugarcane. They noted that increasing doses of nitrogen had a deleterious effect on the sucrose content in the juice. Mahamuni et al. (1973) and Srinivasan and Mariakulandai (1972) noted similar adverse effects of high doses of nitrogen on the juice quality.

Sastry and Venkatachari (1960) stated that at Rudrur (Andhra Pradesh), application of 170 kg N/ha increased the sucrose per cent in juice perceptibly over no nitrogen,

however, such improvement was not observed with further increase in nitrogen dose.

Stanford (1963) observed that in Hawaii, approximately 95 % of the maximum yield of sugar was obtained with 228 kg N/ha. He further reported that application of 454 to 680 kg N/ha tended to increase yield of cane but greatly reduced juice quality. Late application of nitrogen persistently reduced sucrose content of the juice.

Kirti Kar and Anang Nath (1964) reported that the sucrose per cent in juice was markedly influenced by nitrogen doses (114, 228 and 342 kg N/ha). Higher the dose, lower was the sucrose per cent and purity co-efficient.

At Anakapalle in Andhra Pradesh, maximum juice sucrose was recorded by no manuring (18.95 per cent) and it was on par with that of 112 kg N/ha (18.83 per cent). There was significant depression in juice sucrose when the level of nitrogen was increased from 224 to 336 kg N/ha for sugarcane variety CO.62175 (Anonymous, 1969-70).

Gupta and Prasad (1971) carried out studies on the composition of cane juice as affected by nitrogen manuring. It was concluded that though the application of nitrogen had a favourable effect on the tonnage of sugarcane crop, it adversely affected the quality of juice. Similar studies were carried out by the same authors for studying

the effect of N manuring on organic non-sugars. The results indicated that the composition of cane juice was much affected by the manurial treatment of the crop and the nitrogen had a very pronounced effect.

Srinivasan et al. (1971) reported that under Cauvery delta area in Tamil Nadu, higher dose of nitrogen beyond 284 kg N/ha up to 382 kg N/ha did not affect the quality of sugarcane to any extent.

Mathur (1972) in his fertilizer experiment on alluvial soils of eastern tract of Uttar Pradesh, observed no marked depression in juice quality with increasing the nitrogen dose from 75 to 225 kg N/ha.

Hunsigi et al. (1974) reported that effect of nitrogen on sucrose was pronounced and depressing, perhaps because of early application of nitrogen in the 14^{th} week, which is normal practice in Mandya area.

Ojha et al. (1974) at Shahjahanpur in U.P., reported that application of 224 kg N per hectare increased the cane yield significantly, however, increased dose exerted adverse effect on juice quality.

Singh (1974) reported that the application of nitrogen significantly reduced the sucrose content in juice when compared with no nitrogen. Nitrogen application of 300 kg/ha

produced poorest juice quality and this dose was significantly inferior to 75 kg N/ha.

Kirti Kar et al. (1975) observed that in Rohilkhand region of U.P., higher dose of nitrogen (200 kg/ha) brought a slight decrease in the juice quality, while 75 kg P_2O_5/ha improved the juice quality under high level of nitrogen.

Mathur and Tripathi (1975) reported that the juice quality of sugarcane remained practically unaffected due to varying levels of nitrogen from 100 to 300 kg per hectare.

Shanmugasundaram et al. (1975) observed that the higher fertility level resulted in a depression of C.C.S. per cent in different varieties.

Daniel et al. (1976) at Cuddalore (Tamil Nadu), observed that the combination of nitrogen and potash is necessary for promoting juice quality in sugarcane. The interaction of N and K had significant influence on commercial cane sugar per cent for a 12 months crop of sugarcane.

Gill and Singh (1976) stated that in Punjab, per cent sucrose in cane juice had a tendency to decline under nitrogen application, however, such differences in per cent sucrose and purity per cent of juice were not discernible .

Patil et al. (1977) reported that at Kolhapur (M.S.), application of 250 kg nitrogen per hectare for plant cane

was found to be optimum to increase the sucrose percentage of juice.

Thakur et al. (1979) observed that in calcareous soils of North Bihar (Pusa), higher level of nitrogen (200 kg/ha) tended to decrease the sucrose percentage in juice.

Panwar et al. (1980) observed that at Jagadhri (Haryana), increasing levels of nitrogen from 75 to 225 kg/ha decreased sucrose content, purity co-efficient and commercial cane sugar per cent in cane juice.

Daniel and Sanjeevirayar (1980) stated that the economic dose of nitrogen to sugarcane varieties under cultivation in Tamil Nadu was found to be 250 kg/ha, however, the sucrose content of juice and purity coefficient were not influenced by different levels of nitrogen.

Salunkhe et al. (1980) at Kolhapur (Maharashtra), reported that the juice quality of sugarcane was depressed due to increase in nitrogen levels from 168 to 337 kg/ha.

Irfanuddin and Singh (1981) at Kashipur (Nainital) in their studies on response of N P K fertilization reported no marked differences in sucrose and purity percentage of juice due to different treatments. The application of fertilizers slightly depressed sucrose,

but considerably increased the overall production of commercial cane sugar (50.3 %) with N P K fertilization compared to the control. They further reported improvement in commercial cane sugar due to NP and NK combinations by 42.75 and 32.21 per cent, respectively over no fertilization.

Salunkhe et al. (1981) reported that the rates and time of nitrogen application had no effect on sucrose percentage in juice. However, increasing trend in quality was associated with lower levels of nitrogen.

Shinde et al. (1981) in their studies on response of promising early and mid-late varieties of Kolhapur region to rates of nitrogen fertilization, observed that the sucrose percentage in juice was not affected due to different levels of nitrogen, up to 250 kg/ha.

Naidu et al. (1982) at Perumallapalle (A.P.), observed significant suppression in juice sucrose as the levels of nitrogen increased from 0 to 112 kg and 112 to 224 kg nitrogen per hectare.

2.6.4 Effect of maintenance of tillers

At Shahjahanpur (U.P.), in the studies of maintenance of tillers in sugarcane, it was observed that the treatments of de-tillering either by reducing normal

hoeings from six to two or de-tillering up to 33 per cent or controlling plant population by reducing seed rate up to 66 per cent increased the sucrose percentage in juice by 0.5, 0.4 and 0.8 unit, respectively than the control treatment of normal seed rate + normal six hoeings (Anonymous, 1961-62).

Kirti Kar et al. (1964) at Shahjahanpur, reported that the juice quality was slightly improved by the treatments of de-tillering and reduced hoeings.

2.7 Uptake of nitrogen by sugarcane as influenced by nitrogen

Nitrogen is taken up in the form of ammonium (NH_4^+) or nitrate (NO_3^-) ions by the plants. Nitrogen forms the part of chlorophyll molecule. It also combines with carbohydrate to form proteins which play a major role in the synthesis of protoplasm. Nitrogenous constituents of plants, particularly the amino acids, undergo constant breakdown and resynthesis. With an ample supply of nitrogenous compounds and carbohydrates, growth of crop is usually rapid. Large number of investigators have observed beneficial effects of increased doses of nitrogen application on growth, yield and quality of sugarcane, indicating increased uptake of nutrients particularly nitrogen available through the large doses applied (Gupta and Singh, 1974; Mathur and Tripathi, 1975 and Patil, et al., 1977).

2.7.1 Nitrogen uptake by sugarcane

According to Mukherjee and Verma (1950) in India, an average crop of sugarcane yielding 44.8 tonnes per hectare removes 150 kg nitrogen.

Verma (1957) in his studies to see the trend of nitrogen uptake along with the variation of nitrogen status in the soil under the growing conditions prevailing at Shahjahanpur (U.P.), reported that maximum absorption of nitrogen takes place during the first four months of plant life. Nitrogen uptake, however, continues till October after which it practically ceases.

Kale and Babriwala (1959) in their uptake studies at Padegaon (Maharashtra), observed that the uptake of nitrogen in different varieties of sugarcane ranged between 82.23 to 223.33 kg per hectare. The uptake of nitrogen per tonne of cane in different varieties ranged between 0.77 to 1.64 kg.

According to Kanwar and Singh (1960) application of nitrogen in general resulted in an increased uptake of this nutrient, irrespective of the form of its application. They further observed that the absorption of nitrogen under 227 kg N level was higher as compared to that of 114 kg N/ha.

At Anakapalle, in a seasonal crop of sugarcane, an

increase in the uptake of nitrogen up to 210 days after planting was observed and thereafter showed a gradual decline up to harvest. With the manurial schedule for this tract viz., 111.15 kg N/ha, 130.9 tonnes of sugarcane crop was noted to remove 106.21 kg nitrogen (Anonymous, 1965 a).

At Kolhapur (Maharashtra), in a seasonal crop of sugarcane (Var. Co.740), it was observed that 143.9 kg N/ha was removed by a crop yielding 148.8 tonnes (Anonymous, 1968).

Kakade (1971) claimed that 1.4 to 1.6 kg nitrogen is absorbed by sugarcane per tonne of harvested crop.

Parthasarathy (1972) reported that the uptake of nitrogen by the whole plant of sugarcane is about 89.0 kg per hectare.

The uptake of nutrients by cane crop is linked up with the characteristics of the season and the management practices adopted. Zende et al. (1972) studied the inter-relationship between season, management practices and uptake of nutrients by different varieties of sugarcane. These studies revealed that there was a wide variation in the uptake of nutrients in different seasons. A tonne of sugarcane crop on an average removed 1.4 kg nitrogen, 0.6 kg P_2O_5 and 3.5 kg potash from the soil.

Gupta (1973) observed that a sugarcane crop yielding 70 tonnes of cane per hectare removed 85 to 110 kg N (1.21 to 1.57 kg N per tonne).

2.7.2 Effect of levels of nitrogen on uptake of nitrogen by sugarcane crop

Arakeri (1956) stated that the nitrogen uptake was increased with increased doses of nitrogen which resulted in low uptake of P_2O_5 and K_2O leading to imbalanced nutrition.

Kanwar and Singh (1960) reported that at Jalandhar, application of nitrogen, in general, resulted in an increased uptake of nitrogen. The uptake of nitrogen under 250 kg dose of nitrogen per hectare was higher as compared to that of 125 kg level of nitrogen.

In Hawaii, it was seen that the uptake of nitrogen by sugarcane crop was increased with high nitrogen application rates (Anonymous, 1967).

Raghvaiah and Singh (1980) reported that under Nainital conditions of U.P., there was higher increase in nitrogen uptake over control of sugarcane varieties viz., Co.1148, Bo-54 and Co.1336 due to application of 100 kg, 150 kg and 200 kg nitrogen per hectare, respectively.

2.8 Correlation studies in sugarcane

Yield of a crop is considerably affected by plant

characters which constitute the growth of the plant in general and the yield attributing characters in particular. The yield components affecting the final yield of sugarcane are mainly the number of canes per unit area, the thickness of stalk, length of the stalk and number of internodes per cane. Hence a correlation is expected to exist between the yield and these characters.

Singh and Singh (1970) reported positive and highly significant correlation of sugarcane yield with cane height, cane diameter and number of internodes per plant.

Parashar et al. (1980) in their correlation studies at I.A.R.I., New Delhi, observed positive and significant correlation of cane yield with cane height, cane diameter and number of internodes per plant.

Singh and Sharma (1983) at Jalandhar (Punjab), path coefficient analysis revealed that ohly the number of millable stalks and the stalk length exhibited positive association with the cane yield. It was further observed that among yield attributes, the stalk diameter had a negative association with the number of millable stalks and positive association with the number of internodes.

Zende and Kibe (1983) reported that the millable height and millable canes were positively correlated with the cane yield. They further noticed that the agronomic

characters showed varying type of relationship, among which the number of millable canes at harvest showed the highest degree of correlation with cane yield.

MATERIAL AND METHODS

3. MATERIAL AND METHODS

The details of the material used and methods followed for conducting the present investigation are described in this chapter.

3.1 Material

3.1.1 Experimental site

The experiment was conducted for two successive years 1979-80 and 1980-81 and subsequently during 1981-82 with slight modification in the treatment of maintaining tillers at the Regional Sugarcane and Jaggery Research Station, Kolhapur.

The topography of the experimental plot was uniform and levelled with good drainage for all the years. The soil of the experimental field was alluvial clay.

3.1.2 Soil and its physico-chemical properties.

In order to study the physico-chemical properties of soil, the samples from 0-30 cm depth were drawn from five spots in the experimental field before planting of crop during all the years. The composite sample was prepared and analysed for determining the physical and chemical properties of the soil (Table 1).

The data in Table 1 revealed that the soil of the experimental field was alluvial-clay in texture, medium in total nitrogen, available P_2O_5 and K_2O; and was almost

Table 1. Mechanical and chemical analysis of surface soil (0-30 cm depth) from the experimental field

Sr. No.	Soil constituent	Values			Method used
		1979-80	1980-81	1981-82	
A.	Physical properties				
	1. Coarse sand (%)	3.67	3.74	3.50	International Pipette method (Piper, 1966).
	2. Fine sand (%)	10.90	10.32	10.24	
	3. Silt (%)	26.00	26.50	25.76	
	4. Clay (%)	54.20	54.34	55.30	
	5. Textural class	—— Alluvial clay ——			
B.	Chemical properties				
	1. Total nitrogen (%)	0.063	0.061	0.066	Modified Kjeldahl's method (A.O.A.C., 1955).
	2. Available P_2O_5 (kg/ha)	25.88	23.70	22.90	Modified Olsen's method (Olsen et al., 1954).
	3. Available K_2O (kg/ha)	168.00	157.00	175.00	Flame photometer method (Piper, 1966).
	4. Organic carbon (%)	0.68	0.65	0.63	Walkley and Black rapid titration method (Piper, 1966).
	5. Soil reaction (pH)	6.9	7.0	6.8	Beckman's glass electrode method (Piper, 1966).

neutral in reaction with 6.9, 7.0 and 6.8 pH during 1979-80, 1980-81 and 1981-82, respectively.

3.1.3 Climatic and weather conditions

Geographically, the Regional Sugarcane and Jaggery Research Station, Kolhapur is situated at 16°-43' north latitude and 74°-14' east longitude. It has elevation of about 574 metres above the mean sea level. Agro-climatically Kolhapur is situated in the transitional belt between Western Ghat and Desh, with the annual average rainfall of 1050 mm. Most of the rainfall is received from the south-west monsoon, and distribution of rainfall is even during monsoon months.

April and May are hot months with mean maximum temperature varying from 35.9 to 37.3 °C, while December-January are the coldest months, with mean minimum temperature of 14.4 °C. The average relative humidity is about 71 per cent.

From the data presented in Table 2, it would be observed that the total precipitation was 927.3, 1180.8 and 1188.6 mm during the entire crop period of 1979-80, 1980-81 and 1981-82, respectively. About 70 to 74 per cent rainfall was received during June, July and August with total 60, 85 and 53 rainy days during the year 1979-80, 1980-81 and 1981-82, respectively. There were

Table 2. Meteorological data recorded during the period of experimentation on important climatic elements in comparison with last 20 years average

Sr. No.	Month	Temperature (°C)				Mean monthly rainfall (mm)		Relative humidity (%)	
		Mean maximum		Mean minimum					
		1979	Last 20 years average	1979	Last 20 years average	1979	Last 20 years average	1979	Last 20 years average
1.	January	30.80	30.83	16.71	14.28	-	-	82	60.58
2.	February	31.63	32.96	15.34	15.69	-	0.70	73	58.21
3.	March	35.40	35.83	18.80	18.91	-	6.12	44	56.35
4.	April	38.05	37.28	21.67	21.23	15.30	44.56	62	64.02
5.	May	36.46	36.01	21.02	22.02	0.20	66.17	70	72.72
6.	June	33.88	30.93	23.15	21.94	142.60	153.03	80	84.25
7.	July	27.24	26.90	21.74	21.25	132.00	348.74	89	90.25
8.	August	25.88	26.86	20.90	21.04	348.10	191.39	91	91.17
9.	September	28.82	28.68	21.12	20.65	225.70	148.35	88	88.64
10.	October	31.37	31.13	20.94	19.94	8.70	105.36	80	77.03
11.	November	29.56	30.79	20.01	17.22	54.70	55.82	80	65.06
12.	December	29.77	29.91	16.84	15.16	-	12.40	78	65.14
					Total	927.30			

Table 2 (Contd....)

Sr. No.	Month	Temperature (°C)				Mean monthly rainfall (mm)		Relative humidity (%)	
		Mean maximum		Mean minimum					
		1980	Last 20 years average	1980	Last 20 years average	1980	Last 20 years average	1980	Last 20 years average
1.	January	31.08	30.84	15.83	14.41	-	-	79	61.55
2.	February	32.99	32.31	17.28	15.66	-	0.63	67	58.65
3.	March	35.59	35.81	19.37	18.90	22.40	5.64	57	55.70
4.	April	37.44	37.34	22.37	21.23	60.00	43.17	67	63.75
5.	May	38.16	36.04	23.17	21.99	2.40	62.81	73	72.50
6.	June	30.49	31.07	22.69	21.99	287.90	150.29	86	84.05
7.	July	26.70	26.90	21.73	21.27	264.00	339.61	91	90.20
8.	August	26.31	26.82	21.33	21.02	317.90	198.82	94	91.15
9.	September	29.17	28.70	21.01	20.67	148.20	151.79	87	88.60
10.	October	33.24	31.14	20.71	19.97	40.90	99.48	76	77.05
11.	November	31.73	30.73	19.33	17.35	13.10	56.44	66	65.75
12.	December	30.15	29.72	15.05	15.27	24.00	12.27	67	65.95
						Total 1180.80			

Table 2 (Contd....)

Sr. No.	Month	Temperature (°C)				Mean monthly rainfall (mm)		Relative humidity (%)	
		Mean maximum		Mean minimum					
		1981	Last 20 years average	1981	Last 20 years average	1981	Last 20 years average	1981	Last 20 years average
1.	January	29.57	30.87	14.96	14.48	1.00	0.05	76	62.21
2.	February	33.74	32.94	16.35	15.72	-	0.58	61	58.74
3.	March	35.60	35.71	18.93	18.92	4.00	6.27	54	55.94
4.	April	37.49	37.35	21.34	21.27	41.50	44.07	63	63.76
5.	May	36.93	36.14	22.99	22.06	18.80	60.16	71	72.46
6.	June	32.10	31.04	22.93	22.01	227.60	154.65	83	84.17
7.	July	26.85	26.88	21.61	21.28	345.10	338.13	91	90.26
8.	August	25.64	26.80	22.60	21.03	284.90	203.53	93	91.28
9.	September	22.99	28.73	21.44	20.68	228.30	151.08	90	88.53
10.	October	31.94	31.23	20.14	19.99	18.30	96.13	77	76.89
11.	November	30.84	30.78	17.93	17.42	19.10	55.06	70	65.68
12.	December	29.86	29.93	15.60	15.28	-	13.26	67	66.12
					Total	1188.60			

no rains during germination phase, which favoured germination by avoiding the cooling effect on planted seed material.

From January to May, the mean maximum temperature ranged between 30.8 to 38.0, 31.0 to 38.1 and 29.5 to 37.4 °C during the year 1979-80, 1980-81 and 1981-82, respectively.

During tillering and early growth phase, the maximum temperature and humidity were normal with well distributed rainfall, which has favoured the growth of the crop during all the seasons. The relative humidity was quite high i.e. between 80 to 96 per cent during monsoon. However, from October onwards, there was gradual decline in the relative humidity during both the seasons.

The rainfall was near normal precipitation of Kolhapur, during all the seasons. Adequate rainfall was received during rainy months. Light showers were also received during other months except January to March. There was no incidence of major pests and diseases during the period of investigation.

In general, the climatic conditions during all the seasons were almost similar to those of average of 20 years (Fig. 1). All the growth phases enjoyed congenial climatic conditions which helped in luxuriant growth, yield and quality of cane during both the seasons.

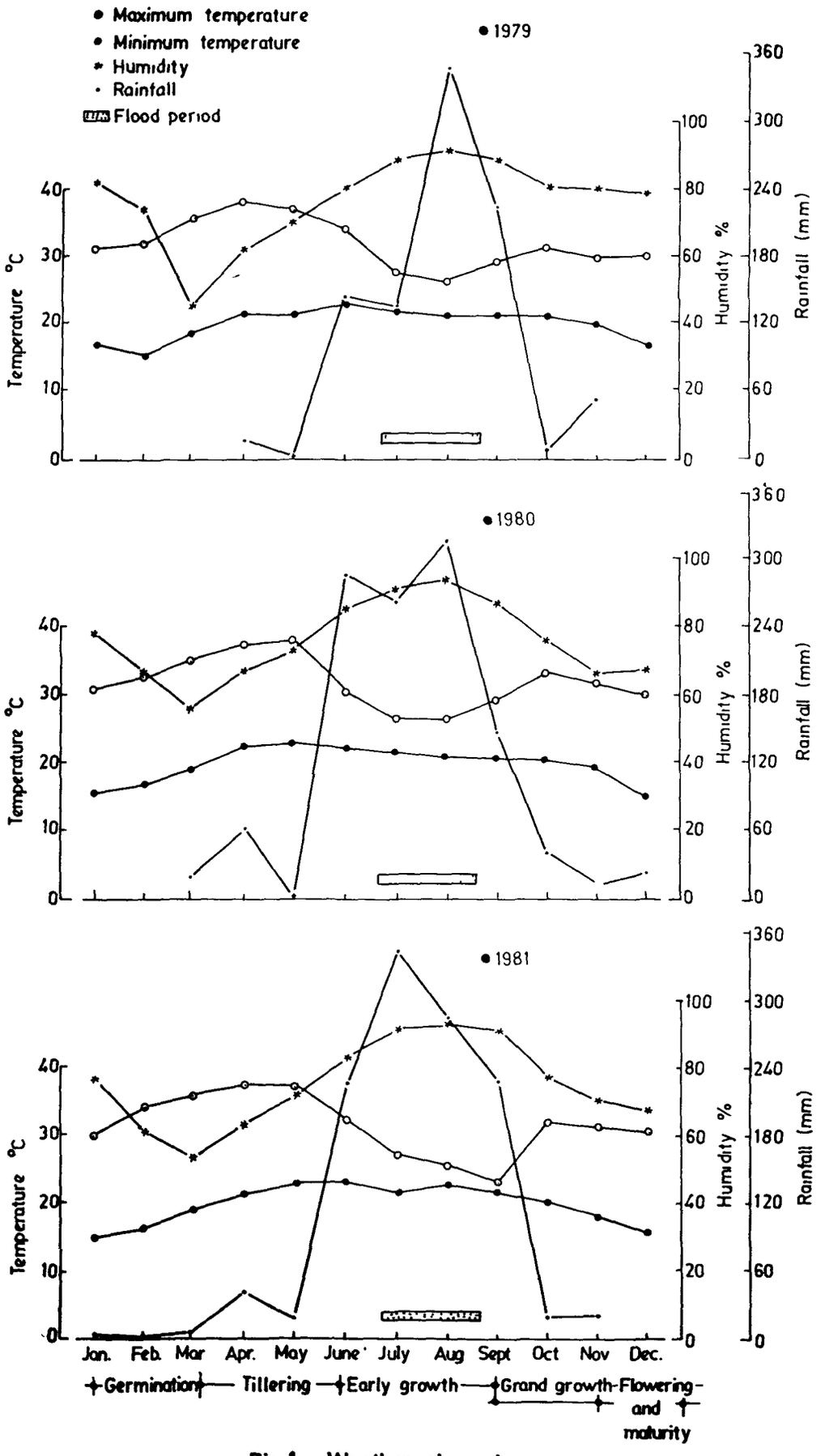


Fig.1 . Weather elements

3.1.4 Cropping history of the experimental field

The cropping history of the experimental field for the last three years is given in Table 3. Paddy-sugarcane was the rotation.

Table 3. Previous three years cropping in the experimental field.

Sr. No.	First year (1979-80)	Second year (1980-81)	Third year (1981-82)	Season	Crop
1.	1975-76	1976-77	1977-78	Kharif	Sugarcane
				Rabi	Sugarcane
				Summer	Fallow
2.	1976-77	1977-78	1978-79	Kharif	Paddy
				Rabi	Sugarcane
				Summer	Sugarcane
3.	1977-78	1978-79	1979-80	Kharif	Sugarcane
				Rabi	Sugarcane
				Summer	Fallow
4.	1978-79	1979-80	1980-81	Kharif	Paddy
				Rabi onwards	Sugarcane crop of present experiment

3.1.5 Experimental details

The experiment was laid out in confounding split plot design with 54 treatments formed from three methods of planting, three plant densities and three levels of nitrogen as

main plot treatments and two sub-plot treatments of tillering and de-tillering. These treatments were replicated twice. The gross plot size was 12.0 x 5.0 m^2 and the net plot size was 10.0 x 3.0 m^2. The allocation of treatments of different plots was done by using random table. The plans of layout of experiment for three seasons are given in Fig. 2 to 4.

The details of treatments and symbols used thereof are given in Table 4.

Table 4. Treatment details and their symbols

	Symbol used	Treatments
I	Main plot treatments	
1	Methods of planting (M)	
	M_1	Normal method of three-budded sett
	M_2	Single budded settling transplanting
	M_3	Single budded sett planting
2	Plant densities (P)	
	P_1	25 x 10^3 buds per hectare
	P_2	50 x 10^3 buds per hectare
	P_3	75 x 10^3 buds per hectare
3	Levels of nitrogen (N)	
	N_1	150 kg nitrogen per hectare
	N_2	200 kg nitrogen per hectare
	N_3	250 kg nitrogen per hectare
II	Sub-plot treatments (T)	
	T_1	Maintaining 10 tillers per m^2 at light earthing(de-tillering)
	T_2	Uncontrolled tillers

Fig. 2 . Plan of layout (1979-80) First year

R II

Sub block- B

M P N T 1 1 2 1	M P N T 1 2 3 2	M P N T 3 3 2 1
1 1 2 2	1 2 3 1	3 3 2 2
2 2 2 2	1 3 1 1	3 1 3 1
2 2 2 1	1 3 1 2	3 1 3 2
2 1 1 2	3 2 1 1	2 3 3 1
2 1 1 1	3 2 1 2	2 3 3 2

Sub block-C

3 1 1 1	2 2 3 2	3 2 2 1
3 1 1 2	2 2 3 1	3 2 2 2
1 1 3 2	1 2 1 1	1 3 2 2
1 1 3 1	1 2 1 2	1 3 2 1
2 1 2 2	3 3 3 1	2 3 1 2
2 1 2 1	3 3 3 2	2 3 1 1

Sub block-A

1 1 1 1	2 3 2 2	3 1 2 1
1 1 1 2	2 3 2 1	3 1 2 2
2 1 3 2	2 2 1 1	1 3 3 2
2 1 3 1	2 2 1 2	1 3 3 1
3 2 3 1	3 3 1 2	1 2 2 1
3 2 3 2	3 3 1 1	1 2 2 2

R I

Sub block - C

M P N T 3 1 1 2	M P N T 1 1 2 2	M P N T 2 1 3 1
3 1 1 1	1 1 2 1	2 1 3 2
2 2 1 2	3 2 2 1	1 2 3 2
2 2 1 1	3 2 2 2	1 2 3 1
1 3 1 2	2 3 2 1	3 3 3 1
1 3 1 1	2 3 2 2	3 3 3 2

Sub block-B

2 1 1 2	3 3 1 1	2 3 3 2
2 1 1 1	3 3 1 2	2 3 3 1
1 2 1 1	2 2 2 1	3 2 3 2
1 2 1 2	2 2 2 2	3 2 3 1
1 3 2 2	1 1 3 1	3 1 2 1
1 3 2 1	1 1 3 2	3 1 2 2

Sub block - A

1 2 2 2	3 1 3 1	2 3 1 2
1 2 2 1	3 1 3 2	2 3 1 1
3 3 2 2	1 1 1 2	2 2 3 1
3 3 2 1	1 1 1 1	2 2 3 2
2 1 2 2	1 3 3 1	3 2 1 1
2 1 2 1	1 3 3 2	3 2 1 2

DESIGN - CONFOUNDING SPLIT PLOT

REPLICATIONS - TWO

BLOCKS - SIX

GROSS PLOT - 12 X 5 m^2

NET PLOT - 10 X 3 m^2

FACTORS - M = METHOD OF PLANTING
P = PLANT DENSITY
N = NITROGEN LEVEL
T = MAINTENANCE OF TILLERS

Fig. 3 Plan of layout (1980-81) Second year

R I

Sub block - A

M P N T	M P N T	M P N T
3 1 2 2	2 1 1 2	3 3 1 1
3 1 2 1	2 1 1 1	3 3 1 2
3 2 3 1	1 2 1 1	2 2 2 1
3 2 3 2	1 2 1 2	2 2 2 2
2 3 3 1	1 3 2 2	1 1 3 1
2 3 3 2	1 3 2 1	1 1 3 2

Sub block-C

1 3 3 2	3 2 1 2	1 2 2 1
1 3 3 1	3 2 1 1	1 2 2 2
1 1 1 1	2 2 3 2	3 3 2 1
1 1 1 2	2 2 3 1	3 3 2 2
3 1 3 2	2 3 1 1	2 1 2 2
3 1 3 1	2 3 1 2	2 1 2 1

Sub block-B

3 3 3 2	3 1 1 2	3 2 2 1
3 3 3 1	3 1 1 1	3 2 2 2
1 2 3 1	2 2 1 2	2 3 2 1
1 2 3 2	2 2 1 1	2 3 2 2
2 1 3 2	1 3 1 2	1 1 2 1
2 1 3 1	1 3 1 1	1 1 2 2

RII

N

Sub block-B

M P N T	M P N T	M P N T
2 1 2 1	3 3 3 1	2 3 1 1
2 1 2 2	3 3 3 2	2 3 1 2
3 1 1 1	1 2 1 1	1 3 2 1
3 1 1 2	1 2 1 2	1 3 2 2
1 1 3 2	2 2 3 1	3 2 2 2
1 1 3 1	2 2 3 2	3 2 2 1

Sub block A

3 3 2 2	2 1 1 1	1 2 3 2
3 3 2 1	2 1 1 2	1 2 3 1
3 1 3 2	2 2 2 1	1 3 1 1
3 1 3 1	2 2 2 2	1 3 1 2
2 3 3 2	1 1 2 2	3 2 1 1
2 3 3 1	1 1 2 1	3 2 1 2

Sub block - C

3 3 1 1	3 1 2 1	3 2 3 2
3 3 1 2	3 1 2 2	3 2 3 1
2 2 1 2	1 3 3 2	2 1 3 1
2 2 1 1	1 3 3 1	2 1 3 2
2 3 2 1	1 2 2 1	1 1 1 2
2 3 2 2	1 2 2 2	1 1 1 1

DESIGN - CONFOUNDING SPLIT PLOT

REPLICATIONS - TWO

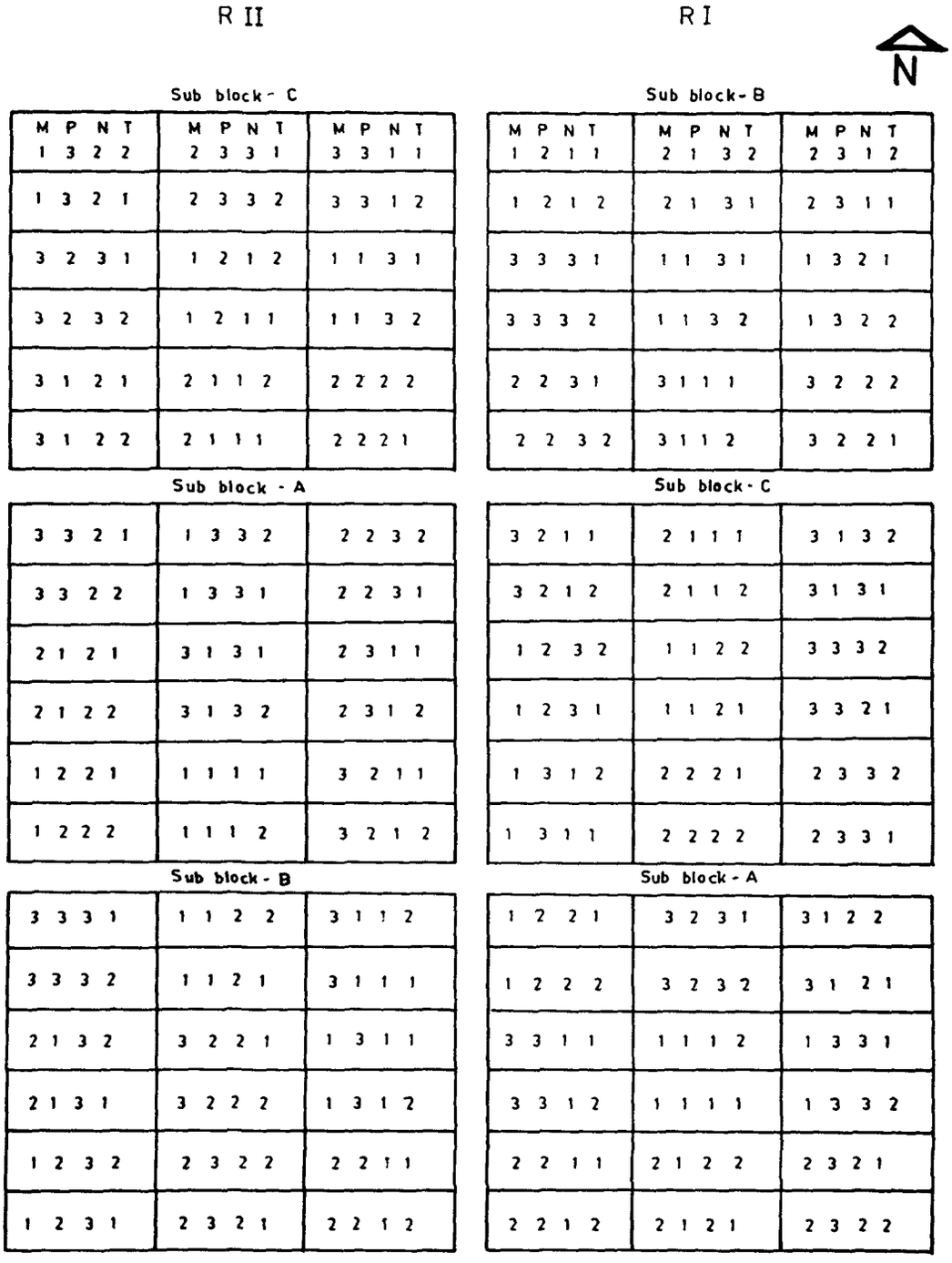
BLOCKS - SIX

GROSS PLOT - 12 X 5 m^2

NET PLOT - 10 X 3 m^2

FACTORS - M = METHOD OF PLANTING
P = PLANT DENSITY
N = NITROGEN LEVEL
T = MAINTENANCE OF TILLERS

Fig. 4. Plan of layout (1981-82) Third year



DESIGN - CONFOUNDING SPLIT PLOT

REPLICATIONS - TWO

BLOCKS - SIX

GROSS PLOT - 12 X 5 m^2

NET PLOT - 10 X 3 m^2

FACTORS - M : METHOD OF PLANTING,
P : PLANT DENSITY
N : NITROGEN LEVEL
T : MAINTENANCE OF TILLERS

3.1.6 Method of maintenance of tillers

Ten tillers were maintained per m^2 by culling the excess tillers close to the ground by sickle at the time of light earthing during first two years of experimentation, however, during third year, the tillers were maintained at the same rate by the same procedure up to final earthing instead up to light earthing.

3.1.7 Field operations

The various cultural operations carried out in the experimental plots for all the years of experimentation are presented in Table 5.

Table 5. Schedule of field operations done in the experimental plots

Sr. No.	Name of operation	Frequency	Date of operation		
			1979-80	1980-81	1981-82
1	Ploughing	1	28.11.78	8.11.79	28.11.80
2	Harrowing	1	10.12.78	20.11.79	9.12.80
3	Collection of stubbles	1	10.12.78	20.11.79	9.12.80
4	F.Y.M. spreading	1	12.12.78	28.11.79	18.12.80
5	Discing	1	12.12.78	28.11.79	18.12.80
6	Ridging	1	13.12.78	13.12.79	22.12.80
7	Layout	1	5.1.79	25.12.79	25.12.80
8	Preparation of water channel	1	6.1.79	25.12.79	29.12.80
9	Planting of sugarcane	1	7.1.79 to 9.1.79	26.12.79 to 28.12.79	1.1.81 to 3.1.81

Table 5 (Contd....)

Sr. No.	Name of operation	Frequency	Date of operation		
			1979-80	1980-81	1981-82
10	Application of fertilizer	4	7.1.79, 2.3.79, 17.4.79, and 18.5.79.	26.12.79, 14.2.80, 3.4.80, and 8.5.80.	1.1.81, 10.2.81, 1.4.81, and 20.5.81.
11	Transplanting of settlings	1	15.2.79	3.2.80	10.2.81
12	Hand weeding	3	10.2.79, 27.3.79, and 27.4.79.	8.2.80, 5.3.80, and 22.4.80	4.2.81, 13.3.81, and 4.4.81.
13	Light earthing	1	17.4.79 to 18.4.79	3.4.80 to 6.4.80	1.4.81 to 4.4.81
14	Final earthing	1	18.5.79 to 22.5.79	8.5.80 to 12.5.80	20.5.81 to 25.5.81
15	Irrigation	Dec.	-	26 & 30	-
		Jan.	7, 10,17 & 28	8, 15 & 25	1, 6, 15 & 28
		Feb.	6, 15 & 24	2, 14 & 24	10, 19 & 27
		Mar.	7, 15 & 28	8, 19 & 30	9, 20 & 29
		Apr.	10, 18 & 25	7, 18 & 28	6, 17 & 27
		May	1, 11 & 23	12, 22 & 31	7, 15 & 26
		Jun.	3	22	25
		Oct.	28	27	21
		Nov.	7, 19 & 30	6, 16 & 28	2, 14 & 29
		Dec.	10 & 22	9 &25	12 & 23
		Jan.	3	-	-
16	Harvesting		23.1.80 to 25.1.80	14.1.81 to 16.1.81	13.1.82 to 17.1.82

3.1.7.1 Application of F.Y.M. and preparation of ridges and furrows

The farm yard manure @ 25 t/ha was evenly spread in the experimental field before planting and was thoroughly mixed in the soil by discing. The ridges and furrows were opened at one metre distance by means of ridger drawn by tractor.

3.1.7.2 Fertilizer application

The experimental crop was fertilized with three levels of nitrogen i.e. 150, 200 and 250 kg/ha through urea and with the recommended dose of 115 kg P_2O_5 through single super phosphate and 115 kg K_2O through muriate of potash per hectare.

Nitrogen was applied in 4 splits as 10:40:10:40 proportion. The basal dose of nitrogen (10 %), 115 kg P_2O_5 and 115 kg K_2O was applied per hectare at planting. The top dressing with 2^{nd} and 3^{rd} dose of nitrogen 40 % and 10 % was done at 8^{th} week and 12^{th} week crop age, respectively, and the final dose of nitrogen (40 %) per hectare was applied at final earthing of sugarcane at 20^{th} week from planting.

3.1.7.3 Seed and planting

The setts of sugarcane (Var. Co.740) were used for planting. Three-budded and single budded setts were prepared.

These were treated with Emisan-6 (6 %) before planting in the experimental plot against smut disease. The planting of sugarcane was completed on 9.1.79, 28.12.79 and 3.1.81; and transplanting of settlings was done on 15.2.79, 3.2.80 and 10.2.81 during 1979-80, 1980-81 and 1981-82, respectively.

3.1.7.4 *Method of* preparation of single budded setts and settlings

The canes with good buds were selected for preparing single budded setts for situ planting as well as for raising the nursery. While preparing the cut was about 2.5 cm above the node and about 7 cm below the node.

(a) Nursery:

Three nursery beds of 1 m width, 10 m length and 15 cm height were prepared with irrigation channels all around. The setts were planted vertically after Emisan-6 treatment, in the beds close to each other allowing about one centimetre interspace between setts. The setts were burried until the bud was covered by the soil. On top, a sprinkling of F.Y.M. and B.H.C. (10 %) was given. Finally, the bed was covered with disinfected paddy straw and watered on alternate day. The nursery thus prepared, was maintained for five weeks in both the years.

(b) Transplanting:

A day prior to transplanting, the nursery beds were flooded with water to enable easy pulling

of seedlings. The seedlings were trimmed by shearing the leaves in the nursery itself to avoid transpiration losses. The seedlings were removed from the nursery and treated again in Emisan solution, before transplanting. While transplanting holes were made with crow-bar in the furrows, at the specified spacing as per the treatments and settlings were planted. Care was taken to press the soil around the settlings after planting to remove air space. This was followed by light irrigation.

3.1.75 Irrigation management

The experimental plot of sugarcane was irrigated considering seasonal rainfall and crop growth stages, during all the years.

3.2 Methods

The details of the biometric and other observations recorded in the experimental crop are given in Table 6.

3.2.1 Sampling technique

Three rows from each plot (gross length 12 metres), were selected for recording emergence, tillering and shoot count. The mean emergence/ survival of settlings, tillering and shoot count at different stages were recorded. The germination percentage at 8^{th} week/survival percentage at 8^{th} week and tillering ratio at 12^{th}, 16^{th} and 20^{th} week was worked out from these observations.

Table 6. Schedule of biometric observations

Particulars	Frequency	Stage i.e. crop age	Plant(s) observed per net plot
A. Growth observations			
1. Germination count	1	8^{th} week	All the plants in 3 rows of 12 m length
2. Survival of settling	1	8^{th} week	-do-
3. Tillering count	3	12^{th}, 16^{th} & 20^{th} week	-do-
4. Shoot count	3	12^{th} 16^{th} & 20^{th} week	-do-
5. Total and millable height, middle girth (cm) and number of internodes	3	At monthly interval, 300 days onwards till harvest	All the plants from randomly selected two clumps
6. Leaf area and dry matter/plant	8	At monthly interval from 30 days after planting up to earthing and 270 days onwards till harvest	-do-
7. Periodical maturity studies	4	At monthly interval from 270 days till harvest	-do-
B. Post-harvest studies			
1. Total and millable height, middle girth (cm), number of internodes per plant and per cane weight	1	At harvest	-do-
2. Number of millable cane	1	At harvest	Net plot
3. Yield of sugarcane	1	At harvest	Net plot
4. Brix, sucrose %, purity % and N.R.	1	At harvest	All the plants from randomly selected two clumps
C. Chemical studies			
1. Soil analysis for determination of physico-chemical constants	1	Before planting	Composite soil sample (30 cm depth)
2. Analysis of sugarcane plant samples for N uptake	1	At harvest	A representative sample from the selected canes

Similarly, shoot count per hectare was also worked out at different stages of crop growth. Two clumps were randomly selected and suitably labelled in each net plot for recording periodic observations such as total height, millable height, middle girth and number of internodes. Another two clumps were randomly selected for dry matter and leaf area studies. During maturity period, two clumps were randomly selected and labelled from each treatment for periodical maturity studies viz., Brix, sucrose % and purity % by extracting the juice. Similarly, at harvest, the maturity studies for Brix, sucrose % in juice, purity % and net rendiment (N.R.) were recorded.

3.2.2 Growth observations

3.2.2.1 Germination/survival percentage

The number of shoots emerged and the number of settlings survived at 8^{th} week in three selected rows were counted and germination/survival percentage was worked out.

3.2.2.2 Tillering ratio

The germination count recorded at 8^{th} week crop age was taken as base population of mother canes and tillering ratio at 12^{th}, 16^{th} and 20^{th} week stage was calculated as follows :

$$\text{Tillering ratio} = \frac{(\text{Total number of shoots}) - (\text{No. of mother canes})}{\text{No. of mother canes}}$$

3.2.2.3 Plant population (shoot) count

As in case of germination count the total number of shoots from three rows of each net plot was counted and number of canes per hectare was worked out at different stages.

3.2.2.4 Total and millable height

The total height of plant (cm) was measured from the ground level up to the base of the top most fully opened leaf, at an interval of 30 days, starting from October onwards till harvest. Millable height of cane was also recorded at above stages measuring from the ground level to the highest visible transverse mark on cane.

3.2.2.5 Number of internodes

The visible internodes on all the plants in the selected two clumps were counted and the mean number of internodes per plant was worked out at different stages.

3.2.2.6 Mid-girth

The circumference of the centrally located internode of different shoots in the selected two clumps was measured and mean middle girth of sugarcane was worked out at different stages.

3.2.2.7 Leaf area

The leaf area studies were done at monthly interval

up to final earthing and maturity phase due to the fact that this being flood prone area, the crop remains under submerged condition, and the field being unaccessible, it is not possible to record leaf area between final earthing to 270 days of crop age. The leaves from all the plants in a randomly selected clump were carefully removed. They were grouped into three categories such as small, medium and large and their number was noted. The length and the maximum breadth of a representative leaf from each category was measured and it was multiplied by the number of leaves of each category, finally summation of all the categories was done and the leaf area per plant was worked out by using the following formula :

$$A = L \times B \times K$$

where,

A = Leaf area per plant (dm^2)
L = Length of leaves (cm)
B = Maximum breadth of leaves (cm)
K = Constant. 0.6274 (Bathla and Sharma, 1978).

3.2.2.8 Leaf area index (LAI)

The leaf area index was calculated at various growth stages from the data on leaf area per plant by using the formula given by Watson (1947).

$$L.A.I. = \frac{\text{Leaf area}}{\text{Land area}} \quad \text{(expressed in same unit)}$$

3.2.2.9 Total dry matter accumulation per plant

The dry matter studies were done on different dates when leaf area studies were made. The leaves and stems of the plants used for leaf area were used for dry matter studies. They were cut into small pieces, dried and final weight of each was recorded after oven drying at 65 $\pm$ 5°C until the constant weight. The mean dry matter per plant (g) was worked out by adding together the weight of leaves and stems of the plants.

3.2.2.10 Absolute growth rate (AGR)

Absolute growth rate (AGR) in terms of dry matter was calculated by using the following formula :

$$A.G.R. = \frac{D_2 - D_1}{t_2 - t_1}$$

where, D_1 and D_2 indicate the dry matter of the plant at times t_1 and t_2, respectively.

3.2.3 Periodical maturity studies

In order to judge the maturity of canes, periodical maturity studies were taken by crushing the canes from the selected two clumps from each treatment starting with 9 months growth of the crop. The Brix reading was recorded by "Brix hydrometer", pol reading of the juice was taken on Polaroscope and sucrose per cent in juice, purity percentage

of juice was worked out at different stages with the help of Schemitz Table.

3.2.4 Yield contributing characters of sugarcane

3.2.4.1 Total and millable height of cane

The canes from selected clumps for recording observations on height of plants were used for recording total and millable height of canes at harvest. Their height was recorded by adopting the method as in case of total and millable height (3.2.2.4).

3.2.4.2 Middle girth and number of internodes at harvest

The circumference (cm) of the centrally located internode and number of internodes per plant of different canes used for millable height was recorded at harvest.

3.2.4.3 Millable canes

At the time of harvesting, all the millable canes from each net plot were cut close to the ground level and their number was counted after dressing. The total number of millable canes per hectare was worked out at harvest.

3.2.5 Yield

3.2.5.1 Yield of sugarcane

After counting the number of millable canes, their weight per net plot was recorded and reported as yield of sugarcane per hectare.

3.2.5.2 Yield response to nitrogen fertilization

To get an idea of the nature of response to nitrogen fertilization since its effect was significant, the treatment sum of squares due to nitrogen were split into linear and quadratic effects and their significance was tested. As the linear effects were significant, a linear equation was fitted for the cane yield data of individual years. The following equation has been worked out to describe a response curve.

$$Y = a + b\,N \quad \text{(Linear response)}$$

where,

Y = Expected yield

a = Mean yield in the absence of input

b = Regression co-efficient

N = Level of nitrogen (kg/ha)

3.2.5.3 Profitability of nitrogen application

Profitability of nitrogen application was examined with present cost structure. The profitability was arrived at by considering the additional income gained and the additional cost involved at different levels of nitrogen.

3.2.5.4 Yield of commercial cane sugar (C.C.S.)

The commercial cane sugar yield (t/ha) was calculated from the net rendiment (N.R.) and the yield of cane per hectare by using the following formula (Spencer and Meade, 1945).

$$\text{C.C.S.(t/ha)} = \frac{\text{Yield X N.R.}}{100}$$

3.2.6 Cane juice quality

Juice was analysed in the laboratory for various constituents like Brix, pol, purity, sucrose and net rendiment. The methods adopted for juice analysis are given in Table 7.

Table 7. Analytical methods used

Juice character determined	Description of methods	Reference
1. Brix	Brix hydrometer with temperature corrected at 27.5°C	Spencer and Meade (1945)
2. Pol reading	Horne's dry lead acetate method	Spencer and Meade (1945)
3. Sucrose	Schemitz's table for Horne's dry lead acetate method	Spencer and Meade (1945)
4. Purity	$\frac{\text{Sucrose \% in juice}}{\text{Correct Brix}} \times 100$	Spencer and Meade (1945)
5. N.R.	Schemitz's table for Horne's dry lead acetate method	Spencer and Meade (1945)

3.2.7 Chemical studies

3.2.7.1 Soil analysis

The methods adopted for soil analysis already given in physico-chemical properties of soil i.e. Table 1.

3.2.7.2 Plant analysis

Sugarcane plant samples from different treatments obtained from selected canes were analysed for nitrogen.

It was estimated by the modified Kjeldahl's method. On the basis of dry matter percentage and nitrogen content, the quantity of nitrogen removed by the crop (kg/ha) was estimated.

3.2.8 Statistical analysis and interpretation of data

The statistical analysis of the data was done by using the standard statistical method of "Analysis of Variance" (Panse and Sukhatme, 1978) and appropriate standard error (S.E.) for each treatment, and correlation studies in respect of yield and yield contributing characters was computed. (Snedecor and Cochran, 1967) using microcomputor. Wherever, results were found to be significant, critical difference (C.D.) values at 5 per cent level of probability were worked out and given. The data have been illustrated graphically at appropriate places.

RESULTS

4. RESULTS

The data on growth, yield and juice quality of sugarcane as affected by different methods of planting, plant densities, levels of nitrogen, maintenance of tillers and their interactions are presented under the following heads.

4.1 Growth and development studies

4.1.1 Germination/survival percentage

Germination/survival count from each treatment plot was taken at 8 weeks from the day of planting and transplanting. The germination and the survival percentage was worked out based on these data (Table 8).

It will be seen that the mean germination/survival percentage at 8 weeks after planting was 91.75 and 97.42 during the year 1979-80 and 1980-81, respectively.

Effect of methods of planting

The mean germination/survival percentage was significantly affected by methods of planting during both the seasons. Single budded sett planting and single budded settling transplanting were significantly superior to three-budded sett planting during both the seasons under investigation. However, during the year 1979-80, the single budded settling transplanting was significantly superior to single budded sett planting, but both the treatments were on par with each other during the year 1980-81.

Table 8. Effects of the various treatments of method of planting, plant density and nitrogen level on germination/survival percentage of sugarcane at 8th week

Treatments	1979-80	1980-81
Method of planting		
M_1 (Three-budded sett planting)	87.50	95.06
M_2 (Single budded settling transplanting)	97.08	99.34
M_3 (Single budded sett planting)	90.66	97.85
'F' test	Sigt.	Sigt.
S.E. ±	0.59	0.58
C.D. at 5 %	1.70	1.67
Plant density		
P_1 (25 x 10^3 buds/ha)	96.59	98.63
P_2 (50 x 10^3 buds/ha)	90.90	97.47
P_3 (75 x 10^3 buds/ha)	87.75	96.15
'F' test	Sigt.	Sigt.
S.E. ±	0.59	0.58
C.D. at 5 %	1.70	1.67
Nitrogen level		
N_1 (150 kg N/ha)	92.01	97.46
N_2 (200 kg N/ha)	91.83	97.62
N_3 (250 kg N/ha)	91.40	97.18
'F' test	N.S.	N.S.
S.E. ±	0.59	0.58
C.D. at 5 %	-	-
Maintenance of tillers		
T_1 (Controlling tillers : 10/m^2)	91.35	97.72
T_2 (Uncontrolled)	92.14	97.11
'F' test	N.S.	N.S.
S.E. ±	0.43	0.29
C.D. at 5 %	-	-
Mean	91.75	97.42

Effect of plant densities

The mean germination/survival percentage was significantly affected by various plant densities. The lowest plant density of 25 x 10^3 buds/ha gave significantly higher germination/survival percentage than the highest plant density of 75 x 10^3 buds/ha during both the seasons. During 1980-81, 25 and 50 x 10^3 buds/ha were on par. Further 50 and 75 x 10^3 buds/ha were on par.

Effect of nitrogen levels

The germination/survival percentage was not influenced by the application of nitrogen during both the seasons.

Interactions

The interaction effects between two and three factors under study were found to be not significant during both the seasons.

4.1.2 Tillering ratio

The data regarding the mean tillering ratio as affected by different treatments are presented in Table 9.

It will be seen that the mean tillering ratio was 6.33, 6.33, 1.87 and 5.70, 5.44,. 2.02 at light earthing, final earthing and one month after final earthing for both the years, respectively.

Table 9. Effects of the various treatments of method of planting, plant density, nitrogen level, maintenance of tillers and their interactions on tillering ratio of sugarcane at different stages

Treatments	1979-80			1980-81		
	At light earthing (12th week)	At final earthing (16th week)	One month after final earthing (20th week)	At light earthing (12th week)	At final earthing (16th week)	One month after final earthing (20th week)
Method of planting						
M_1	6.26	6.27	1.81	4.47	4.52	1.85
M_2	6.85	6.88	1.99	7.12	6.52	2.17
M_3	5.89	5.85	1.80	5.50	5.28	2.04
'F' test	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.
S.E. ±	0.23	0.25	0.04	0.14	0.15	0.03
C.D. at 5 %	0.67	0.74	0.13	0.41	0.43	0.09
Plant density						
P_1	7.68	7.76	3.29	7.29	7.57	3.55
P_2	6.01	5.91	1.43	5.57	5.10	1.65
P_3	5.31	5.33	0.88	4.23	3.63	0.87
'F' test	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.
S.E. ±	0.23	0.25	0.04	0.14	0.15	0.03
C.D. at 5 %	0.67	0.74	0.13	0.41	0.43	0.09
Nitrogen level						
N_1	6.22	6.15	1.77	5.49	5.18	1.93
N_2	6.13	6.21	1.82	5.60	5.38	1.98
N_3	6.65	6.63	2.01	6.00	5.72	2.14
'F' test	N.S.	N.S.	Sigt.	Sigt.	Sigt.	Sigt.
S.E. ±	0.23	0.25	0.04	0.14	0.15	0.03
C.D. at 5 %	-	-	0.13	0.41	0.43	0.09
Maintenance of tillers						
T_1	6.35	6.05	1.73	5.66	4.53	1.86
T_2	6.32	6.61	2.00	5.73	6.34	2.18
'F' test	N.S.	Sigt.	Sigt.	N.S.	Sigt.	Sigt.
S.E. ±	0.09	0.10	0.03	0.08	0.07	0.11
C.D. at 5 %	-	0.29	0.09	-	0.20	0.32
Mean	6.33	6.33	1.87	5.70	5.44	2.02

Table 9 (Contd....) : Interactions - (i) Method of planting X Plant density (M x P))

Treatments	1979-80			1980-81		
	At light earthing (12th week)	At final earthing (16th week)	One month after final earthing (20th week)	At light earthing (12th week)	At final earthing (16th week)	One month after final earthing (20th week)
M_1P_1	7.23	7.33	2.96	5.66	10.11	3.14
M_1P_2	6.26	6.23	1.45	4.33	4.14	1.58
M_1P_3	5.29	5.25	1.03	3.42	3.30	0.84
M_2P_1	8.48	8.48	3.66	8.78	8.86	3.88
M_2P_2	6.29	6.19	1.48	6.98	6.38	1.72
M_2P_3	5.81	5.97	0.82	5.59	4.31	0.91
M_3P_1	7.35	7.46	3.23	7.43	7.76	3.62
M_3P_2	5.49	5.31	1.37	5.40	4.30	1.63
M_3P_3	4.84	4.78	0.81	3.67	3.28	0.85
'F' test	Sigt.	N.S.	Sigt.	Sigt.	Sigt.	Sigt.
S.E. ±	0.39	0.44	0.08	0.22	0.26	0.05
C.D. at 5 %	1.12	-	0.23	0.63	0.75	0.14
			(ii) Method of planting X Nitrogen level (M x N)			
M_1N_1	6.41	6.50	1.82	4.29	4.23	1.76
M_1N_2	6.05	6.00	1.76	4.50	4.77	1.80
M_1N_3	6.31	6.30	1.86	4.63	4.55	2.00
M_2N_1	6.21	6.21	1.87	6.82	6.17	2.06
M_2N_2	6.63	6.86	1.90	6.72	6.29	2.13
M_2N_3	7.83	7.55	2.19	7.81	7.09	2.33
M_3N_1	6.04	5.74	1.62	5.36	5.15	1.98
M_3N_2	5.72	5.79	1.81	5.57	5.09	2.02
M_3N_3	5.92	6.02	1.97	5.57	5.60	2.10
'F' test	Sigt.	N.S.	Sigt.	N.S.	N.S.	Sigt.
S.E. ±	0.39	0.44	0.08	0.22	0.26	0.05
C.D. at 5 %	1.12	-	0.20	-	-	0.14

Table 9 (Contd....):Interactions

(iii) Plant density X Nitrogen level (P x N) 1979-80

Treatments	At light earthing (12th week)	At final earthing (16th week)	One month after final earthing (20th week)
P_1N_1	6.92	6.92	3.02
P_1N_2	7.25	7.55	3.31
P_1N_3	8.88	8.80	3.52
P_2N_1	6.40	6.10	1.34
P_2N_1	6.08	6.01	1.44
P_2N_2	5.56	5.61	1.51
P_2N_3	5.34	5.45	0.94
P_3N_1	5.07	5.07	0.72
P_3N_2	5.52	5.49	0.99
'F' test	Sigt.	N.S.	N.S.
S.E. ±	0.39	0.44	0.08
C.D. at 5 %	1.12	-	-

(iv) Plant density X Maintenance of tillers (P x T) 1980-81

P_1T_1	7.25	6.52	3.34
P_1T_2	7.34	8.63	3.75
P_2T_1	5.56	4.17	1.46
P_2T_2	5.59	6.04	1.83
P_3T_1	4.19	2.91	0.77
P_3T_2	4.27	4.35	0.97
'F' test	N.S.	Sigt.	N.S.
S.E. ±	0.13	0.12	0.18
C.D. at 5 %	-	0.35	-

(v) Nitrogen level X Maintenance of tillers (N x T) 1980-81

N_1T_1	5.28	4.16	1.80
N_1T_2	5.70	6.21	2.07
N_2T_1	5.72	4.62	1.85
N_2T_2	5.48	6.15	2.11
N_3T_1	5.99	4.82	1.92
N_3T_2	6.01	6.67	2.36
'F' test	N.S.	Sigt.	N.S.
S.E. ±	0.13	0.12	0.18
C.D. at 5 %	-	0.35	-

Table 9 (Contd...): Interactions

(vi) Method of planting X Plant density X Maintenance of tillers (M x P x T)

1979-80

Treatments	At light earthing (12th week)	At final earthing (16th week)	One month after final earthing (20th week)
$M_1P_1T_1$	7.39	7.21	2.90
$M_1P_1T_2$	7.07	7.44	3.02
$M_1P_2T_1$	6.56	6.17	1.28
$M_1P_2T_2$	5.96	6.28	1.62
$M_1P_3T_1$	5.46	5.21	0.94
$M_1P_3T_2$	5.11	5.28	1.12
$M_2P_1T_1$	7.89	7.28	3.38
$M_2P_1T_2$	9.04	9.69	3.94
$M_2P_2T_1$	6.28	5.88	1.31
$M_2P_2T_2$	6.29	6.51	1.64
$M_2P_3T_1$	5.60	5.85	0.72
$M_2P_3T_2$	6.03	6.09	0.92
$M_3P_1T_1$	7.56	7.33	3.03
$M_3P_1T_2$	7.14	7.58	3.44
$M_3P_2T_1$	5.53	4.88	1.32
$M_3P_2T_2$	5.45	5.74	1.42
$M_3P_3T_1$	4.88	4.68	0.70
$M_3P_3T_2$	4.80	4.89	0.91
'F' test	N.S.	Sigt.	N.S.
S.E. $\pm$	0.28	0.30	0.08
C.D. at 5 %	-	0.88	-

Effect of methods of planting

The mean tillering ratio was significantly affected due to different methods of planting. The transplanting of single budded settling has recorded significantly more tillering ratio than single budded sett planting at all the stages. Further, it gave significantly more tillering ratio than three-budded sett planting, one month after final earthing and remained on par at the earlier stages of

light and final earthing during 1979-80. However, the transplanting of single budded settling was significantly superior than other methods of planting at all the stages during 1980-81.

Effect of plant densities

The planting of 25 x 10^3 buds/ha gave significantly more tillering ratio at all the stages during both the seasons than 50 and 75 x 10^3 buds/ha. Similarly, 50 x 10^3 buds/ha had its superiority over 75 x 10^3 buds/ha at all the stages during both the seasons, except at final earthing during 1979-80, when they remained on par with each other.

Effect of nitrogen levels

The significant difference was observed in the tillering ratio due to various levels of nitrogen application at all the stages during both the seasons except at the earlier stages of light and final earthing during 1979-80. Application of 250 kg N/ha recorded significantly more tillering ratio than 150 kg N/ha at all the stages during 1980-81 and one month after final earthing during 1979-80. Application of 200 kg and 150 kg N/ha were on par with each other at all the stages during both the seasons.

Effect of maintenance of tillers

The tillering ratio was found to be significantly more with uncontrolled treatment than that with controlling the tillers at both the stages of final earthing and one month after final earthing during both the seasons.

Interactions

(i) Methods of planting X Plant densities (M x P)

The transplanting of single budded settling with 25×10^3 buds/ha gave significantly more tillering ratio than other treatment combinations at all the stages during both the seasons except at final earthing during 1979-80. The transplanting of single budded settling with 50×10^3 buds/ha also gave significantly higher tillering ratio than the other methods of planting at all the stages during 1980-81, however, it was at par with single budded sett planting and three-budded sett planting with 50×10^3 buds/ha during 1979-80. Further, the single budded settling transplanting with 75×10^3 buds/ha was also significantly superior to other methods of planting at light and final earthing during 1980-81 and on par at the latter stage of crop growth, however, it has not shown any significant difference during 1979-80.

(ii) Methods of planting X Nitrogen levels (M x N)

The transplanting of single budded settling with 250 kg N/ha recorded significantly highest tillering ratio

at light earthing and one month after final earthing during 1979-80 and only at one month after final earthing during 1980-81 than the other treatment combinations.

(iii) Plant densities X Nitrogen levels (P x N)

The tillering ratio was influenced significantly only at light earthing during 1979-80, when 25 x 10^3 buds per hectare with 250 kg N/ha had its superiority over other treatment combinations. In general, tillering ratio was found to be more with 25 x 10^3 buds/ha under varying levels of nitrogen.

(iv) Plant densities X Maintenance of tillers (P x T)

The tillering ratio was significantly influenced due to plant density X maintenance of tillers only at final earthing during 1980-81. Though, significant differences were not observed during other stages, by and large, the treatment of planting 25 x 10^3 buds/ha with uncontrolled tillers produced highest tillering ratio than other combinations at all the stages, during both the years.

(v) Nitrogen levels X Maintenance of tillers (N x T)

The effects of interaction between nitrogen levels and maintenance of tillers were found to be non-significant at all the stages, during both the years, except at final earthing during 1980-81. By and large, it was observed

that the increasing level of nitrogen increased tillering ratio in case of uncontrolled tillers, except at light earthing and final earthing during 1980-81 when 200 kg N/ha gave lower tillering ratio than 150 kg N/ha.

(vi) Methods of planting X Plant densities X Maintenance of tillers (M x P x T)

The interaction between various factors under study was found to be not significant at all the stages of crop growth, except at final earthing during 1979-80 when the transplanting of single budded settling with 25 x 10^3 buds/ha and uncontrolled tillers gave significantly highest tillering ratio than other treatment combinations. Although the differences were not discernible at other stages, the above treatment recorded the highest tillering ratio.

4.1.3 Number of shoots at different stages

The data pertaining to the mean shoot count per hectare at different stages as influenced by various treatments are presented in Table 10.

The mean shoot count of 304.41 x 10^3/ha and 282.32 x 10^3/ha at final earthing was declined at harvest by 65.43 and 59.92 per cent (Table 19) during the years 1979-80 and 1980-81, respectively.

Table 10. Effects of the various treatments of method of planting, plant density, nitrogen level, maintenance of tillers and their interactions on number of shoots at different stages in '000'

Treatments	1979-80			1980-81		
	At light earthing (12th week)	At final earthing (16th week)	One month after final earthing (20th week)	At light earthing (12th week)	At final earthing (16th week)	One month after final earthing (20th week)
Method of planting						
M_1	279.60	278.30	100.42	244.24	241.12	118.50
M_2	359.31	357.47	121.84	377.63	334.82	133.00
M_3	278.50	277.47	105.26	287.78	271.01	126.29
'F' test	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.
S.E. ±	7.85	8.01	1.26	4.45	5.90	1.00
C.D. at 5 %	22.65	23.11	3.63	12.85	17.02	2.88
Plant density						
P_1	212.02	212.49	103.71	204.16	211.21	112.04
P_2	312.92	310.99	109.51	323.98	299.30	130.06
P_3	392.44	389.76	114.36	381.51	336.44	135.72
'F' test	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.
S.E. ±	7.85	8.01	1.26	4.45	5.90	1.00
C.D. at 5 %	22.65	23.11	3.63	12.85	17.02	2.88
Nitrogen level						
N_1	294.21	290.99	104.07	295.69	273.07	123.25
N_2	309.99	311.30	109.86	297.92	277.83	124.20
N_3	313.17	310.95	113.59	316.04	296.05	130.37
'F' test	N.S.	N.S.	Sigt.	Sigt.	Sigt.	Sigt.
S.E. ±	7.85	8.01	1.26	4.45	5.90	1.00
C.D. at 5 %	-	-	3.63	12.85	17.02	2.88
Maintenance of tillers						
T_1	304.66	292.36	103.22	301.50	241.01	118.86
T_2	306.92	316.46	115.13	304.93	323.63	136.02
'F' test	N.S.	Sigt.	Sigt.	N.S.	Sigt.	Sigt.
S.E. ±	3.87	4.31	5.71	3.64	2.86	0.87
C.D. at 5 %	-	12.61	2.08	-	8.37	2.54
Mean	305.79	304.41	109.18	303.22	282.32	125.94

Table 10 (Contd...): Interactions

(i) Method of planting X Plant density (M x P) 1979-80

Treatments	At light earthing (12th week)	At final earthing (16th week)	One month after final earthing (20th week)
M_1P_1	199.32	200.05	94.62
M_1P_2	306.86	305.07	103.66
M_1P_3	332.63	329.77	102.99
M_2P_1	234.03	232.13	114.02
M_2P_2	351.12	348.38	120.09
M_2P_3	492.80	491.89	131.40
M_3P_1	202.72	205.28	102.47
M_3P_2	280.80	279.50	104.77
M_3P_3	351.90	347.62	108.52
'F' test	Sigt.	Sigt.	Sigt.
S.E. ±	13.60	13.88	2.18
C.D. at 5%	39.23	40.04	6.28
			1980-81
M_1P_1	163.43	174.83	101.15
M_1P_2	258.29	248.42	124.78
M_1P_3	310.98	300.11	129.22
M_2P_1	240.74	242.76	120.09
M_2P_2	398.43	364.09	135.78
M_2P_3	493.72	397.61	143.19
M_3P_1	208.31	216.06	114.52
M_3P_2	315.22	285.38	129.61
M_3P_3	339.83	311.59	134.76
'F' test	Sigt.	Sigt.	N.S.
S.E.±	7.71	10.21	1.74
C.D. at 5 %	22.25	29.45	-

(ii) Plant density X Nitrogen level (P x N) 1979-80

P_1N_1	193.55	193.00	98.19
P_1N_2	199.39	207.35	103.97
P_1N_3	223.12	236.62	108.96
P_2N_1	325.25	320.60	105.65
P_2N_2	320.31	317.22	110.29
P_2N_3	293.20	295.14	112.58
P_3N_1	363.83	358.87	108.37
P_3N_2	410.29	409.32	115.32
P_3N_3	403.20	401.09	119.22
'F' test	Sigt.	N.S.	N.S.
S.E. ±	13.60	13.88	2.18
C.D. at 5 %	39.23	-	-

Table 10 (Contd....) : Interactions

(iii) Plant density X Maintenance of tillers (P x T)

1980-81

Treatment	At light earthing (12th week)	At final earthing (16th week)	One month after final earthing (20th week)
P_1T_1	202.70	185.71	106.94
P_1T_2	205.62	236.72	117.13
P_2T_1	323.44	254.88	121.33
P_2T_2	324.51	343.71	138.78
P_3T_1	378.36	282.42	128.31
P_3T_2	384.66	390.45	143.14
'F' test	N.S.	Sigt.	N.S.
S.E. ±	6.31	4.95	1.50
C.D. at 5 %	-	14.48	-

(iv) Nitrogen level X Maintenance of tillers (N x T)

1979-80

N_1T_1	297.04	281.89	99.29
N_1T_2	291.38	300.09	108.85
N_2T_1	304.85	296.97	105.04
N_2T_2	315.14	325.63	114.68
N_3T_1	312.09	298.23	105.32
N_3T_2	314.25	323.67	121.85
'F' test	N.S.	N.S.	Sigt.
S.E. ±	6.70	7.47	1.22
C.D. at 5 %	-	-	3.56

1980-81

N_1T_1	286.89	227.23	116.84
N_1T_2	304.49	318.91	129.66
N_2T_1	302.69	244.19	118.63
N_2T_2	293.15	311.46	129.77
N_3T_1	314.92	251.59	121.11
N_3T_2	317.16	340.51	128.52
'F' test	N.S.	Sigt.	N.S.
S.E. ±	6.31	4.95	1.50
C.D. at 5 %	-	14.48	-

Table 10 (Contd...) : Interactions

(v) Method of planting X Plant density X Maintenance of tillers (M x P x T)

1980-81

Treatments	At light earthing (12th week)	At final earthing (16th week)	One month after final earthing (20th week)
$M_1P_1T_1$	168.80	158.90	98.25
$M_1P_1T_2$	158.07	190.75	104.77
$M_1P_2T_1$	259.58	210.42	116.02
$M_1P_2T_2$	257.00	286.42	133.53
$M_1P_3T_1$	295.32	261.72	119.07
$M_1P_3T_2$	326.65	338.50	139.37
$M_2P_1T_1$	230.85	212.85	114.20
$M_2P_1T_2$	250.63	272.67	125.98
$M_2P_2T_1$	397.62	319.55	129.27
$M_2P_2T_2$	399.23	408.63	142.30
$M_2P_3T_1$	499.48	316.28	138.48
$M_2P_3T_2$	487.95	478.93	147.90
$M_3P_1T_1$	208.45	185.38	108.38
$M_3P_1T_2$	208.17	246.73	120.65
$M_3P_2T_1$	313.13	234.68	118.72
$M_3P_2T_2$	317.30	336.08	140.50
$M_3P_3T_1$	340.27	269.27	127.37
$M_3P_3T_2$	339.38	353.92	142.15
'F' test	N.S.	Sigt.	N.S.
S.E. ±	10.94	8.57	2.61
C.D. at 5 %	-	25.07	-

(vi) Method of planting X Nitrogen level X Maintenance of tillers (M x N x T)

1980-81

$M_1N_1T_1$	222.28	200.32	107.42
$M_1N_1T_2$	247.20	260.30	123.80
$M_1N_2T_1$	241.18	208.52	112.13
$M_1N_2T_2$	246.90	283.58	120.13
$M_1N_3T_1$	260.93	222.18	113.78
$M_1N_3T_2$	247.62	271.78	133.73
$M_2N_1T_1$	357.18	261.18	125.47
$M_2N_1T_2$	379.98	385.40	134.83
$M_2N_2T_1$	367.57	288.77	127.58
$M_2N_2T_2$	364.20	365.32	136.25
$M_2N_3T_1$	403.20	298.73	128.90
$M_2N_3T_2$	393.63	409.52	145.10
$M_3N_1T_1$	281.20	220.20	117.65
$M_3N_1T_2$	286.28	311.03	130.33
$M_3N_2T_1$	299.33	235.28	116.17
$M_3N_2T_2$	268.35	285.48	132.92
$M_3N_3T_1$	281.15	233.85	120.65
$M_3N_3T_2$	310.22	340.22	140.05
'F' test	N.S.	Sigt.	N.S.
S.E. ±	10.94	8.57	2.61
C.D. at 5 %	-	25.07	-

Effect of methods of planting

There was a significant difference in mean number of shoots per hectare due to different methods of planting at all the stages of crop growth. The treatment M_2 i.e. transplanting single budded settling significantly increased the shoots over single budded sett planting and three-budded sett planting at all the stages, during both the seasons. Similarly, the single budded sett planting also showed significant increase over three-budded sett planting at all the stages during both the seasons, except at light and final earthing during 1979-80, when both the treatments were on par with each other.

Effect of plant densities

The mean shoot count was significantly affected by different plant densities at all the stages, during both the seasons. The highest number of shoots per hectare was obtained at all the stages, during both the seasons due to planting of 75 x 10^3 buds/ha, which was significantly superior to 50 and 25 x 10^3 buds/ha. Similarly, 50 x 10^3 buds/ha had its superiority over 25 x 10^3 buds/ha. Thus, it was evident that increase in plant densities increase the number of shoot/ha.

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Effect of nitrogen levels

The different levels of nitrogen significantly influenced the number of shoots per hectare at all the

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stages, during both the seasons, except at earlier period of light and final earthing during 1979-80. Application of 250 kg N/ha recorded significantly highest number of shoots per hectare than 200 and 150 kg N/ha. The latter two levels of nitrogen during 1980-81 were on par among themselves. By and large, the increasing level of nitrogen increased the number of shoots at all the stages.

Effect of maintenance of tillers

The mean number of shoots was significantly affected by maintenance of tillers. The highest number of shoots per hectare was observed with uncontrolled treatment than controlling tillers at final earthing and one month after final earthing during both the seasons.

Interactions

(i) Methods of planting X Plant densities (M x P)

The interaction effects due to methods of planting and plant densities were found to be significant at all the stages during both the seasons, except one month after final earthing during 1980-81.

The transplanting of single budded settling with 75×10^3 buds/ha recorded significantly more number of shoots than other treatment combinations at all the stages during both the seasons. The treatments, transplanting of single budded settling with 50×10^3 buds/ha, three and single

budded sett planting with 75 x 10^3 buds/ha were the followers of above treatment at all the stages.

(ii) Plant densities X Nitrogen levels (P x N)

The interaction effects between plant densities and nitrogen levels were found to be not significant at all the stages, except at the earlier stage of light earthing during 1979-80, when planting of 75 x 10^3 buds/ha with different levels of nitrogen gave significantly more number of shoots than other treatment combinations. Although, the interaction effects were not significant at other stages, almost similar trend was observed during both the seasons as in case of light earthing during the year 1979-80.

(iii) Plant densities X Maintenance of tillers (P x T)

The interaction effects between plant densities and maintenance of tillers were found to be not significant at all the stages, during both the seasons, except at final earthing during 1980-81, when the treatment of planting 75 x 10^3 buds/ha with uncontrolled tillers gave significantly more number of shoots than other treatment combinations. By and large, increase in plant density from 25 to 75 x 10^3 buds/ha increased the number of shoots at all the stages during both the seasons. Similarly, more number of shoots were observed where tillers were not controlled.

(iv) Nitrogen levels X Maintenance of tillers (N x T)

The interaction effects at one month after final earthing, during 1979-80 and at final earthing during 1980-81 were found to be significant. Although, significant differences were not observed at other stages, by and large, application of 250 kg N/ha with uncontrolled tillers gave the highest number of shoots per hectare when compared with other treatment combinations.

(v) Methods of planting X Plant densities X Maintenance of tillers (M x P x T)

The interaction effects due to different treatments of methods of planting, plant densities and maintenance of tillers were found to be not significant at all the stages during both the seasons, except at final earthing during 1980-81. The transplanting of single budded settling with 75×10^3 buds/ha and uncontrolled tillers recorded significantly highest number of shoots than other treatment combinations. Though not significant, almost similar trend as that of final earthing stage during 1980-81, was observed at all the stages, however, transplanting of settling with 25 to 75×10^3 buds/ha, with and without controlling tillers had its superiority over other methods of planting.

(vi) Methods of planting X Nitrogen levels X Maintenance of tillers (M x N x T)

The interaction effects at final earthing, during

Table 11. Effects of the various treatments of method of planting, plant density, nitrogen level, maintenance of tillers and their interactions on leaf area per plant (dm^2) at different stages (days). 1979-80

Treatments	30	60	90	120	270	300	330	At harvest
Method of planting								
M_1	1.98	10.14	37.57	72.64	74.49	79.64	71.52	64.59
M_2	0.65	2.51	20.17	59.54	62.59	67.74	60.74	56.09
M_3	1.15	5.90	32.11	61.88	63.98	69.13	61.73	57.19
'F'test	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.
S.E. ±	0.09	0.37	1.69	3.30	2.67	2.58	2.14	1.63
C.D. at 5 %	0.26	1.82	4.47	9.52	7.70	7.44	6.17	4.70
Plant density								
P_1	1.29	6.02	34.51	79.27	80.85	86.00	76.75	69.23
P_2	1.26	6.75	30.27	60.76	61.26	66.41	59.41	54.50
P_3	1.23	5.76	25.07	54.03	58.95	64.10	57.83	54.15
'F' test	N.S.	N.S.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.
S.E. ±	0.09	0.37	1.69	3.30	2.67	2.58	2.14	1.63
C.D. at 5 %	-	-	4.47	9.52	7.70	7.44	6.17	4.70
Nitrogen level								
N_1	1.26	5.97	27.85	62.26	64.29	69.44	63.30	58.16
N_2	1.37	6.21	30.94	65.27	67.08	72.23	64.54	58.94
N_3	1.16	6.36	31.06	66.53	69.70	74.85	66.15	60.17
'F' test	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
S.E. ±	0.09	0.37	1.69	3.30	2.67	2.58	2.14	1.63
C.D. at 5 %	-	-	-	-	-	-	-	-
Maintenance of tillers								
T_1	1.30	6.27	31.68	63.55	66.18	71.33	63.80	58.42
T_2	1.22	6.09	30.22	65.82	67.86	73.01	65.52	60.16
'F' test	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
S.E. ±	0.08	0.23	1.04	1.89	1.88	1.75	1.30	1.01
C.D. at 5 %	-	-	-	-	-	-	-	-
Mean	1.26	6.18	24.95	64.68	67.02	72.17	64.66	59.29

Table 11 (Contd....) 1980-81

Treatments	30	60	90	120	270	300	330	At harvest
Method of planting								
M_1	1.93	7.62	36.71	65.34	79.91	85.90	79.34	71.74
M_2	0.63	3.02	20.44	56.77	73.03	79.12	73.29	64.49
M_3	1.10	6.14	31.16	56.25	74.08	80.77	74.67	64.38
'F' test	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.
S.E. ±	0.09	0.51	1.44	2.80	2.04	1.83	1.30	1.20
C.D. at 5 %	0.26	1.47	4.15	8.08	5.88	5.28	3.75	3.46
Plant density								
P_1	1.37	5.25	31.89	74.74	84.64	90.73	82.46	74.82
P_2	1.13	6.12	30.87	55.04	72.56	78.65	73.74	64.61
P_3	1.16	5.01	25.56	48.51	70.32	76.41	71.10	61.18
'F' test	N.S.	N.S.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.
S.E. ±	0.09	0.51	1.44	2.80	2.04	1.83	1.30	1.20
C.D. at 5 %	-	-	4.15	8.08	5.88	5.28	3.75	3.46
Nitrogen level								
N_1	1.13	5.40	27.53	57.07	73.40	79.49	74.60	65.64
N_2	1.45	5.60	30.91	58.79	75.82	81.90	74.81	66.01
N_3	1.13	5.37	29.37	62.44	78.30	84.39	78.29	68.96
'F' test	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
S.E. ±	0.09	0.51	1.44	2.80	2.04	1.83	1.30	1.20
C.D. at 5 %	-	-	-	-	-	-	-	-
Maintenance of tillers								
T_1	1.17	5.52	29.93	58.85	75.95	81.04	75.64	65.94
T_2	1.27	5.40	28.94	60.02	74.73	82.82	75.89	66.80
'F' test	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
S.E. ±	0.06	0.20	1.09	2.16	1.93	1.21	0.88	0.47
C.D. at 5 %	-	-	-	-	-	-	-	-
Mean	1.22	5.46	29.43	59.43	74.84	81.93	75.76	66.87

Table 11 (Contd....): Interactions (i) Method of planting X Plant density (M x P)

1979-80

Treatments	30	60	90	120	270	300	330	At harvest
M_1P_1	2.02	9.30	39.99	88.41	90.27	95.42	85.87	74.27
M_1P_2	1.86	11.26	39.76	65.03	65.71	70.86	63.75	58.91
M_1P_3	2.05	9.86	32.96	64.48	67.50	72.65	64.96	60.58
M_2P_1	0.70	2.57	22.54	79.50	82.56	87.71	77.09	70.95
M_2P_2	0.63	2.27	20.41	57.32	57.22	62.37	55.83	51.33
M_2P_3	0.63	2.68	17.56	41.79	47.98	53.13	49.30	46.01
M_3P_1	1.15	6.21	40.99	69.91	69.72	74.87	67.30	62.46
M_3P_2	1.29	6.73	30.63	59.94	60.86	66.01	58.65	53.25
M_3P_3	1.02	4.75	24.70	55.80	61.37	66.52	59.24	55.85
'F'test	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	Sigt.
S.E. ±	0.16	0.64	2.92	5.71	7.67	7.44	3.71	2.83
C.D. at 5 %	-	-	-	-	-	-	-	8.16
								1980-81
M_1P_1	2.30	6.42	42.55	81.71	90.15	96.24	86.23	79.68
M_1P_2	1.68	8.11	33.78	60.35	75.52	81.61	77.45	71.73
M_1P_3	1.81	7.13	33.80	53.98	73.76	79.85	74.35	63.81
M_2P_1	0.67	2.79	20.39	72.39	81.85	87.94	80.93	73.22
M_2P_2	0.63	3.32	22.04	52.73	71.82	77.91	72.17	62.44
M_2P_3	0.59	2.94	18.89	44.64	65.41	71.50	66.76	57.81
M_3P_1	1.14	6.55	32.72	69.78	81.90	87.99	80.20	71.57
M_3P_2	1.07	6.91	36.79	52.03	70.33	76.42	71.61	59.66
M_3P_3	1.08	4.95	23.98	46.93	71.80	77.89	72.19	61.91
'F' test	N.S.	N.S.	N.S.	Sigt.	N.S.	N.S.	N.S.	N.S.
S.E. ±	0.15	0.89	2.49	2.49	3.09	3.17	2.25	2.07
C.D. at 5 %	-	-	-	6.92	-	-	-	-

Table 11 (Contd....): Interactions (ii) Method of planting X Maintenance of tillers (M x T) 1980-81

Treatments	30	60	90	120	270	300	330	At harvest
M_1T_1	1.96	7.31	37.67	67.82	82.85	88.91	80.88	72.85
M_1T_2	1.90	7.13	35.75	62.87	76.80	82.89	78.20	70.63
M_2T_1	0.61	2.96	19.83	52.09	70.58	76.67	71.61	63.17
M_2T_2	0.65	3.07	21.05	61.32	75.48	81:57	74.96	65.81
M_3T_1	0.95	6.27	32.30	56.62	74.44	80.53	74.83	64.82
M_3T_2	1.25	6.00	30.03	55.87	74.91	81.00	74.51	63.95
'F' test	N.S.	N.S.	N.S.	N.S.	Sigt.	Sigt.	Sigt.	Sigt.
S.E. ±	0.11	0.35	1.89	3.74	2.17	2.09	1.52	0.81
C.D. at 5 %	-	-	-	-	6.34	6.11	4.45	2.37

(iii) Plant density X Maintenance of tillers (P x T) 1979-80

P_1T_1	1.34	6.31	38.00	83.77	84.59	89.74	79.00	70.88
P_1T_2	1.24	5.74	31.01	74.78	77.11	82.26	74.50	67.57
P_2T_1	1.35	6.59	30.50	56.13	56.86	62.01	55.99	51.71
P_2T_2	1.17	6.91	30.04	65.40	65.67	70.82	62.83	57.28
P_3T_1	1.20	5.92	26.55	50.76	57.09	62.24	56.43	52.67
P_3T_2	1.26	5.61	23.60	57.29	60.81	65.96	59.24	55.62
'F' test	N.S.	N.S.	N.S.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.
S.E. ±	0.13	0.41	1.81	3.27	2.98	3.03	2.25	1.75
C.D. at 5 %	-	-	-	9.57	8.72	8.86	6.74	5.12

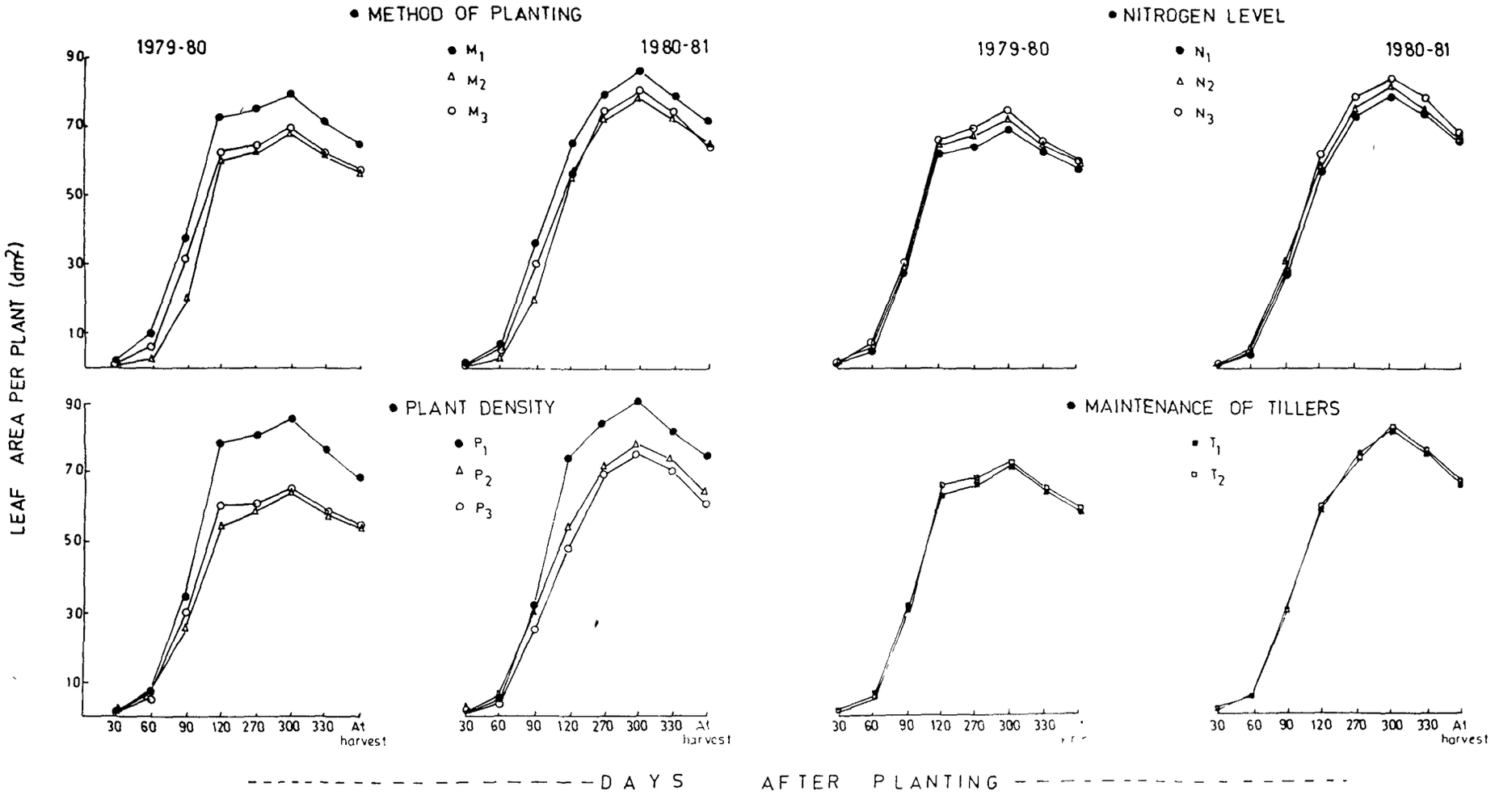

Fig 5 Periodical mean leaf area per plant (dm^2) as influenced by factors

methods of planting at all the stages, during both the seasons. The single budded sett planting had also its superiority over single budded settling transplanting at 30, 60 and 90 days after planting and on par among themselves from 120 days during both the seasons.

Effect of plant densities

The leaf area per plant was significantly affected by the various plant densities from 90 days after planting till harvest in both the seasons. The planting of 25×10^3 buds/ha showed significantly higher leaf area than 75×10^3 buds/ha at all the stages, while it was on par with 50×10^3 buds/ha at 90 days during both the seasons. Although a significant difference was not observed in the earlier period, the trend of leaf area was almost similar as that of latter stages.

Effect of nitrogen levels

Application of nitrogen did not influence the leaf area per plant significantly, at any of the stages of crop growth. However, increase in the level of nitrogen increased the leaf area per plant at all the stages.

Effect of maintenance of tillers

The mean leaf area per plant was not significantly influenced by maintenance of tillers in both the seasons.

Interactions

The interaction effects between two and three factors under study found to be not significant at most of the stages.

(i) Methods of planting X Plant densities (M x P)

In method of planting and plant density interaction however, significant differences were observed at harvest in 1979-80 and at 120 days after planting during 1980-81, when the planting of three-budded sett with 25 x 10^3 buds/ha had its superiority over all other combinations.

Although, significant differences were not observed at other stages, almost similar trend as that of 120 days during 1980-81 was observed throughout the crop growth period except at 60 days during both the years when planting of three-budded sett with 50 x 10^3 buds/ha recorded comparatively higher leaf area per plant than the other combinations.

The transplanting of single budded settling with different plant densities produced the lowest leaf area per plant during both the years up to 90 days from transplanting.

(ii) Methods of planting X Maintenance of tillers (M x T)

The significant difference was observed in the mean leaf area per plant from 270 days till harvest during the

year 1980-81, when the planting of three-budded sett with and without controlling tillers recorded more leaf area than all other combinations. Although not significant at other stages,in general, the planting of three-budded sett with and without controlling tillers recorded higher leaf area per plant than the other two methods of planting.

(iii) Plant densities X Maintenance of tillers (P x T)

In plant density and maintenance of tillers interaction, the differences in leaf area were found to be significant from 120 days after planting till harvest only during the year 1979-80, when the planting of 25 x 10^3 buds/ha with and without controlling tillers showed significantly more leaf area than other treatment combinations. Although not significant, similar trend was observed during 1980-81.

The plant densities of 50 and 75 x 10^3 buds/ha with uncontrolled tillers showed comparatively more leaf area from 120 days after planting till harvest during both the seasons.

The interaction effects due to three factors under study were found to be not significant during both the seasons.

4.1.5 Leaf area index (LAI)

The data on leaf area index (LAI) as affected periodically by different treatments are given in Table 12 and

graphically shown in Fig. 6. The data were not statistically analysed. Inferences are based on mean values.

A glance at Table 12 would reveal that the mean L.A.I. was 0.06 at 30 days from planting. There was a gradual increase in mean leaf area index up to 270 days during 1979-80 and 300 days during 1980-81 from planting and thereafter decreased gradually up to harvest. The mean maximum L.A.I. of 6.67 and 8.25 was recorded at 270 and 300 days from planting during 1979-80 and 1980-81, respectively.

Effect of methods of planting

It would be observed that the maximum L.A.I. was observed with three-budded sett planting. The planting of single budded sett had its superiority over transplanting single budded settling up to 270 days but thereafter, single budded settling transplanting showed comparitively more L.A.I. than single budded sett planting during both the seasons.

Effect of plant densities

The varying plant densities influenced the mean L.A.I. Increase in plant density from 25 to 75 x 10^3 buds/ha increased the L.A.I. up to 120 days from planting. However, 270 days onwards the lower plant density showed higher L.A.I.

Table 12. Effects of the various treatments of method of planting, plant density, nitrogen level and maintenance of tillers on leaf area index (LAI) at different stages (days)

Treatments	1979-80								1980-81							
	30	60	90	120	270	300	330	At harvest	30	60	90	120	270	300	330	At harvest
Method of planting																
M_1	0.10	0.51	1.82	3.43	7.38	6.83	6.10	5.95	0.09	0.37	1.76	3.04	7.88	8.34	7.52	5.87
M_2	0.03	0.13	0.97	2.66	6.24	6.40	5.71	5.36	0.03	0.15	1.00	2.60	7.24	8.33	7.47	5.16
M_3	0.06	0.28	1.47	2.98	6.39	6.18	5.48	4.33	0.05	0.29	1.48	2.62	7.41	8.07	7.39	4.90
Plant density																
P_1	0.03	0.15	0.86	1.98	8.01	7.44	6.55	5.77	0.03	0.13	0.80	1.87	8.35	8.26	7.41	5.76
P_2	0.06	0.34	1.51	3.04	6.11	6.04	5.37	4.76	0.06	0.31	1.54	2.75	7.19	8.25	7.48	5.26
P_3	0.09	0.43	1.88	4.05	5.89	6.03	5.38	4.91	0.08	0.38	1.91	3.64	6.99	8.22	7.48	4.93
Nitrogen level																
N_1	0.06	0.29	1.34	2.79	6.37	5.97	5.38	4.78	0.06	0.28	1.34	2.65	7.24	8.16	7.42	5.29
N_2	0.06	0.31	1.42	3.05	6.69	6.48	5.76	5.23	0.07	0.27	1.44	2.82	7.51	8.10	7.39	5.32
N_3	0.06	0.32	1.50	3.22	6.96	7.06	6.16	5.43	0.06	0.26	1.47	2.79	7.78	8.48	7.56	5.33
Maintenance of tillers																
T_1	0.06	0.31	1.49	2.90	6.57	6.17	5.47	4.83	0.06	0.28	1.41	2.66	7.50	7.90	7.13	5.20
T_2	0.06	0.30	1.35	3.15	6.77	6.84	6.06	5.46	0.06	0.26	1.42	2.84	7.52	8.59	7.78	5.43
Mean	0.06	0.30	1.42	3.02	6.67	6.50	5.77	5.14	0.06	0.27	1.41	2.75	7.51	8.25	7.46	5.31

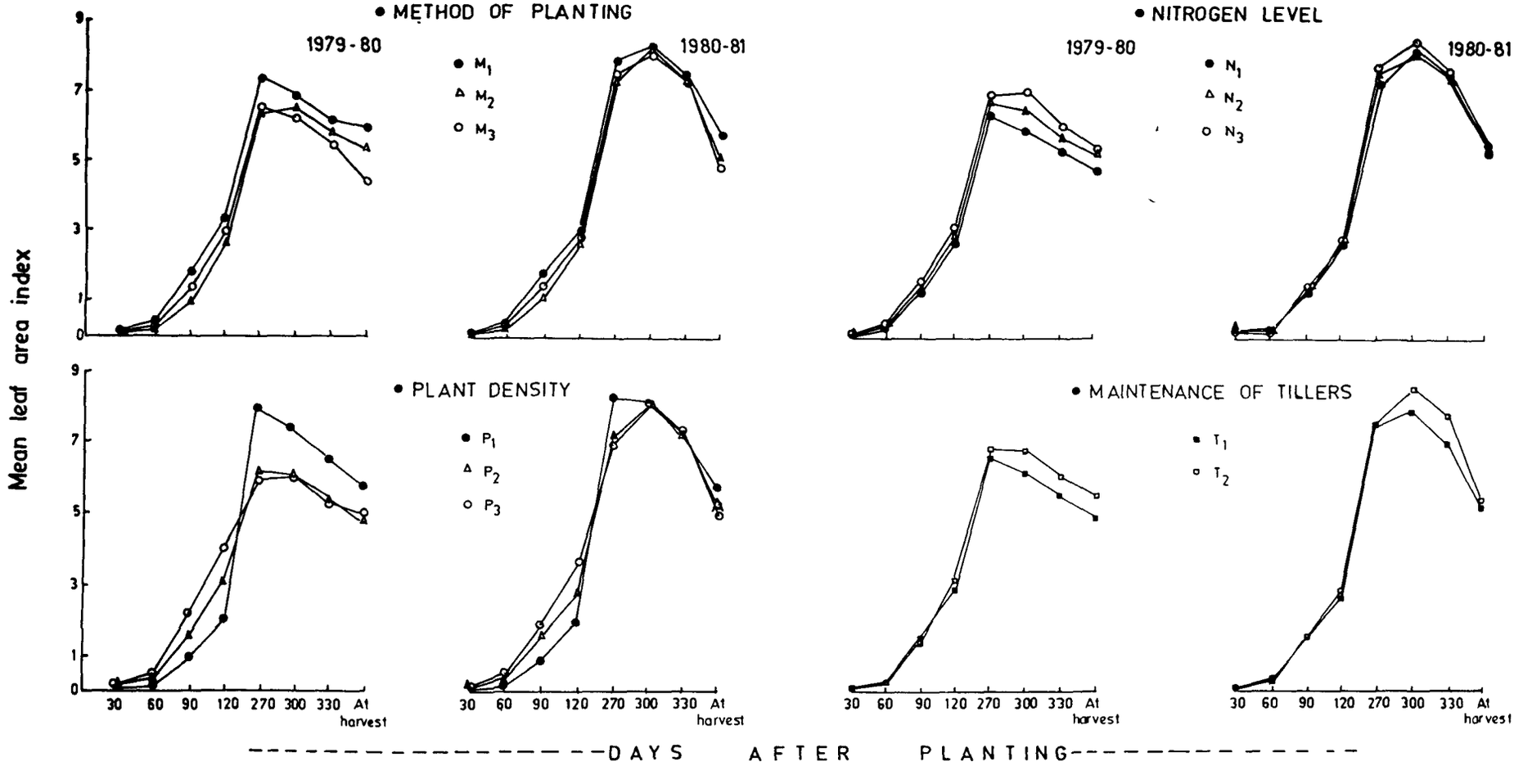

Fig. 6 . Periodical mean leaf area index as influenced by factors.

Effect of nitrogen levels

There was no marked difference in L.A.I. values at all the stages of crop growth due to nitrogen levels during both the seasons. By and large, increase in nitrogen level from 150 to 250 kg N/ha increased the L.A.I. at all the stages.

Effect of maintenance of tillers

There was no marked difference in L.A.I. values at all the stages due to maintenance of tillers during both the seasons. The L.A.I. values were found to be more with the treatment of uncontrolledtillers.

Interactions

There was not much influence on mean L.A.I. as a result of two and three factor interactions.

4.1.6 Total dry matter accumulation per plant

The data on total dry matter production as periodically affected by different treatments are presented in Table 13 and graphically shown in Fig. 7.

It would be seen that the mean dry matter production of sugarcane per plant at the initial stage of 30 days from planting was 1.32 and 1.27 g during 1979-80 and 1980-81, respectively. It was progressively increased with the advancement of crop age reaching maximum at harvest. The

Table 13. Effects of the various treatments of method of planting, plant density, nitrogen level, maintenance of tillers and their interactions on total dry matter per plant (g) at different stages (days) 1979-80

Treatments	30	60	90	120	270	300	330	At harvest
Method of planting								
M_1	2.18	13.58	59.15	170.94	300.61	313.31	356.42	438.44
M_2	0.64	2.53	27.96	120.67	220.34	247.07	288.49	360.85
M_3	1.14	7.68	45.13	130.89	280.56	303.25	346.61	429.70
'F' test	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.
S.E. ±	0.08	0.39	2.34	6.61	6.47	6.51	7.36	9.44
C.D. at 5 %	0.23	1.13	6.76	19.08	18.66	18.78	21.23	27.23
Plant density								
P_1	1.23	7.76	49.49	161.53	281.20	294.10	337.48	419.12
P_2	1.38	8.52	44.89	135.19	264.86	289.13	331.54	411.87
P_3	1.34	7.51	37.86	125.78	265.45	280.40	322.48	398.03
'F' test	N.S.	N.S.	Sigt.	Sigt.	Sigt.	N.S.	N.S.	N.S.
S.E. ±	0.08	0.39	2.34	6.61	6.47	6.51	7.36	9.44
C.D. at 5 %	-	-	6.76	19.08	18.66	-	-	-
Nitrogen level								
N_1	1.42	7.68	41.22	137.19	260.42	272.43	312.55	388.17
N_2	1.36	7.95	45.11	141.43	272.22	288.76	331.65	411.50
N_3	1.18	8.16	45.90	143.87	278.86	302.44	347.31	429.29
'F' test	N.S.	N.S.	N.S.	N.S.	N.S.	Sigt.	Sigt.	Sigt.
S.E. ±	0.08	0.39	2.34	6.61	6.47	6.51	7.36	9.44
C.D. at 5 %	-	-	-	-	-	18.78	21.23	27.23
Maintenance of tillers								
T_1	1.39	8.17	45.40	139.57	269.24	288.04	330.45	409.32
T_2	1.25	7.69	42.76	142.09	271.76	287.72	330.55	410.00
'F' test	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
S.E. ±	0.07	0.32	2.05	4.17	4.05	4.46	5.12	6.26
C.D. at 5 %	-	-	-	-	-	-	-	-
Mean	1.32	7.93	44.08	140.83	270.50	287.88	330.50	409.66

Table 13 (Contd....)

1980-81

Treatments	30	60	90	120	270	300	330	At harvest
Method of planting								
M_1	2.06	11.06	55.38	143.97	311.29	337.01	381.61	467.69
M_2	0.62	2.44	27.85	114.25	246.52	268.66	302.27	387.06
M_3	1.13	9.26	45.41	126.61	283.84	298.70	338.76	421.34
'F' test	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.
S.E. ±	0.09	0.28	1.71	4.60	5.47	6.04	6.90	8.49
C.D. at 5 %	0.25	0.82	4.93	13.69	15.78	17.42	19.91	24.27
Plant density								
P_1	1.30	7.25	44.47	140.56	292.65	311.00	352.77	438.89
P_2	1.25	8.03	45.41	129.64	278.77	299.52	339.63	422.46
P_3	1.25	7.49	38.76	114.64	276.84	293.85	333.24	414.53
'F' test	N.S.	N.S.	Sigt.	Sigt.	Sigt.	N.S.	N.S.	N.S.
S.E. ±	0.09	0.28	1.71	4.60	5.47	6.04	6.90	8.49
C.D. at 5 %	-	-	4.93	13.69	15.78	-	-	-
Nitrogen level								
N_1	1.31	6.89	39.64	122.38	277.21	286.72	325.13	404.54
N_2	1.29	7.79	44.70	130.00	285.13	301.92	342.38	425.92
N_3	1.21	8.08	44.29	132.45	279.30	315.73	358.13	445.42
'F' test	N.S.	Sigt.	N.S.	N.S.	N.S.	Sigt.	Sigt.	Sigt.
S.E. ±	0.09	0.28	1.71	4.60	5.47	6.04	6.90	8.49
C.D. at 5 %	-	0.82	-	-	-	17.42	19.91	24.27
Maintenance of tillers								
T_1	1.27	7.61	44.03	124.39	276.65	304.65	345.47	429.78
T_2	1.26	7.57	41.72	132.17	284.45	298.26	338.29	420.80
'F' test	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
S.E. ±	0.07	0.25	1.41	3.67	4.42	5.51	6.22	7.55
C.D. at 5 %	-	-	-	-	-	-	-	-
Mean	1.27	7.59	42.87	128.28	280.55	301.46	341.88	425.29

Table 13 (Contd....) : Interaction Method of planting X Plant density (M x P) 1980-81

Treatments	30	60	90	120	270	300	330	At harvest
M_1P_1	2.18	10.11	61.42	140.17	312.44	341.97	387.22	474.36
M_1P_2	2.05	11.34	52.92	149.75	312.02	340.48	385.54	472.30
M_1P_3	1.96	11.73	51.79	142.00	294.27	328.58	372.07	455.79
M_2P_1	0.63	2.33	29.48	143.92	266.19	277.24	315.20	399.64
M_2P_2	0.63	2.48	27.64	107.67	249.94	266.82	303.10	384.30
M_2P_3	0.59	2.51	26.42	91.17	243.44	261.91	297.22	377.23
M_3P_1	1.09	9.30	42.50	137.58	299.85	313.80	355.90	442.66
M_3P_2	1.08	10.25	55.67	131.50	273.77	291.25	330.26	410.78
M_3P_3	1.20	8.22	38.06	110.75	273.02	291.05	330.12	410.57
'F' test	N.S.	N.S.	Sigt.	Sigt.	Sigt.	N.S.	N.S.	N.S.
S.E. $\pm$	0.15	0.49	2.97	7.98	6.37	10.47	11.95	14.71
C.D. at 5%	-	-	8.56	20.42	18.37	-	-	-

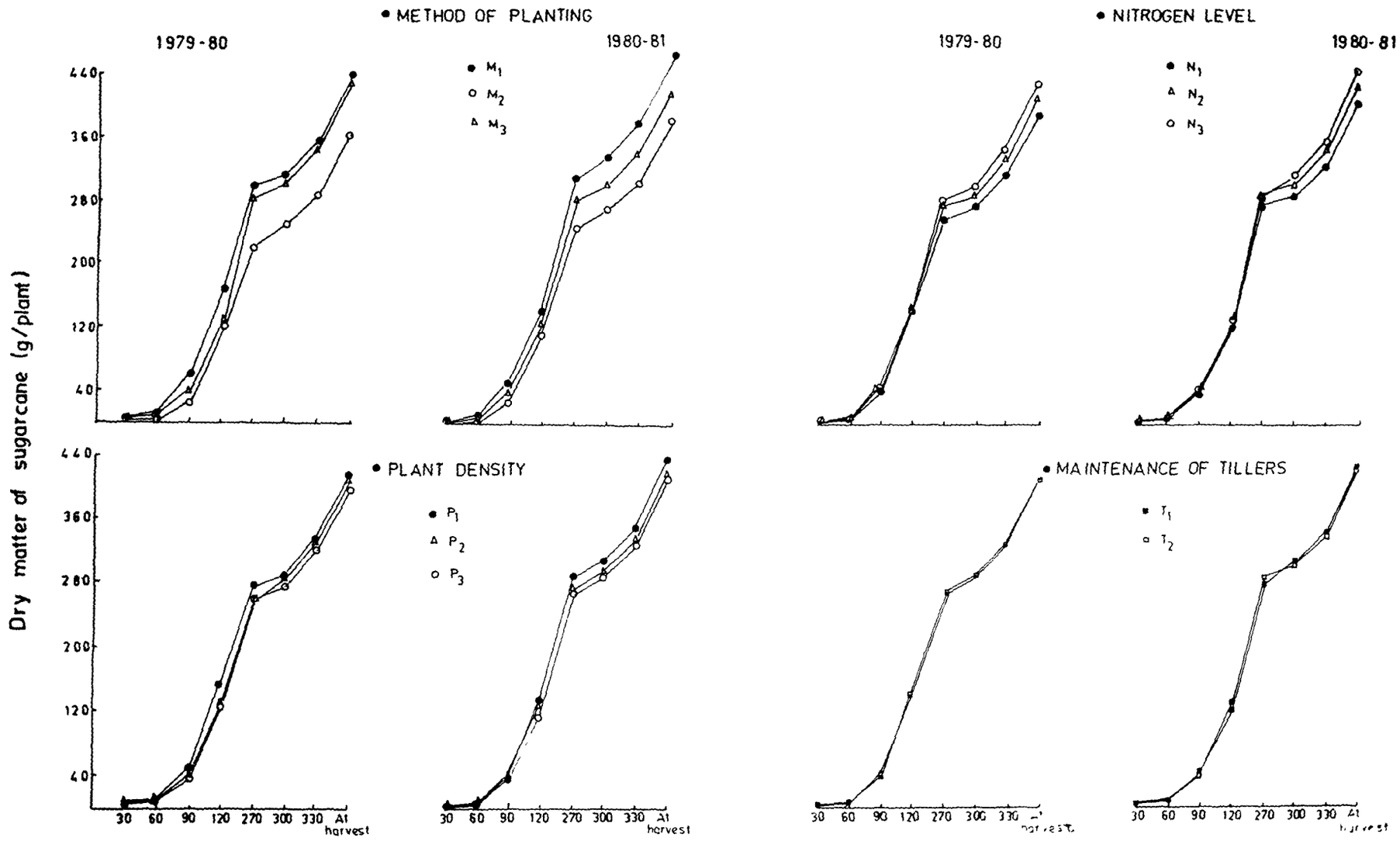

Fig. 7 . Periodical accumulation of mean dry matter (g/plant) as influenced by factors

dry matter at this stage was 409.66 and 425.29 grammes during 1979-80 and 1980-81, respectively.

Effect of methods of plant

The differences in dry matter production of sugarcane per plant as influenced periodically due to methods of planting were found to be statistically significant during both the seasons. The planting of three-budded sett produced significantly more dry matter throughout the crop growth period during 1980-81 and up to 270 days from planting during 1979-80 than the other methods of planting. Similarly, the planting of single budded sett had its superiority over single budded settling at all the stages except at 120 days from planting when these two methods were on par during both the seasons.

Effect of plant densities

There was significant difference in total dry matter production per plant at 90, 120 and 270 days from planting during both the seasons. The planting of 25 x 10^3 buds/ha had its superiority over 50 and 75 x 10^3 buds/ha during both the seasons except at 90 days during 1980-81. The planting of 50 x 10^3 buds/ha recorded significantly more dry matter production per plant at 90 days from planting during 1979-80 and 90 and 120 days during 1980-81. Although not significant, at other stages planting of 50 x 10^3 buds/ha produced more dry matter than 75 x 10^3 buds/ha.

Effect of nitrogen levels

Application of nitrogen influenced the dry matter production significantly during the maturity phase i.e. 300 days from planting till harvest during both the seasons. The application of 250 kg N/ha produced significantly more dry matter than 150 kg N/ha, while the difference between 250 kg and 200 kg N/ha treatments was at par. Also the application of 200 kg N/ha had its superiority over 150 kg N/ha.

Effect of maintenance of tillers

The mean dry matter production was not affected significantly due to maintenance of tillers at all the stages during both the seasons.

Interactions

All the interaction effects between two and three factors were found to be not significant during both the seasons except the interaction of methods of planting X plant densities at 90, 120 and 270 days from planting during 1980-81.

Method of planting X Plant densities (M x P)

In method of planting and plant density interaction, the planting of three-budded sett with 25 x 10^3 buds/ha produced significantly more dry matter than in all other combinations except planting of single budded sett with

50 x 10^3 buds/ha at 90 days from planting. Similarly, at 120 and 270 days, three-budded sett planting with 25 and 50 x 10^3 buds/ha showed their superiority over other treatment combinations.

4.1.7 Absolute Growth Rate (AGR) of dry matter per plant per month

The data on mean A.G.R. of dry matter per plant per month as affected periodically by different treatments in 1979-80 and 1980-81 are presented in Table 14 and graphically shown in Fig. 8. The data were not statistically analysed. Inferences are based on mean values.

A glance at the data would reveal that the mean A.G.R. of dry matter was gradually increased with advanced crop age. However, the rate of increase in A.G.R. of dry matter was maximum between 90 to 120 days from planting during both the years. The A.G.R. showed a significant drop between 270 to 300 days. It again picked up during two latter stages.

Effect of methods of planting

The A.G.R. values did not show a definite trend of variation with the methods of planting over the period of time. It was, however, observed that A.G.R. was higher with three-budded sett planting at all the stages. Further, transplanting of settling showed very poor A.G.R. up to 90 days. Thereafter, the growth rate was picked up compared to single budded sett planting method.

Table 14. Effects of the various treatments of method of planting, plant density, nitrogen level and maintenance of tillers on mean A.G.R. of dry matter (g) per month per plant at different stages (days)

Treatments	1979-80						1980-81					
	60 to 30	90 to 60	120 to 90	300 to 270	330 to 300	360 to 330	60 to 30	90 to 60	120 to 90	300 to 270	330 to 300	360 to 330
Method of planting												
M_1	11.40	45.57	111.79	12.70	43.11	82.02	9.00	44.32	88.59	25.72	44.60	86.08
M_2	1.89	25.43	92.71	26.73	41.42	72.36	1.82	25.41	86.50	22.14	33.61	84.79
M_3	6.54	37.45	85.76	22.69	43.36	83.09	8.13	36.15	81.20	14.86	40.06	82.58
Plant density												
P_1	6.53	41.73	112.04	12.90	43.38	81.64	5.95	37.22	96.09	18.35	41.77	86.12
P_2	7.14	36.37	90.30	24.27	42.41	80.33	6.78	37.38	84.23	20.75	40.11	82.83
P_3	6.17	30.35	87.92	14.95	42.08	75.55	6.24	31.27	75.88	17.01	39.39	81.29
Nitrogen level												
N_1	6.26	33.54	95.97	12.01	40.12	75.62	5.58	32.75	82.74	9.51	38.41	79.41
N_2	6.59	37.16	96.32	16.54	42.89	79.85	6.50	36.91	85.30	16.79	40.46	83.54
N_3	6.98	37.74	97.97	23.58	44.87	81.98	6.87	36.21	88.16	36.43	42.40	87.29
Maintenance of tillers												
T_1	6.78	37.23	94.17	18.80	42.41	78.87	6.34	36.42	80.36	28.00	40.82	84.31
T_2	6.44	35.07	99.33	15.96	42.83	79.45	6.31	34.15	90.45	13.81	40.03	82.51
Mean	6.61	36.15	96.75	17.38	42.62	79.16	6.32	35.28	85.41	20.91	40.42	83.41

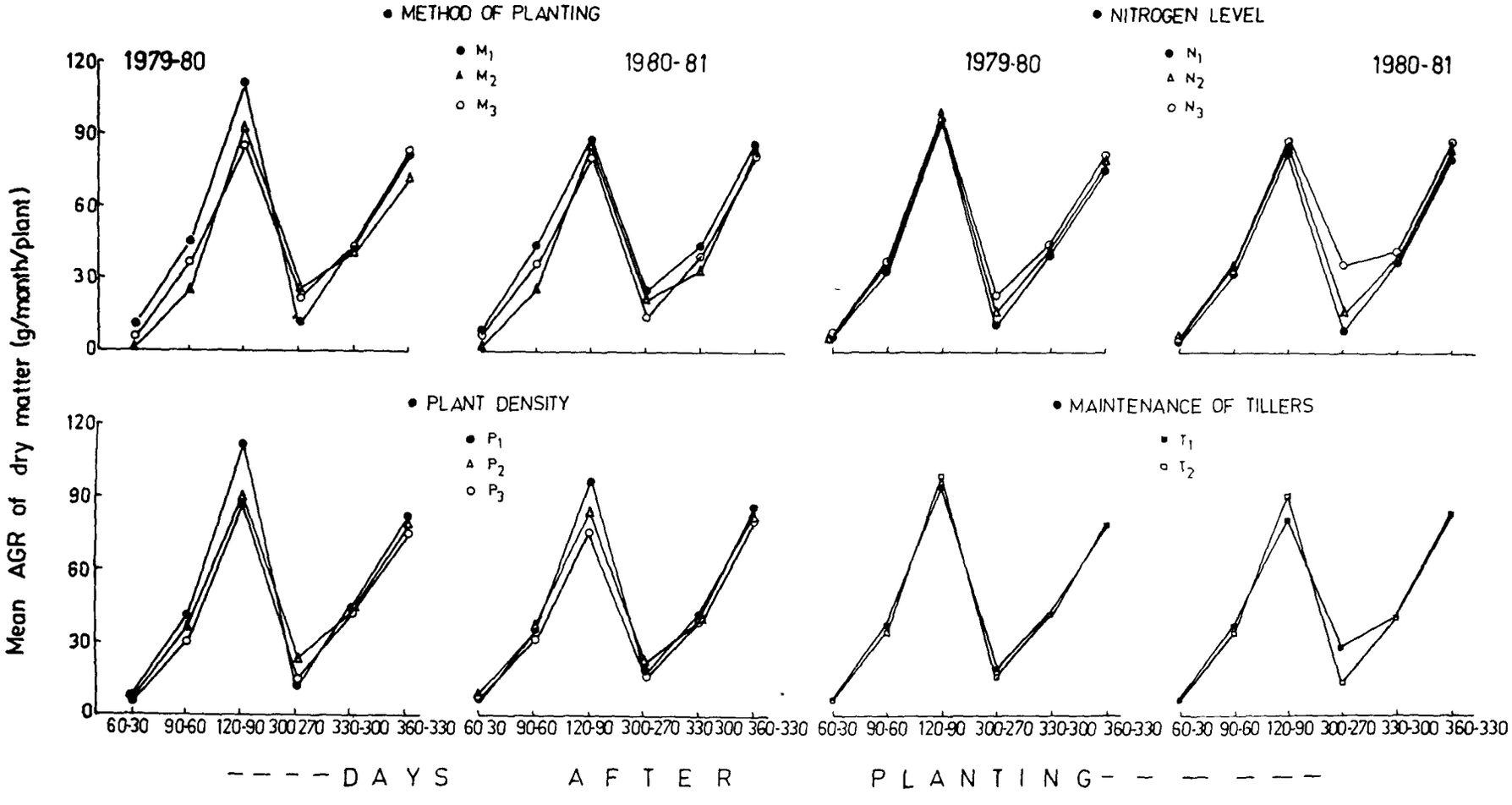

Fig 8 Mean AGR of dry matter (g /month/ plant) as influenced by factors

Effect of plant densities

The A.G.R. values due to various plant densities were maximum with planting 25 x 10^3 buds/ha and declined with increase in the plant density during both the years.

Effect of nitrogen levels

The A.G.R. values increased with increase in the level of nitrogen from 150 to 250 kg N/ha at different stages during both the seasons.

Effect of maintenance of tillers

The A.G.R. values found to be more with maintenance of tillers than uncontrolled tillers particularly at maturity stage during both the seasons.

Interactions

The A.G.R. values due to various interactions did not show a regular trend at different stages.

4.1.8 Total height

The data regarding the mean total height per cane as periodically influenced by different treatments are presented in Table 15.

It will be seen that the mean total height was 288.02, 300.34 cm and 282.44, 307.71 cm at 300 and 330 days during 1979-80 and 1980-81, respectively and it was

Table 15. Effects of the various treatments of method of planting, plant density, nitrogen level, maintenance of tillers and their interactions on total height (cm) at different stages (days)

Treatments	Days after planting			
	300	330	300	330
	1979-80		1980-81	
Method of planting				
M_1	299.82	310.25	289.71	317.46
M_2	268.78	284.86	276.96	298.93
M_3	295.47	305.92	280.68	306.75
'F' test	Sigt.	Sigt.	Sigt.	Sigt.
S.E. ±	2.52	2.08	2.03	2.68
C.D. at 5 %	7.27	6.00	5.85	7.73
Plant density				
P_1	283.51	295.69	279.49	306.89
P_2	287.64	301.39	283.81	307.25
P_3	292.92	303.94	284.06	309.01
'F' test	Sigt.	Sigt.	N.S.	N.S.
S.E. ±	2.52	2.08	2.03	2.68
C.D. at 5 %	7.27	6.00	-	-
Nitrogen level				
N_1	284.11	296.47	275.07	301.29
N_2	288.24	299.44	282.05	306.07
N_3	291.72	305.11	290.22	315.78
'F' test	N.S.	Sigt.	Sigt.	Sigt.
S.E. ±	2.52	2.08	2.03	2.68
C.D. at 5 %	-	6.00	5.85	7.73
Maintenance of tillers				
T_1	289.96	302.18	284.00	308.77
T_2	286.08	298.50	280.89	306.66
'F' test	N.S.	N.S.	N.S.	N.S.
S.E. ±	1.79	1.59	1.49	1.65
C.D. at 5 %	-	-	-	-
Mean	288.02	300.34	282.44	307.71

Table 15 (Contd...): Interaction

Method of planting X itrogen level (M x N)

1979-80

Treatments	Days after planting	
	300	330
M_1N_1	297.83	309.75
M_1N_2	300.25	310.58
M_1N_3	301.38	310.42
M_2N_1	266.67	281.67
M_2N_2	264.25	277.17
M_2N_3	275.42	295.75
M_3N_1	287.83	298.00
M_3N_2	300.21	310.58
M_3N_3	298.38	309.17
'F' test	N.S.	Sigt.
S.E. $\pm$	4.36	3.61
C.D. at 5 %	-	10.41

continued to increase progressively up to the harvest of the crop. At harvest, the mean total height per cane was 312.26 and 314.45 cm during 1979-80 and 1980-81, respectively (Table 24).

Effect of methods of planting

The mean total height was significantly affected by different methods of planting at all the stages during both the seasons. The planting of three-budded sett and single budded sett recorded significantly more total height than transplanting of single budded settling at both the stages during 1979-80 and at 330 days from planting during 1980-81. While at 300 days during 1980-81,

single budded sett planting and settling transplanting were at par with each other. The planting of three-budded sett had its superiority over single budded sett planting during both the years.

Effect of plant densities

The mean total height was significantly affected at both the stages of crop growth during 1979-80. The planting of 75 x 10^3 buds/ha recorded significantly more total height than 25 x 10^3 buds/ha at both the stages which was on par with 50 x 10^3 buds/ha during 1979-80. Though not significant, similar trend as that of 1979-80 was also observed during 1980-81.

Effect of nitrogen levels

By and large, increasing level of nitrogen increased the plant height at all the stages during both the seasons.

The significant difference was observed in the total height of cane due to different nitrogen levels at both the stages during both the seasons except at 300 days in 1979-80. Application of 250 kg N/ha was significantly superior to 150 kg N/ha and on par with 200 kg N/ha in 1979-80. However, in 1980, application of 250 kg N/ha had its superiority over both the lower doses in respect of total height.

Effect of maintenance of tillers

The maintenance of tillers did not influence the total height of plant significantly at any of the stages during both the seasons. However, increased plant height was observed with the maintenance of tillers.

Interactions

All the interaction effects between two and three factors under study were found to be not significant, except method of planting and nitrogen interaction at 330 days from planting during 1979-80, when the planting of three and single budded sett with varying levels of nitrogen recorded significantly more total height than the combinations of transplanting of single budded settling with two lower levels of nitrogen.

4.1.9 Millable height

The data regarding mean millable height per cane as periodically influenced by the various treatments are presented in Table 16 and graphically depicted in Fig. 9.

It would be seen that the mean millable height was 232.41 and 235.00 cm at 300 days from planting during 1979-80 and 1980-81 and was continued to increase progressively up to the harvest of the crop. At harvest, the mean millable height per cane was 260.86 and 288.86 cm during 1979-80 and 1980-81, respectively (Table 24).

Table 16. Effects of the various treatments of method of planting, plant density, nitrogen level and maintenance of tillers on millable height (cm) at different stages (days)

Treatments	Days after planting			
	300	330	300	330
	1979-80		1980-81	
Method of planting				
M_1	243.78	262.19	242.28	284.28
M_2	214.90	236.50	229.21	269.50
M_3	238.57	257.17	233.51	273.97
'F' test	Sigt.	Sigt.	Sigt.	Sigt.
S.E. ±	2.42	2.21	2.04	2.42
C.D. at 5 %	6.98	6.36	5.88	6.99
Plant density				
P_1	228.22	246.83	231.88	274.68
P_2	231.79	254.14	235.21	276.04
P_3	237.24	254.89	237.92	277.03
'F' test	Sigt.	Sigt.	N.S.	N.S.
S.E. ±	2.42	2.21	2.04	2.42
C.D. at 5 %	6.98	6.36	-	-
Nitrogen level				
N_1	229.58	247.11	228.42	269.03
N_2	231.50	251.86	234.49	275.15
N_3	236.17	256.89	242.10	283.57
'F' test	N.S.	Sigt.	Sigt.	Sigt.
S.E. ±	2.42	2.21	2.04	2.42
C.D. at 5 %	-	6.36	5.88	6.99
Maintenance of tillers				
T_1	233.63	252.67	235.65	276.58
T_2	231.20	251.24	234.35	275.25
'F' test	N.S.	N.S.	N.S.	N.S.
S.E. ±	1.67	1.32	1.23	1.56
C.D. at 5 %	-	-	-	-
Mean	232.41	251.95	235.00	275.91

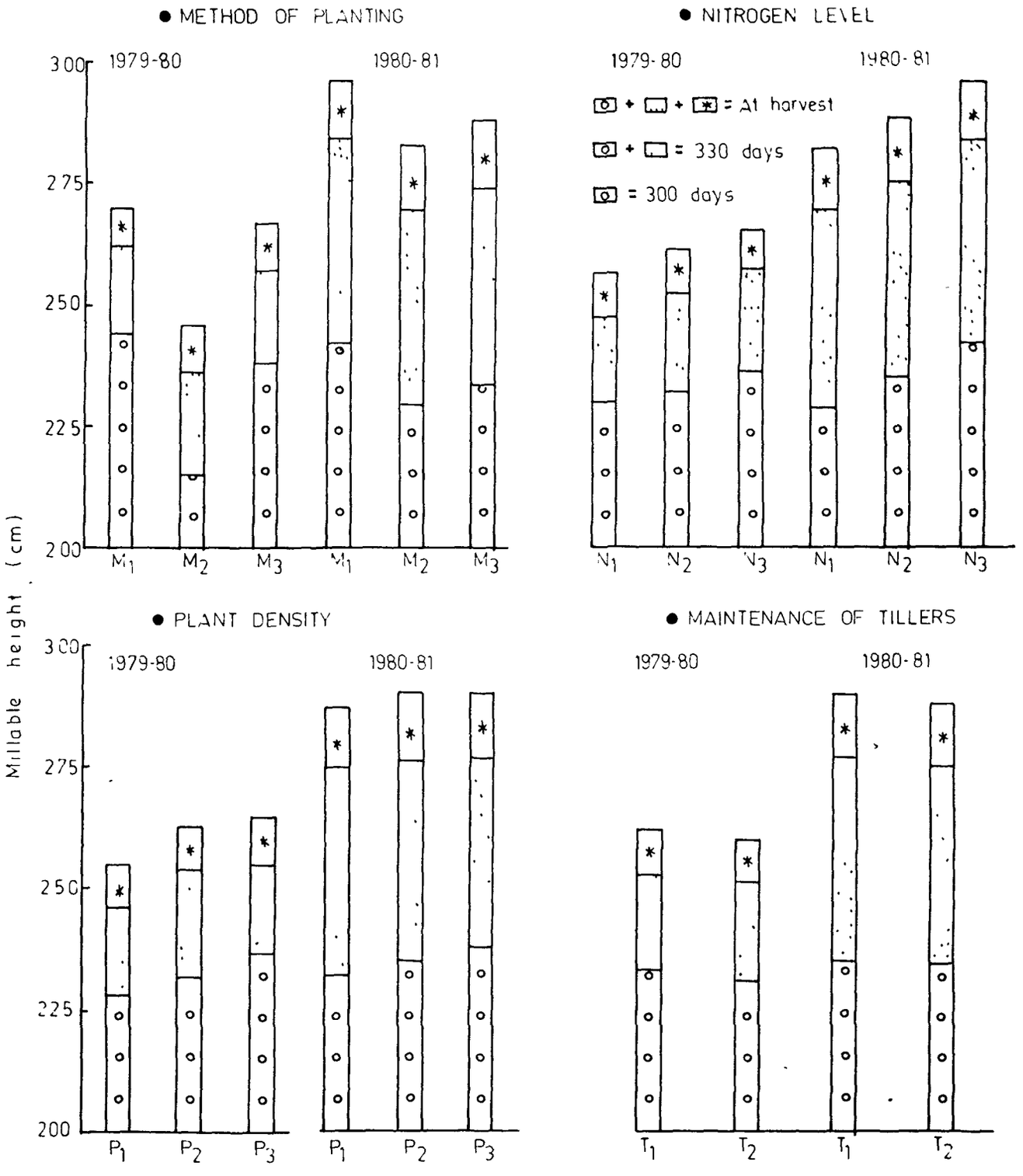

Fig 9 Mean millable height (cm) as influenced by factors

Effect of treatments

Almost similar trend to that of total height was observed in respect of millable height of sugarcane due to various treatments under study during both the seasons.

4.1.10 Girth of internode

The data pertaining to mean girth of internode as affected periodically by different treatments are given in Table 17 and graphically depicted in Fig. 10.

It is observed from the data that the mean middle girth of cane was 7.99 and 7.58 cm at 300 days from planting during 1979-80 and 1980-81, respectively. The girth of cane continued to increase progressively up to the harvest of the crop. At harvest, the mean girth was 8.44 and 8.00 cm during 1979-80 and 1980-81, respectively (Table 24).

Effect of methods of planting

The mean middle girth of cane was affected significantly during both the seasons. The planting of three and single budded sett recorded significantly more girth than planting of single budded settling during 1979-80. However, during 1980-81 the planting of three-budded sett gave significantly higher girth than planting of single budded sett and transplanting of single budded settling which were at par among each other.

Table 17. Effects of the various treatments of method of planting, plant density, nitrogen level and maintenance of tillers on cane girth (cm) at different stages (days)

Treatments	Days after planting			
	300	330	300	330
	1979-80		1980-81	
Method of planting				
M_1	8.19	8.51	7.82	7.93
M_2	7.64	7.99	7.43	7.56
M_3	8.12	8.54	7.49	7.63
'F' test	Sigt.	Sigt.	Sigt.	Sigt.
S.E. ±	0.05	0.06	0.05	0.07
C.D. at 5 %	0.14	0.17	0.15	0.19
Plant density				
P_1	8.03	8.37	7.67	7.81
P_2	7.97	8.30	7.57	7.67
P_3	7.96	8.37	7.51	7.65
'F' test	N.S.	N.S.	N.S.	N.S.
S.E. ±	0.05	0.06	0.05	0.07
C.D. at 5 %	-	-	-	-
Nitrogen level				
N_1	7.99	8.35	7.56	7.69
N_2	7.96	8.28	7.56	7.68
N_3	8.01	8.35	7.63	7.75
'F' test	N.S.	N.S.	N.S.	N.S.
S.E. ±	0.05	0.06	0.05	0.07
C.D. at 5 %	-	-	-	-
Maintenance of tillers				
T_1	8.07	8.48	7.67	7.82
T_2	7.91	8.22	7.49	7.60
'F' test	Sigt.	Sigt.	Sigt.	Sigt.
S.E. ±	0.04	0.05	0.06	0.05
C.D. at 5 %	0.12	0.15	0.17	0.15
Mean	7.99	8.35	7.58	7.71

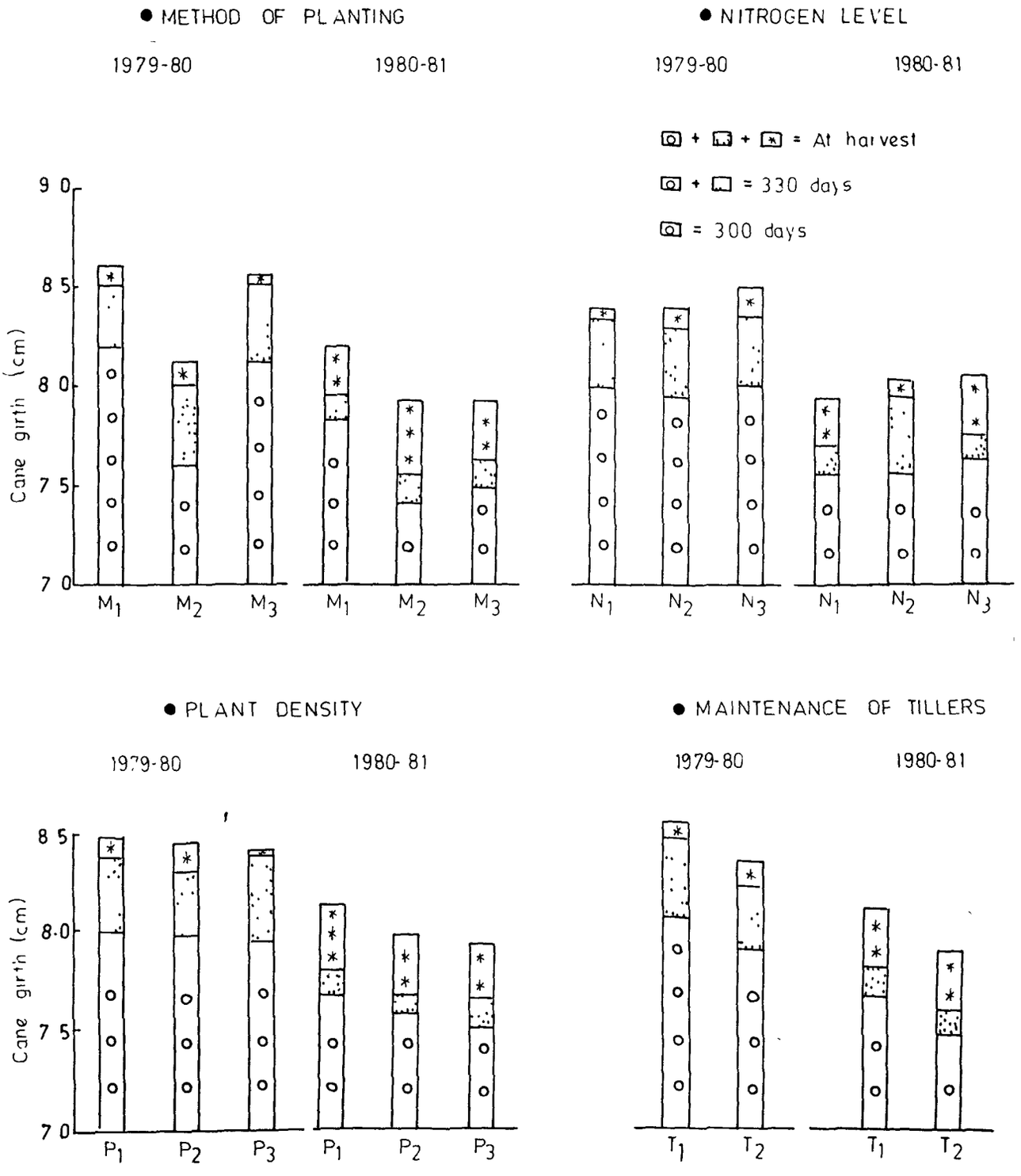

Fig.10. Mean girth (cm) as influenced by factors.

Effect of plant densities and nitrogen levels

The mean girth of internode was not influenced due to plant densities and nitrogen levels at any of the stages in both the years.

Effect of maintenance of tillers

The mean girth of internode was found to be significantly more with controlling the tillers than uncontrolled tillers at all the stages during both the seasons.

Interactions

The interaction effects between two and three factors under study were found to be not significant at all the stages during both the seasons.

4.1.11 Number of internodes per cane

The data regarding mean number of internodes per cane as affected periodically by different treatments are presented in Table 18 and graphically shown in Fig. 11.

It would be seen that the mean number of internodes at 300 days from planting was 20.49 and 16.82 during 1979-80 and 1980-81, respectively. The mean number of internodes continued to increase progressively up to harvest. At harvest, the mean number of internodes per cane was 24.14 and 20.56 during 1979-80 and 1980-81, respectively (Table 24).

Table 18. Effects of the various treatments of method of planting, plant density, nitrogen level and maintenance of tillers on number of internodes per cane at different stages (days)

Treatments	Days after planting			
	300	330	300	330
	1979-80		1980-81	
Method of planting				
M_1	21.50	23.05	17.42	19.42
M_2	18.89	20.94	16.64	17.97
M_3	21.11	22.97	16.42	18.28
'F' test	Sigt.	Sigt.	Sigt.	Sigt.
S.E. ±	0.22	0.15	0.14	0.35
C.D. at 5 %	0.63	0.43	0.40	1.00
Plant density				
P_1	20.55	22.08	16.78	18.50
P_2	20.58	22.28	16.81	18.53
P_3	20.86	22.61	16.89	18.64
'F' test	N.S.	N.S.	N.S.	N.S.
S.E. ±	0.22	0.15	0.14	0.35
C.D. at 5 %	-	-	-	-
Nitrogen level				
N_1	20.22	22.03	16.47	17.81
N_2	20.61	22.22	16.72	18.22
N_3	20.67	22.62	17.28	19.64
'F' test	N.S.	N.S.	Sigt.	Sigt.
S.E. ±	0.22	0.15	0.14	0.35
C.D. at 5 %	-	-	0.40	1.00
Maintenance of tillers				
T_1	20.57	22.46	16.83	18.69
T_2	20.42	22.18	16.81	18.43
'F' test	N.S.	N.S.	N.S.	N.S.
S.E. ±	0.13	0.13	0.09	0.14
C.D. at 5 %	-	-	-	-
Mean	20.49	22.32	16.82	18.56

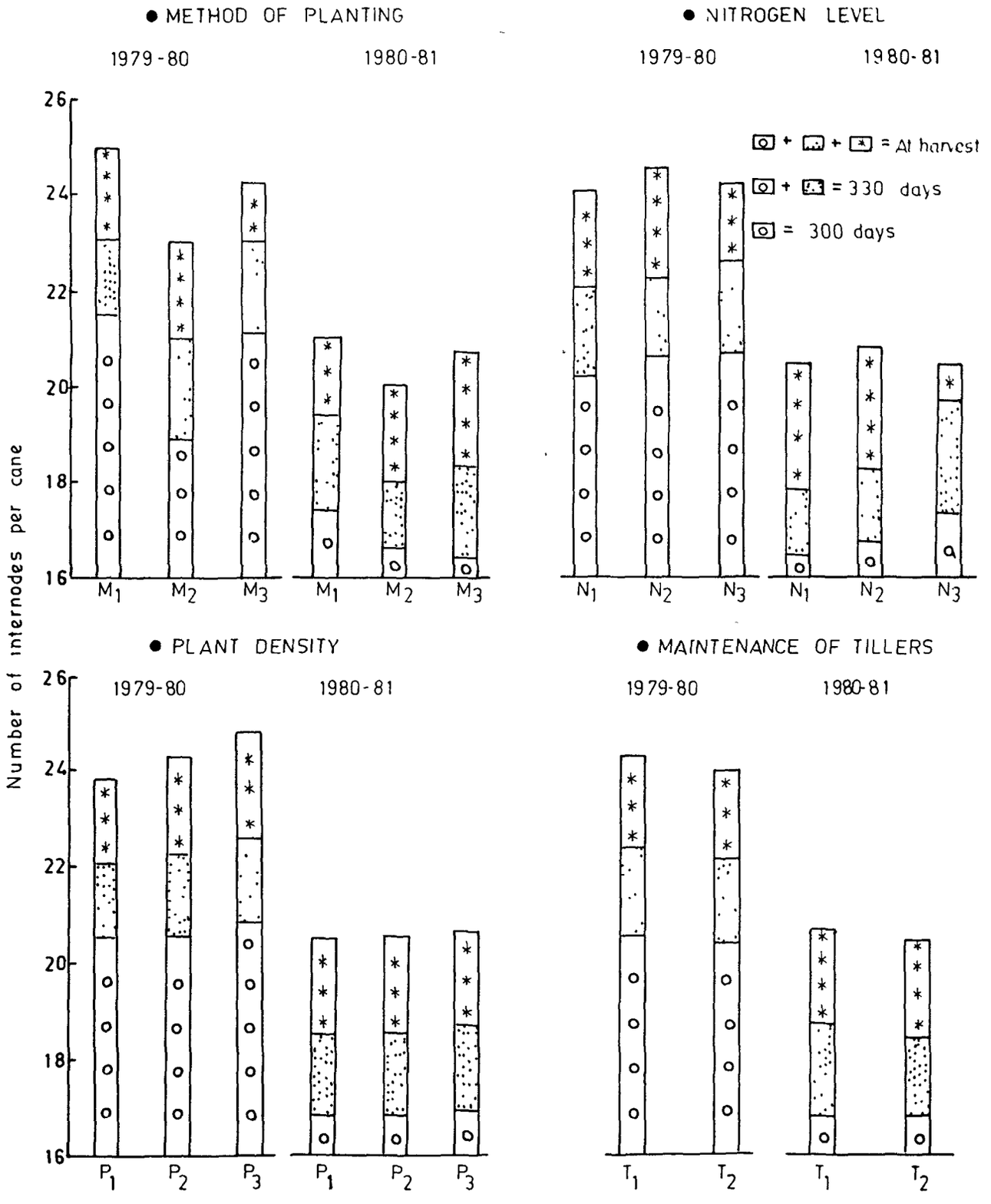

Fig.11 Mean number of internodes as influenced by factors.

Effect of methods of planting

The mean number of internodes was significantly affected by the methods of planting at all the stages during both the seasons. The planting of three and single budded sett recorded significantly more number of internodes than the transplanting of single budded settling at both the stages during 1979-80. However, during 1980-81, three-budded sett planting recorded significantly higher number of internodes than the other two methods of planting. The methods, single budded sett planting and transplanting settling were on par with each other.

Effect of plant densities

The plant densities did not influence the mean number of internodes at both the stages during both the seasons.

Effect of nitrogen levels

There was significant difference in mean number of internodes per cane due to nitrogen levels at 300 and 330 days from planting during 1980-81 only. Application of 250 kg N/ha had its superiority over 200 and 150 kg N/ha. However, 200 and 150 kg N/ha were on par with each other. In general, increasing level of nitrogen increased the number of internodes per cane.

Effect of maintenance of tillers

The maintenance of tillers did not influence the mean number of internodes at any of the stages during both the seasons.

Interactions

None of the interactions influenced the mean number of internodes at any of the stages during both the seasons.

4.1.12 Shoot mortality

The mortality percentage of shoots based on the number of shoots at final earthing and millable canes at harvest was worked out and presented in Table 19.

It would be seen that the mean shoot mortality percentage was 65.43 and 59.92 during 1979-80 and 1980-81, respectively.

Effect of methods of planting

The mean shoot mortality percentage was significantly affected by the different methods of planting during 1980-81. The transplanting of single budded settling did show significantly higher mortality (65.19 per cent) than the three and single budded sett planting which were on par among themselves. Though not significant, similar trend as that of 1980-81 was also observed during the year 1979-80.

Table 19. Effects of the various treatments of method of planting, plant density, nitrogen level and maintenance of tillers on shoot mortality percentage

Treatments	1979-80	1980-81
Method of planting		
M_1	65.17	55.62
M_2	68.06	65.19
M_3	63.07	58.96
'F' test	N.S.	Sigt.
S.E. $\pm$	1.70	1.40
C.D. at 5 %	-	4.03
Plant density		
P_1	54.45	53.64
P_2	68.38	61.33
P_3	73.46	64.79
'F' test	Sigt.	Sigt.
S.E. $\pm$	1.70	1.40
C.D. at 5 %	4.90	4.03
Nitrogen level		
N_1	65.79	59.37
N_2	64.98	59.71
N_3	65.52	60.68
'F' test	N.S.	N.S.
S.E. $\pm$	1.70	1.40
C.D. at 5 %	-	-
Maintenance of tillers		
T_1	65.59	56.13
T_2	66.28	63.72
'F' test	N.S.	Sigt.
S.E. $\pm$	0.98	0.74
C.D. at 5 %	-	2.16
Mean	65.43	59.92

Effect of plant densities

There was a significant difference in shoot mortality percentage, during both the seasons. Mortality per cent increased with increasing plant density. The planting of 75 x 10^3 buds/ha recorded significantly highest mortality percentage than 50 and 25 x 10^3 buds/ha during 1979-80 while, during 1980-81, the planting of 75 and 50 x 10^3 buds/ha were on par and showed significantly more mortality over 25 x 10^3 buds/ha.

Effect of nitrogen levels

The nitrogen levels did not influence the shoot mortality during both the seasons.

Effect of maintenance of tillers

The shoot mortality percentage was found to be significantly more in uncontrolled treatment than maintenance of tillers, during 1980-81. However, the difference was not discernible during 1979-80.

Interactions

The interaction effects between two and three factors under study were found to be not significant during both the seasons.

4.2 Periodical maturity studies

The data on periodical maturity studies viz., Brix, sucrose percentage in juice, purity percentage of juice and net rendiment (N.R.) are presented in Tables 20 to 23.

Table 20. Effects of the various treatments of method of planting, plant density, nitrogen level and maintenance of tillers on Brix at different stages (days)

Treatments	Days after planting					
	270	300	330	270	300	330
	1979-80			1980-81		
Method of planting						
M_1	17.93	20.69	21.36	18.34	20.71	21.64
M_2	16.96	20.31	21.00	18.14	20.60	21.95
M_3	17.55	20.42	21.07	18.11	20.73	21.77
'F' test	Sigt.	N.S.	N.S.	N.S.	N.S.	N.S.
S.E. ±	0.12	0.16	0.14	0.11	0.08	0.09
C.D. at 5 %	0.35	-	-	-	-	-
Plant density						
P_1	17.27	20.36	21.02	17.91	20.67	21.73
P_2	17.36	20.51	21.24	18.21	20.76	21.88
P_3	17.81	20.55	21.16	18.46	20.61	21.75
'F' test	Sigt.	N.S.	N.S.	Sigt.	N.S.	N.S.
S.E. ±	0.12	0.16	0.14	0.11	0.08	0.09
C.D. at 5 %	0.35	-	-	0.32	-	-
Nitrogen level						
N_1	17.67	20.80	21.41	18.33	20.81	21.94
N_2	17.66	20.57	21.18	18.14	20.56	21.81
N_3	17.10	20.04	20.84	18.12	20.67	21.60
'F' test	Sigt.	Sigt.	Sigt.	N.S.	N.S.	Sigt.
S.E. ±	0.12	0.16	0.14	0.11	0.08	0.09
C.D. at 5 %	0.35	0.48	0.41	-	-	0.26
Maintenance of tillers						
T_1	17.59	20.51	21.18	18.20	20.71	21.82
T_2	17.37	20.43	21.10	18.19	20.65	21.75
'F' test	Sigt.	N.S.	N.S.	N.S.	N.S.	N.S.
S.E. ±	0.07	0.08	0.07	0.09	0.05	0.05
C.D. at 5 %	0.20	-	-	-	-	-
Mean	17.48	20.48	21.14	18.20	20.68	21.78

4.2.1 Brix

The data on Brix as periodically affected by different treatments are presented in Table 20.

It would be seen that the mean Brix was 17.48, 20.47, 21.14 and 18.20, 20.68, 21.78 at 270, 300, 330 days from planting during 1979-80 and 1980-81, respectively.

Effect of methods of planting

The mean Brix was significantly affected by planting methods at 270 days from planting during 1979-80 only. The planting of three-budded sett had its superiority over single budded sett planting and transplanting of settling. Though significant difference was not observed at other stages, almost similar trend as above has been observed.

Effect of plant densities

There was a significant difference in Brix, due to plant densities at 270 days during both the years. The planting of 75 x 10^3 buds/ha recorded significantly more Brix than other plant densities during both the years except the planting of 50 x 10^3 buds/ha which was on par during 1980-81.

Effect of nitrogen levels

The mean Brix was significantly affected due to nitrogen levels at all the stages during both the seasons, except at 270 and 300 days during 1980-81. Application of

150 kg N/ha recorded significantly higher Brix than 250 kg N/ha at all the stages during both the seasons. In general, increasing level of nitrogen decreased the Brix at all the stages.

Effect of maintenance of tillers

The maintenance of tillers did not influence the Brix at all the stages, during both the seasons except at 270 days from planting during 1979-80, when the treatment of maintenance of tillers showed its superiority over uncontrolled tillers. Though not significant, similar trend has been observed at other stages in both the years.

Interactions

All the interaction effects due to two and three factors under study were found to be not significant.

4.2.2 Sucrose percentage in juice

The data regarding the mean sucrose percentage in juice as periodically affected due to various treatments are presented in Table 21.

It will be seen that the mean sucrose percentage in juice was 15.28, 18.64, 19.34 and 16.27, 18.73, 20.37 at 270, 300, 330 days from planting, during 1979-80 and 1980-81, respectively.

Table 21. Effects of the various treatments of method of planting, plant density, nitrogen level, maintenance of tillers and their interactions on sucrose percentage in juice at different stages (days).

Treatments	Days after planting					
	270	300	330	270	300	330
	1979-80			1980-81		
Method of planting						
M_1	16.01	18.86	19.57	16.36	18.77	20.19
M_2	14.60	18.43	19.17	16.26	18.73	20.64
M_3	15.24	18.64	19.28	16.20	18.70	20.28
'F' test	Sigt.	N.S.	N.S.	N.S.	N.S.	Sigt.
S.E. ±	0.15	0.20	0.16	0.15	0.12	0.10
C.D. at 5 %	0.44	-	-	-	-	0.29
Plant density						
P_1	14.87	18.48	19.12	15.74	18.68	20.28
P_2	15.27	18.66	19.54	16.41	18.88	20.42
P_3	15.71	18.79	19.36	16.67	18.64	20.40
'F' test	Sigt.	N.S.	N.S.	Sigt.	N.S.	N.S.
S.E. ±	0.15	0.20	0.16	0.15	0.12	0.10
C.D. at 5 %	0.44	-	-	0.43	-	-
Nitrogen level						
N_1	15.65	19.11	19.71	16.75	18.95	20.52
N_2	15.43	18.66	19.36	16.10	18.43	20.40
N_3	14.77	18.16	18.95	15.96	18.79	20.18
'F' test	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.	N.S.
S.E. ±	0.15	0.20	0.16	0.15	0.12	0.10
C.D. at 5 %	0.44	0.58	0.45	0.43	0.35	-
Maintenance of tillers						
T_1	15.39	18.66	19.37	16.29	18.77	20.41
T_2	15.18	18.62	19.31	16.25	18.69	20.33
'F' test	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
S.E. ±	0.10	0.09	0.09	0.09	0.06	0.07
C.D. at 5 %	-	-	-	-	-	-
Mean	15.28	18.64	19.34	16.27	18.73	20.37

Table 21. (Contd...): Interaction

Method of planting X Plant density (M x P)

1979-80

Treatments	Days after planting		
	270	300	330
M_1P_1	15.33	18.86	19.48
M_1P_2	15.98	18.71	20.00
M_1P_3	16.70	19.02	19.22
M_2P_1	13.86	18.03	18.83
M_2P_2	14.78	18.68	19.40
M_2P_3	15.15	18.58	19.29
M_3P_1	15.42	18.55	19.06
M_3P_2	15.04	18.59	19.24
M_3P_3	15.26	18.77	19.56
'F' test	Sigt.	N.S.	N.S.
S.E. $\pm$	0.26	0.34	0.27
C.D. at 5 %	0.75	-	-

Effect of methods of planting

The mean sucrose content in juice was significantly affected due to methods of planting at 270 days from planting during 1979-80 and at 330 days during 1980-81. The planting of three-budded sett gave significantly higher sucrose percentage than other methods of planting during 1979-80, while the single budded settling transplanting had its superiority over other methods of planting at 330 days during 1980-81.

Effect of plant densities

There was a significant difference in sucrose percentage in juice due to plant densities at 270 days

from planting during both the seasons. The planting of 75×10^3 buds per hectare recorded significantly higher sucrose percentage in juice than 25×10^3 buds per hectare and on par with 50×10^3 buds per hectare.

Effect of nitrogen levels

The mean sucrose percentage in juice was significantly affected by various levels of nitrogen at all the stages during both the seasons, except at 330 days from planting during 1980-81. Application of 150 kg N/ha recorded significantly higher sucrose percentage in juice than 250 kg N/ha during both the years except at 330 days and on par with 200 kg N/ha during 1979-80. However, during 1980-81, 150 kg N/ha also produced significantly more sucrose than 200 kg N/ha. It was indicated that the increase in the level of nitrogen reduced the sucrose content in juice.

Effect of maintenance of tillers

There was no significant difference in sucrose of juice due to maintenance of tillers, however, it was found to be more with the maintenance of tillers at all the stages in both the years.

Interactions

The interactions between two and three factors under study were found to be not significant at all the stages during both the seasons except the interaction of methods

of planting X plant densities at 270 days after planting during 1979-80.

Methods of planting X Plant densities (M x P)

The planting of three-budded sett with 75 x 10^3 buds/ha recorded significantly more sucrose percentage than other combinations except planting of three-budded sett with 50 x 10^3 buds/ha. Though there was no significant difference at 270 days during 1980-81, almost similar trend was observed as that of the earlier period during the year 1979-80.

4.2.3 Purity percentage of juice

The data regarding the mean purity percentage of juice as periodically influenced by the various treatments are presented in Table 22.

It would be seen that the mean purity percentage of juice was 87.35, 90.88, 91.46 and 88.52, 90.63, 93.48 at 270, 300 and 330 days from planting, during 1979-80 and 1980-81, respectively.

Effect of methods of planting

The purity percentage of juice was significantly influenced by methods of planting at 270 days from planting during 1979-80 only. At this stage, planting of three-budded sett recorded significantly higher purity % than the other methods of planting which were at par with each other.

Table 22. Effects of the various treatments of method of planting, plant density, nitrogen level, maintenance of tillers and their interactions on purity percentage of juice at different stages (days)

Treatments	Days after planting					
	270	300	330	270	300	330
	1979-80			1980-81		
Method of planting						
M_1	89.19	91.16	91.57	88.52	90.55	93.31
M_2	86.03	90.68	91.27	88.20	91.13	93.99
M_3	86.83	90.81	91.52	88.82	90.19	93.15
'F' test	Sigt.	N.S.	N.S.	N.S.	N.S.	N.S.
S.E. ±	0.48	0.41	0.32	0.42	0.38	0.29
C.D. at 5 %	1.39	-	-	-	-	-
Plant density						
P_1	86.05	90.30	90.94	87.19	90.40	93.35
P_2	87.86	90.93	92.06	89.29	90.01	93.34
P_3	88.15	91.41	91.86	89.06	90.47	93.74
'F' test	Sigt.	N.S.	N.S.	Sigt.	N.S.	N.S.
S.E. ±	0.48	0.41	0.32	0.42	0.38	0.29
C.D. at 5 %	1.39	-	-	1.21	-	-
Nitrogen level						
N_1	88.52	91.42	91.98	89.01	91.14	93.51
N_2	87.27	90.65	91.41	88.78	89.73	93.54
N_3	86.26	90.57	90.97	87.76	89.01	93.40
'F' test	Sigt.	N.S.	N.S.	N.S.	Sigt.	N.S.
S.E. ±	0.48	0.41	0.32	0.42	0.38	0.29
C.D. at 5 %	1.39	-	-	-	1.09	-
Maintenance of tillers						
T_1	87.39	90.93	91.48	88.52	90.68	93.53
T_2	87.32	90.83	91.43	88.51	90.57	93.43
'F' test	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
S.E. ±	0.35	0.22	0.20	0.26	0.22	0.16
C.D. at 5 %	-	-	-	-	-	-
Mean	87.35	90.88	91.46	88.52	90.63	93.48

Table 22 (Contd...): Interaction

Method of planting X Plant density (M x P)

1979-80

Treatments	Days after planting		
	270	300	330
M_1P_1	87.17	91.29	91.25
M_1P_2	88.90	90.85	92.38
M_1P_3	91.51	91.34	91.08
M_2P_1	83.80	89.91	90.73
M_2P_2	87.44	90.44	91.88
M_2P_3	86.87	91.68	91.19
M_3P_1	87.18	89.71	90.83
M_3P_2	87.24	91.50	91.92
M_3P_3	86.07	91.22	91.82
'F' test	Sigt.	N.S.	N.S.
S.E. $\pm$	0.84	0.70	0.56
C.D. at 5 %	2.41	-	-

Effect of plant densities

There was a significant difference in purity percentage of juice due to plant densities at 270 days from planting during both the seasons. The planting of 75 x 10^3 and 50 x 10^3 buds/ha recorded significantly higher purity percentage than 25 x 10^3 buds/ha and remained at par with each other.

Effect of nitrogen levels

Different nitrogen levels significantly influenced the purity percentage of juice at 270 and 300 days from planting during 1979-80 and 1980-81, respectively. Application of 150 kg N/ha recorded significantly more purity

percentage than 200 and 250 kg N/ha at 300 days from planting during 1980-81, however, it was significantly more than 250 kg N/ha and was on par with 200 kg N/ha at 270 days during 1979-80.

Effect of maintenance of tillers

The maintenance of tillers did not influence the purity percentage at all the stages during both the seasons.

Interactions

The interaction effects between two and three factors were found to be not significant at all the stages during both the seasons except the interaction of methods of planting x plant densities at 270 days from planting during 1979-80.

Methods of planting X Plant densities (Mx P)

In the interaction of methods of planting and plant densities at 270 days during 1979-80, planting of three-budded sett with 75 x 10^3 buds/ha recorded highest purity percentage than other combinations.

4.2.4 Net Rendiment (N.R.)

The data on net rendiment (N.R.) as periodically influenced by different treatments are presented in Table 23.

Table 23. Effects of the various treatments of method of planting, plant density, nitrogen level, maintenance of tillers and their interactions on net rendiment (N.R.) at different stages (days)

Treatments	Days after planting					
	270	300	330	270	300	330
	1979-80			1980-81		
Method of planting						
M_1	10.76	12.84	13.29	10.86	12.79	13.84
M_2	9.68	12.55	13.39	10.73	12.74	14.20
M_3	10.14	12.59	13.15	10.81	12.66	13.94
'F' test	Sigt.	N.S.	N.S.	N.S.	N.S.	Sigt.
S.E. ±	0.13	0.16	0.12	0.11	0.09	0.08
C.D. at 5 %	0.38	-	-	-	-	0.23
Plant density						
P_1	9.85	12.53	12.99	10.32	12.67	13.96
P_2	10.19	12.65	13.19	10.99	12.84	13.99
P_3	10.54	12.80	13.35	11.08	12.69	14.03
'F' test	Sigt.	N.S.	N.S.	Sigt.	N.S.	N.S.
S.E. ±	0.13	0.16	0.12	0.11	0.09	0.08
C.D. at 5 %	0.38	-	-	0.31	-	-
Nitrogen level						
N_1	10.47	12.99	13.47	10.41	12.89	14.12
N_2	10.33	12.68	13.21	10.82	12.54	13.97
N_3	9.78	12.31	12.85	10.61	12.77	13.89
'F' test	Sigt.	N.S.	Sigt.	N.S.	Sigt.	N.S.
S.E. ±	0.13	0.16	0.12	0.11	0.09	0.08
C.D. at 5 %	0.38	-	0.35	-	0.26	-
Maintenance of tillers						
T_1	10.58	12.70	13.21	10.82	12.78	14.03
T_2	10.11	12.62	13.14	10.79	12.68	13.96
'F' test	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
S.E. ±	0.12	0.07	0.07	0.08	0.06	0.06
C.D. at 5 %	-	-	-	-	-	-
Mean	10.34	12.67	13.17	10.80	12.73	13.99

Table 23 (Contd...): Interaction

Method of planting X Plant density (M x P)

1979-80

Treatments	Days after planting		
	270	300	330
M_1P_1	10.16	12.90	13.25
M_1P_2	10.74	12.66	13.63
M_1P_3	11.38	12.94	12.98
M_2P_1	9.13	12.35	12.78
M_2P_2	9.85	12.61	13.26
M_2P_3	10.07	12.69	13.21
M_3P_1	10.27	12.35	12.94
M_3P_2	9.98	12.67	13.15
M_3P_3	10.18	12.77	13.37
'F' test	Sigt.	N.S.	N.S.
S.E. ±	0.23	0.28	0.21
C.D. at 5 %	0.66	-	-

It would be seen that the mean N.R. was 10.34, 12.67, 13.17 and 10.80, 12.73, 13.99 at 270, 300 and 330 days during 1979-80 and 1980-81, respectively.

Effect of methods of planting

The different methods of planting significantly affected the net rendiment during earlier period i.e. at 270 days from planting in 1979-80, when the planting of three-budded sett recorded highest N.R. Though not significant, similar trend has been observed during earlier period of 1980-81. At latter stage i.e. 330 days from planting during the year 1980-81, the trans-planting of single budded settling had its superiority over other methods of planting.

Effect of plant densities

the differences in N.R. due to different plant densities were found to be significant at 270 days from planting during both the seasons. The planting of 75 x 10^3 buds/ha had its superiority over 25 x 10^3 buds/ha and was at par with 50 x 10^3 buds/ha.

Effect of nitrogen levels

The N.R. was found to be significantly affected due to nitrogen levels at 270 and 330 days from planting during 1979-80 and at 330 days during 1980-81. Though, significant difference was not observed at other stages by and large, increase in the nitrogen levels reduced the net rendiment of cane.

Effect of maintenance of tillers

The net rendiment (N.R.) was not significantly influenced by the maintenance of tillers at all the stages during both the seasons, however, it was found to be more with the maintenance of tillers at all the stages in both the years.

Interactions

Interaction effects between various factors under study were not found significant except the methods of planting and plant densities at 270 days from planting during 1979-80 when the planting of three-budded sett with

75 x 10^3 buds/ha gave significantly more N.R. than other combinations except three-budded sett planting with 50 x 10^3 buds/ha.

4.3 Yield contributing characters

4.3.1 Mean total and millable height per cane at harvest

The data regarding mean total and millable beight (cm) per cane at harvest, as affected by different treatments are presented in Table 24.

It would be seen that the mean total and millable height per plant was 312.26, 260.86 and 314.45, 288.86 cm at harvest during 1979-80 and 1980-81, respectively.

Effect of methods of planting

The mean total and millable height was significantly influenced by the methods of planting during both the seasons. Three and single budded sett planting methods recorded significantly more total height than the transplanting of single budded settling during both the seasons. The planting of three-budded sett also gave more total height than single budded sett planting.

Similarly, the millable cane height was significantly more in case of three-budded sett planting than transplanting of single budded settling during 1979-80 and over transplanting and single budded sett planting during the year 1980-81.

Table 24. Effects of the various treatments of method of planting, plant density, nitrogen level, main tenance of tillers and their interactions on total and millable height, girth (cm) and number of internodes per plant at harvest

Treatments	1979-80				1980-81			
	Total height	Millable height	Girth	Number of internodes	Total height	Millable height	Girth	Number of internodes
Method of planting								
M_1	323.03	270.47	8.61	24.94	323.40	296.06	8.17	21.03
M_2	292.33	246.11	8.14	22.94	305.46	282.54	7.92	20.00
M_3	318.44	266.00	8.58	24.23	314.49	288.00	7.93	20.67
'F' test	Sigt.	Sigt.	N.S.	Sigt.	Sigt.	Sigt.	Sigt.	Sigt.
S.E. ±	1.78	1.96	0.17	0.14	2.74	2.09	0.05	0.14
C.D. at 5 %	5.14	5.66	-	0.40	7.90	6.03	0.15	0.40
Plant density								
P_1	306.19	254.86	8.47	23.83	313.99	287.04	8.12	20.50
P_2	312.28	263.08	8.45	24.33	314.42	289.81	7.98	20.58
P_3	318.33	264.64	8.41	24.85	314.94	289.75	7.92	20.61
'F' test	Sigt.	Sigt.	N.S.	Sigt.	N.S.	N.S.	Sigt.	N.S.
S.E. ±	1.78	1.96	0.17	0.14	2.74	2.09	0.05	0.14
C.D. at 5 %	5.14	5.66	-	0.40	-	-	0.15	-
Nitrogen level								
N_1	307.83	256.33	8.40	24.05	307.94	282.33	7.94	20.47
N_2	311.97	260.83	8.41	24.54	312.78	288.32	8.03	20.78
N_3	317.00	265.39	8.51	24.19	322.63	295.94	8.05	20.44
'F' test	Sigt.	Sigt.	N.S.	N.S.	Sigt.	Sigt.	N.S.	N.S.
S.E. ±	1.78	1.96	0.17	0.14	2.74	2.09	0.05	0.14
C.D. at 5 %	5.14	5.66	-	-	7.90	6.03	-	-
Maintenance of tillers								
T_1	314.61	261.87	8.54	24.26	315.21	289.82	8.12	20.69
T_2	309.92	259.85	8.34	24.02	313.69	287.91	7.89	20.44
'F' test	Sigt.	N.S.	Sigt.	N.S.	N.S.	N.S.	Sigt.	Sigt.
S.E. ±	1.19	1.25	0.05	0.12	1.53	1.32	0.05	0.07
C.D. at 5 %	3.48	-	0.15	-	-	-	0.15	0.20
Mean	312.26	260.86	8.44	24.14	314.45	288.86	8.00	20.56

Table 24 (contd...) : Interactions

(i) Method of planting X Plant density (M x P) 1979-80

Treatments	Total height	Millable height	Girth	Number of internodes
M_1P_1	317.25	264.83	8.77	24.58
M_1P_1	320.75	274.33	8.50	25.17
M_1P_2	331.08	272.25	8.55	25.08
M_2P_1	290.42	243.50	8.26	23.92
M_2P_1	296.17	244.67	8.14	21.83
M_2P_2	299.42	250.17	8.03	23.08
M_3P_1	310.92	256.25	8.38	24.50
M_3P_1	319.92	270.25	8.58	24.50
M_3P_2	324.50	271.50	8.78	24.58
'F' test	N.S.	N.S.	N.S.	Sigt.
S.E. ±	3.08	3.40	0.29	0.22
C.D. at 5 %	-	-	-	0.63

(ii) Method of pla.ting X Nitrogen level (M x N) 1979-80

M_1N_1	320.83	265.92	8.77	24.92
M_1N_1	324.33	272.92	8.54	25.00
M_1N_2	323.93	272.58	8.51	24.92
M_2N_1	293.25	242.08	8.18	22.58
M_2N_1	283.33	241.33	8.08	23.00
M_2N_2	305.42	254.92	8.17	23.25
M_3N_1	309.42	261.00	8.58	24.67
M_3N_1	324.25	268.33	8.59	24.50
M_3N_2	321.67	268.67	8.55	24.42
'F' test	N.S.	N.S.	N.S.	Sigt.
S.E. ±	3.08	3.40	0.29	0.22
C.D. at 5 %	-	-	-	0.63

Effects of plant densities

There was a significant difference in total and millable height during 1979-80 only. The planting of 75 x 10^3 buds/ha recorded significantly more total height than 50 and

25 x 10^3 buds/ha. The planting of 75 x 10^3 buds/ha recorded significantly more millable height than 25 x 10^3 buds/ha and was on par with 50 x 10^3 buds/ha.

Effect of nitrogen levels

The differences in total and millable height due to nitrogen levels were found to be significant during both the seasons. Application of 250 kg N/ha had its significant superiority over both the lower levels during 1980-81 and was on par with 200 kg N/ha during the year 1979-80. In general, increase in total and millable plant height was associated with the increasing levels of nitrogen.

Effect of maintenance of tillers

The difference in total height was found to be significant during 1979-80, while total and millable height differences during 1980-81 were not discernible. By and large, the maintenance of tillers recorded more total and millable height than uncontrolled tillers.

Interactions

The interaction effects between two and three factors under study were found to be not significant during both the seasons.

4.3.2 Mean middle girth per cane at harvest

The data on mean middle girth of cane at harvest as influenced by different treatments are presented in Table 24.

It would be seen that the mean middle girth per cane was 8.44 and 8.00 cm during 1979-80 and 1980-81, respectively.

Effect of methods of planting

The mean middle girth of cane was significantly affected due to methods of planting during 1980-81. The planting of three-budded sett showed significantly more girth than the other methods of planting. Similar trend was also observed during 1979-80 as that of 1980-81.

Effect of plant densities

There was a significant difference in mean middle girth due to plant densities during 1980-81. The planting of 25 x 10^3 buds/ha recorded significantly more girth than 75 x 10^3 buds/ha and on par with 50 x 10^3 buds/ha.

Effect of nitrogen levels

Application of nitrogen did not influence the cane girth at harvest during both the seasons.

Effect of maintenance of tillers

The mean middle girth was significantly more with the maintenance of tillers than the uncontrolled tillers during both the seasons.

Interactions

The interaction effects between two and three factors were found to be not significant during both the seasons.

4.3.3 Mean number of internodes per cane at harvest

The data on mean number of internodes per cane at harvest, as influenced by various treatments are given in Table 24.

It is gathered from Table 24 that the mean number of internodes was 24.14 and 20.56 during 1979-80 and 1980-81, respectively.

Effect of methods of planting

The significant difference was observed in the mean number of internodes due to methods of planting at harvest during both the seasons. The planting of three-budded sett recorded significantly more number of internodes over other methods during 1979-80, however, it was on par with the planting of single budded sett and significantly superior to transplanting of single budded settling during 1980-81.

Effect of plant densities

The mean number of internodes per cane was significantly affected by different plant densities during 1979-80. The planting of 75 x 10^3 buds/ha was significantly superior to 50 and 25 x 10^3 buds/ha. The planting of 50 x 10^3 buds/ha had also its superiority over 25 x 10^3 buds/ha.

Effect of nitrogen levels

The mean number of internodes did not differ significantly by nitrogen levels during both the seasons.

Effect of maintenance of tillers

The mean number of internodes was found to be significantly more with the maintenance of tillers than uncontrolled tillers during 1980-81. Though not significant, similar trend was also observed during 1979-80.

Interactions

The interaction effects between methods of planting X plant densities and methods of planting X nitrogen levels were found to be significant during 1979-80 and all other interaction effects found to be not significant.

(i) Methods of planting X Plant densities (M x P)

In the interaction of methods of planting and plant densities, planting of three-budded sett with 50×10^3 buds/ha recorded significantly more number of internodes than other combinations except planting of three-budded setts with 25 and 75×10^3 buds/ha and planting of single budded sett with 75×10^3 buds/ha.

(ii) Methods of planting X Nitrogen levels (M x N)

In the interaction of methods of planting X nitrogen levels, planting of three-budded sett with 200 kg N/ha had its superiority over the treatment combinations of transplanting single budded settling with varying levels of nitrogen and on par with all other combinations.

4.3.4 Per cane weight (kg) at harvest

The data regarding the weight of individual cane, as affected by different treatments at harvest are given in Table 25 and graphically depicted in Fig. 12.

A glance at the data would reveal that the weight of individual cane at harvest was 1.058 and 0.957 kg during 1979-80 and 1980-81, respectively.

Effect of methods of planting

The difference in the weight of individual cane between various treatments of methods of planting was found to be significant, during both the seasons. The planting of three-budded sett gave significantly more per cane weight than other methods of planting. Further, the transplanting of settling produced cane of lighter weight.

Effect of plant densities

There was a significant difference in per cent weight due to different plant densities during 1980-81. The planting 25 x 10^3 buds/ha had its superiority over 50 and 75 x 10^3 buds/ha, which were on par among themselves.

Effect of nitrogen levels

The mean per cane weight was significantly affected by the nitrogen levels. Application of 250 kg N/ha gave significantly more weight of individual canes than 150 kg

Table 25. Effects of the various treatments of methods of planting, plant density, nitrogen level and maintenance of tillers on per cane weight in kg at harvest

Treatments	1979-80	1980-81
Method of planting		
M_1	1.164	1.011
M_2	0.919	0.917
M_3	1.093	0.945
'F' test	Sigt.	Sigt.
S.E. ±	0.014	0.014
C.D. at 5 %	0.040	0.040
Plant density		
P_1	1.071	1.005
P_2	1.063	0.933
P_3	1.041	0.936
'F' test	N.S.	Sigt.
S.E. ±	0.014	0.014
C.D. at 5 %	-	0.040
Nitrogen level		
N_1	1.014	0.934
N_2	1.065	0.946
N_3	1.096	0.994
'F' test	Sigt.	Sigt.
S.E. ±	0.014	0.014
C.D. at 5 %	0.040	0.040
Maintenance of tillers		
T_1	1.082	0.978
T_2	1.035	0.937
'F' test	Sigt.	Sigt.
S.E. ±	0.010	0.010
C.D. at 5 %	0.029	0.029
Mean	1.058	0.957

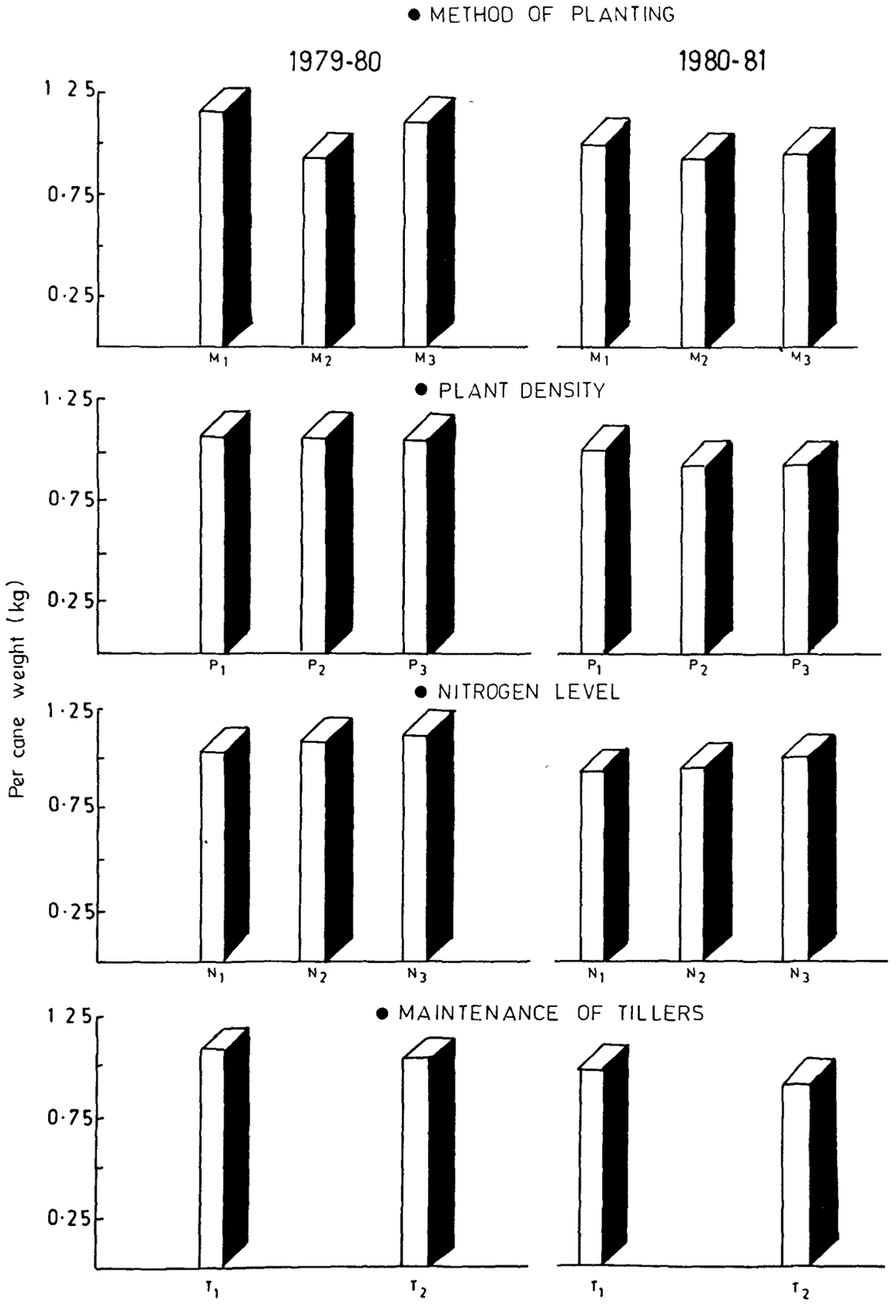

Fig.12. Mean per cane weight (kg) as influenced by factors.

N/ha and on par with 200 kg N/ha, during 1979-80. While, during 1980-81, it was significantly superior to both the lower levels of nitrogen.

Effect of maintenance of tillers

The per cane weight was found to be significantly more with the maintenance of tillers than the uncontrolled treatment, during both the seasons.

Interactions

All the interaction effects due to two and three factors under study were found to be not significant.

4.3.5 Number of millable canes per hectare

The data relating to mean number of millable canes per hectare at harvest as influenced by various treatments are presented in Table 26 and graphically depicted in Fig.13.

Perusal of the data from Table 26 revealed that the mean number of millable canes per hectare was 96.7×10^3 and 106.2×10^3 during 1979-80 and 1980-81, respectively.

Effect of methods of planting

The mean number of millable canes per hectare was significantly affected by different methods of planting. The transplanting of single budded settling gave significantly more number of millable canes than other methods of planting during both the seasons. The planting of single

Table 26. Effects of the various treatments of method of planting, plant density, nitrogen level, maintenance of tillers and their interactions on number of millable canes/ha at harvest in '000'.

Treatments	1979-80	1980-81
Method of planting		
M_1	91.944	101.600
M_2	102.277	110.044
M_3	95.879	107.007
'F' test	Sigt.	Sigt.
S.E. $\pm$	1.213	1.052
C.D. at 5 %	3.499	3.035
Plant density		
P_1	93.638	94.341
P_2	95.814	110.434
P_3	100.648	113.878
'F' test	Sigt.	Sigt.
S.E. $\pm$	1.213	1.052
C.D. at 5 %	3.499	3.035
Nitrogen level		
N_1	91.212	103.082
N_2	99.009	106.406
N_3	99.879	109.165
'F' test	Sigt.	Sigt.
S.E. $\pm$	1.213	1.052
C.D. at 5 %	3.499	3.035
Maintenance of tillers		
T_1	91.617	101.326
T_2	101.783	111.110
'F' test	Sigt.	Sigt.
S.E. $\pm$	1.254	0.723
C.D. at 5 %	3.657	2.115
Mean	96.700	106.218

Table 26 (Contd...) : Interaction

Plant density X Maintenance of tillers (P x T)

Treatments	1979-80	1980-81
P_1T_1	89.660	92.388
P_1T_2	98.111	96.295
P_2T_1	90.666	103.461
P_2T_2	100.963	117.406
P_3T_1	95.018	108.128
P_3T_2	106.277	119.628
'F' test	N.S.	Sigt.
S.E. $\pm$	2.173	1.253
C.D. at 5 %	-	3.666

budded sett also produced significantly more number of millable canes than three-budded sett planting during both the seasons.

Effect of plant densities

Different plant densities significantly influenced the number of millable canes. The planting of 75 x 10^3 buds/ha gave significantly more number of millable canes than 50 and 25 x 10^3 buds/ha, during both the seasons. The planting of 50 and 25 x 10^3 buds/ha were on par with each other, during 1979-80, while 50 x 10^3 buds/ha had its superiority over 25 x 10^3 buds/ha during 1980-81.

Effect of nitrogen levels

The variation in millable cane number per hectare was found to be significant due to nitrogen levels. The application of 250 and 200 kg levels of N/ha were significantly superior to 150 kg N/ha. However, these treatments were on par with each other, during both the seasons.

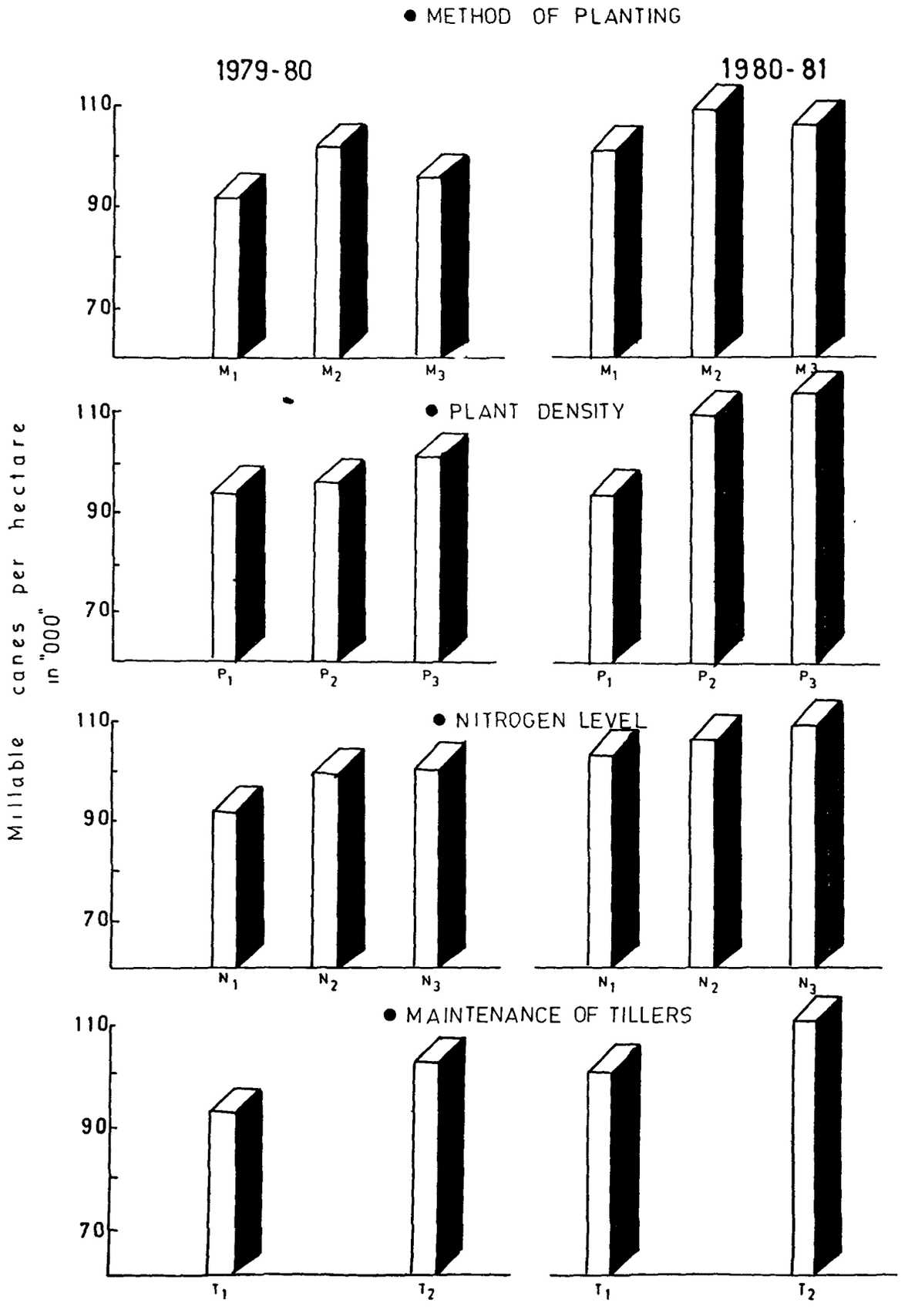

Fig.13. Mean number of millable canes/ha as influenced by factors.

Effect of maintenance of tillers

The mean number of millable canes per hectare at harvest was significantly more with the treatment of uncontrolled tillers during both the seasons.

Interactions

The interaction effects between two and three factors under study were found to be not significant, during both the seasons, except the interaction of plant densities X maintenance of tillers during 1980-81.

Plant densities X Maintenance of tillers (P x T)

In the interaction of plant densities X maintenance of tillers, the treatment combinations of planting 50 and 75 x 10^3 buds/ha with uncontrolled tillers recorded significantly more number of millable canes than other combinations. The lowest number of millable canes was observed with the planting of 25 x 10^3 buds/ha with and without controlling tillers.

4.4 Yield

4.4.1 Yield of sugarcane

The data regarding the mean cane yield (t/ha) as influenced by various treatments are presented in Table 27 and 28, and graphically depicted in Fig. 14 and 15.

Table 27. Effects of the various treatments of method of planting, plant density, nitrogen level and maintenance of tillers on cane yield(t/ha)

Treatments	1979-80	1980-81	Weighted mean
Method of planting			
M_1	107.036	102.560	102.855
M_2	93.684	100.841	100.368
M_3	104.897	101.179	101.425
'F' test	Sigt.	N.S.	N.S.
S.E. ±	2.188	1.731	1.183
C.D. at 5 %	6.312	-	-
Plant density			
P_1	100.101	94.761	95.114
P_2	101.267	103.023	102.907
P_3	104.249	106.796	106.628
'F' test	N.S.	Sigt.	Sigt.
S.E. ±	2.188	1.731	1.183
C.D. at 5 %	-	4.994	3.278
Nitrogen level			
N_1	91.897	95.958	95.690
N_2	104.841	100.685	100.959
N_3	108.878	107.937	107.999
'F' test	Sigt.	Sigt.	Sigt.
S.E. ±	2.188	1.731	1.183
C.D. at 5 %	6.312	4.994	3.278
Maintenance of tillers			
T_1	98.807	99.412	99.386
T_2	104.937	103.642	103.697
'F' test	Sigt.	Sigt.	Sigt.
S.E. ±	1.690	1.093	0.757
C.D. at 5 %	4.828	3.198	2.098
Mean	101.872	101.527	

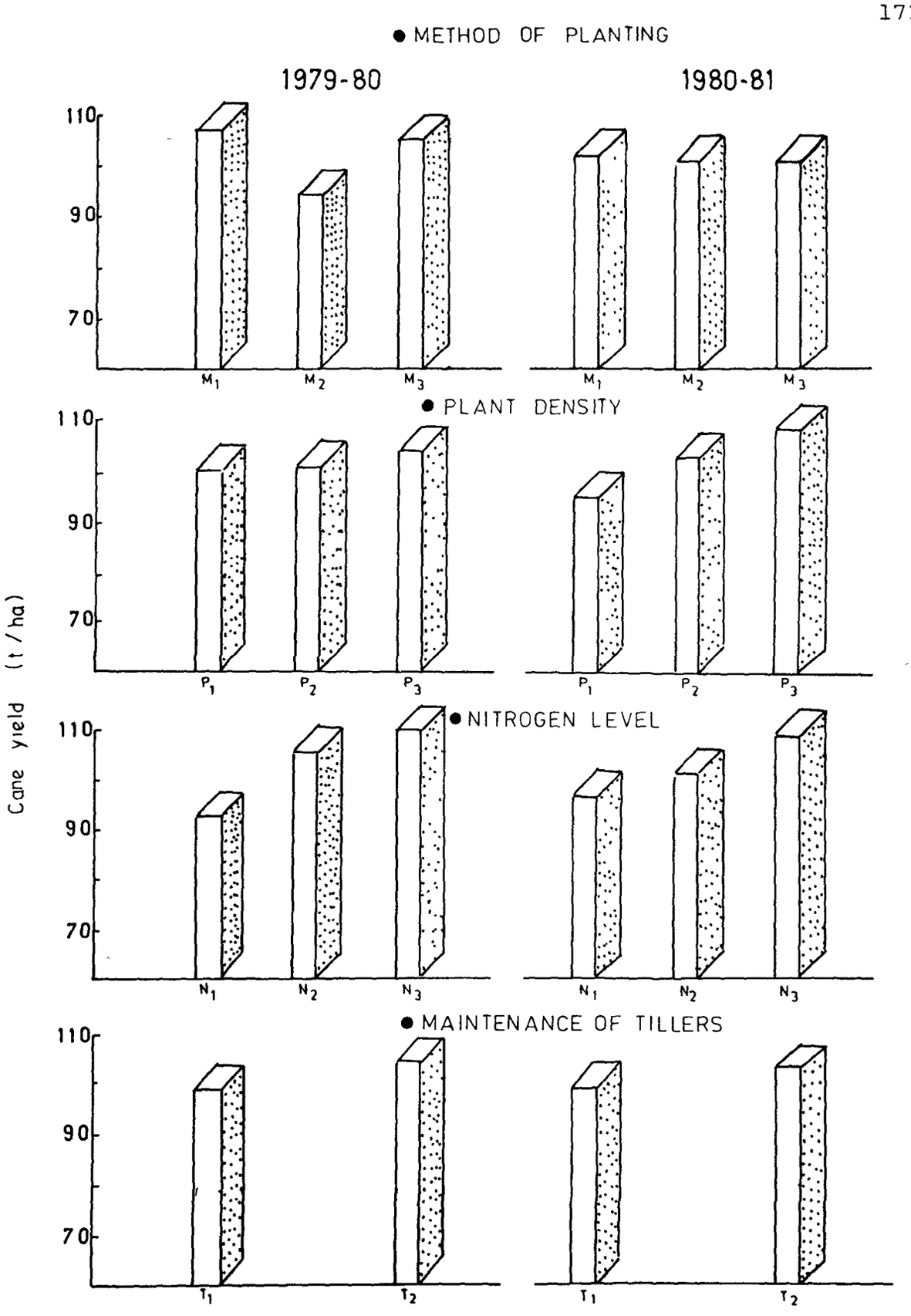

Fig.14 . Mean cane yield (t/ha) as influenced by factors .

Table 28. Effects of the various treatments of method of planting, plant density, nitrogen level and maintenance of tillers on cane yield(t/ha) under modified treatment of maintenance of tillers during 1981-82.

Treatments	Yield (t/ha)
Method of planting	
M_1	109.479
M_2	89.083
M_3	109.877
'F' test	Sigt.
S.E. ±	2.649
C.D. at 5 %	7.643
Plant density	
P_1	95.638
P_2	102.712
P_3	110.090
'F' test	Sigt.
S.E. ±	2.649
C.D. at 5 %	7.643
Nitrogen level	
N_1	94.685
N_2	106.165
N_3	107.591
'F' test	Sigt.
S.E. ±	2.649
C.D. at 5 %	7.643
Maintenance of tillers	
T_1	99.249
T_2	106.378
'F' test	Sigt.
S.E. ±	1.237
C.D. at 5 %	3.619
Mean	102.814

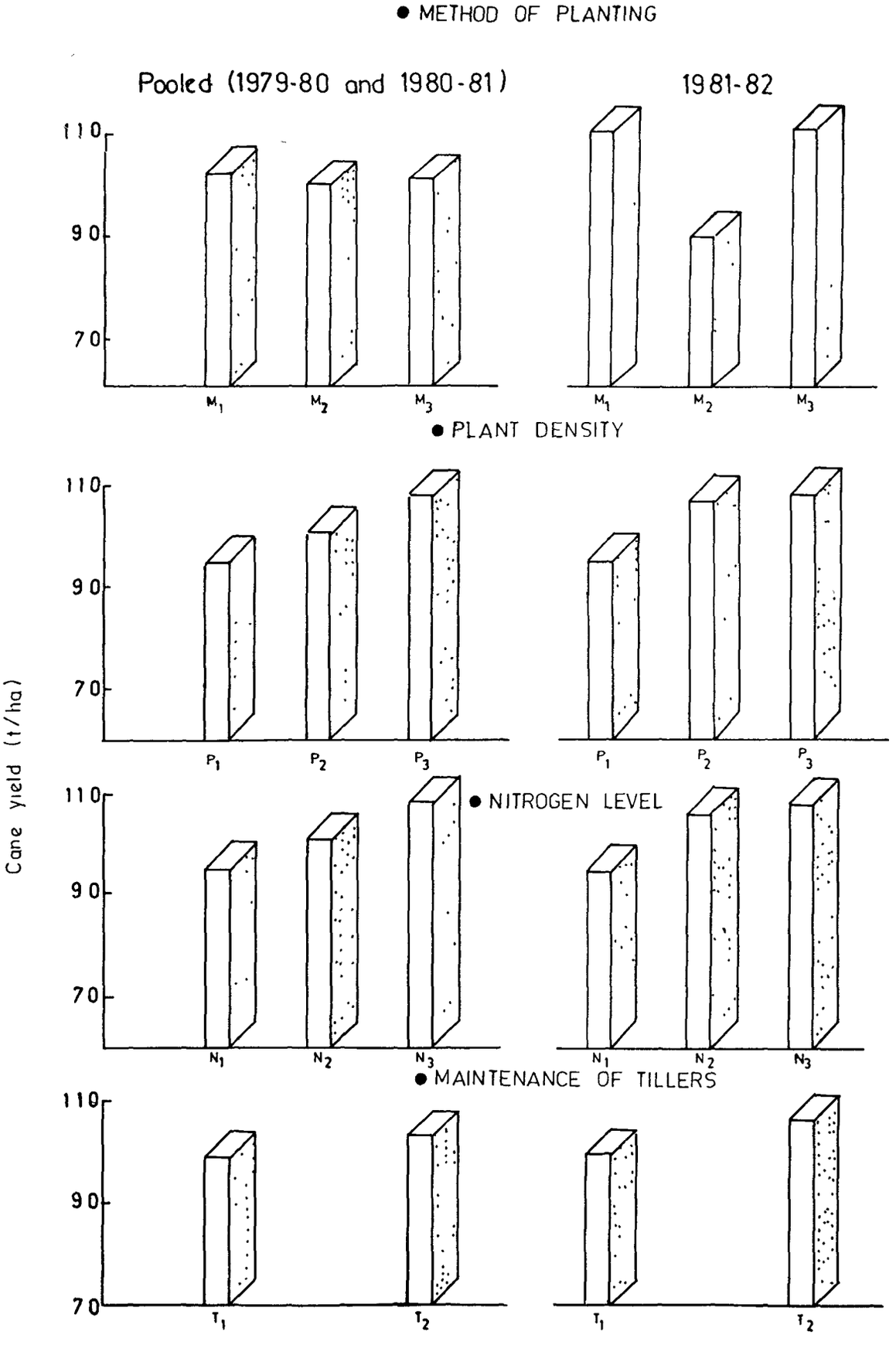

Fig. 15. Mean cane yield (t/ha) as influenced by factors Pooled (1979-80 and 1980 81) and 1981-82

A glance at the data in Table 27 and 28 revealed that the mean yield of sugarcane per hectare was 101.872, 101.527 and 102.814 t/ha during 1979-80, 1980-81 and 1981-82, respectively.

Effect of methods of planting

The differences in cane yield due to methods of planting were statistically significant during 1979-80. The maximum yield of sugarcane (107.036 t/ha) was obtained from planting of three-budded sett, which was on par with planting of single budded sett (104.897 t/ha) and significantly superior over the transplanting of single budded settling (93.684 t/ha). Though the differences were not significant, single and three-budded sett planting methods surpassed the settling transplanting method in cane yield during 1980-81 and when the data were pooled over seasons. Similarly, single and three-budded sett planting methods recorded significantly more cane yield (109.479 and 109.877 t/ha) than transplanting of settling (89.083 t/ha) with the maintenance of tillers beyond light earthing, up to final earthing, was imposed during 1981-82.

Effect of plant densities

The per hectare yield of sugarcane was significantly affected by different plant densities in 1980-81 and when the data were pooled over seasons. The cane

yield was found to be increased with increased plant density and the highest plant density (75 x 10^3 buds/ha) recorded the highest cane yield of 104.249 and 106.796 t/ha during the year 1979-80 and 1980-81, respectively. The yield recorded with the plant density of 75 x 10^3 buds/ha was significantly more than the plant density of 25 x 10^3 buds/ha during 1980-81 and over 25 and 50 x10^3 buds/ha when the data were pooled over seasons. Similarly, the highest plant density of 75 x 10^3 buds/ha recorded significantly more cane yield (110.090 t/ha) compared to 25 and 50 x 10^3 buds/ha (95.638 and 102.712 t/ha, respectively) when the maintenance of tillers was extended up to final earthing during 1981-82.

Effect of nitrogen levels

Application of nitrogen influenced the cane yield significantly, during both the seasons and when the data were pooled over seasons. The cane yield per hectare was increased significantly with increasing levels of nitrogen during 1980-81 and when the data were pooled over seasons. However, the cane yield obtained with the application of 200 and 250 kg N/ha were at par and significantly more than 150 kg N/ha during 1979-80. Similarly, the cane yield obtained with 200 and 250 kg N/ha (106.165 and 107.591 t/ha) were at par and significantly more than 150 kg N/ha (94.685 t/ha) when the maintenance of tillers was extended up to final earthing during the year 1981-82.

Effect of maintenance of tillers

The cane yield was significantly more in uncontrolled treatment than with the maintenance of tillers during both the seasons and when the data were pooled over seasons. Similarly, the uncontrolled treatment recorded significantly more cane yield (106.378 t/ha) than the maintenance of tillers (99.249 t/ha) when the maintenance of tillers was extended up to final earthing during the year 1981-82.

Interactions

All the interaction effects between two and three factors under study were found to be not significant during both the seasons.

4.4.2 Yield of commercial cane sugar (C.C.S. t/ha)

The data on mean commercial cane sugar (C.C.S.) as influenced by different treatments are presented in Table 29 and graphically depicted in Fig. 16.

From the data, it would be seen that the mean C.C.S. yield was 14.790 and 14.437 tonnes per hectare, during 1979-80 and 1980-81, respectively.

Effect of methods of planting

The differences in commercial cane sugar due to methods of planting were found to be statistically significant during 1979-80. The planting of three-budded sett

Table 29. Effects of the various treatments of method of planting, plant density, nitrogen level and maintenance of tillers on commercial cane sugar (t/ha)

Treatments	1979-80	1980-81
Method of planting		
M_1	15.546	14.485
M_2	13.614	14.439
M_3	15.211	14.387
'F' test	Sigt.	N.S.
S.E. ±	0.30	0.23
C.D. at 5 %	0.87	-
Plant density		
P_1	14.630	13.410
P_2	14.806	14.635
P_3	14.936	15.266
'F' test	N.S.	Sigt.
S.E. ±	0.30	0.23
C.D. at 5 %	-	0.66
Nitrogen level		
N_1	13.586	13.775
N_2	15.184	14.340
N_3	15.602	15.195
'F' test	Sigt.	Sigt.
S.E. ±	0.30	0.23
C.D. at 5 %	0.87	0.66
Maintenance of tillers		
T_1	14.383	14.147
T_2	15.198	14.727
'F' test	Sigt.	Sigt.
S.E. ±	0.26	0.16
C.D. at 5 %	0.76	0.47
Mean	14.790	14.437

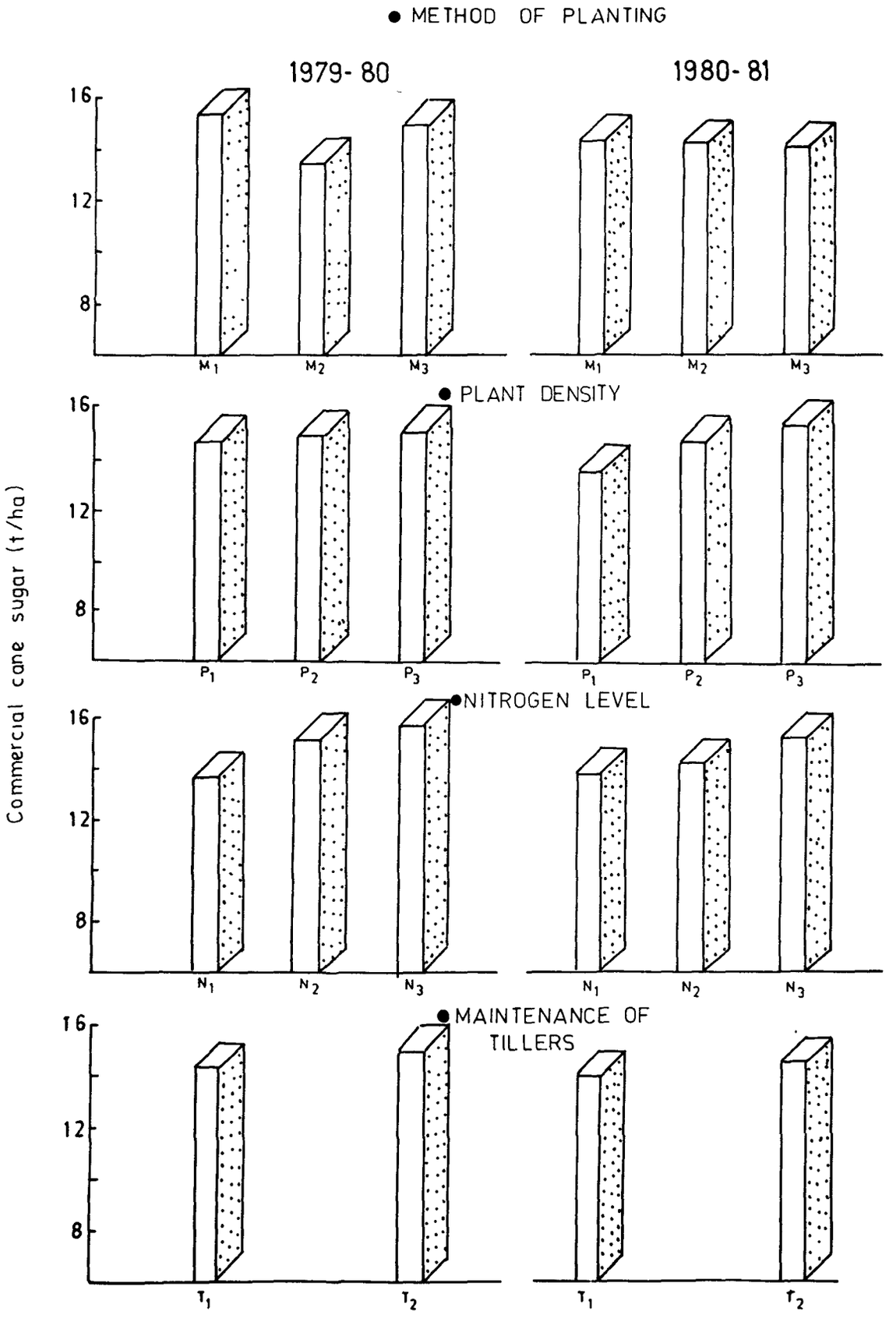

Fig. 16.. Mean commercial cane sugar (t/ha) as influenced by factors.

gave significantly higher yield of commercial cane sugar (15.546 t/ha) than the transplanting of single budded settling (13.614 t/ha) and it was on par with single budded sett planting (15.211 t/ha). However, the differences in commercial cane sugar yield due to methods of planting were not discernible during the year 1980-81.

Effect of plant densities

The mean yield of commercial cane sugar was significantly influenced by different plant densities in 1980-81. The planting of 75 x 10^3 buds/ha gave significantly more C.C.S. yield (15.266 t/ha) than 25 x 10^3 buds/ha (13.410 t/ha) and on par with 50 x 10^3 buds/ha (14.635 t/ha). Though, different plant densities did not differ significantly during the year 1979-80, almost similar trend was observed as that of 1980-81.

Effect of nitrogen levels

Application of nitrogen influenced the yield of commercial cane sugar significantly during both the seasons. Application of 250 and 200 kg N/ha gave significantly more C.C.S. yield than 150 kg N/ha during 1979-80, however, in 1980-81, 250 kg N/ha was significantly superior to both the lower levels of nitrogen. In general, increase in levels of nitrogen increased the yield of commercial cane sugar during both the seasons.

Effect of maintenance of tillers

The commercial cane sugar yield was found to be significantly more with uncontrolled tillers than the maintenance of tillers during both the seasons.

Interactions

All the interaction effects between two and three factors under study were found to be not significant, during both the seasons.

4.5 Cane juice quality at harvest

The data regarding cane juice quality i.e. Brix, sucrose and purity percentage of juice and net rendiment (N.R.), as influenced by the various treatments at harvest, are presented in Table 30.

4.5.1 Brix

It would be seen that the mean Brix was 22.29 and 22.12 during 1979-80 and 1980-81, respectively.

Effect of treatments

The mean Brix was not significantly affected either by methods of planting, plant densities, maintenance of tillers or their interactions. However, the application of nitrogen significantly influenced the Brix during both the seasons. Application of 150 kg N/ha recorded significantly more Brix than 200 and 250 kg N/ha in 1979-80,

Table 30. Effects of the various treatments of method of planting, plant density, nitrogen level and maintenance of tillers on Brix, sucrose and purity percentage in juice and net rendiment (N.R.) at harvest

Treatments	1979-80				1980-81			
	Brix	Sucrose %	Purity %	N.R.	Brix	Sucrose %	Purity %	N.R.
Method of planting								
M_1	22.40	21.14	94.65	14.63	22.25	20.85	93.76	14.33
M_2	22.29	21.06	94.40	14.58	21.98	20.55	93.41	14.14
M_3	22.18	20.99	94.41	14.52	22.13	20.68	93.48	14.23
'F' test	N.S.	N.S.	N.S.	N.S.	N.S.	Sigt.	N.S.	N.S.
S.E. ±	0.11	0.15	0.28	0.11	0.10	0.08	0.16	0.06
C.D. at 5 %	-	-	-	-	-	0.23	-	-
Plant density								
P_1	22.32	20.89	94.77	14.46	22.03	20.61	93.64	14.18
P_2	22.34	21.14	94.62	14.61	22.17	20.70	93.31	14.21
P_3	22.21	21.17	94.08	14.66	22.16	20.78	93.69	14.30
'F' test	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
S.E. ±	0.11	0.15	0.28	0.11	0.10	0.08	0.16	0.06
C.D. at 5 %	-	-	-	-	-	-	-	-
Nitrogen level								
N_1	22.56	21.31	94.64	14.79	22.27	20.85	93.73	14.36
N_2	22.19	21.00	94.46	14.50	22.12	20.70	93.49	14.25
N_3	22.12	20.89	94.37	14.44	21.97	20.53	93.43	14.09
'F' test	Sigt.	N.S.	N.S.	Sigt.	Sigt.	Sigt.	N.S.	Sigt.
S.E. ±	0.11	0.15	0.28	0.11	0.10	0.08	0.16	0.06
C.D. at 5 %	0.31	-	-	0.31	0.29	0.23	-	0.18
Maintenance of tillers								
T_1	22.33	21.09	94.53	14.60	22.20	20.79	93.59	14.25
T_2	22.25	21.05	94.45	14.58	22.14	20.70	93.50	14.23
'F' test	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
S.E. ±	0.07	0.08	0.18	0.07	0.04	0.04	0.13	0.04
C.D. at 5 %	-	-	-	-	-	-	-	-
Mean	22.29	21.07	94.49	14.58	22.12	20.70	95.54	14.24

however, during 1980-81 application of 150 kg N/ha gave significantly more Brix than 250 kg N/ha and remained at par with 200 kg N/ha.

4.5.2 Sucrose percentage in juice

From the data in Table 30, it will be seen that the mean sucrose percentage in juice was 21.07 and 20.70 per cent during 1979-80 and 1980-81, respectively.

Effect of treatments

The sucrose percentage in juice was not influenced significantly due to different treatments of methods of planting, plant densities, nitrogen levels and maintenance of tillers during 1979-80, however, it was influenced significantly due to methods of planting and nitrogen levels during 1980-81. Three-budded sett planting gave significantly more sucrose (20.85 per cent) in juice than settling transplanting (20.55 per cent) and on par with planting of single budded sett (20.68 per cent).

As regards the nitrogen levels, application of 150 kg N/ha gave significantly more sucrose than 250 kg N/ha and remained at par with 200 kg N/ha.

The interaction effects between two and three factors under study were found to be not significant.

4.5.3 Purity percentage of juice at harvest

The data on purity percentage of sugarcane juice as affected by different treatments are presented in Table 30.

It would be seen that the mean purity percentage of juice was 94.49 and 95.54 during 1979-80 and 1980-81, respectively.

Effect of treatments

Differences in purity percentage of juice among different treatments and their interactions were found to be not significant, during both the seasons.

4.5.4 Net Rendiment (N.R.)

The data regarding the net rendiment at harvest in different treatments are presented in Table 30.

It would be seen that the mean net rendiment was 14.58 and 14.24 per cent, during 1979-80 and 1980-81, respectively.

Effect of treatments

Different levels of nitrogen influenced the N.R. significantly, during both the seasons, however, it was not affected by other treatments or their interactions. Application of 150 kg N/ha gave significantly more N.R. than 250 kg N/ha and it was on par with 200 kg N/ha.

4.6 Chemical studies

4.6.1 Uptake of total nitrogen (kg/ha) by the sugarcane crop at harvest

The data regarding the mean uptake of total nitrogen by the sugarcane crop at harvest, as influenced by various treatments are presented in Table 31 and graphically depicted in Fig. 17.

It would be seen that the mean uptake of nitrogen was 90.91 and 93.76 kg/ha at harvest, during 1979-80 and 1980-81, respectively.

Effect of methods of planting

Different methods of planting significantly affected the uptake of total nitrogen, during both the seasons. The planting of single budded sett recorded significantly more uptake of total nitrogen than three-budded sett planting and it was on par with the transplanting of settling during 1979-80. However, during 1980-81, single budded sett planting was on par with three-budded sett planting and both the methods were significantly superior to transplanting of settling.

Effect of plant densities

The differences in the uptake of total nitrogen due to different plant densities were statistically significant during 1980-81. The planting of 75 x 10^3 buds/ha showed

significantly highest uptake of nitrogen than 50 and 25 x 10^3 buds/ha. Also the planting of 50 x 10^3 buds/ha had its superiority over 25 x 10^3 buds/ha. In general, similar trend as that of 1980-81 was also observed during the year 1979-80.

Effect of nitrogen levels

Application of nitrogen levels significantly affected the uptake of total nitrogen, during both the seasons. Successive increase in nitrogen uptake was noticed with increased levels of nitrogen. Nitrogen application of 250 kg/ha had its superiority over the lower doses. Similarly, 200 kg N/ha also showed significantly more uptake of total nitrogen than 150 kg N/ha during both the seasons.

Effect of maintenance of tillers

The uptake of total nitrogen was significantly more in the treatment, where tillers were not controlled than that of the controlled tillers, during both the seasons.

Table 31. Effects of the various treatments of method of planting, plant density, nitrogen level, maintenance of tillers and their interactions on total uptake of nitrogen (kg/ha) at harvest

Treatments	1979-80	1980-81
Method of planting		
M_1	87.93	95.43
M_2	89.76	87.15
M_3	95.07	98.71
'F' test	Sigt.	Sigt.
S.E. ±	1.98	1.20
C.D. at 5 %	5.71	3.46
Plant density		
P_1	88.53	82.39
P_2	91.72	95.98
P_3	92.51	102.91
'F' test	N.S.	Sigt.
S.E. ±	1.98	1.20
C.D. at 5 %	-	3.46
Nitrogen level		
N_1	77.40	84.14
N_2	87.87	96.43
N_3	107.49	100.72
'F' test	Sigt.	Sigt.
S.E. ±	1.98	1.20
C.D. at 5 %	5.71	3.46
Maintenance of tillers		
T_1	83.43	90.91
T_2	98.40	96.61
'F' test	Sigt.	Sigt.
S.E. ±	1.21	0.20
C.D. at 5 %	3.54	0.58
Mean	90.91	93.76

Table 31 (Contd....): Interactions

(i) Method of planting X Plant density (M x P)

Treatments	1979-80	1980-81
M_1P_1	90.61	79.75
M_1P_2	86.45	100.78
M_1P_3	86.73	105.77
M_2P_1	79.36	80.34
M_2P_2	92.75	87.47
M_2P_3	97.17	93.63
M_3P_1	95.63	87.09
M_3P_2	95.95	99.68
M_3P_3	93.62	109.35
'F' test	Sigt.	Sigt.
S.E. ±	3.43	2.09
C.D. at 5 %	9.89	6.03

(ii) Method of planting X Nitrogen level (M x N)

M_1N_1	72.91	83.28
M_1N_2	87.98	103.25
M_1N_3	102.91	99.77
M_2N_1	82.68	79.49
M_2N_2	77.85	86.56
M_2N_3	108.75	95.39
M_3N_1	76.61	89.64
M_3N_2	97.77	99.48
M_3N_3	110.82	107.00
'F' test	Sigt.	Sigt.
S.E. ±	3.43	2.09
C.D. at 5 %	9.89	6.03

(iii) Plant density X Nitrogen level (P x N)

P_1N_1	74.06	71.35
P_1N_2	86.47	85.37
P_1N_3	101.05	90.46
P_2N_1	75.11	91.07
P_2N_2	83.76	100.15
P_2N_3	106.79	96.72
P_3N_1	83.04	89.99
P_3N_2	93.43	103.77
P_3N_3	114.63	114.98
'F' test	Sigt.	Sigt.
S.E. ±	3.43	2.09
C.D. at 5 %	9.89	6.03

Table 31 (Contd....) : Interactions

(iv) Method of planting X Maintenance of tillers (M x T)

Treatments	1979-80	1980-81
M_1T_1	81.32	90.91
M_1T_2	94.99	99.96
M_2T_1	78.29	85.14
M_2T_2	101.22	89.15
M_3T_1	90.69	96.67
M_3T_3	99.14	100.74
'F' test	Sigt.	Sigt.
S.E. ±	2.10	0.35
C.D. at 5 %	6.14	1.02

(v) Plant density X Maintenance of tillers (P x T)

P_1T_1	80.59	82.88
P_1T_2	96.48	91.91
P_2T_1	86.21	91.66
P_2T_2	97.22	100.29
P_3T_1	83.50	98.18
P_3T_2	101.51	107.64
'F' test	Sigt.	Sigt.
S.E. ±	2.10	0.35
C.D. at 5 %	6.14	1.02

(vi) Nitrogen level X Maintenance of tillers (N x T)

N_1T_1	73.71	85.01
N_1T_2	81.09	83.26
N_2T_1	81.57	88.40
N_2T_2	94.16	104.46
N_3T_1	95.02	99.35
N_3T_2	119.96	102.12
'F' test	Sigt.	Sigt.
S.E. ±	2.10	0.35
C.D. at 5 %	6.14	1.02

Table 31. (Contd...)

(vii) Method of planting X Plant density X Maintenance of tillers (M x P x T)

Treatments	1979-80	1980-81
$M_1P_1T_1$	82.75	79.73
$M_1P_1T_2$	98.47	79.77
$M_1P_2T_1$	83.33	93.02
$M_1P_2T_2$	90.58	108.55
$M_1P_3T_1$	78.87	99.98
$M_1P_3T_2$	94.98	111.55
$M_2P_1T_1$	72.81	81.90
$M_2P_1T_2$	85.90	78.77
$M_2P_2T_1$	82.22	82.86
$M_2P_2T_2$	103.28	92.08
$M_2P_3T_1$	79.85	90.67
$M_2P_3T_2$	114.48	96.59
$M_3P_1T_1$	86.20	87.00
$M_3P_1T_2$	105.06	87.18
$M_3P_2T_1$	94.08	99.11
$M_3P_2T_2$	97.81	100.25
$M_3P_3T_1$	91.79	103.91
$M_3P_3T_2$	95.45	114.78
'F' test	Sigt.	Sigt.
S.E. $\pm$	3.63	0.60
C.D. at 5 %	10.62	1.75

(viii) Method of planting X Nitrogen level X Maintenance of tillers (M x N x T)

$M_1N_1T_1$	70.36	79.41
$M_1N_1T_2$	75.45	87.15
$M_1N_2T_1$	81.00	92.74
$M_1N_2T_2$	94.97	113.75
$M_1N_3T_1$	92.59	100.58
$M_1N_3T_2$	113.22	98.97
$M_2N_1T_1$	73.40	81.24
$M_2N_1T_2$	91.96	77.74
$M_2N_2T_1$	71.00	82.67
$M_2N_2T_2$	84.70	90.51
$M_2N_3T_1$	90.48	91.57
$M_2N_3T_2$	127.01	99.20
$M_3N_1T_1$	77.36	84.38
$M_3N_1T_2$	75.87	84.90
$M_3N_2T_1$	92.72	89.84
$M_3N_2T_2$	102.82	109.11
$M_3N_3T_1$	101.99	105.80
$M_3N_3T_2$	119.65	108.21
'F' test	Sigt.	Sigt.
S.E. $\pm$	3.63	0.60
C.D. at 5 %	10.62	1.75

Table 31 (Contd....) : Interactions

(ix) Plant density X Nitrogen level X Maintenance of tillers (P x N x T)

Treatments	1979.80	1980-81
$P_1N_1T_1$	73.90	69.90
$P_1N_1T_2$	76.31	72.80
$P_1N_2T_1$	74.49	87.90
$P_1N_2T_2$	92.92	94.24
$P_1N_3T_1$	110.03	97.24
$P_1N_3T_2$	120.21	82.74
$P_2N_1T_1$	92.34	84.84
$P_2N_1T_2$	75.77	85.89
$P_2N_2T_1$	87.24	90.16
$P_2N_2T_2$	69.02	110.14
$P_2N_3T_1$	99.05	90.19
$P_2N_3T_2$	130.22	117.34
$P_3N_1T_1$	74.88	93.90
$P_3N_1T_2$	91.20	87.03
$P_3N_2T_1$	82.99	96.94
$P_3N_2T_2$	103.88	96.50
$P_3N_3T_1$	92.65	107.12
$P_3N_3T_2$	109.45	122.84
'F' test	Sigt.	Sigt.
S.E. $\pm$	3.63	0.60
C.D. at 5 %	10.62	1.75

Interactions

(i) Effect of methods of planting X Plant densities(M x P)

There was a significant difference in the uptake of total nitrogen due to the interaction of methods of planting X plant densities. The transplanting of single budded settling with 75 x 10^3 buds/ha gave significantly more uptake of nitrogen than three-budded sett planting with 50 and 75 x 10^3 buds/ha and transplanting of settling with

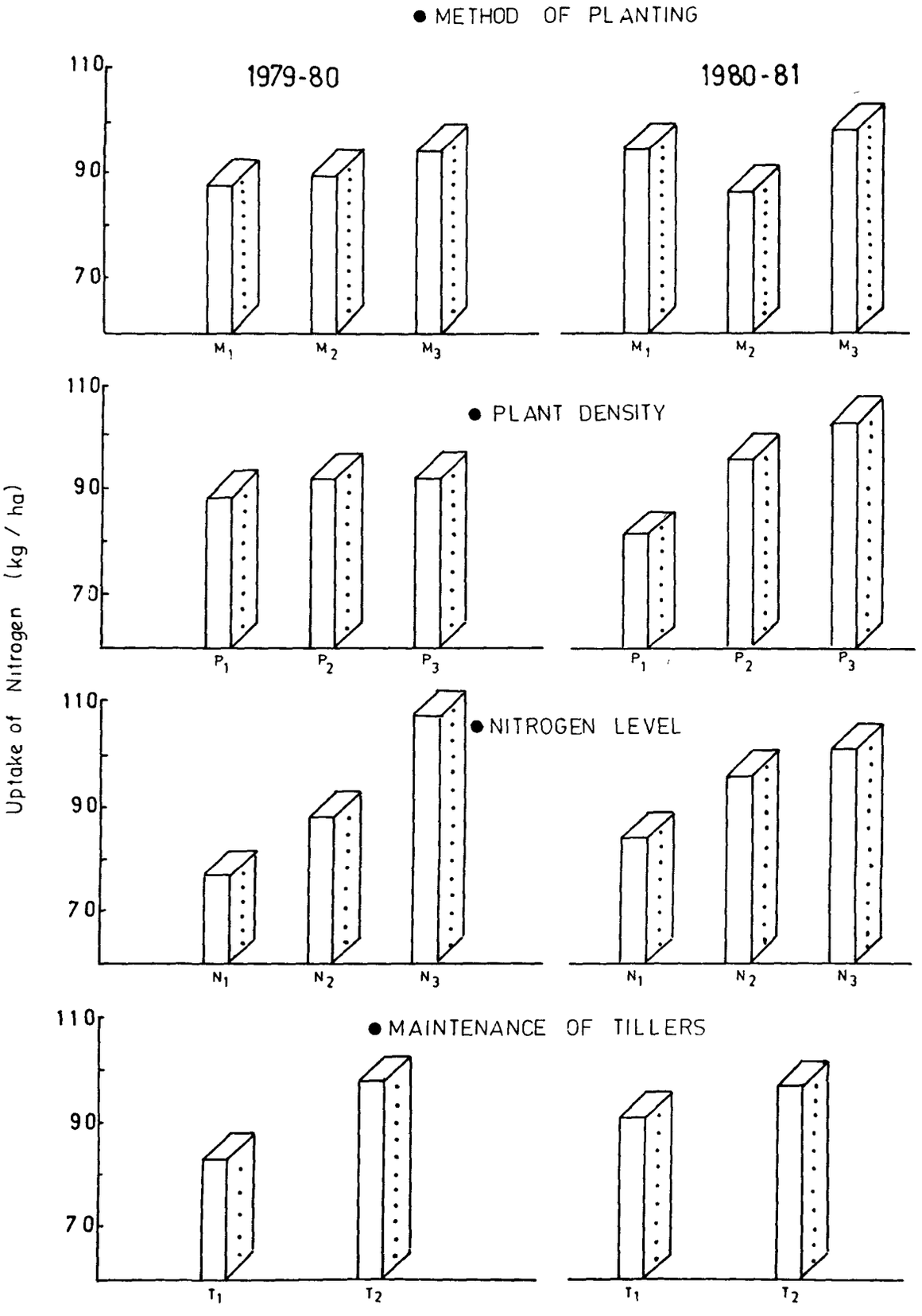

Fig. 17 . Mean uptake of Nitrogen (kg/ha) as influenced by factors.

25 x 10^3 buds/ha and remained at par with other combinations during 1979-80. However, planting of single budded sett with 75 x 10^3 buds/ha recorded significantly more uptake of total nitrogen than all other combinations, except planting three-budded sett with 75 x 10^3 buds/ha.

(ii) Effect of methods of planting X Nitrogen levels(M x N)

The interaction effects due to methods of planting and nitrogen levels on the uptake of total nitrogen were found to be significant, during both the seasons. Single budded sett planting with 250 kg N/ha showed significantly more uptake of total nitrogen than other combinations, except transplanting of single budded settling and planting of three-budded sett with 250 kg N/ha, during 1979-80 and planting of three-budded sett with 200 kg N/ha, during 1980-81. In general, it was observed that the increasing level of nitrogen increased the uptake of total nitrogen with different methods.

(iii) Effect of plant densities X Nitrogen levels (P x N)

The differences in uptake of total nitrogen due to the interaction of plant densities and nitrogen levels were found to be significant, during both the seasons. The planting of 75 x 10^3 buds/ha with 250 kg N/ha recorded significantly more uptake of nitrogen than all other combinations, except planting of 50 x 10^3 buds with 250 kg N/ha during 1979-80. However, during both the years planting of 75 x 10^3 buds/ha with 250 kg N/ha had its superiority over other

combinations. In general, it was observed that the increasing levels of nitrogen increased the uptake of nitrogen with all the plant densities.

(iv) Effect of methods of planting X Maintenance of tillers (M x T)

The interaction effects between methods of planting and maintenance of tillers were found to be significant during both the seasons. Planting of single budded sett and transplanting of settling with uncontrolled tillers recorded significantly more uptake of nitrogen than other combinations during 1979-80, while during 1980-81, the treatment combinations of planting single budded sett and three-budded sett with uncontrolled tillers had their superiority over other combinations.

(v) Effect of plant densities X Maintenance of tillers (P x T)

The differences in uptake of total nitrogen were found to be significant due to interaction of plant densities and maintenance of tillers. The planting of 75 x 10^3 buds/ha with uncontrolled tillers showed significantly more uptake of nitrogen than other combinations, except planting of 50 and 25 x 10^3 buds/ha with uncontrolled tillers during 1979-80, however, during 1980-81, planting of 75 and 50 x 10^3 buds/ha with uncontrolled tillers had its superiority over other combinations.

(vi) Effect of nitrogen levels X Maintenance of tillers (N x T)

Application of 250 kg N/ha with uncontrolled tillers gave significantly more uptake of nitrogen than other combinations, during 1979-80. However, during 1980-81, 200 kg N/ha with uncontrolled tillers had its superiority over other combinations.

(vii) Effect of methods of planting X Plant densities X Maintenance of tillers (M x P x T)

The interaction effects between three factors under study were significant, during both the seasons. Transplanting of 75 x 10^3 single budded settlings/ha and planting of 25 x 10^3 single budded setts without maintenance of tillers were at par with each other, among which the former was significantly superior to other combinations during 1979-80. However, during 1980-81, the planting of 75 x 10^3 single budded setts without maintenance of tillers had its superiority over all other combinations.

(viii) Effect of methods of planting X Nitrogen levels X Maintenance of tillers (M x N x T)

The interaction effects between methods of planting, nitrogen levels and maintenance of tillers influenced the uptake of nitrogen significantly, during both the seasons. The transplanting of single budded settling with 250 kg N/ha without maintenance of tillers showed significantly

more uptake of nitrogen than other combinations, except planting of single budded sett with 250 kg N/ha without maintenance of tillers, during 1979-80 while, during 1980-81, three-budded sett planting with 200 kg N/ha without maintenance of tillers had its superiority over other combinations.

(ix) Effect of plant densities X Nitrogen levels X Maintenance of tillers (P x N x T)

The uptake of total nitrogen was significantly affected by the interaction of plant densities, nitrogen levels and maintenance of tillers, during both the seasons. Planting of 50 x 10^3 buds/ha with 250 kg N/ha without maintenance of tillers and planting of 25 x 10^3 buds/ha with 250 kg N/ha without maintenance of tillers were at par, of which former was significantly superior to other combinations, during 1979-80. While the treatment combination of planting 75 x 10^3 buds/ha with 250 kg N/ha without maintenance of tillers had its superiority over other combinations, during 1980-81.

4.7 Yield response for nitrogen fertilization

From the magnitude and return of response of cane yield data to nitrogen levels, it would be seen that the response of sugarcane to nitrogen fertilization was of linear nature for all the three seasons. Hence a linear equation :- $Y = a + bN$ was fitted to the yield data of

individual year for all the three seasons. The yield equations worked out as follows :

$$Y = 67.91 + 0.17\ N \text{ for } 1979\text{-}80$$
$$Y = 77.57 + 0.12\ N \text{ for } 1980\text{-}81$$
$$Y = 77.00 + 0.13\ N \text{ for } 1981\text{-}82$$

In the above equation 'Y' refers to the expected yield of cane t/ha and 'N' to the nitrogen levels. The positive co-efficient of linear term 'N' denotes that the cane yield of sugarcane increase with the addition of nitrogen. From the above equation predicted yields for specified levels of nitrogen were calculated and are presented in Table 32 and graphically depicted in Fig.18.

Table 32. Observed and predicted cane yield (t/ha) for the various levels of nitrogen

Sr. No.	Year	Treatments		
		N_1	N_2	N_3
		150 kg N/ha	200 kg N/ha	250 kg N/ha
1	1979-80			
	Observed	91.90	104.84	108.88
	Predicted	93.41	101.91	110.41
2	1980-81			
	Observed	95.96	100.69	107.94
	Predicted	95.57	101.57	107.57
3	1981-82			
	Observed	94.69	106.17	107.59
	Predicted	96.52	103.02	109.52

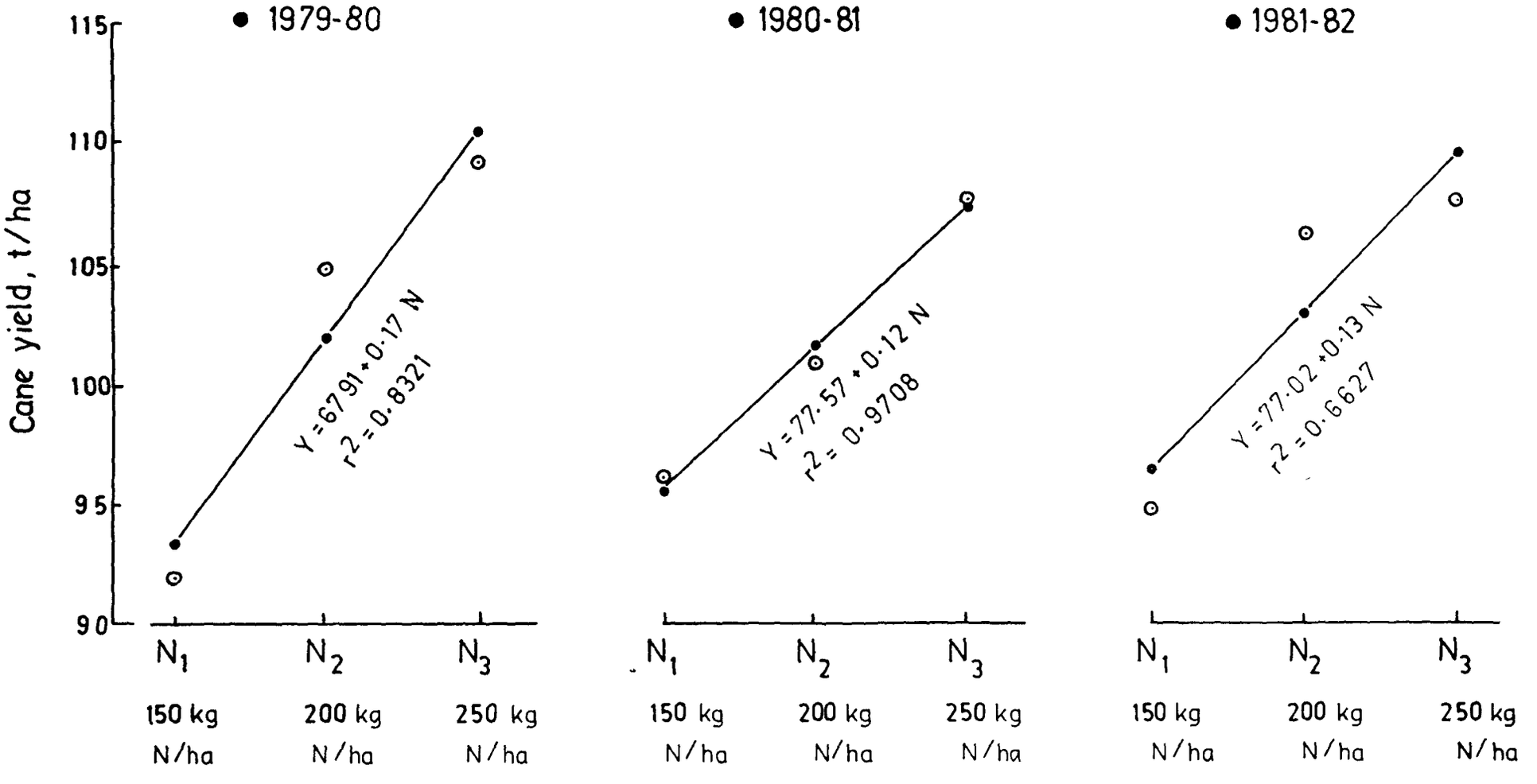

Fig.18. Response curve for nitrogen fertilization.

4.8 Levels of nitrogen in sugarcane and the profitability

In order to examine the levels of application of nitrogen and the profitability associated by deducting the additional cost of nitrogen involved in by considering all other conditions constant, the levels of nitrogen viz., 150, 200 and 250 kg N/ha were analysed and the profitability gained is shown in Table 33.

It can be seen that application of 150 kg N/ha costed Rs. 652/- and yielded 95.69 t/ha which resulted in an income of Rs. 19,138/- per hectare at the assumed price of Rs. 200/- per tonne of cane. When this level of nitrogen was raised to 200 and 250 kg/ha, involved additional cost of Rs. 217/- at each level. Against these levels, the additional yield obtained was 5.27 and 12.31 t/ha, respectively over base level of 150 kg N/ha. This additional cane at each of these two levels gave additional income of Rs. 1054/- and Rs. 2462/- per hectare. By deducting the additional cost of nitrogen from this additional income, additional gross profit obtained at 200 and 250 kg nitrogen levels worked out to Rs. 837/- and Rs. 2028/- per hectare over base level, respectively.

Benefit cost ratio worked out on value of cane to cost of fertilizer applied comes to 29.35, 23.21 and 19.17 at 150, 200 and 250 kg N/ha level, respectively.

Table 33. Profitability associated with levels of nitrogen in sugarcane and benefit cost ratio

Nitrogen (kg/ha)	Cane yield (t/ha) (Pooled)	Additional yield (t/ha) over		Cost of nitrogen (Rs)*		Value of cane (Rs/ha)**	Additional income (Rs/ha) over		Gross profit (Rs/ha)		Benefit cost ratio based on value of cane
		Base level	Previous level	Base level	Previous level		Base level	Previous level	Base level	Previous level	
150	95.69	-	-	652	-	19138	-	-	-	-	29.35
200	100.96	5.27	5.27	870	217	20192	1054	1054	837	837	23.21
250	108.00	12.31	7.04	1087	217	21600	2462	1408	2028	1191	19.87

* Estimated cost of nitrogen @ Rs. 4.35 per kg, ** Estimated value of cane @ Rs. 200 per tonne

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This clearly showed that the production of sugarcane with increasing level of nitrogen indicated definite profitability. Besides this, the trend of production with increasing levels of nitrogen was of increasing gross returns.

4.9 Correlation studies of sugarcane yield with different yield contributing attributes

Co-efficient of correlation was worked out between the cane yield and yield contributing characters and these values have been reported in Table 34.

Correlation studies of sugarcane yield when correlated with millable height, middle girth, number of millable canes, per cane weight, dry matter production and commercial cane sugar (C.C.S. t/ha) revealed that these characters showed highly significant positive correlation except the middle girth of cane which was not significant and not related with the cane yield during both the seasons.

Middle girth with millable height, per cane weight with millable height and middle girth, dry matter with millable height and per cane weight and, commercial cane sugar with all these characters except middle cane girth were also highly correlated, during both the seasons.

Further, it was observed that the middle girth was not correlated with all these characters except millable height

Table 34. Correlation of sugarcane yield with millable height, middle girth, number of millable canes, per cane weight, dry matter and C.C.S. t/ha

Characters	Season	Middle girth (cm)	Number of millable canes/ha	Per cane weight (kg)	Dry matter production (g)	C.C.S. (t/ha)	Yield (t/ha)
Millable height (cm)	1979-80	0.5692**	- 0.1389	0.7276**	0.5159**	0.6010**	0.6204**
	1980-81	0.5050**	0.0715	0.5890	0.4712**	0.5231**	0.5973**
Middle girth (cm)	1979-80		- 0.4321	0.5818**	0.2209	0.1927	0.1953
	1980-81		0.4971	0.6330**	0.2171	- 0.0773	- 0.0502
Number of millable canes per hectare	1979-80			- 0.4502	- 0.2050	0.3643**	0.4336**
	1980-81			- 0.5662	- 0.2696	0.7642**	0.7317**
Per cane weight (kg)	1979-80				0.7458**	0.6085**	0.6034**
	1980-81				0.4898**	0.3878**	0.3701**
Dry matter (g)	1979-80					0.6147**	0.5777**
	1980-81					0.6200**	0.5852**
C.C.S. (t/ha)	1979-80						0.9405**
	1980-81						0.9796**

Table 'r' values at 5 % = 0.266, at 1 % = 0.348

and per cane weight. Similarly, the number of millable canes per hectare has negative relationship with per cane weight and dry matter production during both the seasons. There was a very high degree of correlation between cane yield and commercial cane sugar (C.C.S./ha) during both the years.

DISCUSSION

5. DISCUSSION

The results of the investigation presented in the previous chapter are discussed in the succeeding paragraphs.

5.1 Soil, weather and crop development

The soil of the experimental plot was alluvial-clay. The chemical composition indicated that it was medium in total nitrogen, available P_2O_5 and K_2O; and was almost neutral in reaction. It was well drained and fairly deep.

Sugarcane was planted during 7^{th} to 9^{th} January in the year 1979, 26^{th} to 28^{th} December in 1979 and 1^{st} to 3^{rd} January in 1981, the normal planting time for seasonal sugarcane. During the period of investigations, the climatic conditions were favourable for the growth and development of the sugarcane crop. The mean maximum and minimum temperatures ranged from 25.8 to 38.0 and 15.3 to 23.1 °C during 1979-80, 26.3 to 38.1 and 15.0 to 23.1 °C during 1980-81 and 22.9 to 37.4 and 14.9 to 23.0 °C during the year 1981-82, respectively. The crop received 927.3, 1180.8 and 1188.6 mm rainfall during the growth period of crop in 1979-80, 1980-81 and 1981-82, respectively. The uniform distribution of rainfall in all the years helped the sugarcane crop to achieve better growth of crop. The relative humidity ranged from 44.0 to 91.0 in 1979-80, 57.0 to 94.0 in 1980-81 and 54.0 to 93.0 per cent in 1981-82. The season of 1980-81 was more favourable due

to more rainfall and higher humidity, conducive for vegetative growth. The crop in all the years was free from any serious pest and diseases.

An extract of information on the important growth and yield contributing characters of sugarcane, variety Co. 740 used in the present investigation is presented in Table 35 to get an idea about the nature and extent of crop growth.

The germination of the crop was good and the crop was healthy throughout its growth period during all the years. The tillering ratio and number of shoots at the 20^{th} week, mean leaf area, leaf area index and dry matter per plant were also more in second year than in the first year. The total height as well as millable height were substantially more in second year than that in first year. This might be due to more rainfall during the grand growth phase of the crop in second year. At harvest, the total and millable height recorded were 312.2 and 260.8 cm in 1979-80 and 314.4 and 288.8 cm in 1980-81, respectively. Cane girth and number of internodes increased progressively as the crop advanced in age. In 1979-80, the cane girth as well as number of internodes were more than that in 1980-81. This might be due to more number of millable canes per hectare at harvest in 1980-81.

Table 35. An extract of relevant information on growth, yield contributing characters, yield of cane and sugar, quality of sugarcane and uptake of nitrogen

Sr. No.	Characters	Mean values	
		1979-80	1980-81
1.	Germination percentage at 8^{th} week	91.75	97.42
2.	Tillering ratio at 16^{th} week	6.33	5.44
3.	Tillering ratio at 20^{th} week	1.87	2.02
4.	Number of shoots at 16^{th} week('000')	304.41	282.32
5.	Number of shoots at 20^{th} week('000')	109.18	125.94
6.	Leaf area (dm^2) per plant at harvest	59.29	66.87
7.	Leaf area index at harvest	5.14	5.31
8.	Total dry matter (g) per plant at harvest	409.66	425.29
9.	Total height (cm) at harvest	312.26	314.45
10.	Millable height (cm) at harvest	260.86	288.86
11.	Middle girth (cm) of cane at harvest	8.44	8.00
12.	Number of internodes per cane at harvest	24.14	20.56
13.	Shoot mortality percentage	65.43	59.92
14.	Per cane weight (kg)	1.06	0.96
15.	Number of millable canes per hectare at harvest ('000')	96.70	106.22
16.	Cane yield (t/ha)	101.87	101.53
17.	Commercial cane sugar (C.C.S. t/ha)	14.79	14.44
18.	Brix at harvest	22.29	22.12
19.	Sucrose percentage in juice at harvest	21.07	20.70
20.	Purity percentage of juice at harvest	94.49	95.54
21.	Net rendiment (N.R.) at harvest	14.58	14.24
22.	Uptake of nitrogen (kg/ha) at harvest	90.91	93.76

5.2 Effect of methods of planting

An extract of relevant information regarding the effect of methods of planting on growth and yield contributing characters, yield and quality of sugarcane, and uptake of nitrogen is presented in Table 36.

5.2.1 Growth, yield contributing characters and yield of cane and sugar

Method of planting exerted considerable influence on the growth and vigour of the crop. Krishnamurthy (1978) from his studies at Mandya (Karnataka) reported higher germination percentage and survival to start with in spaced transplanting technique. This might be due to culling of weaklings in the beginning itself. In the present investigation similar trend was noticed. Transplanting of settling showed higher survival percentage. Jothimoorthy et al. (1980) and Shinde et al. (1983) have also opined better performance of either settling transplanting or single budded sett planting compared to three-budded sett planting. Better survival of shoots resulted in higher number of tillers and ultimately higher number of shoots throughout the growth period, in both the seasons under experimentation. Similar observations have also been reported by Kharkar and Kulkarni (1957) and studies carried out at Kolhapur and Padegaon (Anonymous, 1979 and 1982).

Table 36. An extract of relevant information showing the effect of methods of planting on growth, yield contributing characters, yield, quality of sugarcane and uptake of nitrogen

Sr. No.	Characters	1979-80 Methods of planting			1980-81		
		M_1	M_2	M_3	M_1	M_2	M_3
1.	Germination percentage at 8^{th} week	87.50	97.08	90.66	95.06	99.34	97.85
2.	Tillering ratio at 16^{th} week	6.27	6.88	5.85	4.52	6.52	5.28
3.	Tillering ratio at 20^{th} week	1.81	1.99	1.80	1.85	2.17	2.04
4.	Number of shoots at 16^{th} week ('000')	278.30	357.47	277.47	241.12	334.82	271.01
5.	Number of shoots at 20^{th} week ('000')	100.42	121.84	105.26	118.50	133.00	126.29
6.	Leaf area (dm^2) per plant at harvest	64.59	56.09	57.19	71.74	64.49	64.38
7.	Leaf area index at harvest	5.95	5.36	4.33	5.87	5.16	4.90
8.	Dry matter (g) per plant at harvest	438.44	360.85	429.70	467.69	387.06	421.34
9.	Total height (cm) at harvest	323.03	292.33	318.44	323.40	305.46	314.49
10.	Millable height (cm) at harvest	270.47	246.11	266.00	296.06	282.54	288.00
11.	Middle girth (cm) at harvest	8.61	8.14	8.58	8.17	7.92	7.93
12.	Number of internodes at harvest	24.94	22.94	24.23	21.03	20.00	20.67
13.	Shoot mortality percentage	65.17	68.06	63.07	55.62	65.19	58.96
14.	Per cane weight (kg)	1.16	0.92	1.09	1.01	0.92	0.95
15.	Number of millable canes per hectare ('000')	91.94	102.28	95.88	101.60	110.05	107.01
16.	Yield of cane (t/ha)	107.04	93.68	104.90	102.56	100.84	101.18
17.	Yield of commercial cane sugar (t/ha)	15.55	13.61	15.21	14.49	14.44	14.39
18.	Brix at harvest	22.40	22.29	22.18	22.25	21.98	22.13
19.	Sucrose percentage in juice at harvest	21.14	21.06	20.99	20.85	20.55	20.68
20.	Purity percentage of juice at harvest	94.65	94.40	94.41	93.76	93.41	93.48
21.	Net rendiment (N.R.) at harvest	14.63	14.58	14.52	14.33	14.14	14.23
22.	Total uptake of nitrogen (kg/ha) at harvest	87.93	89.76	95.07	95.43	87.15	98.71

This desirable trend observed in the beginning appeared to be of not much use. The leaf area and L.A.I. were higher with conventional method of three-budded sett planting. Per plant leaf area was 64.59 and 71.74 dm^2 during the first and second year of experiment when conventional method of planting was adopted. Whereas, these observations were around 56 and 64 dm^2 per plant in either single budded sett planting or settling transplanting. It appeared that the single budded sett planting or settling transplanting lack vigour as could be seen from the dry matter studies. In the conventional method of three-budded sett planting, the dry matter production at harvest was 438.4 and 467.6 g/plant in 1979-80 and 1980-81, respectively. Compared to this in case of single budded sett planting, the dry matter production was 429.7 and 421.3 g/plant in the first and second year. Whereas, in settling transplanting method, it was far behind. Actual dry matter production was 360.8 and 387.0 g/plant in the first and second year, respectively. It was, therefore, felt that the shock received by the plants during the transplanting, could not be overcome with, in this growth period. A cursory look at the growth would also prove this point. Thus, the dry matter accumulation was at higher rate in conventional planting method.

The height, both total and millable, was also observed to be more in conventional method of three-budded

sett planting obviously due to better growth rate. Settling transplanting method showed the lowest height (Table 15, 16 and 24). Thakur and Jayaswal (1957) also reported better height due to three-budded sett planting.

In the case of mid-girth and number of internodes also three-budded sett planting was superior compared to other two methods. Settling planting showed the lowest girth and number of internodes (Table 24). These observations, are however, contradictory to those reported by Krishnamurthy (1978). He reported that length and number of internodes were on higher side in spaced transplanting method compared to conventional method of three-budded sett planting. Probably, the type of the cane might be the answer to this type of contradiction. Mortality in STP method was more than conventional method. The higher tillering ratio and more shoot population in case of transplanting of settling might have enhanced the competition for survival and therefore, naturally increased the chances for greater mortality. Lack of vigour may be one of the reasons for such high per cent mortality.

Yield of the cane depends on the number of millable canes per unit area and the weight of the individual cane. In the present investigation these two yield contributing parameters were affected differently in the different treatments of planting. Single budded settling planting

showed significantly more number of millable canes. However, these canes did not develop so as to produce higher cane weight. On the contrary, though the millable cane number was less in conventional method of three-budded sett planting and single budded sett planting, these treatments produced heavier cane weight (Table 25). As a result, the yield of cane was higher in three-budded sett planting and single budded sett planting (107.036 and 104.897 t/ha) in 1979-80 and 102.560 and 101.179 t/ha in 1980-81, respectively), than the yield obtained from settling planting method (93.684 and 100.841 t/ha)(Table 27). The commercial cane sugar also showed similar trend as in case of cane yield. Similarly, three-budded and single budded sett planting methods recorded significantly more cane yield (109.479 and 109.877 t/ha) than settling planting (89.083 t/ha) with the maintenance of tillers beyond light earthing, up to final earthing was imposed during 1981-82 (Table 28). At Lucknow, the single sprouted buds also showed higher number of millable canes compared to three budded sett planting (Anonymous,1972). These observations are also confirmed by Sharma and Chauhan (1974). Higher cane yields due to conventional method of three-budded sett are reported by many workers (Kale and Deshpande, 1956; Bhonsale and Tonapy, 1962; Anonymous, 1980 d and Shinde et al., 1983). Thus, as pointed out earlier the plots developed out of settlings remained

weak with lack of vigour, resulting in lower cane weight. The uptake of nitrogen would confirm this. The total uptake of nitrogen in settling planting was lower than the other two methods, particularly during 1980-81 season.

5.2.2 Periodical maturity studies and juice quality

The maturity of cane as judged by the quality parameters also showed that settling planted crop reached maturity at later stages with lower Brix reading. In the year 1980-81, when season was more favourable for cane development the sucrose and N.R. reading in settling planted crop had its superiority over other methods. At harvest, quality attributes were of higher order with three-budded sett planting compared to other methods (Table 30).

5.2.3 Uptake of nitrogen

The single budded sett planting method recorded maximum total uptake of nitrogen compared to other methods treid. The total uptake of nitrogen in settling planting was lower than other methods tried, particularly during 1980-81 season. This low uptake of nitrogen may be due to lack of vigour in case of settling transplanting during formative phase.

Thus, it showed that development of crop raised from settlings takes longer time to catch up with the growth with other methods of planting. It may be true that

12 months period was too short to express fully the merit of the settling planting method. For the same reason, the yield of commercial cane sugar (C.C.S.) was lower in this method. The single budded sett planting method appeared to be a mid-way of the other two methods of planting. Thus, there is also a scope to reduce the seed material by this method.

5.3 Effect of plant densities

An extract of relevant information regarding the effect of plant densities on growth, yield contributing characters, yield and quality of sugarcane and uptake of nitrogen is presented in Table 37.

5.3.1 Growth, yield contributing characters and yield of cane and sugar

Sugarcane basically belongs to grass family and thus, produces tillers like other grasses. The extent of such shoots produced depends upon the space available. With a view to provide space for tillering, thereby, also reducing the planting material the population was changed. Germination/survival was found to increase due to low plant density. This was attributed to adequate space, moisture and sunlight. Favourable effects of low seed rate are reported by many others (Gahlot, 1957; Bhoj et al., 1960; Singh and Singh, 1967; Gupta and Lal, 1975 and Shinde et al., 1983). As a result of adequate space; tillering and number of shoots

were also increased. The mean shoot number at 20 weeks stage was 103.7, 109.5 and 114.4 x 10^3/ha in 25, 50 and 75 x 10^3/ha seed rate, respectively in 1979-80. The orresponding figures in 1980-81 were 112.0, 130.1 and 135.7 x 10^3/ha, respectively (Table 10). Ultimately the leaf area and leaf area index were also more with lower plant density. With increase in plant density these parameters showed decrease.

The real picture of the development can be obtained from the dry matter accumulation. The dry matter accumulation was progressively increased with advancement in crop (Table 13). Dry matter accumulation also showed a similar trend to that of leaf area. With lower plant density dry matter accumulation was more. The absolute figures for 25, 50 and 75 x 10^3 buds/ha were 419, 412 and 398 q/plant, respectively in 1979-80. The corresponding figures in 1980-81 were 439, 422 and 414 g/plant. The vigour due to less population resulted in higher dry matter production. Irvine and Benda (1980) made detailed study. They opined that due to close spacing induce continuous growth. But conditions became limiting towards harvest, the growth remained smaller.

Observation on height and ultimately millable height of the cane showed the advantage due to high plant density. This was quite understandable. Due to crowding

Table 37. An extract of relevant information showing the effect of plant densities on growth, yield contributing characters, yield, quality of sugarcane and uptake of nitrogen

Sr. No.	Characters	1979-80 Buds per hectare			1980-81		
		P_1	P_2	P_2	P_1	P_2	P_3
1.	Germination percentage at 8th week	96.59	90.90	87.75	98.63	97.47	96.15
2.	Tillering ratio at 16th week	7.76	5.91	5.33	7.57	5.10	3.63
3.	Tillering ratio at 20th week	3.29	1.43	0.88	3.55	1.65	0.87
4.	Number of shoots at 16th week ('000')	212.49	310.99	389.76	211.21	299.30	336.44
5.	Number of shoots at 20th week ('000')	103.71	109.51	114.36	112.04	130.06	136.72
6.	Leaf area (dm^2) per plant at harvest	69.23	54.50	54.15	74.82	64.61	61.18
7.	Leaf area index at harvest	5.77	4.76	4.91	5.76	5.26	4.23
8.	Dry matter (g) per plant at harvest	419.12	411.87	398.03	438.89	422.46	414.53
9.	Total height (cm) at harvest	306.19	312.28	318.33	313.99	314.42	314.94
10.	Millable height (cm) at harvest	254.86	263.08	264.64	287.04	289.81	289.75
11.	Middle girth (cm) at harvest	8.47	8.45	8.41	8.12	7.98	7.92
12.	Number of internodes at harvest	23.83	24.33	24.85	20.50	20.58	20.61
13.	Shoot mortality percentage	54.45	68.38	73.46	53.64	61.33	64.79
14.	Per cane weight (kg)	1.07	1.06	1.04	1.00	0.93	0.94
15.	Number of millable canes per hectare ('000')	93.64	95.81	100.65	94134	110.43	113.88
16.	Yield of cane (t/ha)	100.10	101.27	104.25	94.76	103.02	106.80
17.	Yield of commercial cane sugar (t/ha)	14.63	14.81	14.94	13.41	14.64	15.27
18.	Brix at harvest	22.32	22.34	22.21	22.03	22.17	22.16
19.	Sucrose percentage in juice at harvest	20.89	21.14	12.17	20.61	20.70	20.78
20.	Purity percentage of juice at harvest	94.77	94.62	94.08	93.64	93.31	93.69
21.	Net rendiment (N.R.) at harvest	14.46	14.61	14.66	14.18	14.21	14.30
22.	Total uptake of nitrogen (kg/ha) at harvest	88.53	91.72	92.51	82.39	95.98	102.91

resulting in competition for sunlight, shoots in the higher plant density showed more length (Table 16 and 24). These findings are in conformity with those reported by Singh and Singh (1967) and Singh et al. (1970). However, higher plant density also resulted in more mortality. As a consequence to the competition for light due to crowding the plants remained lanky. This finding is similar to that of Tandon et al. (1957) and Bhoj et al. (1960). At harvest, the girth of cane was influenced with low plant density and the number of internodes was found to increase with increased plant density. Similar results were also observed at Padegaon (Anonymous, 1982). The per cane weight, thus, was on lower side in the higher plant density plots. Under increasing seed rates, the millable canes increased but average cane weight decreased due to over-crowding and competition between the tillers (Table 25 and and 26). The beneficial effects of increased seed rate on number of millable canes have also been reported by earlier workers (Gahlot, 1957; Anang Nath and Bajaj, 1969; Singh et al., 1972 and Reddy, 1981).

The yield of cane is a product of number of millable canes per hectare and the weight of individual cane. Though individual cane was properly developed due to low plant density, the per hectare yield of sugarcane was found to be increased with increased plant density and the highest

plant density (75 x 10^3 buds/ha) recorded the highest cane yield of 104.249 and 106.796 t/ha during the year 1979-80 and 1980-81, respectively. The yield recorded with the plant density of 75 x 10^3 buds/ha was significantly more than the plant density of 25 x 10^3 buds/ha during 1980-81 and over 25 and 50 x 10^3 buds/ha when the data were pooled over seasons (Table 27). Similarly, the highest plant density of 75 x 10^3 buds/ha recorded significantly more cane yield (110.090 t/ha) compared to 25 and 50 x 10^3 buds/ha (95.638 and 102.712 t/ha, respectively) when the maintenance of tillers beyond light earthing, up to final earthing was imposed during 1981-82 (Table 28). This indicated that increase in seed rate from 25 to 75 x 10^3 buds/ha helped in enhancing the cane yield which may be attributed to the higher number of millable canes in higher plant densities. The present studies confirmed the finding of numerous research workers like Gahlot (1957), Singh and Singh (1967), Singh et al. (1970), Anonymous (1978 b, 1980 b, 1981 and 1982) and Reddy (1981).

Mean commercial cane sugar (C.C.S.) yield was significantly influenced by varying plant densities in 1980-81. Plant density of 75 x 10^3 buds/ha gave significantly more C.C.S. yield (15.266 t/ha) than the lowest plant density of 25 x 10^3 buds/ha (13.410 t/ha) and on par with 50 x 10^3 buds/ha (14.365 t/ha). Similar trend was also observed in 1979-80 (Table 29). This might be due to higher cane yield

and net rendiment in case of higher seed rate treatments. Similar results have also been reported by Narayanan (1970), Shanmugasundaram et al. (1975), Gascho and Shih (1978) and Shinde et al. (1983).

5.3.2 Periodical maturity studies and juice quality

Periodical juice analysis for judging the maturity of sugarcane in both the years showed that the Brix, sucrose, purity percentage of juice and net rendiment (N.R.) were found increased with increased plant density during early period of maturity i.e. 270 days after planting in both the years. This shows that maturity of the crop was hastened due to higher seed rate. Similar observations have been reported by Bhoj et al. (1960), Anang Nath and Bajaj (1969) and Thomas et al. (1977). At harvest, these quality attributes were not influenced significantly, whereas in general, higher seed rate tended to improve the juice quality (Table 30). The improved juice quality might be due to larger number of mother stalks and early formed tillers in case of higher seed rate. A similar observation has been reported by Anonymous (1963-64), Narayanan (1970) and Shinde et al. (1983).

5.3.3 Uptake of nitrogen

The highest plant density of 75 x 10^3 buds/ha removed more nitrogen compared to medium and low (50 x 10^3

25 x 10^3 buds/ha) plant densities. The higher uptake of nitrogen resulted in higher yield of cane indicating thereby the response of nitrogenous fertilizer to higher seed rate.

5.4 *Effect of nitrogen levels*

An extract of relevant information regarding the effect of nitrogen levels on growth, yield and quality of sugarcane and uptake of nitrogen is presented in Table 38.

5.4.1 Growth, yield contributing characters and yield of cane and sugar

Nitrogen is the most essential element in the development of plant, particularly, the vegetative development. In the case of sugarcane, the commercially economic part is stem, essentially, the vegetative part. There is tendency in Maharashtra state to use nitrogen fertilizer in much larger proportion compared to other cane growing areas. Nitrogen affects growth in various ways. Germination/ survival of tillers at early stage of 8 weeks, however, remained unaffected. Many research woekrers also reported the observations on these lines (Mathur, 1972; Kirti Kar, et al., 1975; Gill and Singh, 1976 and Salunkhe et al., 1980 and 1981) Tillering phase, however, affected significantly due to nitrogen application. Maximum tillering ratio of 2.01 and 2.14 was observed at 20 weeks with 250 kg N/ha in 1979-80 and 1980-81 season, respectively.(Table 9).

Table 38. An extract of relevant information showing the effect of nitrogen levels on growth, yield contributing characters, yield, quality of sugarcane and uptake of nitrogen

Sr. No.	Characters	1979-80 Nitrogen kg/ha			1980-81		
		150	200	250	150	200	250
1.	Germination percentage at 8th week	92.01	91.83	91.40	97.46	97.62	97.18
2.	Tillering ratio at 16th week	6.15	6.21	6.63	5.18	5.381	5.72
3.	Tillering ratio at 20th week	1.77	1.82	2.01	1.93	1.98	2.14
4.	Number of shoots at 16th week ('000')	290.99	311.30	310.95	273.07	277.83	296.05
5.	Number of shoots at 20th week ('000')	104.07	109.86	113.59	123.25	124.20	130.37
6.	Leaf area (dm^2) per plant at harvest	58.16	58.94	60.17	65.64	66.01	68.96
7.	Leaf area index at harvest	4.78	5.23	5.43	5.29	5.32	5.33
8.	Dry matter (g) per plant at harvest	388.17	411.50	429.29	404.54	425.92	445.42
9.	Total height (cm) at harvest	307.83	311.97	317.00	307.94	312.78	322.63
10.	Millable height (cm) at harvest	256.33	260.83	265.39	282.33	288.32	295.94
11.	Middle girth (cm) at harvest	8.40	8.41	8.51	7.94	8.03	8.05
12.	Number of internodes at harvest	24.05	24.54	24.19	20.47	20.78	20.44
13.	Shoot mortality percentage	65.79	64.98	65.52	59.37	59.71	60.68
14.	Per cane weight (kg)	1.01	1.07	1.10	0.93	0.95	0.99
15.	Number of millable canes/ha ('000')	91.21	99.01	99.88	103.08	106.41	109.17
16.	Yield of cane (t/ha)	91.90	104.84	108.88	95.96	100.69	107.94
17.	Yield of commercial cane sugar (t/ha)	13.59	15.18	15.60	13.78	14.34	15.20
18.	Brix at harvest	22.56	22.19	22.12	22.27	22.12	21.97
19.	Sucrose percentage in juice at harvest	21.31	21.00	20.89	20.85	20.70	20.53
20.	Purity percentage of juice at harvest	94.64	94.46	94.37	3.73	93.49	93.43
21.	Net rendiment (N.R.) at harvest	14.79	14.50	14.44	14.36	14.25	14.09
22.	Total uptake of nitrogen (kg/ha) at harvest	77.40	87.87	107.49	84.14	96.43	100.72

This may be because of plants require nutrients especially nitrogen for tillering and this is also probably due to adequate supply of nitrogen to the plant which influences the formation and survival of tillers. These results are in agreement with the findings of Kirti Kar and Anang Nath (1964), Mathur (1972), Mathud and Tripathi (1975), Sugumaran et al. (1976), Narwal and Behl (1979), Naidu et et al. (1982) and Shinde et al. (1983).

Almost similar trend as that of tillering was observed in respect of number of shoots. In 1979-80 at 20 weeks, the number of shoots with 150, 200 and 250 kg N/ha was 104.07, 109.86 and 113.59 X 10^3/ha. The corresponding figures in 1980-81 were 123.25, 124.20 and 130.37 X 10^3 (Table 10). This indicated that the increase in level of nitrogen from 150 to 250 kg N/ha increased the number of shoots per hectare. Similar observations were recorded earlier by Dillewijn (1952), Sastry and Venkatachari (1960) and Mali et al. (1982).

The leaf area per plant recorded at various stages increased progressively with increase in level of nitrogen in both the years. The maximum leaf area observed at 300 days after planting and thereafter, there was gradual decline in leaf area till harvest. This might be due to drying and abscission of leaves in advance stage of crop growth. At harvest, the leaf area with 150, 200 and 250 kg

N/ha was 58.16, 58.94 and 60.17 dm^2 in the year 1979-80, respectively. The corresponding values in 1980-81 were 65.64, 66.01 and 68.96 dm^2 (Table 11). Thus, even at late stage higher level of nitrogen showed better leaf area. Cheema and Moolani (1970) and Patil (1974) also found that increase in level of nitrogen increased the leaf area at peak period of growth. Almost similar trend was observed to that of leaf area in respect of leaf area index.

Total dry matter recorded at harvest showed marked variations due to different levels of nitrogen in both years. In the first year, total dry matter per plant was 388.17, 411.50 and 429.29 g with 150, 200 and 250 kg N/ha, respectively. The corresponding figures in the second year were 404.54, 425.92 and 445.42 g (Table 13). Thus, it could be seen that the dry matter increased with increase in the levels of nitrogen. This might be the effect of better photosynthetic activities as a result of higher leaf area till harvest as seen on the observations of this parameter. Similarly, the A.G.R. was also increased with increased level of nitrogen from 150 to 250 kg N/ha in both the years. In Tamil Nadu, Srinivasan and Mariakulandai (1969) also reported that the increasing dose of nitrogen from 170 to 340 kg N/ha increased early vigour in terms of dry matter accumulation.

The height of cane is one of the important attributes deciding the commercial weight of cane. The nitrogen generally helps in elongation of plant parts. It was, therefor, interested to s tudy the effect of nitrogen levels on total and millable height of cane. In the present investigation increase in the height, commensurated with the increased level of nitrogen reaching maximum height at 250 kg N/ha in both the years. In the first year, however, height differences between 200 and 250 kg N/ha were not significant. These observations confirmed the findings of Dillewijn (1952), Sastry and Venkatachari (1960) and Srinivasan and Mariakulandai (1969). Similar trend was noticed in the case of millable height as that of total height. In 1979-80, the millable height at harvest ranged from 256.3 to 265.3 cm with 150 and 250 kg N/ha, respectively. The corresponding variation in 1980-81 was 282.3 to 295.9 cm (Table 24). These figures indicate that nitrogen had marked and substantial influence in increasing the millable height, since increased quantity of nitrogen was made available from soil due to differential fertilization. Patil et al. (1964) and Cheema and Moolani (1970) have also reported similar results.

The ultimate weight of cane depends on height, number of internodes and the girth. In the present investigation, it has already been brought out that nitrogen levels significantly affected the height. For other two characters though significant differences was not noticed, in respect of middle girth and number of internodes, these characters were influenced numerically as the nitrogen levels increased. Similar results were reported by Srinivasan and Mariakulandai (1969) and Singh (1973).

The weight of individual cane increased progressively with increase in level of nitrogen in both the years. In 1979-80, it ranged between 1.014 to 1.096 kg and that in 1980-81 from 0.934 to 0.994 kg with 150 and 250 kg N/ha, respectively (Table 25). Srinivasan and Mariakulandai (1969) reported that increasing dose of nitrogen from 170 to 340 kg per hectare increased the weight of individual cane due to increased early vigour of the crop.

Earlier observations at 20th week showed the influence of nitrogen levels on number of shoots per hectare. The higher proportion of shoots was associated with the higher nitrogen level. Thus, resulted

in the marked influence on the number of millable canes per hectare. In 1979-80, the number of millable canes was 91.21, 99.00 and 99.87 x 10^3/ha with 150, 200 and 250 kg N/ha, respectively. The corresponding figures in 1980-81 were 103.08, 106.40 and 109.16 x 10^3/ha (Table 26). Mathur and Tripathi (1975) observed appreciable increase in the formation of millable canes when nitrogen dose was increased from 100 to 200 kg per hectare. Similarly, Dixit et al. (1975), Virendra Kumar (1976), Narwal and Behl (1979) and Salunkhe et al. (1980) also reported beneficial effects of increased levels of nitrogen.

The preceeding discussion exerted significant effect on growth attributes, agronomic indices like tillering and population, and cane attributes like length of millable cane and individual weight of cane. The effect of nitrogen on these various indices which go to make up final yield, was also reflected in the final yield of cane. The effect of nitrogen on increasing the cane yields, therefore, can be traced to its effect on millable cane population at harvest. growth measurements and individual cane attributes at harvest. These are the apparent effects of

nitrogen on cane which are probably due to the increased absorption of nitrogen resulting in higher vegetative growth and dry matter.

The cane yield per hectare was found increased significantly with increasing levels of nitrogen during 1980-81 and when the data were pooled over seasons. However, the cane yield obtained with the application of 200 and 250 kg N/ha were at par and significantly more than 150 kg N/ha during the year 1979-80 (Table 27.). Similarly, the cane yield obtained with 200 and 250 kg N/ha (106.165 and 107.591 t/ha, respectively) were at par and significantly more than 150 kg N/ha (94.685 t/ha) when the maintenance of tillers beyond light earthing, up to final earthing was imposed during the year 1981-82 (Table 28). The cane yield obtained with 150, 200 and 250 kg N/ha was 91.897, 104.841 and 108.878 t/ha in the year 1979-80 and 95.958, 100.685 and 107.937 t/ha in the year 1980-81 respectively. This shows that the application of 250 kg N/ha increased the cane yield by 16.981 and 4.037 t/ha in the year 1979-80 and 11.979 and 7.252 t/ha in 1980-81 than that of 150 and 200 kg N/ha, respectively. Similar observations were recorded earlier by Mohan Rao and Narasimhan (1956), Sastry and

Venkatachari (1960), Srinivasan and Mariakulandai (1969), Anonymous (1969, 1969-70 and 1983 b), Cheema and Moolani (1970), Mathur and Tripathi (1975), Ojha et al. (1977), Patil et al. (1977), Mane and Salunkhe (1978), Narwal and Behl (1979) and Singh et al. (1981).

The commercial cane sugar (C.C.S. t/ha) followed similar trend to that of cane yield as far as nitrogen application is concerned. The application of increasing doses of nitrogen from 150 to 250 kg/ha increased the C.C.S. per hectare. The highest level of nitrogen (250 kg N/ha) gave significant increase over the lowest level of nitrogen (150 kg N/ha) in both the years. In 1979-80, the C.C.S. yield of 13.586, 15.184 and 15.602 t/ha was obtained with 150, 200 and 250 kg N/ha, respectively. The corresponding values in 1980-81 were 13.775, 14.340 and 15.195 t/ha (Table 29). Similar observations were recorded earlier by Srinivasan and Mariakulandai (1969), Irfanuddin and Singh (1981) and Shinde et al. (1981).

5.4.2 Periodical maturity studies and juice quality

In crop like sugarcane it is very important to decide the period of maturity to indicate the harvesting. The nitrogen application as seen earlier, promoted vigorous and continued growth. This had affected the maturity period. The studies in terms of Brix, sucrose percentage in juice, purity percentage of juice and net rendiment(N.R.)

recorded from 270.days onwards till harvest indicated adverse effect of nitrogen on maturity (Table 20 to 23). The lowest level of nitrogen (150 kg/ha) recorded higher values of these attributes than the highest level (250 kg N/ha).

The statistically analysed data for the sugarcane juice quality attributes viz., Brix, sucrose percentage in juice, purity percentage of juice and net rendiment (N.R.) at harvest revealed that nitrogen application did not improve juice quality, whereas, in general, the application of additional levels of nitrogen lowered these qualities (Table 30). A number of other workers like Gahlot (1954), Bains (1960), Stanford (1963), Gupta and Prasad (1971), Ojha et al. (1974), Panwar et al. (1980), Salunkhe et al. (1980 and 1981) and Naidu et al. (1982) also observed similar trend.

5.4.3 Uptake of nitrogen

Application of nitrogen significantly influenced the total uptake of nitrogen in both the years. The total uptake of nitrogen was significantly more with higher level of nitrogen as compared to its succeeding lower level in both the years. In 1979-80, the total uptake of nitrogen was 77.40, 87.87 and 107.49 kg/ha with 150, 200 and 250 kg N/ha, respectively. The corresponding uptake of nitrogen in 1980-81, was 84.14, 96.43 and 100.72 kg per hectare (Table 31.).

Similar results have been reported by Arakeri(1956), Kanwar and Singh (1960), Verma and Verma (1964), Anonymous (1967), and Raghvaiah and Singh (1980).

5.5 Effect of maintenance of tillers

An extract of relevant information regarding the effect of maintenance of tillers on growth and yield contributing characters, yield and quality of sugarcane, and uptake of nitrogen is presented in Table 39.

5.5.1 Growth, yield contributing characters and yield of cane and sugar.

With a view to regulate the growth and to maintain fixed number of shoots to be developed into heavy millable canes, the treatment of maintaining tillers at 12^{th} week i.e. at light earthing was introduced. Looking to the experience of first two years, the maintenance of tillers continued till 20^{th} week after planting i.e. upto final earthing. The ultimate aim was to divert food material to fixed population. Thus, the lower tillering ratio was maintained which was also seen from the observations recorded at 16^{th} and 20^{th} week after planting.

The leaf area, leaf area index and dry matter accumulation did not differ significantly because of the maintenance of tillers. However, slight edge of uncontrolled treatment was noticed with this treatment over controlled.

Table 39. An extract of relevant information showing the effect of maintenance of tillers on growth, yield contributing characters, yield, quality of sugarcane and uptake of nitrogen.

Sr. No.	Characters	1979-80		1980-81	
		T_1	T_2	T_1	T_2
1.	Germination percentage at 8^{th} week	91.35	92.14	97.72	97.11
2.	Tillering ratio at 16^{th} week	6.05	6.61	4.53	6.34
3.	Tillering ratio at 20^{th} week	1.73	2.00	1.86	2.18
4.	Number of shoots at 16^{th} week ('000')	292.36	316.46	241.01	323.63
5.	Number of shoots at 20^{th} week ('000')	103.22	115.13	118.86	133.02
6.	Leaf area (dm^2) per plant at harvest	58.42	60.16	65.94	66.80
7.	Leaf area index at harvest	4.83	5.46	5.20	5.43
8.	Dry matter (g) per plant at harvest	409.32	410.00	429.78	420.80
9.	Total height (cm) at harvest	314.61	309.92	315.21	313.69
10.	Millable height(cm) at harvest	261.87	259.85	289.82	287.91
11	Middle girth (cm) at harvest	8.54	8.34	8.12	7.89
12.	Number of internodes at harvest	24.26	24.02	20.69	20.44
13.	Shoot mortality percentage	65.59	66.28	56.13	63.72
14.	Per cane weight (kg)	1.08	1.04	0.98	0.94
15.	Number of millable canes per hectare ('000')	91.62	101.78	101.33	111.11
16.	Yield of cane (t/ha)	98.81	104.94	99.41	103.64
17.	Yield of commercial cane sugar (t/ha)	14.38	15.20	14.15	14.73
18.	Corrected Brix at harvest	22.33	22.25	22.20	22.14
19.	Sucrose percentage in juice at harvest	21.09	21.05	20.79	20.70
20.	Purity percentage of juice at harvest	94.53	94.45	93.59	93.50
21.	Net rendiment (N.R.) at harvest	14.60	14.58	14.25	14.23
22.	Total uptake of nitrogen (kg/ha)	83.43	98.40	90.91	96.61

The development of the cane as revealed from total and millable height, mid-girth and number internodes was influenced by maintaining the tillers. Though, singificant differences were not observed in case of height and number of interodes, slight improvement in these attributes, was noticed due to maintaining tillers. This might be explained by way of diverting all the photosynthates to the fixed number of shoots resulting in better development.

The shoot mortality percentage was found to be more with uncontrolled treatment. As seen earlier this treatment was associated with higher tillering ratio and more number of shoots before and after final earthing which might have resulted in higher mortality due to greater competition for space, food and light.

The weight of individual cane was significantly more with the treatment of controlling tillers than uncontrolled treatment in both the years. It was increased from 1.035 to 1.082 kg in 1979-80 and from 0.937 to 0.978 kg in 1980-81 (Table 25). This indicated that controlling tillers helped in improving the weight of individual cane.

The production of millable canes per hectare was significantly more in the treatment of uncontrolled tillers. In 1979-80, the number of millable canes was 91.61 and 101.78 x 10^3/ha with controlled and uncontrolled tillers, respectively. The corresponding figures in 1980-81 were 101.32 and 111.11 x 10^3/ha (Table 26). The removal of extra tillers in case of controlled treatment produced lowest number of millable canes.

The yield of sugarcane was significantly influenced due to maintenance of tillers in both the years. It was significantly more in uncontrolled treatment than with controlling tillers in both the years and when the data were pooled over seasons (Table 27). The cane yield with controlled and uncontrolled tillers was 98.807 and 104.937 t/ha in 1979.80, and 99.412 and 103.642 t/ha in 1980.81, respectively. Similarly, the uncontrolled treatment recorded significantly more cane yield (106.378 t/ha) than the controlled tillers (99.249 t/ha), when the maintenance of tillers beyond light earthihg, up to final earthing was imposed during 1981-82. This was attributed to low number of millable canes in the treatment of controlled tillers. Though, the per cane weight was increased the ultimate production which is also based on number of millable canes, was reduced due to maintenance of tillers. It is quite possible that some more time might be required to develop the individual cane to compensate the loss of number of canes. At Padegaon, plant population control in sugarcane by removing the extra shoots above the desired number was not found beneficial as the yield of cane did not differ much in both the treatments of controlled and uncontrolled shoots (Anonymous, 1956-57).

Almost similar trend to that of cane yield was observed in respect of commercial cane sugar (C.C.S.) per

hectare. The yield of C.C.S. with controlled and uncontrolled tillers was 14.383 and 15.198 t/ha in 1979-80 and 14.147 and 14.727 t/ha in 1980-81, respectively (Table 29). The treatment of uncontrolled tillers produced significantly more sugar/ha than controlled tillers. Similar observations were recorded at Padegaon (Anonymous, 1956-57). Shanmugasundaram and Venugopal (1979) opined that de-tillering and population control to the pre-determined levels (125 to 175 x 10^3 plants per hectare) do not result in enhanced sugar yields and the concept of de-tillering in the place of an optimum seed rate appears illconceived.

5.5.2 Periodical maturity studies and juice quality

The periodical maturity studies based on quality characters such as Brix, sucrose percentage in juice, purity percentage of juice and net rendiment, were not influenced significantly due to maintenance of tillers at any of the stages in both the years. However, in general, controlling tillers showed comparatively more values of these attributes during maturity and at harvest. Since late tillers were removed in controlled treatment, it produced lowest number of tillers per plant, the juice quality was slightly better in controlled tillers. Kirti Kar et al. (1964) also observed slight improvement in juice quality by de-tilliering.

5.5.3. Uptake of nitrogen

The uptake of nitrogen per hectare was significantly

more in the treatment of uncontrolled tillers. The uptake of nitrogen was 83.43 and 98.40 kg/ha in 1979-80 and; 90.91 and 96.61 kg/ha in 1980-81 with controlled and uncontrolled tillers, respectively (Table 31). This could be attributed to the higher dry matter production in uncontrolled treatment.

To sum up the disucussion on maintaining the tillers , it is observed that it is really a good practice to discourage the unwanted growth, particularly during the late stage of crop development. Not only the weight of individual cane increased but maturity was reached earlier, favourably influencing quality attributes like Brix sucrose, purity and N.R. However, the fact cannot be denied that the de-tillering produced low yields. The system has promise in case of situations where farmers resort to very high population. Further, it might also work in case more growing period is allowed like 18 months cane.

5.6 Effect of interaction

The interaction effects between two and three-factors under study are discussed in the following paragraphs.

5.6.1 Growth, yield contributing characters and yield of cane and sugar

The tillering ratio was influenced significantly due to two and three factor interactions. The transplanting

of single budded settling with low (25×10^3 buds/ha) plant density gave significantly more tillering ratio compared to other treatment combinations at all the stages. Similarly, transplanting of settling with 250 kg N/ha had its superiority in producing maximum tillering ratio. The maximum tillering ratio was associated with the lowest plant density (25×10^3 buds/ha) and the highest level of nitrogen (250 kg N/ha).

The tillering of sugarcane was also influenced favourably due to combination of maintenance of tillers with method of planting, plant density and nitrogen at most of the stages. By and large, the treatments with uncontrolled tillers in combination with above factors gave comparatively more tillering ratio than that with controlling tillers.

In 1979-80, the transplanting of single budded settling with 25×10^3 buds/ha and uncontrolled tillers gave significantly highest tillering ratio at final earthing. At other stages, though not significant, similar effect has been observed during both the years.

The number of shoots recorded at different stages from 12^{th} week to 20^{th} week at monthly interval was also favourably influenced due to two and three factor interactions. It was generally observed that combination of higher seed rate (75×10^3/ha), with settling planting,

higher level of nitrogen (250 kg N/ha) and uncontrolled tillers produced the maximum shoots.

The leaf area recorded at different stages was affected by two factor interactions. In 1979-80, planting of three budded sett and transplnating of settlıng with 25 $x10^3$ buds/ha recorded significantly more leaf area per plant at harvest, though not significant similar trend was observed in 1980-81.

The leaf area significantly influenced from 270 days onwards till harvest in 1980-81, by three-budded sett planting with and without controlling tillers resulting significantly more leaf area than other combinations. Similarly, plant density in combination with maintenance of tillers influenced the leaf area significantly from 120 days onwards till harvest in 1979-80.

By and large, almost similar trend as that of leaf area was observed in case of leaf area index at all the stages in both the years with minor deviations in their effects.

In general, three-budded sett planting with the lowest plant density of 25 x 10^3 buds/ha showed beneficial effects on dry matter accumulation. Only the number of internodes was favourably influenced due to method of planting with nitrogen interactions in 1979-80 at harvest. Three-budded sett planting with varying levels of nitrogen and plant density recorded more number of internodes than other combinations.

The production of millable canes was influenced significantly in 1980-81 due to the interactions of plant density X maintenance of tillers. Plant densities of 50 and 75 x 10^3 buds/ha with uncontrolled tillers produced maximum number of millable canes in both the years.

There was no significant effect of two and three factor interactions on yield of cane and sugar.

5.6.2 Periodical maturity studies and juice quality

By and large, three-budded sett planting with 50 x 10^3 buds/ha recorded more sucrose percentage in juice, purity percentage of juice and net rendiment (N.R.). Increase in nitrogen level from 150 to 250 kg N/ha with different combinations of method of planting, plant density and maintenance of tillers resulted in depressing the quality attributes indicating thereby increasing level of nitrogen depresses the quality of sugarcane juice.

5.6.3 Uptake of nitrogen

The total uptake of nitrogen was significantly affected due to various two and three factor interactions in both the years. The uptake of nitrogen was significantly more with planting of single budded sett with varying plant densities in both the years. The total uptake of nitrogen was in increasing order with increase in the level of nitrogen irrespective of method of planting and plant density. However, single budded sett planting had its superiority in this respect. Plant density of 75 x 10^3 buds/ha with 250 kg N/ha removed significantly more nitrogen than other combinations.

The interaction of different methods of planting with uncontrolled tillers had its superiority over methods of planting X maintenance of tillers. Increase in plant density and nitrogen level in combination with uncontrolled tillers removed significantly more nitrogen when compared with the combinations of plant density and nitrogen with the maintenance of tillers.

5.7 Yield response and profitability of nitrogen application

Since the response to nitrogen was found to be linear, there is limited scope for working out economic optima from the available data However, there is considerable scope to increase the level of nitrogen beyond the limit tested in this experiment. Simple economic analysis based on input output relationship is carried out. At the 150 kg N/ha level, the cane yield was valued at Rs. 19138 per hectare. The benefit cost ratio at this stage works out at 29.35. When the nitrogen level is increased to 200 kg N/ha, involved additional cost of Rs. 217 per hectare giving additional income of Rs. 1054 per hectare, the benefit cost ratio comes down to 23.21. At the highest level of 250 kg N/ha, the additional cost involved is Rs. 434 per hectare over base level and the value of produce estimated at Rs. 21600 per hectare resulting in benefit cost ratio of 19.87.

It is interesting to note that the additional income generated from 200 and 250 kg/ha over a base level of 150 kg N/ha showed increased gross profit at 250 kg N/ha (Rs. 1191) compared to 200 kg nitrogen level per hectare (Rs. 837). Thus, it is more profitable to use higher rate of nitrogen, though benefit cost ratio comes down at the higher level of nitrogen application. It is, thus, possible to go for higher nitrogen application even on the basis of economics. The margin of profit is high enough to accommodate the cost of additional fertilizer.

5.8 Correlation studies in sugarcane

The yield of cane and sugar was significantly and positively correlated with some of the yield contributing characters such as millable cane height, number of millable canes, per cane weight and dry matter (Table 34). The millable height of cane was significantly and positively correlated with middle girth, per cane weight, dry matter production, cane yield and commercial cane sugar (C.C.S. t/ha). Thus, increased height of millable cane would positively yield more tonnage and C.C.S. per hectare. The middle girth had only positive correlation with per cane weight. Curiously enough there is no relation between middle girth and cane yield. This has been born out of the data. The number of millable canes was positively

correlated with the yield. The correlation particularly strong during 1980-81. Similarly, per cane weight was positively correlated with dry matter production, C.C.S. and cane yield. There was a very high degree of correlation between yield and commercial cane sugar (C.C.S. t/ha). These results are in agreement with the findings of Parashar et al. (1980), Zende (1981) and Zende and Kibe(1983)

SUMMARY AND CONCLUSION

6. SUMMARY AND CONCLUSIONS

The present agronomic investigations, the results of which have been reported and discussed in the preceeding chapters were planned with a view to find out a suitable method of management of cane. The factors involved were plant density, optimum dose of nitrogen and possibility of controlling tillers which will lead to increase the yield of sugarcane and sugar. Its effects on growth, yield and quality of seasonal sugarcane variety Co.740 were studied. The experiment was conducted for three successive years from 1979-80 to 1981-82 at the Regional Sugarcane and Jaggery Research Station, Kolhapur (Maharashtra).

The soil of the experimental plot was alluvial clay in texture, medium in nitrogen, available phosphorus and potash and was almost neutral in reactin. The experiment was laid out in confounding split plot deisgn with 54 treatments formed from three methods of planting, three plant densities and three levels of nitrogen as main plot treatments and two sub-plot treatments of de-tillering and uncontrolled tillers. These treatments were replicated twice. The gross plot size was 12.0 x 5.0 m^2 and the net plot size was 10.0 X 3.0 m^2.

The experimental crop was fertilized with three levels of nitrogen i.e. 150, 200 and 250 kg N/ha through urea, and recommended dose of 115 kg P_2O_5 (through single super phosphate) and 115 kg K_2O (through muriate of potash)

per hectare. Nitrogen was applied in 4 splits as 10:40: 10:40 proportion. The basal dose of nitrogen (10 %), 115 kg P_2O_5 and 115 K_2O was applied per hectare at planting. The top dressing with 2^{nd} and 3^{rd} dose of nitrogen (40 % and 10 %) was done at 8^{th} week and 12^{th} week crop age, respectively and the final dose of nitrogen 40 % per hectare was applied at final earthing of sugarcane at 16^{th} week from planting.

In addition to yield data, periodic observations on plant growth in respect of height, girth, number of internodes, dry matter accumulation and leaf area were recorded to evaluate the treatment effects. The observations on quality studies viz. Brix, sucrose percentage in juice, purity percentage of juice and net rendiment (N.R.) were recorded periodically and at harvest. The important findings emerged from the present investigations are summarised below :

6.1 Summary

6.1.1 Crop growth and development

The climatic conditions during the period of investigations were congenial which helped in luxuriant growth, yield and quality of cane.

Germination percentage recorded at 8^{th} week was 91.7 and 97.4 in 1979-80 and 1980-81, respectively. The

tillering ratio observed at 16^{th} week was 6.3 in the first year and 5.4 in second year. The number of shoots per hectare recorded at 16^{th} week was 304 4 and 282.3 x 10^3/ha in the first and second year, respectively.

The maximum height of cane recorded at harvest was 312.2 cm in 1979-80 and 314.4 cm in 1980-81. Millable height in the first and second year was 260.8 and 288.8 cm, respectively.

The girth of cane at harvest in the first year was 8.4 cm and that in second year 8.0 cm. The number of internodes was more in 1979-80 than that in 1980-81. It was 24.1 and 20.5 in the first and second year respectively.

The maximum leaf area per plant was observed at 300 days after planting. It was 72.17 dm^2/plant in 1979-80 and 81.93 dm^2/plant in 1980-81, At harvest, it was 59.29 and 66.87 dm^2 in the first and second year, respectively. The dry matter accumulated at 300 days after planting was 287.88 and 301.46 g/plant in 1979-80 and 1980-81, respectively. At harvest, it was increased to 409.66 and 425.29 g per plant in the first and second year, respectively.

These studies clearly showed that the growth and development of sugarcane crop in both the years was normal.

6.1.2 Effect of methods of planting

Various growth and yield contributing characters were influenced markedly by different methods of planting.

The germination/survival percentage at 8th week after planting was significantly lowest (87.50 and 95.06 %) with three-budded sett planting than single budded settling transplanting (97.08 and 99.34 %) and Single budded sett planting (90.66 and 97.85 %) in 1979-80 and 1980-81, respectively. The method of transplanting of settling recorded significantly more tillering ratio at 20th week after planting during both the years indicating its superiority, while conventional method of three-budded sett planting was ranking the lowest during both the years. Almost similar trend to that of tillering ratio was observed in respect of number of shoots per hectare.

The conventional method of three-budded planting recorded significantly higher leaf area and leaf area index (L.A.I.) as compared to single budded sett planting and transplanting of settling in both the years of experimentation. At harvest, the leaf area was 64.59 and 71.74 dm^2 with three-budded sett planting in 1979-80 and 1980-81, respectively. The corresponding values for single budded sett planting and single budded settling transplanting were 57.19 and 64.38 and 56.09 and 64.49 dm^2/plant.

The dry matter accumulation and the growth rate in terms of dry matter production was of higher order with conventional method of three-budded sett planting compared to rest of the methods tried during both the years. In 1979-80, the dry matter accumulation was 438.44, 429.70 and 360.85 g/plant with three budded sett planting, single budded sett planting and single budded settling transplanting, respectively. The corresponding values in 1980-81, were 467.69, 421.34 and 387.06 g/plant.

The important growth attribute in sugarcane i.e., total and millable cane height was also of higher order in the case of three-budded sett planting during both the years as compared to the rest of the methods tried.

The values of mean middle girth of cane were more with three budded sett planting during both the years. The planting of three-budded sett also recorded significantly more number of internodes (24.94 and 21.03 per cane) in 1979-80 and 1980-81, respectively. So also the shoot mortality was the lowest in three budded sett planting.

The above resultant effect of the growth attributes has been reflected in the main yield attribute viz. per cane weight. The method of three-budded sett planting exhibited its superiority over rest of the methods tried during both the years. It was 1.164 and 1.011 kg in the

year 1979-80 and 1980-81, respectively. The corresponding per cane weight with single budded sett planting and single budded settling transplanting was 1.093 and 0.945 kg; and 0.919 and 0.917 kg. The number of millable canes was the highest in settling transplanting as compared to single and three-budded sett planting in both the years.

The per hectare sugarcane yield was significantly more with three-budded sett planting (107.036 t/ha) than transplanting of single budded settling (93.684 t/ha) and on par with single budded sett planting (104.897 t/ha) in 1979-80. Though not significant, in 1980-81 and when the data were pooled over seasons almost similar trend to that of 1979-80 was observed in respect of cane yield. Similarly, single and three-budded sett planting methods recorded significantly more cane yield (109.877 and 109.479 t/ha) than transplanting of settling (89.083 t/ha) when the maintenance of tillers was extended up to final earthing during 1981-82. Similar trend was noticed in the yield of commercial cane sugar (C.C.S. t/ha) in both the years.

The method of three-budded sett planting exhibited its superiority in periodical maturity studies viz. Brix, sucrose in juice, purity of juice and N.R. The similar trend in respect of quality of juice was also noticed at harvest.

The total uptake of nitrogen was significantly higher with single budded sett planting in both the years. Though the quantum of nitrogen removed was the lowest in three-budded sett planting, the efficacy of utilization was of the higher order resulting in higher per cane weight and total cane and sugar yield.

6.1.3 Effect of plant densities

The growth and yield contributing attributes were significantly influenced.

The germination percentage was found increased with decrease in the plant density in both the years. Similarly, the tillering ratio was also wider with lower plant density and narrowed with every increase in the plant density. At the 20^{th} week after planting in 1979-80, the tillering ratio was decreased from 3.29 to 1.43 and from 1.43 to 0.88 due to increase in plant density from 25 to 50 and from 50 to 75 x 10^3 buds/ha, respectively. Similarly, in 1980-81, it was decreased from 3.55 to 1.65 and from 1.65 to 0.87 with corresponding increase in plant density from 25 to 50 and 50 to 75 x 10^3 buds/ha. The number of shoots found progressively increased with increasing plant density. In 1979-80, the number of shoots enhanced from 103.71 x 10^3 per hectare with 25 x 10^3 buds per hectare to 114.36 x 10^3per hectare with 75 x 10^3 buds per hectare. In the following

year the corresponding increase was from 112.04 to 135.72 X 10^3 shoots per hectare.

Except at earlier stages, the leaf area per plant and L.A.I. was of higher magnitude in the lowest plant density (25 x 10^3 buds/ha) during the entire growth period and at harvest. At harvest, in 1979-80, the leaf area with 25, 50 and 75 x 10^3 buds/ha was 69.23, 54.50 and 54.15 dm^2. The corresponding values in 1980-81 were 74.82, 64.61 and 61.18 dm^2.

The rate of dry matter accumulation and the total dry matter accumulated per plant was higher in lower plant density during both the years of experimentation. The total dry matter at harvest was 419.12, 411.87 and 398.03 g per plant with 25, 50 and 75 x 10^3 buds per hectare, respectively. The corresponding figures in 1980-81 were 438.84, 422.46 and 414.53 g per plant.

The plant height, both total and millable at harvest was found to increase with increasing level of plant density. However, the middle girth of cane at harvest was more with lower plant density while the number of internodes was found to increase with increased plant density during both the years.

The mortality of shoots was enhanced by high plant density (75 x 10^3 buds/ha) as compared to low plant density (25 x 10^3) in both the years.

The number of millable canes per hectare was found to increase with increased plant density in both the years. In 1979-80, the number of millable canes per hectare with 25, 50 and 75 x 10^3 buds per hectare was 93.63, 95.81 and 100.64 x 10^3, respectively. The corresponding cane number in 1980-81 was 94.34, 110.43 and 113.87 per hectare.

The per cane weight was significantly influenced due to varying plant densities in 1980-81. It was significantly more with the lowest plant density of 25 x 10^3 buds per hectare. Though not significant, similar trend to that of 1980-81 was also observed in 1979-80.

The yield of sugarcane was found increased with increased plant density. The highest plant density (75 x 10^3 buds/ha) recorded the highest cane yield of 104.249 and 106.796 t/ha during the year 1979-80 and 1980-81, respectively. Similarly, the highest plant density of 75 x 10^3 buds per hectare recorded significantly more cane yield (110.090 t/ha) compared to 25 and 50 x 10^3 buds per hectare (95.638 and 102.712 t/ha, respectively) when the maintenance of tillers beyond light earthing, up to final earthing was imposed during 1981-82. The similar trend was noticed in respect of C.C.S. yield per hectare during both the years.

The periodical maturity studies indicated that the

Brix, sucrose percentage in juice, purity percentage of juice and net rendiment (N.R.) were found increased with increasing plant density in earlier stages of maturity during both the years and even at harvest, these parameters of juice quality were of higher order in higher level of plant density, though the differences were not significant.

The uptake of nitrogen was increased with increasing level of plant density. This indicated that higher uptake of nitrogen resulted in higher tonnage of cane with higher plant density.

6.1.4 Effect of nitrogen levels

The germination percentage was not found influenced due to different levels of nitrogen during both the years. The tillering ratio was increased progressively with increased level of nitrogen and the tillering ratio at 20th week after planting obtained with 250 kg N/ha was significantly more than that recorded with lower levels of nitrogen during both the years of experimentation. The similar trend was observed in respect of number of shoots per hectare.

The leaf area per plant and the leaf area index were in increasing order with increase in nitrogen level from 150 to 250 kg N/ha.

The total dry matter accumulation per plant and the A.G.R. of dry matter at various stages of crop growth and at harvest were found increased with increasing level of nitrogen during both the years. In 1979-80, at harvest the total dry matter was 388.17, 411.50 and 429.29 g/plant with 150, 200 and 250 kg N/ha, respectively. The corresponding figures in 1980-81 were 404.54, 425.92 and 445.42 g/plant.

The plant height, both total and millable recorded with 250 kg N/ha was the highest than the rest of the nitrogen levels tried from 330 days onwards till harvest in both the years. The middle girth of cane was also found increased with increasing levels of nitrogen, though the differences were not significant. The number of internodes was increased progressively with every increase in the level of nitrogen during both the years. The differences in the shoot mortality due to various levels of nitrogen were not significant during both the years of experimentation.

The weight of individual cane recorded with application of 250 kg N/ha was the highest and was significantly superior to rest of the levels tried during 1980-81, while superior to 150 kg N/ha during 1979-80.

During both the years of experimentation, the number

of millable canes was significantly more with the application of 200 and 250 kg N/ha than 150 kg N/ha. In 1979-80, the number of millable canes with 150, 200 and 250 kg N/ha was 91.21, 99.00 and 99.87 x 10^3 per hectare, respectively. The corresponding figures in 1980-81 were 103.08, 106.40 and 109.16 x 10^3 per hectare.

The cane yield per hectare was found increased significantly with increasing levels of nitrogen during 1980-81 and when the data were pooled over seasons. However, the cane yield obtained with the application of 200 and 250 kg N/ha were at par and significantly more than 150 kg N/ha during 1979-80. Similarly, the cane yield obtained with 200 and 250 kg N/ha (106.165 and 107.591 t/ha) were at par and significantly more than 150 kg N/ha (94.685 t/ha), when the maintenance of tillers beyond light earthing, up to final earthing was imposed during 1981-82. The yield of commercial cane sugar (C.C.S.) per hectare was also found increased with increasing level of nitrogen during both the years up to 250 kg N/ha, the highest level tried.

The periodical maturity studies from 270 days onwards till harvest in terms of Brix, sucrose percentage in juice, purity percentage of juice and net rendiment (N.R.) values indicated that increasing levels of nitrogen lowers the values of these attributes and thereby the quality of juice.

The uptake of nitrogen was found increased significantly with increasing levels of nitrogen during both the years of experimentation.

6.1.5 Effect of maintenance of tillers

The tillering ratio was significantly more at 16th and 20th week after planting due to uncontrolled treatment than in maintenance of tillers during both the years. Similar to that of tillering ratio, significantly more number of shoots was observed with uncontrolled treatment.

The leaf area, leaf area index (LAI) and total dry matter accumulation per plant recorded at different stages from light earthing till harvest were not influenced significantly due to maintenance of tillers in both the years.

The maintenance of tillers did not influence the total and millable height of plant significantly from 300 days onwards till harvest in both the years, except at harvest in 1979-80. By and large, increased plant height, both the total and millable was observed with the maintenance of tillers than the uncontrolled treatment. The girth of the cane 300 days onwards till harvest was found significantly more with the treatment of maintenance of tillers than uncontrolled treatment. The number of internodes at harvest was found to be influenced by the maintenance treatment. The shoot mortality was more in

uncontrolled treatment than the treatment of maintenance of tillers.

The weight of individual cane was significantly more in the treatment of maintenance of tillers during both the years of experimentation, while the number of millable canes was significantly more in uncontrolled treatment resulting in significantly higher cane yield from the uncontrolled treatment, during both the years and when the data were pooled over seasons. Similarly, the uncontrolled treatment recorded significantly more cane yield (106.378 t/ha) than the maintenance of tillers (99.249 t/ha), when the maintenance of tillers beyond light earthing, up to final earthing was imposed during 1981-82. The similar trend was observed in respect of C.C.S. per hectare.

The periodical maturity studies based on quality characters viz., Brix, sucrose percentage in juice, purity percentage of juice and net rendiment (N.R.) values were found to be slightly favoured by the treatment of controlling tillers and the similar trend was exhibited by the values of these parameters at harvest also.

The uptake of nitrogen was significantly more in uncontrolled treatment resulting in higher millable canes and cane yield.

6.1.6 Effect of interactions

The tillering ratio and number of shoots were favourably influenced by two or three factor interactions. The transplanting of the single budded settling with

25 x 10^3 buds/ha recorded maximum tillering ratio than other treatment combinations at all the stages during both the seasons. The transplanting of single budded settling with 250 kg N/ha recorded significantly highest tillering ratio, one month after final earthing during both the seasons than the other treatment combinations. The treatment combination of settling transplanting with 75 x 10^3 buds/ha produced maximum number of shoots per hectare during both the years.

The leaf area was not significantly influenced due to three factor interactions, however, two factor interactions significantly affected the leaf area, particularly in method of planting and plant density interaction, significant differences were observed at 120 days after planting during 1980-81 when the planting of three-budded sett with 25 x 10^3 buds/ha had its superiority over all other combinations. Though significant differences were not observed at other stages, almost similar trend as that of 120 days during 1980-81, was observed throughout the crop growth period. The treatment combination of three-budded sett planting with and without controlling tillers recorded maximum leaf area than all other combinations during entire crop growth period in both the years. There was not much influence on mean L.A.I. as a result of two and three factor interactions.

The total dry matter production was not significantly influenced due to various two and three factor interactions during both the years except the interaction of method of planting and plant density. The treatment combination of planting three-budded sett with 25 and 50×10^3 buds/ha produced maximum dry matter at all the stages during both the years. The average rate of growth in terms of dry matter did not show regular trend in both the years.

The growth measured in terms of height, both total and millable and girth of internodes, was not significantly influenced due to various interactions. In general, at harvest these attributes were comparatively higher with three-budded sett planting in combination with varying plant densities and nitrogen levels without controlling tillers in both the years.

The number of internodes was favourably influenced by method of planting X plant density and method of planting X nitrogen level interactions at harvest during both the years. Three-budded sett planting with 50 and 75×10^3 buds/ha and with higher levels (200 and 250 kg N/ha) produced more number of internodes during both the years.

The interactions in respect of periodical maturity studies such as sucrose per cent in juice, purity per cent of juice and net rendiment (N.R.) indicated that during

early period of maturity, three-budded sett planting with higher plant densities (50 and 75 x 10^3 buds/ha) recorded more sucrose, purity percentage and net rendiment compared to rest of the treatment combinations during both the years. At harvest, these quality attributes were not influenced significantly due to various interactions of two and three factors.

The weight of individual cane at harvest did not vary significantly due to various interactions in both the years. The number of millable canes was maximum with the plant density of 75 x 10^3 buds/ha without controlling tillers than other treatment combinations in both the years.

There was no significant influence of two and three factor interactions on the yield of cane and commercial cane sugar.

The total uptake of nitrogen was favourably influenced due to various interactions. In general, the high yielding treatment combinations showed significantly more uptake of nitrogen compared to low yielding treatments.

6.1.7 Yield response and profitability of nitrogen application

The response to nitrogen application was found to be linear. The economics of nitrogen fertilizer used for

sugarcane showed higher rate of profitability even at 250 kg N/ha level. The benefit cost ratio based on the valuation of production and cost of nitrogen worked out as 29.35, 23.21 and 19.87 at 150, 200 and 250 kg N/ha level, respectively.

6.1.8 Correlation studies

The various yield contributing components like millable height, number of millable canes and per cane weight showed a significant positive correlation with cane yield. Similarly, these components were also positively correlated with the yield of commercial cane sugar.

6.2 Conclusions

The following are the broad conclusions emerged from the present investigations.

1 Conventional method of three-budded sett planting exhibited its superiority in leaf area, L.A.I. and dry matter accumulation, total and millable cane height, cane girth and number of internodes over rest of the methods tried while the shoot mortality was the lowest in this method resulting in significantly higher per cane weight and cane and sugar yield. The quality of juice was also superior in this method.

2 The lower plant density favoured the germination, tillering ratio, leaf area and L.A.I., rate of dry matter accumulation and total dry matter production. However, the number of shoots, plant height

number of internodes were found to increase with increase in plant density. The number of millable canes also increased with increase in plant densities. While per cane weight was highest with the lowest density. As a resultant effect the yield of cane and sugar was highest with the highest plant density tried (75 x 10^3 buds/ha). The quality of juice was improved as revealed from parameters studied in high levels of plant densities. The removal of nitrogen was also increased with increasing level of plant density.

3 The tillering ratio and number of shoots, leaf area and L.A.I. values, total dry matter and A.G.R. of dry matter, plant height both total and millable, girth and number of internodes were found increased with increase in the level of nitrogen. Individual cane weight and number of millable canes increased significantly with 200 and 250 kg N/ha over 150 kg N/ha resulting in higher yield of cane and sugar. While the juice quality parameters were adversely affected by increasing level of nitrogen. The uptake of nitrogen was found increased significantly with increasing levels of nitrogen. The yield response to nitrogen fertilization was found to be linear. The higher rate of profitability was observed even at 250 kg/ha level of of nitrogen.

4 Maintaining all the tillers was favoured in respect of tillering ratio, number of shoots, number of millable canes resulting in significantly more yield of cane and sugar. Whereas, the juice quality parameters were found slightly improved by the maintenance of tillers.

5. Thus, three-budded sett planting with 75 x 10^3 buds/ha, application of 200 to 250 kg N/ha and maintaining all the tillers is beneficial to obtain higher yield of cane and sugar.

6.3 Future line of work

1. The present investigations have proved that the new technique of spaced transplanting method as well as maintaining the tillers was not found to be useful. A critical observation, however, revealed that the yield parameters like number of millable canes and quality of juice at late maturity stage were improved. This shows the merit of this method, however, the lack of vigour in the STP method in the initial stages is not compensated in a period of 12 months crop of sugarcane, it is therefore, felt that had some period been allowed for compensation, this method (STP) and maintaining the definite number of tillers may prove to be superior to the traditional method of planting cane. It is, therefore, suggested that similar studies need to be carried out in pre-seasonal and adsali cane

2. Nitrogen application in the present investigation showed linear response. Thus, there is a scope for further increase in the levels of nitrogen to work out economic optima. It is further interesting to note that the nitrogen application showed enough margin of profit as revealed from benefit cost ratio.

LITERATURE CITED

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Anang Nath and Bajaj, J. 1969. Influence of seed rate on yield and quality of cane under Tarai conditions. Indian Sugar., 19(5):411-417.

Anonymous. 1956-57. Plant population control experiment in sugarcane (Adsali planting). Ann. Re . Sug. Res. Scheme, Bombay State, Padegaon, pp. 73-79.

Anonymous. 1960-61. The effect of planting cane at different seed rates during autumn on the growth, yield and quality. Ann. Rep. Sug. Res. Stn., Shahjahanpur (U.P.), pp.84-85.

Anonymous. 1961-62. Effect of planting cane at different seed rates during spring on the growth, yield and juice quality. Ann. Rep. Sug. Res. Stn., Shahjahanpur (U.P.), pp. 51-52.

Anonymous. 1963-64. The effect of planting cane at different seed rates during spring on the growth, yield and quality. Ann. Rep. Sug. Res. Work at Golagokarannath (U.P.), pp. 181-182.

Anonymous. 1965 a. Half a century of agricultural research at Anakapalle. Agri. Inform. Service, Deptt. of Agri., Andhra Pradesh. pp. 87.

Anonymous. 1965 b. To study the effect of varying levels of nitrogen and its application in split doses on yield of cane and crop log indices. Agresco. Rep. Sug. Res. Stn., Padegaon. pp. 4-6.

*Anonymous. 1967. Climate and cane growth. Haw. Plant. Rec. 57(1):58-59.

Anonymous. 1968. Nutritional studies of sugarcane. Agresco. Rep. Reg. Sug. Res. Stn., Kolhapur (M.S.).

Anonymous. 1969. To study the effect of mode of application of P and K under different N levels on nutrition and quality of sugarcane as judged by the uptake on N, P and K nutrients. Agresco. Rep. Reg. Sug. Res. Stn., Kolhapur (M.S.). pp. 8-12.

Anonymous. 1969-70. Studies to determine optimum level of N fertilization to Co.62175 variety of sugarcane. Ann. Rep. Sug. Res. Stn., Anakapalle (A.P.).pp.40.42.

Anonymous. 1972. Effect of different methods of planting, row spacing, seed material and time of planting on yield and quality of sugarcane. Ann. Rep. IISR, Lucknow. pp. 15-17.

Anonymous. 1973. Plant population studies in sugarcane varieties in relation to various levels of fertility. Ann. Rep. SBI., Coimbatore, pp. 20-23.

Anonymous. 1978 a. Studies on possibilities of increasing the yield of early varieties by agronomic practices. Ann. Rep. SBI., Coimbatore. pp. 84-93.

Anonymous. 1978 b. Spaced transplanting trial on Co.740 variety of sugarcane. Agresco. Rep. Sug. Res. Stn., Padegaon. pp. 24-25.

Anonymous. 1979. To study the effect of spaced transplanting in sugarcane with a view to reduce the seed rate and fertilizer application. Agresco. Rep. Sug. Res. Stn., Padegaon. pp. 53-63.

Anonymous. 1980 a. Studies on the influence of planting dates and spacing on the early and mid-late varieties of sugarcane. Ann. Rep. SBI., Coimbatore. pp. 91-97.

Anonymous. 1980 b. Effect of different planting material on yield and quality of sugarcane. Ann. Rep. IISR., Lucknow. pp.25-26.

Anonymous. 1980 c. Response of promising early, mid-late and late varieties of sugarcane to rates of nitrogen application. Agresco. Rep. Sug. Res. Stn., Padegaon. pp. 9-12.

Anonymous. 1980 d. Effect of single and scooped eye-bud settling transplanting with different spacing on growth and yield of sugarcane (Co. 740). Agresco. Rep. Sug. Res. Stn., Padegaon. pp. 23-27.

Anonymous. 1981. To study the package of practices for new promising sugarcane varieties. Agresco. Rep. Sug. Res. Stn., Padegaon. pp. 9-13.

Anonymous. 1982. To study the package of practices for new promising sugarcane varieties for Adsali planting. Agresco. Rep. Sug. Res. Stn., Padegaon. pp. 1-5.

Anonymous. 1983 a. Statistics. Indian Sugar. 33(5): 358-365.

Anonymous. 1983 b. Response of promising early, mid-late and late varieties of sugarcane to rates of nitrogen application. Agresco. Rep. Sug. Res. Stn., Padegaon. pp. 9-12.

A.O.A.C. 1955. Official methods of analysis. Association of Official Agricultural Chemists, 8th Edn. Washington, D.C. (U.S.A.).

Arakeri, H.R. 1956. Studies on nutrition of sugarcane-present position of sugarcane research and development in Bombay State. pp. 30-35.

Arakeri, H.R., Mirajkar, M.A., Tippanvar, M.B. and Y.V. Hedge, Y.V. 1961. Sugarcane research in new Mysore State. Indian J. Sug. Res. and Dev. 5(4):191- 196.

Bains, A.S. 1959. Effect of spacing on growth and yield of sugarcane under varying levels of nitrogen. Indian Sugar. 9(6):329-336.

Bains, A.S. 1960. Juice quality in sugarcane as influenced by nitrogen with varying levels of spacings and seed rates. Indian Sugar. 9(2):637-642.

Bathla, H.V.L. and Sharma, H.L. 1978. Measurement of leaf area in sugarcane. Indian Sug. Crops. J. 5(1): 16-18.

Bhoj, R.L., Shukla, S.S. and Shrikhande, J.G. 1960. Inter-row spacing and seed rate in sugarcane planting. Proc. 4th All India Conf. Sug. Res. and Dev. Workers., pp. 47-52.

Bhonsale, D.N. and Tonapy, G.K. 1962. Single shoot planting versus double shoot planting. Proc. 18th Ann. Convn. DSTA. Pt. I, pp.69-70.

Cheema, S.S. and Moolani, M.K. 1970. Growth and yield of sugarcane as influenced by varying soil moisture regimes and nitrogen levels. Indian Sugar. 20(7): 533-539.

Daniel, K.V., Sugumaran, T. and Suresh Kumar, M. 1976. Effect of nitrogen and potassium on the yield and quality of sugarcane. Co-op. Sugar. 7(7):341-344.

Daniel, K.V. and Sanjeevirayar, L. 1980. Economic dose of nitrogen to sugarcane varieties undercultivation in Tamil Nadu. Indian Sugar., 29(10):645-648.

*Del Rosalio, E.L. 1974. Towards maximization of sugar yield. Sugarland. 11(4):8-10 and 24-27.

Dillewijn, C. Van. 1952. Botany of sugarcane. The Chronica Botanica Co., Book Deptt., Waltham, U.S.A.

Dixit, R.S., Gupta, D.N., Nath, A. and Saroj, J.S. 1975. Response of sugarcane to nitrogen and irrigation in Tarai tract of U.P., Co-op. Sugar. 6(1):503-507.

Dixit, R.S. and Saroj, J.S. 1975. Response of sugarcane to row spacing and nitrogen in the Tarai tract of U.P., Proc. 5th Joint Convn. STAI, DSTA and SISTA, Pt.-I, 17-19.

Dixit, R.S. and Saroj, J.S. 1976. Response of sugarcane to row spacing and nitrogen in the Tarai tract of Uttar Pradesh. Proc. 27th Ann. Convn. DSTA. Pt.-I, pp. 19-21.

Du-Toit, J.L. 1959. Recent advances in nutrition of sugarcane in South Africa. Proc. 10th Congress. ISSCT. pp. 432-440.

Gahlot, K.N.S. 1954. Different forms of inorganic nitrogenous manures in sugarcane cultivation. 2nd Bien. Conf. Sug. Res. and Dev. Workers. pp. 451-456.

Gahlot, K.N.S. 1957. The effect of different seed rates, yield and juice quality of sugarcane. Proc. 3rd All India Conf. Sug. and Dev. Workers. pp. 194-197.

Gascho, G.J. and Shih, S.F. 1978. Row spacing effects on biomass and composition of sugarcane in Florida. Proc. American Soc. Sug. Tech., pp.72-76.

Gill, P.S. and Masood, A. 1967. Effect of seed rate on density and yield of pre-winter planted sugarcane. Indian Sugar. 17(6):471-473.

Gill, H.S. and Singh, Onkar. 1976. Response of some sugarcane varieties to different levels of N, P and K in Punjab. Indian Sugar. 26(3):145-149.

Gupta, A.P. and Prasad, B. 1971. Composition of cane juice-II. Effect of nitrogen manuring on various organic non-sugars in cane juice of plant and ratoon crops. Proc. 4th Joint Convn. STA, DSTA and SISTA, pp. 91-98.

Gupta, D.N. 1973. Sugarcane yield and juice quality-Effect of NPK. Sugar News. 5(6):15-17.

Gupta, D.N. and Singh, R. 1974. Increasing sugarcane production through judicious manuring and irrigation. Sugar News. 6(5):22-25.

Gupta, D.N. and Lal, U. 1975. Sugarcane yield and quality-Effect of seed rate-cum-row distance-cum-nitrogen levels. Co-op. Sugar. 6(5):1-5.

Holman, C., Williams, B. and Forte, L.A. 1938. Double versus single planting. Proc. 6th Cong. ISSCT. pp. 266-271.

Hunsigi, G., Nadagoudar, B.S. and Puttaraj, B. 1974. Response of sugarcane to phosphate fertilization at graded level of nitrogen. Indian J. Agri. Sci., 44(8):513-516.

Irfanuddin and Singh, R.G. 1981. Response of sugarcane to application of nitrogen, phosphorus and potassium. Indian Sug. Crops J. 8(1):15-17.

Irvine, J.E. and Matherne, R.J. 1978. Close row spacing and sugarcane yield. Proc. American Soc. Sug. Tech. pp.157.

Irvine, J.E. and Benda, G.T.A. 1980. Sugarcane spacing. II. Effect of spacing on the plant. Proc. 17th Congress. ISSCT. 1:357-366.

Jaisinghani, C.J. and Jain, S.V. 1964. Fertilizer response on sugarcane in Rajasthan. Indian J. Sug. Res. and Dev. 8(3):311-314.

Joshi, K.V. and Mahajan, V.O. 1964. Sugarcane cultivation on F type of soil. Indian J. Sug. Res. and Dev. 8(4):399-416.

Jothimoorthy, S., Durai, R. and Sanjeevi, P.S. 1980. Performance of setts and settling planting in the coastal belt of Tamil Nadu. Co-op. Sugar. 12(3): 131-134.

Kadian, V.S., Srivastava, S.N.L. and Singh, V.R. 1981. Effect of doses of nitrogen, phosphorus and potash on yield and quality of sugarcane. Indian Sugar. 31(6):405-408.

Kakade, J.R. 1971. Sugarcane manuring in Maharashtra-A brief review. Pt.-I. Manures and nitrogen fertilization. Sugar News., 3(3):17-23.

Kakade, J.R. 1972. Nitrogen in sugarcane cultivation in Maharashtra. Sugar News. 3(13):21-25.

Kale, K.S., Deshpande, P.V. and Ramchandra Rao, I.G. 1950. Studies on yield and quality of sugarcane grown on the estate of the Ugar Sugar Works Ltd., Mysore. Proc. 7th Ann. Convn. DSTA, Pt.-I, pp.1-11.

Kale, K.S. and Deshpande, P.V. 1956. Studies in planting bud, shoot and seedling setts of sugarcane. Proc. 9th Congress ISSCT. 1:271-282.

Kale, R.A. and Babriwala, G.T. 1959. A note on certain studies of morphological characters and uptake behaviours in a few sugarcane varieties. Proc. DSTA 16th Ann. Convn. Pt.-I, pp.141-146.

Kanwar, R.S. and Kochhar, A.S. 1960. Effect of N, P, K fertilizers on the mineral uptake and juice quality of sugarcane. Proc. 4th All India Conf. Sug. Res. Dev. Workers, pp. 74-76.

Kanwar, R.S. and Singh, H. 1960. Studies on the relative efficiency and effect of certain nitrogenous fertilizers on soil composition, juice quality and yield of sugarcane. Indian J. Sug. Res. and Dev. 4(2): 57-63.

Khan, A.R. and Pattanayak, N. 1956. Irrigation-cum-nitrogen-cum-depth of cultivation response of sugarcane. Proc. 9th Congress. ISSCT. pp. 311-318.

Kharkar, N.C. and Kulkarni, P.B. 1957. Further studies in single eye bud planting. Proc. 14th Ann. Convn. DSTA. Pt.-I, pp. 81-93.

Kirti Kar and Anang Nath. 1964. Irrigation and nitrogen response of sugarcane in Eastern U.P. Indian Sugar. 14(9):633-637.

Kirti Kar, Anang Nath and Mathur, B.K. 1964. De-tillering studies in sugarcane. Proc. 5th All India Conf. Sug. Res. and Dev. Workers. pp. 112-115.

Kirti Kar and Saroj, J.S. 1974. The effect of systems of planting under different levels of nitrogen and irrigation on sugarcane. Co-op. Sugar. 6(4):149-152.

Kirti Kar, Dixit, R.S., Ali, M.I. and Singh, S.P. 1975. Effect of N x P on sugarcane in Rohil Khand Region of Uttar Pradesh. Co-op. Sugar. 6(8):333-338.

Krishnamurthy, T.N. 1978. Studies on spaced transplanting of sugarcane. Comparison of S.T.P. and usual method. Co-op. Sugar. 9(12):629-631.

Lakhdive, B.A. 1981. Studies on spaced transplanting technique of sugarcane. Proc. 31st Ann. Convn. DSTA, Pt.-I, pp.35-38.

Lal, U. and Lal, B. 1978. Effect of spacing and levels of nitrogen on the yield and quality of sugarcane in Tarai conditions of Uttar Pradesh. Co-op. Sugar. 10(4):163-165.

Mahamuni, I., Iyer, T.A.G., Ramamoorthy, N. and Rajan, S.D. 1973. Influence of manures and fertilizers on the quality of constituents of sugarcane juice. Indian J. Sug. Res. and Dev. 22(10):775-789.

Mali, S.A., Pawar, K.R. and Borulkar, D.N. 1982. Yield contributing characters of three varieties of seasonal sugarcane as influenced by nitrogen and phosphate levels. Indian Sugar. 32(2):95-104.

Mane, V.S. and Salunkhe, C.D. 1978. Studies on sugarcane ratoons. Indian Sugar. 28(7):405-408.

*Matherne, R.J. 1977. The influence of row spacing on sugarcane stalk population and yield. 7th Ann. Meeting American Soc. Sug. Tech. (Cited from Sugar Azugar., 72(6):36-37).

Mathur, B.K., Bhadauria, V.S. and Singh, A. 1968. Study on the effects of different doses of nitrogen and systems of planting on plant cane and its subsequent effect on ratoon crop. Indian Sugar., 18(8): 611-619.

Mathur, B.K. 1972. Response of NPK fertilizers on sugarcane- Crop agronomical view. Indian Sugar. 21(12): 809-815.

Mathur, B.K. and Tripathi, K.B. 1975. Boosting sugarcane quality through nitrogen in relation to irrigation. Indian Sugar. 25(5):389-392.

Mohan Rao, N.V. and Narasimhan, R.L. 1951. Studies on N fertilization on sugarcane. Proc. Ist Bien. Conf. Sug. Res. and Dev. Workers, Pt.-I, pp.64-73.

Mohan Rao, N.V. and Narasimhan, R.L. 1956. Some aspects of nitrogen nutrition of sugarcane in Andhra. Proc. 9th Congress. ISSCT., Vol. I, pp.74-93.

Mukherjee, J. and Verma, G. 1950. Manuring of sugarcane. Proc. 19th Ann. Convn. STAI. pp.49-69.

Muthukrishnan, K.S. 1979. "Does sugarcane need family planning ?". SISTA. Sugar J. 5(1):39-45.

Naidu, V.C., Sreenivasan, S. Janardhan, P.R. and Reddy, M. 1982. Effect of nitrogen, phosphorus and potassium on the yield and quality of sugarcane variety Co.740. Maharashtra Sugar. 7(9):51-56.

Nair, P.K.C. 1979. The effect of nitrogen, phosphorus and potash on the yield and sucrose content of sugarcane in acid soils of Kerala. Proc. 43rd Ann. Convn. STAI. Pt -I. pp 15-24.

Narayanan, K. 1970. Studies on spacing and seed rate and their effect on tillering, yield and juice quality of sugarcane. Madras Agri. J., 57(7):384-386.

Narwal, S.S. and Behl, K.L. 1979. Effect of graded doses of nitrogen on growth and yield of sugarcane varieties. Co-op. Sugar., 10(6):275-279.

Narwal, S.S. and Malik, D.S. 1981. Effect of levels of nitrogen and their time of application on the growth, yield and quality of sugarcane. Indian Sugar. 31(5): 333-337.

Ojha, S.K., Dua, S.P. and Singh, S.V. 1974. Effect of nitrogen, phosphorus and potash on yield and juice quality of sugarcane. Proc. 14th Ann. Convn. STAI. Pt.-I, pp.43-48.

OJha, S.K. Dua, S.P. and Singh, K.P. 1977. Response of cane to nitrcgen and phosphorus fertilization. Co-op. Sugar. 9(3):109-111.

Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A. 1954. Estimation of available P in soils by extraction with $NaHCO_3$. U.S.D.A., Cir. 939.

Panje, R.R. 1973 a. On the effect of plant densities on yield components in sugarcane. Proc. 25th Ann. Convn. DSTA. pp. 46-51 (Pt.-I Addendum).

Panje, R.R. 1973 b. On the need for basic studies in sugarcane agronomy. Diamond Jubilee Souvenir, Sugarcane Res. Stn., Anakapalle (1973). pp. 10-17.

Panse, V.G. and Sukhatme, P.V. 1978. Statistical methods for agricultural workers. Revised Edn. ICAR. New Delhi.

Panwar, B.S., Rathore, D.N. and Joon, R.K. 1980. Effect of graded levels of nitrogen on growth, yield and quality of sugarcane varieties. Indian Sugar. 30(9): 487-490.

Parashar, K.S., Patil, R.R., Mahavir Prashad and Dhaka, B.S. 1980. Studies on the inter-relationship between cane yield, juice quality and plant characters of sugarcane. Indian Sugar. 30(3): 149-151.

Parthasarathy, S.V. 1972. Sugarcane in India. K.C.P. Publication, Madras.

Patil, S.K., Tippanvar, M.B., Hiregoudar, S.V. and Gopal Reddy, M. 1964. Studies on the response of varying levels of N, P, K in V.C. tract. Proc. 5th All India Conf. Sug. Res. and Dev. Workers. pp. 196-203.

Patil, B.V. 1974. Influence of levels of press-mud cake and nitrogen on the growth, yield and quality of Suru sugarcane. Thesis submitted for M.Sc. (Agri.) to Mahatma Phule Agril. University, Rahuri (M.S.).

Patil, J.P., Bawaskar, V.S. and Ranadive, S.J. 1977. Response of sugarcane varieties to rates of nitrogen fertilization. Indian Sugar. 27(9):581-586.

Patwardhan, G.K. and Patil, R.S. 1965. Studies on relative merits of rayungan planting and sett planting method of cane cultivation. Proc. 20th Ann. Convn. Pt-I, pp. 128-142.

Piper, C.S. 1966. Soil and plant analysis. Hans Publishers, Bombay.

Prihar, N.S. 1971. Nitrogen requirement of sugarcane in Rajasthan. Indian Sugar. 21(8):555-558.

Raghvaiah, C.V. and Singh, P.P. 1980. Yield and nitrogen uptake of sugarcane varieties at graded levels of nitrogen. Indian Sugar. 30(1):13-17.

Raheja, P.C. and Azeez, M.A. 1948. Multiple factor experiment on spacing, nitrogen doses and time of application of nitrogen. Indian J. Agri. Sci. 18(2): 113-122.

Raja. R., Appaji, V.K. and Chockalingam, S. 1964. Manuring adsali crop of sugarcane. Indian Sugarcane J. 9(1):15-18.

Recaud, R., Cochran, B.J. and Newton, G.W. 1978. Methods of planting sugarcane in Louisiana. Proc. American Soc. Sug. Tech. pp. 160.

Reddy, R.M., Reddy, C.S. Venkatachari, A. and Kulkarni, H.L. 1978. Studies on the effect of nitrogen and moisture regime on yield and quality of sugarcane. 42nd Ann. Convn. STAI. Pt.-I, pp. 99-105.

Reddy, M.R. 1981. Effect of inter-row spacing on yield and quality of sugarcane. Proc. 45th Ann. Convn. STAI. pp. 61.

Rege, R.D. 1954. Problems of sugarcane physiology in the Deccan canal tract. IV mineral nutrition of nitrogen. Indian J. Agri. Sci. 14: 1-18.

Rege, R.D., Rajgopal, V.R. and Bhaskar Rao, U.K. 1963. Fertilizer experiments on sugarcane. Indian J. Sug. Res. and Dev. 7(3):176-182.

Salunkhe, C.D., Patil, V.D., Patil, J.P. and Shinde, A.G. 1980. Response of sugarcane to rates and time of nitrogen fertilization in Kolhapur region (Variety Co.740). Sugar News. 11(9):11-13.

Salunkhe, C.D., Patil, V.D. and Shinde, A.G. 1981. Response of sugarcane to rates and time of nitrogen fertilization in Kolhapur region (Variety Co.740). Maharashtra Sugar. 6(6):21-26.

Samuels, G. and Landrau, P. 1956. The sucrose content of sugarcane, as influenced by fetilizers. Proc. 9th Congress. ISSCT. 1:365-375.

Sastry, S.K. and Venkatachari, A. 1960. Nutrient requirement of sugarcane at Rudrur (A.P.). Proc. 4th All India Conf. Sug. Res. and Dev. Workers. pp. 145-148.

Shanmugasundaram, S.J., Ethirajan, A.S. and Choudhary, P.N. 1975. Plant population studies in sugarcane. STAI Golden Jubilee. Pt.-II:1-4.

Shanmugasundaram, S. and Venugopal, K. 1979. Row spacing, seed rate and population control in relation to cane and sugar yield- A review. Indian Sugar. 28(10): 685-693.

Shanmugasundaram, S., Misra, A., Venugopal, K. and Ethirajan, A.S. 1981. Effect of varying plant density on performance of plant and ratoon of different sugarcane varieties. Indian Sugar. 31(3): 171-174.

Sharma, R.K. and Chauhan, D.R. 1974. Effect of rayungan planting on the growth and yield of sugarcane in Madhya Pradesh. Sugar News. 6(3):21-23.

Shinde, A.G., Gaur, S.L. and Salunkhe, C.D. 1981. Response of promising early and mid-late sugarcane varieties of Kolhapur region to rates and time of nitrogen application. Maharashtra Sugar. 6(12): 39-43.

Shinde, A.G., Salunkhe, C.D. and Magdum, D.N. 1983. Effect of spaced planting on yield and quality of seasonal sugarcane (Co. 740). Maharashtra Sugar, 8(9):75-78.

Singh, H., Mohammad, K. and Singh, H. 1940. Effect of quantity and quality of seed material on germination Proc. 10th Ann. Convn. STAI. Pat I., pp. 58-59.

Singh, H., Singh H. and Singh. A. 1954. Irrigation and manurial requirement of sugarcane under Gurdaspur conditions. Proc. 2nd Bien. Conf. Sug. Res. and Dev. Workers. Pt.-II, pp. 527-531.

Singh, M. and Gupta, R.C. 1960. Time of application of nitrogen fertilizers to sugarcane in Western tract of Uttar Pradesh. Proc. 4th All India Conf. Sug. Res. and Dev. Workers. pp. 66-73.

Singh, U.S. and Singh, Lallan. 1967. Optimum requirement of three-budded setts under normal spacing of cane planting during autumn and spring season. Indian Sugar. 17(3):275-281.

Singh, B.V. and Singh, A.S. 1970. Correlation studies in sugarcane. Madras Agri. J. 57:474-477.

Singh, U.S., Singh, Lallan and Saxena, M.M.S. 1970. Optimum requirement of seed rate and nitrogen for sugarcane in Uttar Pradesh. Sugar News. 2(2):21-28.

Singh, B., Srivastava, S.C. and Ghosh, A.K. 1972. Comparative dynamics of sugarcane stalk population due to variations in row spacing, material and fertilizer levels. Proc. 38th Ann. Convn. STAI. pp. 1-9.

Singh, U.S. 1973. Nitrogen and sugarcane. III. Relation between leaf nitrogen and cane yield, sucrose content and purity co-efficient of juice. Indian Sugar. 23 (3):323-328.

Singh, P.P. 1974. Growth, yield and juice quality of sugarcane varieties as influenced by nitrogen. Indian J. Agri. Sci. 44(9):593-597.

Singh, S.W. 1975. A note regarding the economics of modified rayungan method of cane planting of Lauriya farms. Indian Sugar. 25 (6):400-401.

Singh, B.K., Bose, P.K., Ashraf, M.S. and Rai, Y. 1981. Response of promising regional varieties to rates of nitrogenous fertilizer application. Maharashtra Sugar. 6(5):9-11.

Singh, P.P., Saini, S.K. and Kamlesh Kumar. 1982. Studies on plant density and nitrogen levels in sugarcane. Indian Sugar. 32(9):581-585.

Singh, H. and Sharma, H.L. 1983. Path co-efficient analysis of cane yield in sugarcane. The Indian Sug. Crops J. 9(2):7-9.

Snedecor, G.W. and Cochran, W.G. 1967. Statistical Methods. 6th Edn. Oxford and IBH Pub. Co., Bombay.

Spencer, G.L. and Meade, G.P. 1945. "Cane sugar Hand Book". John, Wiley and Sons., New York (U.S.A.)

Srinivasan, T.R. and Mariakulandai, A. 1969. Influence of nitrogen and moisture regimes on agronomic indices and yield of sugarcane. Indian Sugar. 19(4):349-357.

Srinivasan, T.R., Sanjeevi, P.S., Govindasamy and Parameswaran, P. 1971. Response of sugarcane to major nutrients under Cauvery delta area (Madras). Indian Sugar. 21(2):75-77.

Srinivasan, T.R. and Mariakulandai, A. 1972. Quality of sugarcane in relation to sheath moisture. Indian Sugar. 22(2):83-87.

Srivastava, S.C. (1971). Improving the efficiency of fertilizer nitrogen in sugarcane production under Indian conditions. Indian Sugar. 21(5):387-391.

Srivastava, K.K., Narasimhan, R. and Shukla, R.K. 1981. A new technique for sugarcane planting. Indian Farming. 31(3):15-17.

*Stanford, G. 1963. Sugarcane quality and nitrogen fertilization. Haw. Plant. Rec. Vol. 4:289-318.

Sugumaran, T., Daniel, K.V. and Suresh Kumar, M. 1976. Response of promising varieties to nitrogen application in Tamil Nadu. Indian Sugar. 26(5):299-301.

Suresh Kumar, Daniel, M. and Subramaniam, K.V. 1978. A study on time of application of nitrogen to sugarcane. Co-op. Sugar. 9(11):579-581.

Suryanarayana, J.V.V. and Seetharamaiah, P. 1963. Sugarcane Development in Andhra Pradesh. Indian J. Sug. Res. and Dev. 7(4):448-459.

Tanimoto, T. and Burr, G. 1959. The growth of sugarcane as influenced by nitrogen fertilization. Proc. 10th Congress. ISSCT. pp. 450-461.

Tandon, R.K., Misra, G.N. and Upadhaya, U.C. 1957. On different seasons of planting sugarcane. Proc. 3rd All India Conf. Sug. Res. and Dev. workers. pp. 187-193.

Thakur, C. and Jayaswal, M.C. 1957. Size of setts in relation to tonnage and quality of sugarcane. Proc. 3rd All India Conf. Sug. Res. and Dev. Workers. pp. 211-219.

Thakur, K., Bose, P.K., Sahi, B.P. and Roy Sharma, R.P. 1979. Response of sugarcane to nitrogen and phosphate to calcareous soils. Maharashtra Sugar. 4(7):23-27.

*Thomas, J.R., Salinas, F.G. and Namken, L.N. 1977. Growth and yield of sugarcane as affected by row spacing and irrigation regime (Cited from Sug. Azugar. 72(6):33.

Thuljaram Rao, J. 1980 Sugarcane potential to meet the needs of 2000 A.D. Indian Sugar Crops J. 7(3):67-71.

Tripathi, R.L. and Jaiswal, S.P. 1974. A study on the mode of nitrogen application in sugarcane. Indian Sugar. 24(2):101-103.

Verma, H.P. 1957. Studies in the uptake of nitrogen by sugarcane plant under Shahjahanpur conditions. Proc. 3rd All India Conf. Sug. Res. and Dev. Workers. pp. 87-94.

Verma, S.C. and Verma, H.P. 1964. Leaf nitrogen studies under different cultural and manurial practices in sugarcane. Indian J. Sug. Res.and Dev. 4(4): 234-238.

Virendra Kumar. 1976. A review of sugarcane manuring in Uttar Pradesh. Co-op. Sugar. 7(6):293-302.

*Watson, D.J. 1947. Comparative physiological studies on growth of field crops. II. The effect of varying levels of nutrient supply on NAR and leaf area. Ann. Bot. N.S. 11:375-407.

Zende, G.K., Chinchorkar, S.V. and Javalekar, D.V. 1972. Effect of season and management practices on the uptake of nutrients by different varieties of sugarcane. Proc. DSTA, 24th Convn., pp. 73-89.

Zende, G.K. 1981. Soil management for economic production of sugarcane (A lead paper), DSTA 31st Ann. Convn. Pt.-I, 1-97.

Zende, G.K. and Kibe, M.M. 1983. Correlation between soil attributes, uptake of nutrients, agronomic characters and the cane yield of an adsali crop of sugarcane. Maharashtra Sugar. 8(7):79-89.

* Original not seen

8. VITAE

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