Some Studies On Press Mud Cake, Its Residual Effect On Yield And Quality Of Sugarcane

(Saccharum officinarum L.) CO.740 (Adsali)

And Soil Chemical Properties

BY

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DIVISION OF SOIL SCIENCE
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AUGUST, 1979.

DEDICATION

DEDICATED TO THE SACRED MEMORY

OF MY

LATE FATHER

PANDURANG LAXMAN PATIL

CANDIDATE'S DECLARATION

I hereby declare that the contents of this thesis or any part thereof has not been previously submitted by me for the award of degree of any other University.

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Dated : 15th August 1979.

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C E R T I F I C A T E

This is to certify that Shri S.P. Patil, Senior Research Assistant, Padegaon has satisfactorily prosecuted his course of research for a period of more than two academic years and that the thesis entitled " SOME STUDIES ON PRESS MUD CAKE, ITS RESIDUAL EFFECT ON YIELD AND QUALITY OF SUGARCANE (Saccharum officinarum L.) CO.740 (Adsali) AND SOIL CHEMICAL PROPERTIES ", submitted by him to the Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra) for the award of MASTER OF SCIENCE (AGRICULTURE) in SOIL SCIENCE is the result of bona fide research of original nature conducted under my guidance and supervision and is of sufficiently high standard to warrant its presentation for the said examination.

The assistance and help received during the above course of investigation and source of literature cited above have been duly acknowledged.

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CHAPTER 1

INTRODUCTION

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I N T R O D U C T I O N

Sugarcane (Saccharum officinarum L.) crop is grown extensively on an area of 3.22 million hectares in India and 0.25 million hectares in Maharashtra State. Sugarcane crop and ultimately the sugarcane industry commands an unique position in the socio-economic structure and stability of India. It has played a vital role in bringing about the desirable socio-economic upliftment of the rural life of the sugarcane growers.

The sugarcane crop exhausts a large quantities of nutrients viz; N, P_2O_5 and K_2O from the soil, as it stands in the field from 12 to 18 months depending upon the planting season. It requires a large expenses on fertilization. Hence, the judicious manuring and fertilization is required to meet its nutritional requirements without adversely affecting physico-chemical and biological properties of soil to achieve higher productivity. However, the ultimate product is sugar which does not contain any of these nutrients added.

In the present plight of fertilizer shortage, especially of phosphate and potash which are imported and need huge foreign exc hange any reduction in fertilizer use without concomitant decrease in yield in cane would obviously be welcome to the sugarcane culture. The use of organic manures, agricultural

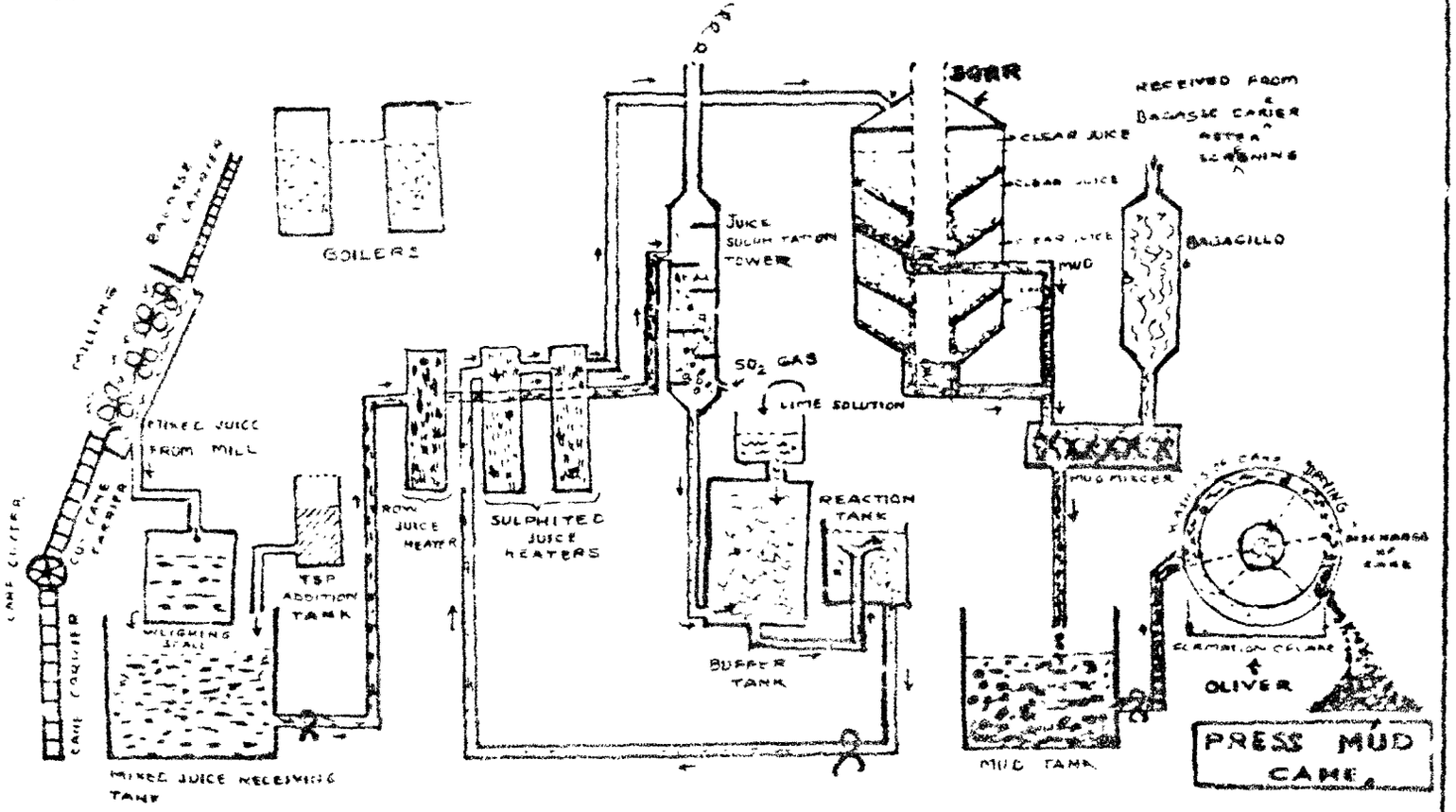
and industrial waste products have come to limelights and assumed an unequivocal eminence. There is no other alternative than to use these waste products. These wastes will include all kinds of organic manures, organic soil amendants and soil conditioners etc. which will ferret the way for their proper disposal. Recycling of these organic wastes in agriculture would help in efficient utilization of natural resources instead of more dependance on fertilizer. The sugar industry waste product like press mud cake (PMC) in this respect can not be an exception.

In sugar factory, after milling of canes the raw juice is processed by adding specific quantity of triple superphosphate (TSP) solution (Fig. 1), then heated and further processed either by carbonation or sulphitation process. The impurities are settled in the form of mud in Dorr. The mud is taken out in mud mixer where bagasse is mixed and the material is collected in mud tank. The same material is delivered to Oliver (filter press) where the cake builts up, and after washing, the cakes are partially dried and discharged through the Oliver which is commonly known as press mud cake. It is also called as filter mud, filter cake or Cachaza (Haines, 1961).

The press mud cake consists of mixture of sugarcane fibre, sucrose, coagulated colloids, albuminoides, waxy material and other insoluble solids. Physically, it is a soft spongy, lightweight material of dark brown to black colour generally containing from 55 to 70 per cent moisture as it comes out from

FIG. 1.

FLOW DIAGRAM OF PRESS MUD CAKE PRODUCTION



the sugar factory (loc. cit). Press mud cake is a rich source of organic carbon, N, P_2O_5 and K_2O. It contains 1 to 2 per cent N, 2 to 4 per cent P_2O_5 and 0.5 to 1.5 per cent K_2O. Now a days, in shortage of inorganic fertilizers, it can be best utilized in sugarcane manuring.

The production of sugarcane in India is about 181.63 million tonnes and if all the cane is crushed in sugar factory, it is estimated that about 4.54 to 5.45 million tonnes of press mud cake will available every year. This can mostly meet the organic manure requirements as well as the nutritional requirements of the sugarcane crop. Bawasakar, et al. (1978) pointed out that with 1.00 per cent total nitrogen, 3.00 per cent P_2O_5 and 1.5 per cent K_2O; 3 million tonnes of press mud cake would provide 30,000 tonnes of nitrogen; 90,000 tonnes of phosphoric acid and 45,000 tonnes of potash. The use of this indigenous by product can act as a substitute for artificial nitrogenous, phosphatic and potassic fertilizers; can thus save a large amount of foreign exchange which would be required to be spent on the imported inputs.

There are number of reports regarding the utilization of press mud cake as organic manure. However, these are not field observations supported by systematic basic studies. Progressive farmers are also using it as a source of organic matter and sugar factories are selling it at nominal price. It is

essential to ascertain its quality during crushing period and the variation in chemical composition as a consequence of different locations.

The experiments conducted at Jagadhari Zones at Bandhanpuri (Anon. 1956-57) showed the beneficial effects of application of press mud cake on yield of sugarcane. Misra (1968) noticed the increased yield of sugarcane and sugar with the incorporation of press mud cake. Golden, et al. (1959) and Patil (1975) also observed the similar results in their studies.

Number of workers reported beneficial effects of organic manures on one or the other succeeding crops and on soil properties. However, the PMC has not been studied considerably in this respect. Hashimoto (1971) from Japan observed the beneficial effect of FYM on growth and yield of subsequent crops of wheat and potato and on availability of nutrients. Boyd et al., (1972) from Rothamsted Experimental Station (U.K.) studied the residual effect of four forms of P fertilizer, Bawasakar (1976) observed the residual effect of penicillin mycelium residue on growth and yield of dry matter of maize. Yelwande (1976) also reported the encouraging beneficial residual effects of edible and non-edible cakes and fertilizers on yield of gram and on soil fertility. Few workers reported the residual effect of press mud cake on the agronomic aspects of sugarcane. However, references on systematic studies

on the residual effect of the incorporation of press mud cake on soil are scare.

The experiment conducted at Sugarcane Research Station, Padegaon (Anon. 1977) on Adsali cane with CO-740 showed that the press mud cake was equally efficient to fertilizers. The treatments of PMC increased the yield as well as net profit over recommended dose of inorganic fertilizers (Patil, et al. 1978). It was also further reported that availability of N, P_2O_5, K_2O and uptake of nutrients were also increased as a consequence of incorporation of press mud cake (Bawasakar, et al. 1978) due to high nutrients supplied through PMC. It was further felt necessary to study the residual effect of press mud cake on succeeding crop of sugarcane.

With this background in view the detail investigation with the following objectives were undertaken at Sugarcane Research Station, Padegaon during 1977-79.

1. To study the quality of press mud cake produced from various sugar factories in Maharashtra in respect of nutrient status.

2. To study the residual effect of application of press mud cake on yield and quality of sugarcane and uptake of nutrients.

3. To study the effect of press mud cake on soil properties under laboratory and field conditions.

The results of these investigations are compiled, discussed and embodied in this report.

CHAPTER 2

REVIEW OF LITERATURE

CHAPTER 2

R E V I E W O F L I T E R A T U R E

The present strategy of fertilizers has made the farmer to make the use of organic and inorganic sources of manuring more judiciously with a view to obtain profitable income by reducing the major cost incurred on these inputs. Sugarcane being a long duration crop as compared to other food, steple and fibre crops the nutritional requirements of sugarcane are high. These requirements are to be met by impregnating the soil with organic manures and inorganic fertilizers without impairing the physico-biological fertility of soil in order to obtain sustained production of sugarcane yield.

Because of intensive agriculture, the demand of the organic manures is increasing from time and on. The present sources of organic manures like F.Y.M., farm compost are found to be inadequate to meet these requirements. Hence, it has necessiated to explore other alternate sources of organics. These may be agricultural wastes and other agro-industrial wastes.

Considering the substantive acrage under sugarcane cultivation and increasing percentage of sugarcane utilized for crushing by the sugar industry; it has obviously given rise to large amount of filter press mud commonly known as Press Mud Cake (PMC) which is a waste product of sugar

industry where it has become a problem of disposal. The recent awareness of the utilization of this waste product in sugarcane culture has cultivated interest amongst the cane cultivators.

Different aspects of organics including FYM, compost, edible and non-edible cakes, farm waste, industrial wastes etc. have been reviewed by several workers (Kallel, 1902; Waksman, 1938; Bremner, 1951, 1954, 1956; Broadbent, 1953, 1955; Dawson, 1956; Alexander, 1961; Reheja and Mann, 1961; Dubach and Mehta, 1963; Bawasakar, 1966; Raheja, 1966; Pelbeck, 1965; Zende, 1970; Gaur, et al. 1971; Narkhede and Deshpande, 1974; Deshmane and Sawant, 1975; Vimal, 1975; Zende, 1975; Patil, 1975; Yelwande, 1977). They have found that the addition of these organicsare beneficial towards the soil fertility and productivity. They have also useful for maintaining the physical status of soil.

The PMC being a waste product of recent origin, few efforts have been made in this direction to study its effects on soil properties, yield and quality of cane and its residual effects. In this chapter, an effort is made to review the work on PMC under different topics as mentioned below.

2.1 Production

2.2 Availability

2.3 Chemical composition of PMC

2.4 Potential uses

2.4.1 Industrial uses

2.4.2 Agricultural value - i) as nutrient source
ii) as amendment
(influencing the following)

2.4.2.1 Cane yield

2.4.2.2 Quality of cane juice

2.4.2.3 Uptake of nutrients

2.4.2.4 Availability of nutrients

2.4.2.5 Physico-chemical properties

2.4.2.6 Biological properties

2.4.2.7 Residual effect

2.4.2.8 As soil amendment.

2.1 Production :

Ramos (1961) reported that the quantity of filter cake produced depend upon the type of filter presses used in the filtration process. The studies carried out by him in Puerto Rico with new filtration process showed that 3.78 tons of filter cake was produced per 100 tons of sugarcane.

Bangur (1976) reported that 3 million tons of press mud cake was produced annually in India. Patil (1976) reported that a factory produces 2.5 to 3.0 metric tons of press mud cake when 100 tons of sugarcane is crushed.

2.2 Availability :

Of the total sugarcane production in India, Uttar Pradesh

produced 44.46 per cent of sugarcane being first and Maharashtra State produced 12.84 per cent being second in India (Anon. 1978). Maharashtra State was the first in sugar production followed by Uttar Pradesh. According to the estimates of press mud cake production during 1977-78; these two States were the first two States produced 20.19 to 24.23 lakh tons (Uttar Pradesh , and 5.83 to 7.00 lakh tons (Maharashtra State) of PMC. India produced 4.54 million tons to 5.45 million tons of PMC. Statewise availability is reported in Appendix I.

The number of sugar factories in operation; sugar, mollasses and estimated press mud cake and baggasse production in India and Maharashtra during 1977-78 are given in Appendix II. PMC production in India and Maharashtra on 2.5 to 3.0 per cent estimation are 16.82 to 20.19 and 4.81 to 5.77 lakh tons per year.

2.3 Chemical composition of press mud cake (PMC) :

The main factors responsible for the chemical composition of PMC produced from the sugar factory depend upon the variety of cane, climate and soil (Haines, 1961). Another important factor is the process adopted for clarification of cane juice. There are mainly two process of manufacture of sugar viz., Carbonation and Sulphitation (Spencer, et al., 1905). In Maharashtra State almost all the sugar factories are adopting the sulphitation process. The press mud produced from sulphitation process contains more sulphate and carbonation contains more of lime (Garg, et al., 1971).

Agarwal (1951) indicated that as the sugarcane is a highly exhaustive crop, it is logical to return as much plant food as possible from sugarcane after sugar manufacture back to the land to maintain soil fertility. The following table shows how the three major plant nutrients of sugarcane are disposed off in the factory.

Nutrient	Percentage disposal of the nutrient			
	Raw sugar	Bagasse	Molasses	Mud
1. Nitrogen	3	56	31	10
2. Phosphoric acid	2	39	24	35
3. Potash	2	23	74	1

It will be seen that over 15 per cent of the major foods contained in the crop find their way to the PMC with high concentration of phosphate.

Barton (1927) while working on press mud cake for fodder reported that apart from the impurities such as sand, soil and cane fibre, the press cake which varies little in its composition throughout Queensland, contained colloids such as cane wax, phosphate of lime, albuminoids and proteins.

Samuels, et al. (1955) also reported that filter cake from Puerto Rico contained N-2.12, P-1.21, K-0.37,

Ca-2.38, Mg-2.29 per cent as a major nutrients while micro-nutrients were Mn-1000 ppm, Fe-7300 ppm and B-30 ppm.

Chopra (1959) worked out the composition of press mud cake at Mushere in Bihar and observed that it contained CaO-8.0, P_2O_5-3.0, K_2O-1.0 and N-1.0 per cent.

Pandey (1966) found that sulphitation factories' press mud contained varying amount of wax (8 % to 20 %) depending upon the type of soil and variety of cane. Press mud as it comes out of factory contained about 65 to 70 per cent moisture. Haines (1961) also observed that fresh PMC contained 55 to 70 per cent moisture when it comes out from the factory.

Bawasakar (1968) observed that since PMC contained appreciable quantity of organic carbon and NPK, it could serve as a good substitute to conventional sources of organic bulky manures. It contained 17.64 per cent organic carbon, 11.69 per cent humus, 0.73 per cent total nitrogen, 1.05 per cent P_2O_5, 1.38 per cent total K_2O, 3.33 per cent Ca, 1.71 per cent Mg and 66.26 per cent humified matter.

Alexander (1972) reported that the filter press mud from South African sugar factories contained N-1.69, P-0.90, K-0.27, Ca-1.84, Mg-0.37 and S-0.19 per cent; Mn-898, Cu-52 and Zn-69 ppm.

Da Gloria, et al. (1972) studied the composition of press mud cake alongwith vinase and factory waste water over

a period of four months and observed that N and Ca were the main nutrients of filter cake, while vinase was the best source of K and sugar factory waste water was poor in all nutrients. They (1974) also analysed 22 composite filter cake samples out of 264 samples collected from single factory in Brazil and observed that N from filter cake contained was a major macronutrients in protein form. Out of the total present in PMC, about 30 per cent was in the organic form. Iron was the most common micronutrient followed by Mn, Zn, Cu and Mo.

Experience in Holland and Beljium (Anon., 1974) showed the merits of carbonation mud as a fertilizer. It was observed that best dried to about 70 per cent dry solids, 10 tons of carbonation mud contained 6500 kg $CaCO_3$, 110 kg P_2O_5, 30 kg N and 700 kg organic matter.

Mesbahul, et al. (1974) studied the composition of press mud cake from Rajshah Sugar Mills (Haryana) in Bangladesh found that it contained 1.14 per cent N, 2.16 per cent P, 0.30 per cent K, 20 per cent C, 2.88 per cent Ca, 0.27 per cent S and 0.03 per cent Mn indicating that it was the rich source of P and Ca.

Patil (1975) at the Regional Sugarcane Research Station, Kolhapur observed that the press mud cake contained maximum amount of N i.e. 2.03 per cent followed by P_2O_5 - 1.95

per cent and K_2O-0.71 per cent. He also reported that it contained 20.55 per cent organic carbon.

Prasad (1976) observed that the filter press mud from Trinidad having pH 9.05 contained N-1.71 per cent, P-0.45, K-0.48, Ca-1.97 per cent, Mg-0.70 per cent and Mn-2450 ppm, Fe-5000 ppm, B-22 ppm, Cu-28 ppm, Zn-224 ppm, Al-5235 ppm and Mo-14.9 ppm.

The press mud cake used in the experimental fields at Sugarcane Research Station, Padegaon (Anon. 1977) contained N-1.20 per cent, P_2O_5-3.88 per cent and K_2O-1.46 per cent and observed that PMC was rich source of N, K_2O and especially of P_2O_5.

Patil, et al. (1978) observed that 12.5 tons of press mud cake supplied 150 kg N, 485 kg P_2O_5 and 182 kg K_2O indicating that PMC as a rich source of P_2O_5.

2.4 Potential uses :

Press mud cake (Filter cake) has large potentiality in its use. Though its agricultural value as a nutrient source and as an amendment is well known; the industrial uses can not be neglected. The cane wax, fats and resin can be extracted from the filter cake. It can be used in the production of sinters and pallets from iron ore-fines in the steel industries, recovery of lime from it, a cattle feed, replacement of feed lime in pig and brioler chicken rations, preparing bio-gas etc. which are reviewed as under.

2.4.1 Industrial uses :

Seshadri, et al. (1968) described the tests in which carbonation mud as substituted for lime stone in the production of sinters and pallets from iron ore-fines suitable for use as blast furnace charge in steel manufacture.

Navia (1969) in a study of the contribution of filter cake which can be made to growing need for fats in Cuba, reviewed the literature on the constitution of cane wax extracted from filter cake and various processes for extraction of fats from the crude wax and their yields, fractionation of fats and pointed out that the refined hard wax and resin would be the byproducts of great value.

Markus (1971) pointed out that replacement of feed lime in pig and broiler chicken rations with dried carbonation mud (6 %) of total feed led to greater weight gains, while more and somewhat heavier eggs were laid by hens.

Vernois (1971) reported that lime could be recovered from filter cake by precipitating organic matter from prelimed juice by adding 0.3 per cent CaO and gassing with CO_2 and settling.

Krishna Murthy (1976) reported that in addition to agricultural value filter mud cake can be used for extraction of wax as well as it can be used in preparing bio-gas like gobargas.

2.4.2 Agricultural value :

2.4.2.1 Effect of press mud cake on yield contributing parameters and yield of cane :

Havnur, et al. (1954) reported the phosphate response in F type of soil in increasing the cane yield by addition of 150 lb of P_2O_5/acre in the estate of Phaltan Sugar Works Ltd. There was no response in B type soil.

Response of sugarcane to graded doses of phosphatic and potassic fertilization was studied by Havangi, et al.(1956) by taking scattering trials on the basis of the nutrients in the soil, on the estates of sugar factories during 1954-56. They observed the following effects.

1. Variations of nutrients in the soils exhibited varying response to the application of phosphate and potash.

2. The combined effect of phosphate and potash was found to be beneficial in soils deficient in available P_2O_5 whereas the application of potash alone gave good results in soils rich in phosphate. As a result of phosphate and potash application, tillers were increased while phosphate application hastened the maturity of cane.

The effect of application of organic manures in the form of press mud cake was studied at Jagadhari factory zones at Bandhanpuri (Anon. 1956-57) and reported that the

application of the press mud cake at the rate of 5 tons and 10 tons per hectare gave 5.80 tons and 11.60 tons more yield, respectively over control indicating that the higher dose of press mud cake was better in increasing the yield of sugarcane.

The effect of inorganic and organic nitrogen on germination and yield of sugarcane was studied by Muthuswamy (1958) at Purtabpore in Bihar during 1956-57 and 1957-58 using different proportions of organic and inorganic N as castor cake and ammoniumsulphate. The observation indicated that germination was adversely affected by the application of ammonium sulphate alone or a mixture containing high proportion of ammonium sulphate in soils with low moisture index and retarded germination had direct bearing in tillering millable canes and yield.

Somasundaram, et al. (1959) at Sakkarnagar observed the beneficial effects of press mud cake on yield of sugarcane and suggested that press mud can replace oil cakes satisfactorily.

Misra (1968) studied the rational approach to the problem of organic Vs inorganic manuring at Shahajahanpur and Muzaffarnagar during 1938-42 and 1946-50 and reported that average response of organic manures and ammonium sulphate in muds of cane per pound of nitrogen applied in the order of their merit as Ammonium sulphate (1.78) > Castor Cake (1.68) > Press mud (1.18) > Farm compost and Town compost (0.96) > FYM (0.49).

The investigation on a manurial value of factory byproduct in cane culture under wet land conditions in Vadapathi Mangalam Sugar Factory Zone was studied by Rao, et al. (1970) and observed that filter press mud applied at the rate of 10 tons per acre as a basal feed in trench before planting of Co.419 and Co. 449 cane increased the cane yield by about 3 tons and sugar yield by about 1 ton per acre as compared to the control which received 200 lbs of nitrogen as top dressing. For higher yields 10 tons of filter cake plus 200 lbs N per acre was found to be economical.

The yield increases of sugarcane as a result of filter press mud application have been reported by Samuels, et al. (1955), Alexander (1972) and Prasad (1976).

The effect of N application on cane (Co.740) and yields in Maharashtra were studied by Shingarey, et al. (1972). It was reported that the optimum rates varied for maximum cane yield, maximum sugar yields and maximum profits. Application of N in excess of 480 lb/acre decreased the total cane yield, while N in excess of 427 lb/acre reduced the total yield of sugar.

The influence of organic and inorganic nitrogen on yield and quality of juice was studied by Singh and Singh (1973) and they observed that when sugarcane were supplied with 134 kg N per hectare in organic as well as inorganic form, the inorganic

form, (through S/A) gave higher yield of cane (73.54 t/ha). The ammonium sulphate proved most effective in increasing the yield of cane followed by Castor cake, press mud, groundnut cake and urinated earth.

De Robillard, et al. (1974) studied the effect of quantity of seed cane, filter cake and irrigation on yield of sugarcane and reported that addition of filter cake in the furrows increased the tillering and yields in all cases, maximum response was obtained under rainy condition.

In the pot culture experimental conducted as Tongi in Bangladesh to compare press mud and triple super phosphate (TSP); as a source of phospharous for rice and sugarcane Mesbahul, et al. (1974) observed that 157 kg P_2O_5/ha from 3202 kg of press mud gave 'A' value of 224 kg P_2O_5/ha and was, therefore, equivalent to 224 kg P_2O_5/ha from 448 kg of TSP. Similarly, under pot culture experiment with sugarcane indicated that 3208 kg of press mud was equivalent to 502 kg of TSP. Results of green house and field trials demonstrated that dry matter, yield, phospharus uptake and straw yield of rice were comparable for press mud and TSP.

Patil (1975) at Regional Sugarcane Research Station, Kolhapur observed the linear response of cane yield to application of increased doses of press mud cake. With the increased doses of PMC from 7.41 to 18.52 t/ha, the increase in yields

were obtained from 94.27 to 106.93 t/ha in first season and 91.38 to 105.00 t/ha in second season.

While reviewing the work of sugarcane manuring in U.P. Kumar (1976) observed that sulphitation press mud had given average increase in yields of 14 to 45 per cent at Shahajahanpur. In the experiments carried out from 1945-46 to 1949-50 the press mud cake increased the cane yields by 28 per cent as compared to 70 per cent by ammonium sulphate. It was further observed that about 200 mds of press mud cake per acre was considered to be sufficient for sugarcane crop at Muzaffarnagar.

Prasad (1976) studied the response of sugarcane to filter press mud and N, P and K fertilizers on yield and sucrose content of cane at Trininad and observed that out of eight field experiments, filter press mud increased the yield of cane in six experiments including residual filter press mud experiment. It was recommended that

1. No P fertilizer needs to be applied where FPM was applied in quantities as high as 20 metric tons/ha on dry weight basis.

2. Ratoons following plant cane may need P fertilizer but possibly in much smaller amounts than normal, particularly, if FPM rates were high.

The response of sugarcane to press mud cake and inorganic fertilizers was also studied by Patil, et al. (1978) at

Sugarcane Research Station, Padegaon on variety Co.740 (Adsali) and found that incorporation of PMC in soil before planting of cane had beneficial effect on yield contributing parameter and yield of cane. They observed maximum germination percentage (87.66 %), maximum average number of tillers per hill (2.16) and maximum plant population (107600) per hectare when 18.5 t/ha of press mud cake was applied. Though the yield was higher in the case of recommended dose of N,P,K, the press mud cake treatments produced economical profitable yields. Increase in net profit to the extent of 25.26 per cent over recommended dose was produced by application of 12.5 t/ha of press mud cake in combination with 250 kg N through sulphate of ammonia. The depressing effect of higher doses of PMC above 18.5 t/ha was observed on the yield of cane.

Number of workers thus investigated some of the observation on the yield contributing parameter and on the yield of sugarcane. Further, utilization of factory press mud cake as a organic manure alone or incombination with inorganic fertilizer to sugarcane were reported by Chinna (1957), Soman (1957), Soman, et al. (1959), Chopra (1959), Chacravarti (1967), Golden, et al. (1972) and Krishna Murthy (1976). They also reported the method of preparation of compost from press mud cake and the method of application to the sugarcane fields.

2.4.2.2 Effect of press mud cake on quality of cane juice :

The quality of cane plays an important role in sugar industries. Climate, soil conditions, varieties, nutrition and other factors like preharvest sprays of chemicals, damaged and dead cane, pests and diseases lodged canes etc. affect the quality of cane (Kakade, 1971). Amongst the nutritional aspects of the juice, N, P and K content are important. Fertilization effects are varied in creating non-utilization of starch into sucrose and increased formation of amino acids and other non-sugar components, all leading to poor clarification and recovery.

The proportion of N and P_2O_5 present in juice decide the quality of juice. Kadrekar (1955), Chinchorkar (1970) and Kakade (1971) pointed out that the N/P_2O_5 ratio in juice had direct influence on quality of juice and it was the good guide of purity coefficient. When it was below 1.5, the juice was supposed to be of better quality, while N/P_2O_5 ratio in juice beyond 1.5 adversely affected the juice quality in cane. Brix and pol reading also decide the quantity of sugar produced from the cane. The phosphate content of juice helped in elimination of colloids during processing and minimum of 300 mg of P_2O_5 per litre of juice were noted by Parthasarathi (1972) as minimum for good quality of juice.

Kadrekar (1955) in his preliminary investigations to identify the causes of high recovery of sugar observed that low

content of N and low mineral matter (ash) content in juice were responsible for high recovery of sugar in cane grown in Kolhapur region. Further, he observed that high ash content in cane juice at Phaltan Sugar Works was due to more absorption of K_2O and high nitrogen content in juice as a consequence of heavy nitrogenous manuring followed in that area. It was further observed that the N/P_2O_5 ratio in juice had great influence of recovery of sugar. Peculiar climatic conditions in the Kolhapur tract was found to lower the salt contents of the soil which in turn became a favourable factor in giving a better quality juice.

Scattered trials carried out on the estates of sugar factories during 1954-56 included grades doses of phosphate and potash by Havangi, et al. (1956) indicated that phosphate application hastened the maturity of cane and slightly increased the sucrose content, the effect of potash on purity of juice, however, was more conspicuous.

Gupta and Prasad (1968) studied the effect of N and P_2O_5 application to cane crop and they reported that increase in doses of nitrogen decreased the P_2O_5 and K_2O and ash content in juice and increased N/P_2O_5 ratio of juice indicating nitrogen content of juice was inversely related with P_2O_5 and K_2O and ash content of juice.

Singh and Singh (1973) while studying the effects of organic and inorganic nitrogen on cane quality observed that

the juice quality was adversely affected by application 134 kg N/ha through ammonium sulphate. The same dose of N through caster cake, groundnut cake and press mud cake produced the higher sucrose percentage over the ammonium sulphate. Sucrose percentage was in the order of Press mud cake (14.96) > Ground nut cake (14.83) > Castor cake (14.66) > ammonium sulphate (14.64). Further, they found that in spite of the maximum adverse effect of ammonium sulphate on sucrose and on purity coefficient of juice, it gave the highest production of sugar per hectare. The next in order of merit were press mud cake, castor cake, urinated earth, municipal compost and farm yard manure.

Effect of nitrogen, phosphate and potash fertilization on yield and quality of cane was studied by Ojha, et al. (1974). It was observed that application of N increased the cane yield but adversely affected the juice quality, P application gave inconsistant results while K did not have any effect on yield or juice quality.

Patil (1975) at Regional Sugarcane Research Station, Kolhapur observed that increased doses of press mud cake from 11.11, 14.82 and 18.52 t/ha had significantly increased CCS t/ha.

Prasad (1976) reported that incorporation of filter press mud increased the percentage of sucrose of the cane in the experiment conducted at Waterloo. Similar effect was

observed in the first ratoon in the Felicite and Mc Bean ratoon experiment in Trininad. It had been, further, observed that P, when applied to P-deficient soil, improved the quality of cane. In the experiment at Waterloo, increasing both N and P gave better quality of juice plant cane. An inverse relationship between N level and quality was well documented. K had no significant effect on sugarcane quality.

* Patil, et al. (1978) studied the response of sugarcane to press mud cake at Sugarcane Research Station, Padegaon and they found very interesting results. It was observed that the sucrose per cent was higher in all the press mud cake treatments than that of recommended dose of fertilizer for Maharashtra State (400 kg N plus 170 kg P_2O_5 plus 170 kg K_2O/ha to Adsali cane. Maximum sucrose (20.26 %) and purity coefficient (94.85 %) was given by incorporation of press mud cake at the rate of 12.5 t/ha plus 250 kg N through sulphate of ammonia. Sulphate of ammonia adversely affected the sucrose and purity but maximum commercial cane sugar (17.41 t/ha) was obtained in the case of the recommended dose. Lowest N/P_2O_5 ratio (1.1) was observed in the treatment of 18.5 t/ha followed by 12.5 t/ha of press mud cake.

2.4.2.3 Effect of press mud cake on uptake of nutrients :

The nutritional requirements of sugarcane were reported to be 1 to 1.5 kg N, 0.5 to 0.75 kg P_2O_5 and 3 to 4 kg

K_2O per ton (Arakeri, 1956). The higher application of doses of N and P to soil does not mean higher uptake of these nutrients but the uptake will depend on N/P ratio, sugarcane variety and soil type (Chitale, 1956).

Verma (1951) studied the uptake of nitrogen in sugarcane and reported that in leaf sheath and stem nitrogen percentage was increased with increasing doses of nitrogen. The differences of uptake were more pronounced in leaf and stem than in sheath. The total uptake of N in cane for 40, 100 and 200 lb N was as 48.54, 70.94 and 88.70 lbs, respectively.

Rege, et al. (1952) studied biochemical mineral nutrition of sugarcane at Sugarcane Research Station, Padegaon and they reported that a decline of sugar recovery in cane under heavy manuring with nitrogen was mainly due to imbalanced nutrient supply. The results showed the ratio of fertilization with N : P_2O_5 above, 2 : 1 was conductive for better tillering, maturity and sugar recovery. Similarly highest proportion of P showed accelerating absorption of N P K during active growth phase with early ceasation of growth.

Lad, et al. (1954) carried out the manurial investigation on sugarcane at Padegaon and observed that with the application of 20 tons FYM per hectare plus 300 kg N per hectare to suru (planted in January) sugarcane crop. The uptake of N, P and K by sugarcane was continued upto October

and November. Half of the added nitrogen and K_2O and 15 to 20 per cent P_2O_5 were absorbed by the cane plant during the first 6 months crop age indicating the need of these nutrients in the early stages of sugarcane growth.

Chopra (1959) quoted the data worked out by Mukharji and Verma on uptake of nutrients by the sugarcane crop. He stated that 30 tons (800 mds) of cane stalks per acre, weighing about 40 tons (1100 mds) including leaves and tops, removed the following approximate quantities of nutrients in pounds :-

Nitrogen-105, Phosphoric acid-63, Potash-315, Lime-75, Sulphuric acid-22, Magnesia-37, Silica-322, Ferric oxide-42, Aluminium-14, Chloride-16, Titanic acid-8 and Manganese oxide-2

The absorption of CaO was not found to be influenced by phosphatic manuring, however, P and K absorption was comparatively depressed. Gupta and Sen (1962) also observed the maximum absorption when nitrogen and P_2O_5 were applied in 2:1 or 3:1 ratio. They claimed that uptake of nitrogen and P_2O_5 increased when applied together.

Singh (1974) studied the nitrogen nutrition of sugarcane through different organic sources in comparison with ammonium sulphate and observed that amongst all the sources ammonium sulphate proved most efficient in nitrogen feeding

for leaf (1.539 %) throughout the whole life cycle of crop followed by press mud cake, compost, caster cake and groundnut cake. Urinated earth and F.Y.M. proved least efficient in N nutrition.

Patil (1975) while studying the effect of factory press mud cake at Kolhapur observed that increase doses of press mud cake, increased the uptake of N, P and K. He observed the linear response for uptake of these nutrients. Highest content of K in cane was observed in the treatment of application of 18.5 t/ha of press mud cake.

Prasad (1976) studied the effect of filter press mud on plant composition at Trininad and observed that the nutritional value of N in filter press mud was uncertain, although there were indications that it could supply some N, when it was incorporated in to soil for decompose for few months. The phosphorus in the filter press mud was found to be more effective than triple super phosphate in increasing leaf P at rates tested. Filter press cake also increased K, Ca, Mg in leaf but reduced leaf Al in four experiments, leaf Zn and Fe in two experiments and leaf Mn in one experiment.

Bawasakar, et al. (1978) studied the nutritional bhaviour of press mud cake and reported that the uptake of nitrogen increased to grand growth stage and was then reduced at harvest. Inorganic fertilizer treatment appeared to increase

the contents of N over press mud cake treatments. Linear rise in the content of total P_2O_5 was observed throughout the growth phases of sugarcane. PMC treatments were better supplier of P_2O_5. Total K_2O content in sugarcane was increased at grand growth stage and then reduced at harvest. Further, it was reported that maximum (1.27 kg/t) uptake was noticed in PMC at the rate of 25.0 t/ha and minimum was in recommended NPK dose. Positive co-relation between the levels of PMC and the uptake of P_2O_5 was observed which was evident due to higher supply of P_2O_5 through increased doses of PMC. Increase uptake of K_2O was found in 18.5 t/ha of PMC followed by 25.0 t/ha of PMC.

2.4.2.4 Effect of press mud cake on availability of nutrients

The availability of nutrients in soil depends on the type of manure and fertilizer, their proportion of application, the organic matter content of soil, soil type, moisture, temperature aeration, soil reaction and soil microbes present in soil complex. The effects of filter press mud and inorganic fertilizers on availability of nutrients were studied by number of research workers.

Reactions between press mud cake from usual double sulphitation process and from Saha's process with Kanpur and Kanhegaon sugarcane growing soil, at different moisture levels were studied by Sen and Mehra (1956) and observed that the

release of available N and P_2O_5 of two press muds was optimum at 15 per cent moisture level. The rate of their release was greater in new process press mud cake.

In the studies on early availability of N in soils of Gola Gokarnath Zone, Sinha (1961) also noted that press mud cake applied in different proportions with sulphate of ammonia showed more satisfactory nitrification.

Chan (1970) pointed out that the soil incubation method was the best method available for determining the availability of N, since the biological mineralization of soil organic N controlled the N supply to the soils, which were extremely variable. He found that the production capacity of mineralizable N for sugarcane in Taiwan soils was weak. The amount of mineralizable N was closely related to the amount of organic carbon in the soil. Most of the mineralizable N was produced one week after incubation commenced.

Ahmed, et al. (1971) reported that by addition of dried blood to soil, the availability of P, K and Fe was increased especially with submerged condition of soil. Further, they noted that the mineralization of blood increased with increase in incubation time. Submerged soil condition favoured the release of NH_4^+-N and field moisture conditions favoured NO_3^--N accumulation.

Prasad (1974) in the laboratory incubation studies

observed that the application of filter press mud to the soil (equivalent to 40 and 80 metric tons/ha on dry weight basis) increased the availability of P, K, Ca, Mg and Zn as evidenced by the soil test.

Schreven and Sieban (1972) incubated four soils for 10 weeks at 29°C with 0 or 100 ppm N as $(NH_4)_2 SO_4$ at 65 per cent of water holding capacity, either fresh or after water logged storage for 1 to 4 month and noted that NH_4^+-N content increased with the length of storage. During incubation NH_4^+-N was nitrifyed in all soils; however, nitrification was delayed for one or more weeks in some of the soils and was further retarded by $(NH_4)_2 SO_4$. Water logged soils increased N mineralization on subsequent incubation and decreased the amount of NH_4^+-N fixed after addition of $(NH_4)_2 SO_4$. The number of nitrifying organisms decreased after water logging for 2, 3 and 4 months and remained fewer during incubation compared to untreated soil.

Guirgus and Saber (1972) investigated the effect of the organic matter on calcareous soils at National Research Centre, Dokki, Cairo by supplying 1 to 3 per cent dried sewage sludge to calcareous soils and observed the increased mineralization rate of organic N with increasing $CaCO_3$ content. N fixation was inhibited by a high $CaCO_3$ but incorporation of large amount of organic matter counteracted this inhibitory effects.

2.4.2.5 Effect of press mud cake on physico-chemical properties of soil :

The utilization of factory waste products from view point of soil manure and soil conditioner was studied by Puranik (1945) and he observed that press mud cake was a rich source of organic matter, it helped in adding humus in the soil to improve soil structure and aggregation. Similar results were recorded by Bawasakar (1966). He observed that when the manures and waste materials were applied at the rate of 25 cart loads per hectare at field conditions, the soil aggregation was more under the press mud cake. The aggregation in press mud cake treatment was recorded to the extent of 78.70 per cent for the fraction more than 0.25 mm size, but under pot culture conditions tamarind seed powder, produced maximum aggregation. Krillium, pig dung and press mud were the next in order of merit.

Lad and Patel (1954) studied the long range effects of compost, on sugarcane soils and reported that incorporation of compost at the rate of 20 t per hectare improved the soil fertility than that of control.

The report of the Export Committee of manures and fertilizers (Anon. 1953) as quoted by Singh and Sinha (1959) showed that at Mysore a mixture of groundnut cake and sulphate of ammonia was found to be better than ammonium

sulphate alone. The use of organic manures and fertilizers gave the optimum results both in long and short term planning for improving soil productivity and maintaining soil fertility under Indian conditions.

Sen (1954) studied the chemical and physico-chemical reactions of the soil when the molasses and press mud from sulphitation and carbonation sugar factories were added in sugarcane growing fields and observed that :

a) the colloidal complex of soil was enhanced with both types of molasses,

b) exchangeable Ca increased at the cost of exchangeable Na ions in soils treated with sulphitation byproduct,

c) hydrogen ion concentration of the soil treated with sulphitation products was lowered.

d) total nitrogen increased in the soil treated with sulphitation molasses or press mud cake on long exposure.

Further, he reported that by application of 5-6 tones of press mud cake per hectare as manure in bulk quantities lowered the soil pH from 8.69 to 8.50.

Biswas, et al. (1964) studied the effect of organic matter on physical properties of soil in permanent manurial experiments and reported that the plot receiving continuous application of dung, rape cake or green manure in combination

with super phosphate depicted higher percentage of water stable aggregates of more than 0.25 mm size as compared to unmanured plots and the plots treated with inorganic material.

Prasad (1974) reported the effect of application of filter press mud at Trininad to sugarcane soils and observed the spectacular increase in available P but he further confirmed that the same lead to P-induced Zn and Fe deficiency in sugarcane.

Hagihara (1974) studied the effect of cane trash mulching and filter cake incorporation on sugarcane in Hawaii essentially as organic matter like other organics. It was observed that organic matter added benefitted cropping by improving the physical condition of poor soil. These materials released the plant nutrients from the soil, promoted granulation of heavy and sticky soil, increased water holding capacity and promoted energy for micro-organisms leading to increased productivity of sugarcane soils. Further, he evaluated the nutrient contribution of filter cake in soil, after incorporating a mixture of equivalent to 25 tons per acre of the wet material to a depth of a foot of soil and after a week of moist storage and obtained the following changes in nutrient level.

i) Phosphorus and potassium levels increased which reduced the fertilizer recommendation by approximately 50 lbs/acre.

ii) Ca and Mg levels were also increased.

iii) N levels, however, decreased.

The report on fertilizer and soil fertility practices for sugarcane production in Louisiana (Anon. 1975) showed that no micronutrients were required when the application of lime, rock phosphate and/or filter cake were given for three Louisiana cane growing areas due to improvement of soil fertility.

Golden (1975) in application of filter press mud at the rate of 80 tons/acre in Louisiana observed that there was increase in N and extractable P, K, Ca and Mg without affecting the pH of the soil. Similar observations were made at the Regional Sugarcane Research Station, Kolhapur by Patil (1975).

Yelawande (1977) studied the effects of fertilizers and different edible and non-edible oil cakes on soil chemical properties and observed that the oil cakes were better than fertilizers for maintaining the soil chemical properties.

Bawasakar, et al. (1978) at Padegaon reported that incorporation of press mud cake increased the carbon content of soil, availability of P_2O_5 and K_2O with advance in age of crop. While NO_3^--N content of soil was increased in inorganic fertilizer treatments only.

2.4.2.6 Effect of press mud cake on biological properties of soil :

Preliminary studies conducted by Albuquarque and Patel (1955) to investigate the different manurial treat-

ments on microbial population in B type of soils in January, April and in September observed that fungi population was negligible and that of bacteria and actinomycetes predominated. F.Y.M. and Safflower cake induced greater activities of micro-organisms as compared to other fertilizers and manures. Microbial population was found to be depressed by sulphate of ammonia and sodium nitrate. Superphosphate showed beneficial effect on the total population but its effect was particularly seen on non-symbiotic nitrogen fixing organisms. Sulphate of potash and muriate of potash had not shown any specific difference in their effect. Similar observations were made by Chopra (1959) and found continuous use of concentrated nitrogen manures like $(NH_4)_2 SO_4$ not only made the soil acidic but also decreased the total number of soil micro-organisms and hampered the N fixation.

Roth (1971) recorded varying responses of cane to filter cake. He studied the different stages of decomposition of filter cake and observed that the invesion of spore forming bacilli and actinomycetes in latter stages of decomposition. Micro-organisms were shown to have a positive influence on soil aggregate stability.

The relationship between micro-organisms and yield decline in Louisiana was studied by Yang (1971). He observed no association between number of fungi, bacteria and

actinomycetes and the amount of organic matter or moisture levels of soil.

Guirgus and Saber (1972) reported that the effect of organic matter on soil micro-organisms in calcareous soils and found that there was increase in the counts of bacteria, streptomycetes, azotobacter and denitrifiers during incubation was inversely proportional to the $CaCO_3$ of soil.

2.4.2.7 Residual effect of press mud cake on yield and soil properties :

Mill mud (PMC) proved to be an effective fertilizer and soil improver especially in phosphate deficient soils and an application of 70-80 tons of mill mud to ratoons supplied more than enough phosphorus for next crop, nitrogen equivalent to at least 3 cwt. Sulphate of ammonia, improvement in soil tilth and a big increase in cane yield to the extent of 15 tons per acre (Anon. 1969).

Aloma (1970) presented the results of filter mud as a fertilizer on grey and brown plastic soils on the north coast of Oriente province and reported that yield increase upto 30 per cent on application of 100 metric tons/ha. He also observed other benefits of residual effect of mud over five years and reduction of labour in grass removal.

Hashimoto (1971) in Japan studied the long term

application of FYM on soil fertility in the green house experiments with wheat on the soil taken from field plots that had received FYM at the rates upto 60 tons/ha and observed that the soil K supply was more than that of P and P supply exceeded than that of N. In the field experiments, the residual effects of FYM on the growth and yield of subsequent crops of wheat and sweet potatoes were significantly greater at higher levels of FYM than at rates less than 15 tons/ha. NPK contents and contents of bases in the plants showed a similar tendency. The total and available N contents of the soil increased with increasing FYM especially in the surface soil. Organic N content (after acid hydrolises) increased without affecting the N distribution of the total N. Readily soluble humus also increased. Long term application of FYM increased CEC, base contents, especially that of K and Mg and degree of saturation. Weak mineral acid soluble Al decreased somewhat, organic P, inorganic P and available P increased, moisture content at wilting point and limit of shrinkage also increased. Soil texture became lighter and water sedimentation volume increased.

Boyd, et al. (1972) studied the residual effect of four forms of P fertilizer at Rothamsted Experimental Station. They applied fertilizer between 1951-1964 and evaluated the effects by top dressing superphosphate in 1967 in experiments with potatoes and kale and noted that the effects of residual and newly applied P. The response to different forms of P

varied greatly depending on the P sorption characteristics of soil.

Giskin,et al.(1972) made the investigations on residual phosphorus, availability of chemical and plant tests in green house. In their investigation, Italian millet was grown for 4 weeks in 8 samples of clay soil (5.5 - 24 ppm $NaHCO_3$, extractable P) and 8 samples of silty clay soil (5.5 - 19.2 ppm extractable P) fertilization with 0, 40, 100 and 250 ppm P and observed that at any one residual P level ($NaHCO_3$ extractable) the absolute yield on the silty clay soil increased with increasing levels of P application but on the clay soil this was true only upto residual level of 11 ppm P. In both soils with few exceptsions, it was noted that larger the residual P, smaller the yield increase from P fertilizing. Relative yields of non-fertilized pots were co-rrelated with the amount of P previously applied in the field. Relative efficiencies of residual P accumulated in the field were found to be inversely dependent on heavy rates of field application of P at the rate of 80 kg/ha.

Prasad (1976) observed in Trinidad that the application of filter press mud resulted in increased yields of sugarcane in six sites. He, further, evaluated the residual effect of filter press mud after one year and observed that the yield increases were greater in plant cane than in ratoons, possibly due to incorporation of filter mud in the former.

In addition, the plant cane experiments had not received P fertilizer for longer period than the ratoon.

Yelwande (1977) studied the residual effect of fertilizers and edible and non-edible oil cakes and observed that the oil cakes were superior over inorganic fertilizer as far as the residual fertility of the soil and the yield of gram (dry matter). The residual effect of neem cake on the yield of gram (dry matter) was observed to be significantly superior over control, followed by castor cake, groundnut cake and inorganic fertilizers.

2.4.2.8 Press mud cake as soil conditioner :

Soman, et al. (1955) reported that the press mud cake and distillery slops were quite useful in conditioning the chopan soils of deccan canal tract. They observed that the infiltrability of soils was better when treated with press mud or distillery slops than when treated with standard gypsum dose alone. Improvement in pH was also noticed.

Karve (1956) conducted the experiments to improve alkaline B type of soil having pH more than 9.0 at the Godavari Sugar Mills' estate and observed that addition of farm yard manure and of press mud alone was effective in improving the chopan soil.

Kanwar, et al. (1965) studied the reclamation of

saline and sodic soils in Punjab and observed that 25 kg of N/ha plus 25 kg of P_2O_5 in combination with amendments like press mud cake at the rate of 5 tons/ha or 5 tons gypsum plus 35 tons FYM/ha increased the infiltration rate of paddy soil. They, further, adduced that it could be due to the finer physical condition of amendments. The $CaCO_3$ present in press mud cake was more effective than the $CaCO_3$ present in the soil.

Zende (1968) summarised the work on different agricultural waste materials in improving the saline alkali soil (pot experiment) at Sugarcane Research Station, Padegaon and pointed that application of press mud cake :- (i) reduced the pH level of soil by 0.5 units. (ii) reduced the total soluble salts from 1.70 to 1.32 per cent. (iii) increased the humus level from 0.26 to 0.44 per cent, and (iv) improved the salinity of soil to the extent of 18.52 per cent.

Story (1970) reported that the rotary filter mud was found to be most beneficial in eroded areas and soil problem areas where texture was affected; but further he observed that it was uneconomical for good soils.

Dzubay (1973) studied the reclamation of saline-alkali soil by surface application of the gypseous sub-soil (at 200-300 m^2/ha) followed by flood irrigation and of an acid soil by application of sugar factory muds in Hungeria. After seven years of treatments he observed that all exchangeable Na and soluble salts had disappeared from the 0-20 cm layer in saline

alkali soil but porosity was unaffected. Ca had replaced Na in the exchangeable complex. In the acid soils treatments for five years considerably increased the saturation and reduced hydrolytic acidity to negligible levels.

Millapchand, et al. (1977) conducted a field experiment at Central Soil Salinity Research Institute, Karnal to study the effects of eight soil amendments on soil properties and yield of their subsequent crops grown in highly sodic soil and observed that when amendments applied in chemically equivalents quantities; gypsum, sulphuric acid and aluminium were nearly equally effective in improving the soil properties and yield of barley crop. Application of FYM and press mud from carbonation factories caused only slight improvement. The high doses of press mud cake from sulphitation factory had beneficial effect on soil properties and crop growth.

Bawasakar, et al. (1978) at Padegaon also observed the beneficial effects of incorporation of press mud cake on reduction of salt contents.

CHAPTER 3

MATERIALS AND METHODS

CHAPTER 3

M A T E R I A L S A N D M E T H O D S

The present investigation was carried out during the year 1977-79 by undertaking the field studies and laboratory studies with a view -

i) to study the quality of press mud cake (PMC) produced by sulphitation method from sugar factories in Maharashtra State in respect of nutrient status,

ii) to study the residual effect of press mud cake (PMC) on yield and quality of sugarcane,

iii) to study the effect of press mud cake on soil properties under laboratory and field conditions.

3.1 Materials :

3.1.1 Soil :

A medium black clayey soil from Sugarcane Research Station, Padegaon, Dist. Satara, alkaline in reaction and with a high reserve in $CaCO_3$ was used. This is a typical B type of soil as classified by Basu and Sirur (1938). A soil is considered as fairly fertile with moderate drainage. For incubation the soil was collected from the same plot to the depth of 0-30 cm.

The physico-chemical characteristics of the soil used in the investigation are given in Table 1.

Table 1 : Physico-chemical characteristics of the soil.

Sr.No.	Constituents	Per cent on oven dry basis
I.	**Physical constituents**	
1.	Moisture equivalent	35.74
2.	Maximum water holding capacity	73.27
3.	Bulk density	1.14
4.	Pore space	30.37
5.	Moisture at 1/3 bar	35.07
6.	Moisture at 15 bar	21.94
II.	**Mechanical analysis**	
1.	Course sand	9.43
2.	Fine sand	2.75
3.	Silt	27.75
4.	Clay	50.62
5.	$CaCO_3$	9.10
6.	Organic matter	1.50
III.	**Chemical constituents**	
1.	NH_4^+ Nitrogen mg/100 g	2.35
2.	NO_3^- Nitrogen mg/100 g	3.13
3.	Organic carbon %	0.87
4.	Total nitrogen %	0.077
5.	C/N ratio	11.17
IV.	**Fertility constituents**	
1.	Available P_2O_5 mg/100 g	1.18
2.	Available K_2O mg/100 g	14.75
V.	**Exchangeable bases**	
1.	Ex. Ca meq. %	35.48
2.	Ex. Mg meq. %	7.04
3.	Ex. Na meq. %	0.43
4.	Ex. Ca/Mg ratio	5.05
5.	pH (1 : 2.5 soil : water ratio)	7.9
6.	EC. mmhos/cm	0.82

3.1.2 Fertilizers and manures :

Ammonium sulphate, superphosphate, muriate of potash and PMC were used as sources of N, P, K and organic matter, respectively.

All the products used were analysed and the chemical analysis is given in Table 2.

Table 2 : Chemical analysis of press mud cake (PMC) and fertilizers used in incubation studies.

Sr. No.	Characteristics	Ammonium sulphate	Super-phosphate	Muriate of potash	PMC
		% on oven dry basis			
1.	Moisture	1.66	1.62	1.96	2.32
2.	Loss on ignition	-	-	-	76.30
3.	Mineral matter(Ash)	-	-	-	23.70
4.	Acid insoluble	-	-	-	13.78
5.	Organic carbon	-	-	-	19.32
6.	Total N	19.18	-	-	1.61
7.	P_2O_5	-	16.42 (Water soluble)	-	2.02
8.	K_2O	-	-	59.25 (Water soluble)	1.38
9.	Total CaO	-	-	-	9.59
10.	Total MgO	-	-	-	1.40
11.	pH (1:7.5 PMC:Water ratio)	-	-	-	6.7
12.	EC mmhos/cm	-	-	-	2.46
13.	C/N ratio	-	-	-	12.00
14.	Organic matter	-	-	-	33.32
15.	$CaCO_3$	-	-	-	5.48

3.1.3 Weather :

The meteorological data recorded at the meteorological

observatory from the Sugarcane Research Station, Padegaon, during the period of experimentation are presented in Appendix III. Padegaon is situated 556 metre above the sea level; on 18°-12' to North latitude and 74°-10' to East longitude. Total rainfall received from August 77 to February 79 was 872.8 mm during 142 rainy days. It would be observed that during the growth of sugarcane crop maximum temperatures were from 27.1°C to 37.4°C whereas minimum temperatures ranged from 10.5°C to 21.7°C. The humidity at 8.0 am ranged from 70.0 per cent to 93.0 per cent and at 3.0 pm it was from 19.0 per cent to 71.0 per cent. The evaporation per day ranged from 3.1 mm to 9.6 mm.

3.1.4 Studies into the quality of press mud cake :

Out of the 48 co-operative and private sugar factories contacted, only 21 sugar factories from the State of Maharashtra sent the press mud cake samples at an interval of one month during the crushing season viz., November, 77 to May, 1978. On receipt, the samples were dried pounded in wooden mortar and pestle, passed through different sieves and were subjected to chemical analysis with a view to study the quality of press mud cake received from different sugar factories.

Districtwise list of sugar factories in operation in Maharashtra State during 1977-78 and the sugar factories under study is given in Table 3 and presented in Fig. 2.

Table 3 : Districtwise co-operative and joint-stock sugar factories in operation in Maharashtra State during 1977-78.

Sr. No.	Name of sugar factory	Acronyms used in thesis
	I. KOLHAPUR DISTRICT	
1.	Daulat S.S.K. Ltd., Yashwantnagar	-
2.	Bhogawati S.S.K. Ltd., Parite	-
3.	Kumbhi Kasari S.S.K. Ltd., Kuditre	-
4.	Dudhganga Vedhganga S.S.K. Ltd., Bidri	-
+*5.	Kolhapur Cane Sugar Works Ltd., Kasaba Bavada	Kolhapur
6.	Warana S.S.K. Ltd., Warananagar	-
+ 7.	Panchganga S.S.K. Ltd., Ganganagar, Ichalkaranji	Panchganga
+ 8.	Datta S.S.K., Shirol	Datta
	II. SANGLI DISTRICT	
9.	Shetkari S.S.K. Ltd., Sangli	
10.	Walwa Taluka S.S.K. Ltd., Sakharale	
11.	Vishwas S.S.K. Ltd., Yashwantnagar	
	III. SATARA DISTRICT	
+ 12.	Krishna S.S.K. Ltd., Nethare (Bk.)	Krishna
13.	Sahyadri S.S.K. Ltd., Yashwantnagar	-
14.	Balasaheb Desai S.S.K. Ltd., Karali	-
15.	Satara S.S.K. Ltd., Kisanveernagar	-
*16.	Phaltan Sugar Works Ltd., Sakharwadi	-
+17.	Shriram S.S.K. Ltd., Phaltan	Shriram
	IV. SOLAPUR DISTRICT	
18.	Shankar S.S.K. Ltd., Sadashivnagar	-
+19.	Yashwant S.S.K. Ltd., Yashwantnagar	Yashwant
20.	Saswad Mali S.S.K. Ltd., Malinagar	-
*21.	Brima Sugar Ltd., Shreepur	-
+22.	Siddheshwar S.S.K. Ltd., Siddheshwarnagar	Siddheshwant

Contd..

Table 3 (Contd.)

Sr. No.	Name of sugar factory	Acronyms used in thesis
	V. PUNE DISTRICT	
*23.	Walchandnagar Sugar Industries Ltd.,Walchandnagar	-
+24.	Chhatrapati S.S.K. Ltd., Bhavaninagar	Chhatrapati
25.	Malegaon S.S.K. Ltd., Malegaon	-
26.	Someshwar S.S.K. Ltd., Someshwarnagar	-
27.	Yashwant S.S.K. Ltd., Chintamaninagar	-
	VI. AHMEDNAGAR DISTRICT	
*28.	Shrigonda S.S.K. Ltd., Shrigonda factory	Shrigonda
29.	Jagadamba S.S.K. Ltd., Kashin	-
+30.	Rahuri S.S.K. Ltd., Rahuri	Rahuri
31.	Pravara S.S.K. Ltd., Pravaranagar	-
+32.	Sangamner Bhag S.S.K. Ltd., Amrutnagar	Sangamner
*33.	Maharashtra Sugar Mills Ltd., Tilaknagar	-
34.	Ashok S.S.K. Ltd., Ashoknagar	-
*35.	Belapur Sugar and Allied Industries Ltd.,Harigaon	-
*36.	Changdeo Sugar Mills Ltd., Changdeonagar	-
+*37.	Godavari Sugar Mills Ltd., Sakarwadi	Godavari-S
38.	Sanjivani (Takli) S.S.K. Ltd.,Sahajanandnagar	-
+*39.	Godavari Sugar Mills Ltd., Laxmiwadi	Godavari-L
+40.	Kopargaon S.S.K. Ltd., Gautamnagar	Kopargaon
41.	Ganesh S.S.K. Ltd., Ganeshnagar	-
42.	Vrudheshwar S.S.K. Ltd., Kasarpimpalgaon	-
+43.	Dnyaneshwar S.S.K. Ltd., Bhende (Bk.)	Dnyaneshwar
	VII. NASIK DISTRICT	
44.	Kadava S.S.K. Ltd., Khedgaon	-
+45.	Karmaveer Kakasaheb Wagh S.S.K.Ltd.,Kakasahebnagar	Kakasaheb Wagh
+46.	Niphad S.S.K. Ltd., Pimpalas	Niphad
47.	Nasik S.S.K. Ltd., Palase	-
48.	Girana S.S.K. Ltd., Bhausaheb Hirenagar	-
*49.	Ravalgaon Sugar Farms Ltd., Ravalgaon	-

Contd...

Table 3 (Contd.)

Sr. No.	Name of sugar factory	Acrnomys used in thesis
	VIII. DHULE DISTRICT	
50.	Panzarakan S.S.K. Ltd., Bhadane	-
+51.	Satpuda Tapi Parisar S.S.K. Ltd., Purushottamnagar	Satpuda
	IX. JALGAON DISTRICT	
52.	Belganga S.S.K. Ltd., Bhoras	-
+53.	Vasant S.S.K., Kasoda	Vasant
54.	Madhukar S.S.K. Ltd., Nhavi Marg, Faizpur	-
	X. AURANGABAD DISTRICT	
55.	Kannad S.S.K. Ltd., Kannad	-
56.	Siddheshwar S.S.K. Ltd., Sillod	--
57.	Gangapur S.S.K. Ltd., Gangapur	-
58.	Vinayak S.S.K. Ltd., Parasoda	-
	XI. BHIR DISTRICT	
59.	Jai Bhavani S.S.K. Ltd., Georai	-
60.	Ambajogai S.S.K. Ltd., Ambajogai	-
	XII. OSMANABAD DISTRICT	
61.	Shetkari S.S.K. Ltd., Killari	-
+62.	Terana S.S.K. Ltd., Dhoki	Terana
	XIII. NANDED DISTRICT	
+63.	Kalambar S.S.K. Ltd., Gandhinagar	Kalambar
	XIV. YEOTMAL DISTRICT	
64.	Vasant S.S.K. Ltd., Pusad	-
	XV. BULDHANA DISTRICT	
65.	Jijamata S.S.K. Ltd., Shankarnagar	-
	XVI. PARABHANI DISTRICT	
66.	Marathwada S.S.K. Ltd., Dongarkada	-

* Joint Stock Sugar Factories.

\+ Sugar Factories under study.

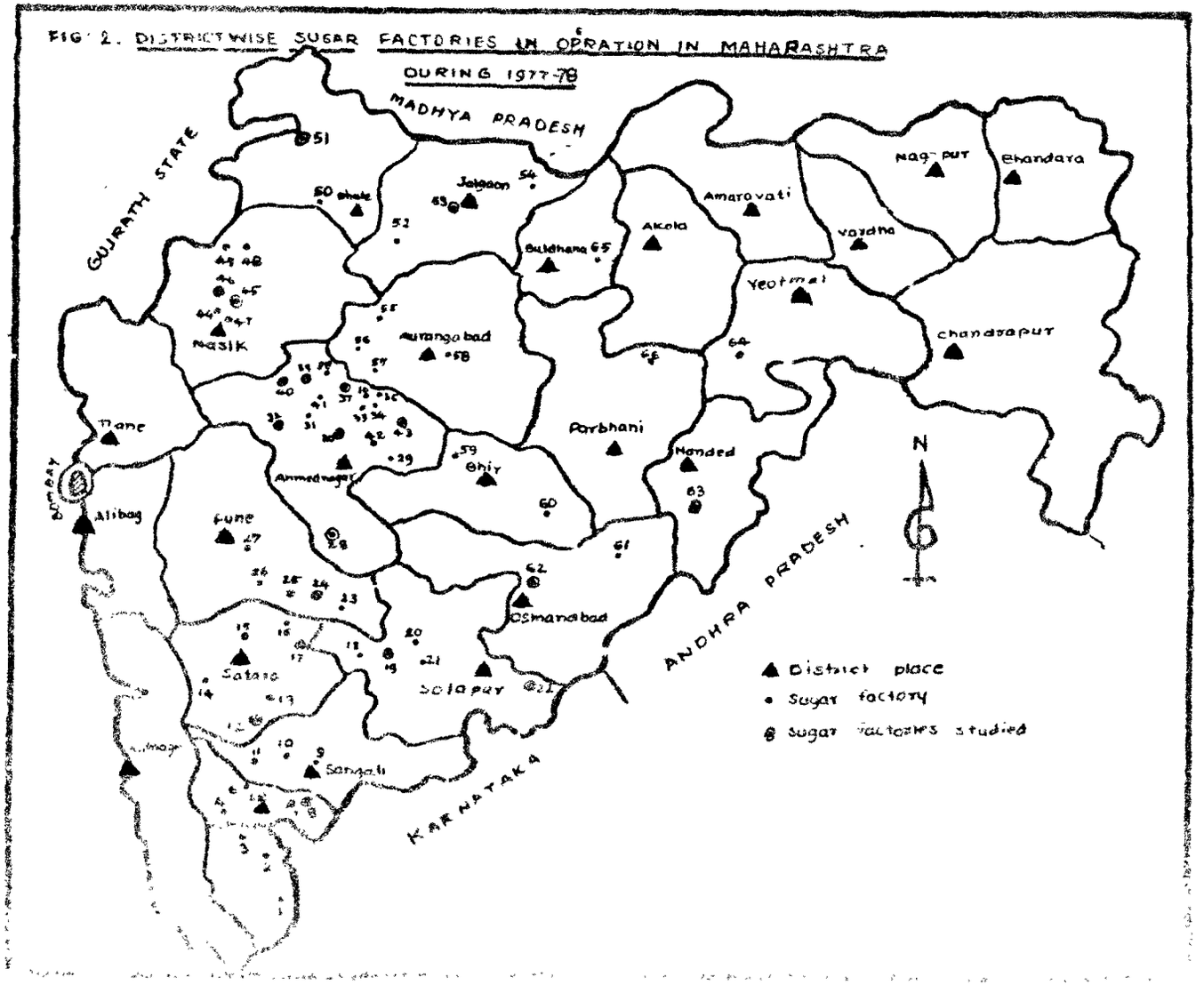


FIG. 2. DISTRICTWISE SUGAR FACTORIES IN OPERATION IN MAHARASHTRA DURING 1977-78
MADHYA PRADESH
GUJRATH STATE
ANDHRA PRADESH
KARNATAKA
BOMBAY
Nagpur
Bhandara
Amaravati
Akola
Buldhana
Jalgaon
Wardha
Yeotmal
Chandrapur
Aurangabad
Nasik
Parbhani
Nanded
Ahmednagar
Beed
Osmanabad
Solapur
Satara
Sangali
Thane
Alibag
Pune
N
District place
Sugar factory
Sugar factories studied

3.1.5 Field experiment :

Residual effect of press mud cake on yield, quality of sugarcane and on soil properties.

A field experiment on Adsali sugarcane with Co. 740 was laid out in a randomised block designwith three replications during 1975-77 with following treatments.

Details of the treatments and the symbols used.

Sr.No.	Treatments	Symbols
1.	400 kg N/ha alone	A
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha (Recommended dose)	B
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	C
4.	Press mud cake @ 12.5 t/ha	D
5.	Press mud cake @ 18.5 t/ha	E
6.	Press mud cake @ 25.0 t/ha	F

In the treatments D, E and F, the nitrogen was adjusted to 400 kg/ha taking into consideration N content of press mud cake N, P and K was applied through ammonium sulphate, super phosphate and muriate of potash respectively.

The residual effect (without addition of fertilizers or press mud cake) on Adsali sugarcane with Co.740 was studied at the site during 1977-79 by following the same randomization in the above experiment.

The gross plot size was 13.72 x 7.31 m and net plot size was 12.19 x 4.88 m.

The details of the plan of layout of field experiment are presented in Fig. 3.

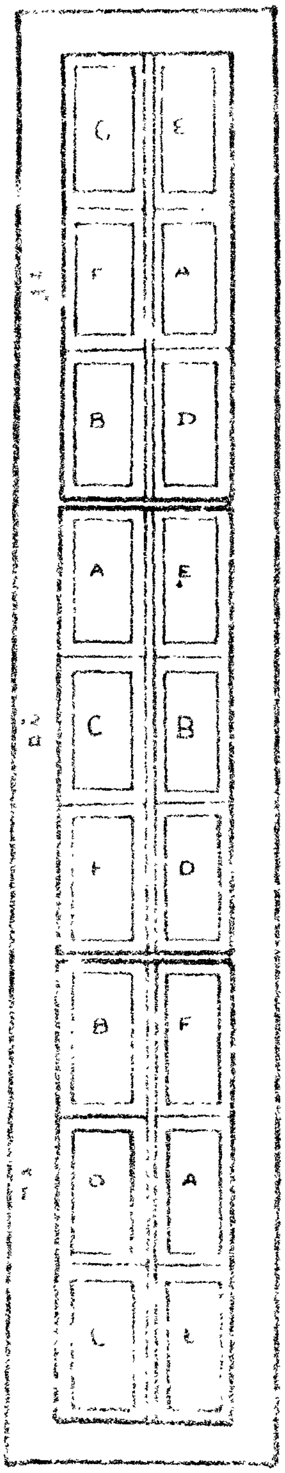
3.1.5 (A) Details of cultivation :

After harvesting of previous adsali crop of sugarcane where the response of sugarcane to PMC was studied in January 1977 the same field was kept fallow for three to four months. Then ploughed twice one clod crushing and two harrowing were given to the field. The ridges and furrows were opened by ridger with a spacing of 1.22 m. Length and breadth of each plot was kept 13.72 x 7.31 m. Healthy sugarcane seed material of CO.740 variety was obtained from the seed nursery of Sugarcane Specialist, Sugarcane Research Station, Padegaon and cut into three eye buded setts. The sugarcane setts were treated with a fungicidal mercury compound to keep the seed free from diseases. Then the planting was carried out by wet planting method on 3-8-1977. The seed rate used was 25,000 three eye buded setts per hectare.

Earthing up was done after five months of planting. The experimental plots were weeded six times and the irrigation was given at an interval of 10 days during summer and during rainy days as and when required. Harvesting was done on 4-2-1979.

FIG. 3

PLAN OF LAYOUT

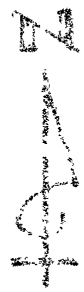


Design: Randomised Block Design.

Plot Size:

Gross : 3.72 x 7.31 m²

Net : 2.44 x 6.09 m²



(B) Fertilizer and manure application :

The quantities of N, P_2O_5 and K_2O supplied to the previous Adsali crop (1975-77) through press mud cake is given below :

Sr. No.	Treatments	PMC treatments t/ha	N	P_2O_5	K_2O
			kg/ha		
1.	D	12.5	150	485	182
2.	E	18.5	225	728	273
3.	F	25.0	300	970	364

In order to study the residual effect of PMC, no manure or fertilizers were applied to the experimental plots.

(C) Soil sample :

Soil samples were collected at a depth of 0-30 cm from each plot at different stages of crop growth i.e. (i) before planting of sugarcane, (ii) at earthing up, (iii) at grand growth, and (iv) at harvest. They were air dried, pounded and used for chemical analysis.

(D) Plant sample and growth observation :

Plant samples were taken at grand growth and at harvest stage. Ten canes from each plot were cut to ground level. Biometric observation such as total weight, total height, millable height, number of internodes and girth were

recorded. The canes (stems) and green leaves (crown) were cut into small pieces composited and representative samples from each plot was taken. Samples were oven dried at 70°C and prepared to a fine powder and used for chemical analysis. Juice samples were also taken by crushing the canes from each plot for quality study.

(E) Cane yield :

Millable harvested canes from net plot were weighed and cane yield per hectare was calculated.

(F) Commercial cane sugar (CCS) in tons per hectare :

It was calculated as

$$\text{CCS t/ha} = \frac{\text{Net sediment x yield in t/ha}}{100}$$

3.1.6 Incubation studies :

An incubation study was conducted to study the mineralization of nitrogen from different levels of press mud cake and different levels of inorganic fertilizers and also to study the availability of phosphorus and potash. The soil for the incubation studies was collected from the field experimental plot. The treatment in the studies are on the basis of treatments of the field experiment.

Galvanized iron pots were used for this incubation studies. There were six treatments each being replicated

thrice. Two kg of soil (2 mm) was taken and to it calculated, quantities of press mud cake and fertilizers as per treatments were mixed well. The details of the treatments and quantities of the fertilizers and press mud cake added for different treatments are given in Table 4.

After thorough mixing of fertilizers and press mud cake in the soil, the material was uniformly filled in, in each pot. The treated soil was brought to the level of moisture equivalent by adding calculated quantities of distilled water. The moisture level was maintained throughout the incubation period (90 days). The room temperature was $27^{\circ} \pm 2^{\circ}C$ throughout the incubation period.

The soil samples were taken initially after two days and thereafter at an interval of fifteen days incubation period and analysed for NH_4^+-N, NO_3^--N, Av.P_2O_5, Av.K_2O, organic carbon, pH, electrical conductivity (EC) and $CaCO_3$.

The soil samples were also analysed for the microflora before start of incubation studies, at 60 days and at 90 days of incubation.

3.2 Methods of analysis :

3.2.1 Fertilizer analysis :

Fertilizer were analysed for their nutrients content by the methods as described in A.O.A.C., 1950.

Table 4 : Details of treatments, quantities of fertilizers and press mud cake used for incubation study.

Sr. No.	Treatments	Symbol	Quantities added in g/pot (2 kg soil)			
			Ammonium sulphate	Super-phosphate	Muriate of potash	Press mud cake
1.	400 kg N/ha alone	A	1.861	-	-	-
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha (Recommended dose)	B	1.861	0.926	0.256	-
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	C	2.607	1.852	0.256	-
4.	*Press mud cake @ 12.5 t/ha	D	0.923	-	-	11.156
5.	*Press mud cake @ 18.5 t/ha	E	0.454	-	-	16.734
6.	*Press mud cake @ 25.0 t/ha	F	-	-	-	22.312

* In treatment D, E and F the N dose was adjusted to 400 kg/ha through ammonium sulphate. The necessity of addition of P_2O_5 and K_2O in these treatments did not arise.

3.2.2 Press mud cake analysis :

The press mud cake samples were air dried, pounded, sieved through 2 mm and 100 mesh sieves and used for further analysis.

1) Moisture :

A known quantity was dried to a constant weight at 70°C in electrical oven.

2) Loss of ignition :

A moisture free sample was ignited in a muffle furnace until the organic matter was fully destroyed and cooled. The loss on ignition after correcting for the moisture was calculated.

3) Mineral matter (Ash) .

A known quantity of samples was taken in silica dish ignited and weighed to a constant weight.

4) HCl insolubles :

It was determined during HCl - extract preparation. HCl insoluble residue was transferred to filter paper, dried in a electrical oven, and then ignited in silica crucible and weighed to a constant weight.

5) Organic carbon :

It was estimated by Walkley and Black rapid titration method using 100 mesh PMC samples. Organic matter was

calculated by multiplying organic carbon per cent by conventional factor 1.725 (Piper, 1950).

6) Total nitrogen :

It was determined by Kjeldahl's method as described by Piper (1950).

7) Total phosphorus :

It was estimated by triple acid digestion method (Wright, 1934).

8) Total potash :

The wet digested material was used and potash was determined on Lange's flame photometer (Chapman and Pratt, 1961).

9) Calcium carbonate :

A known weight of 100 mesh PMC samples was taken. About 1 gram of Darco G.60 was added, treated with 1N HCl, mixture was shaken an hour, filtered and back titrated with 0.1N, NaOH using phenolphthalein as an indicator (Piper,1950 .

10) pH :

The ratio of PMC to water was standardized first by taking 1:2.5, 1:5, 1:7.5 and 1:10 ratios, and it was observed that 1:7.5 ratio is the optimum ratio for determination of pH of press mud cake (Piper, 1950).

11) Electrical conductivity (EC) :

EC was determined electrically using 1:7.5 PMC : Water suspension with the help of conductivity bridge (Solubridge) (Jackson, 1958).

12) HCl soluble CaO :

From the filtrate, after separation of iron and aluminia, calcium was precipitated as calcium oxalate and estimated by titrating against standard permanganate solution as described by Piper (1950).

13) HCl soluble MgO :

In the filtrate from CaO determination, magnesium was precipitated as magnesium ammonium phosphate. It was ignited, cooled and weighed as Magnesium pyrophosphate (Piper, 1950).

3.2.3 Soil analysis :

The soil samples were analysed by adopting standard methods of analysis as under.

A) Physical analysis :

1) Moisture :

It was determined by drying a known quantity of soil to a constant weight at 105°C in a electrical oven (A.O.A.C., 1950).

2) Mechanical composition :

This was carried out according to the inter-national Pipette method using soda dispersion, HCl and H202 treatments (Piper, 1950).

3) Moisture equivalent :

This was determined according to method given by Piper (1950) by using Briggs Mclane moisture equivalent centrifuge fitted with a special drum head rotated at 2240 rpm for 30 minutes.

4) Maximum water holding capacity :

This was determined by the method described by Piper (1950).

5) Moisture at 1/3 bar and 15 bar :

This was determined by pressure membrane apparatus as described by Richards (1954).

6) Bulk density :

This was determined according to the method described by Baver (1956).

7) Pore space :

This was estimated as per the method given by Baver (1956).

B) Chemical analysis :

1) Total Nitrogen :

Kjeldahl's method with Bals modification was adopted for estimation of nitrogen as described by Piper (1950).

2) Organic carbon :

It was determined by the Walkley and Black rapid titrations method using 100 mesh soil samples (Piper, 1950). The organic matter was calculated by multiplying organic carbon per cent by conventional factor 1.725 (Piper, 1950).

3) Available P_2O_5 :

The available P_2O_5 was determined colorimetrically by following Olsen's methods (Olsen, et al. 1954).

4) Available K_2O :

It was determined by using neutral normal NH_4OAc as soil extractant (Volk and Truog, 1934). Potash in the extract was estimated on Lange's flame photometer (Fox, 1951).

5) Soil pH :

It was determined by using 1:2.5 soil water ratio suspension by means of glass, calomel electrodes assembly using electrically operated pH meter (Jackson, 1958).

6) Electrical conductivity :

It was estimated electometrically using 1:2.5 soil

water suspension with the help of conductivity bridge (Solubridge) as described by Jackson (1958) and expressed as millimhos/cm.

7) Calcium carbonate :

A known weight of 100 mesh soil was taken and treated with 1N HCl. Soil-HCl mixture was shaken, filtered and back titrated with 0.1N NaOH using phenolphthalein as an indicator (Piper, 1950).

8) NH_4^+-N and NO_3^--N :

A known weight of soil was taken and treated with 2 N KCl plus 2 N HCl and shaken for an hour (Bremner, 1965) and NH_4^+-N and NO_3^--N was determined by steam distillation with MgO and Devarda's alloy.

9) Exchangeable Ca and Mg :

These were determined by EDTA method using 6 per cent NaCl as extractant, NH_4Cl and NH_4OH mixture as buffers and murexide and eriochrome black T as indicators, respectively (Jackson, 1958).

10) Exchangeable Na :

The extract obtained for the determination of the available potash was directly used for the estimation of exchangeable Na. It was estimated on Lange's flame photometer (Jackson, 1958).

3.2.4 Micro-biological analysis :

Microbial counts were recorded as per the methods described by Alexander (1961).

1) Total bacteria :

The total bacterial population and that of actinomycetes in 1 g of soil was counted by dilution plating method on soil extractant media.

2) Azotobacter :

The azotobacter count in 1 g of soil was determined by using the same dilution plate technique but on Jenson's media.

3) Fungi colony :

The fungi colony count in 1 g of soil was determined by using the dilution plating method on Martin's Rose Bengal media.

3.2.5 Plant analysis :

The plant stem and green leaves (crown) samples were dried well in well ventilated oven at 70°C. The dry matter was finally ground in a mill to pass through 0.5 mm sieve and then fine homogenous samples were used for further analysis.

1) Nitrogen :

It was estimated by Kjeldahl's method as described by Piper (1950).

2) Phosphorus :

The plant sample was digested with triple acid mixture and volume was made. The phosphorus was estimated in a suitable aliquot of this extract by precipitating it as ammonium phosphomolybdate by Pemberton's method (Wright, 1934).

3) Potassium :

The wet digested material was diluted and potash was determined by using Lange's flame photometer (Chapman and Pratt, 1961).

3.2.6 Juice analysis :

1) Brix :

Brix was read by Brix hydrometer with temperature for corrected Brix at 20°C.

2) Pol reading :

Pol readings were taken on polariscope. About 100 ml of juice was taken in 150 ml beaker. 2-3 g lead acetate (Monobasis powder was added to precipitate the impurities. filtered the juice through Whatman No. 1 filter paper. The filtrate was filled in 25 mm tube and observed the readings.

3) Sucrose :

Sucrose per cent was read from the graphical table value of Brix and Pol readings (Spencer and Meade, 1945).

4) Co-efficient of purity :

This was calculated as

$$\text{Coefficient of purity} = \frac{\text{Sucrose \%}}{\text{Corrected Brix}} \times 100$$

5) Total nitrogen :

It was estimated by Kjeldahl's method as described by Piper (1950).

6) Mineral matter :

A known quantity of juice was taken in a silica dish, evaporated on water bath till dryness and then ignited and weighed to a constant weight.

7) Total phosphorus :

It was determined from HCl - extract of juice and by precipitation with ammonium molybdate nitric acid reagent by precipitating it as ammonium phosphomolybdate (Piper, 1950).

3.2.7 Statistical methods :

The data collected was statistically examined by following the procedure described by Panse and Sukhatme (1961).

CHAPTER 4

RESULTS AND DISCUSSION

CHAPTER 4

RESULTS AND DISCUSSION

With a view to study the quality of press mud cake (PMC) produced from various sugar factories in Maharashtra State, the chemical composition of press mud cake was studied during the crushing season of 1977-78. The field experiment was conducted to study the residual effect of application of press mud cake on soil properties, yield and quality of sugarcane. The incubation studies were also taken to assess the supply of nitrogen and its mineralization, availability of P_2O_5 and K_2O in comparison with inorganic fertilizers and the data thus collected have been reported and discussed in this chapter.

4.1 Studies on the quality of press mud cake produced from various sugar factories in Maharashtra State in respect of nutrient status :

4.1.1 Fresh moisture content, pH and electrical conductivity of press mud cake :

Most of the press mud cake samples from various sugar factories of Maharashtra were received in wet condition but some of them were received in dry condition and hence the large variation in moisture content was observed.

The values of moisture content, pH and electrical

conductivity are reported in Table 5. The pH and electrical conductivity is shown graphically in Fig. 4.

It was observed from the Table 5 that the range of pH was from 4.40 to 5.70 when the moisture content of press mud cake was above 50 per cent. However, when the moisture content was below 50 per cent, the range of pH was found to be from 6.18 to 6.80.

It was observed that the maximum moisture content (78.03 %) was found in press mud cake samples of Chhatrapati S.S.K. Ltd. indicating that the PMC was in lumps and very wet and minimum (16.27 %) being in samples of Siddheshwar S.S.K. Ltd., indicating that these were almost dried samples. It was also observed from the data that when moisture content in press mud cake was high, the pH was low (4.40) and at the same time the electrical conductivity in suspension was also high (3.83 mmhos/cm). The mean pH value for factories was 5.66 and it ranged from 4.35 to 6.86. The mean values for electrical conductivity determined by using suspension and filtrate were 2.80 and 3.70 mmhos/cm, respectively, indicating that there was more resistance in the filtrate. This may be due to more soluble and active concentration of different salts in the filtrate.

Haines (1961) and Pandey (1966) also observed that the fress press mud cake contained 55 to 70 per cent moisture

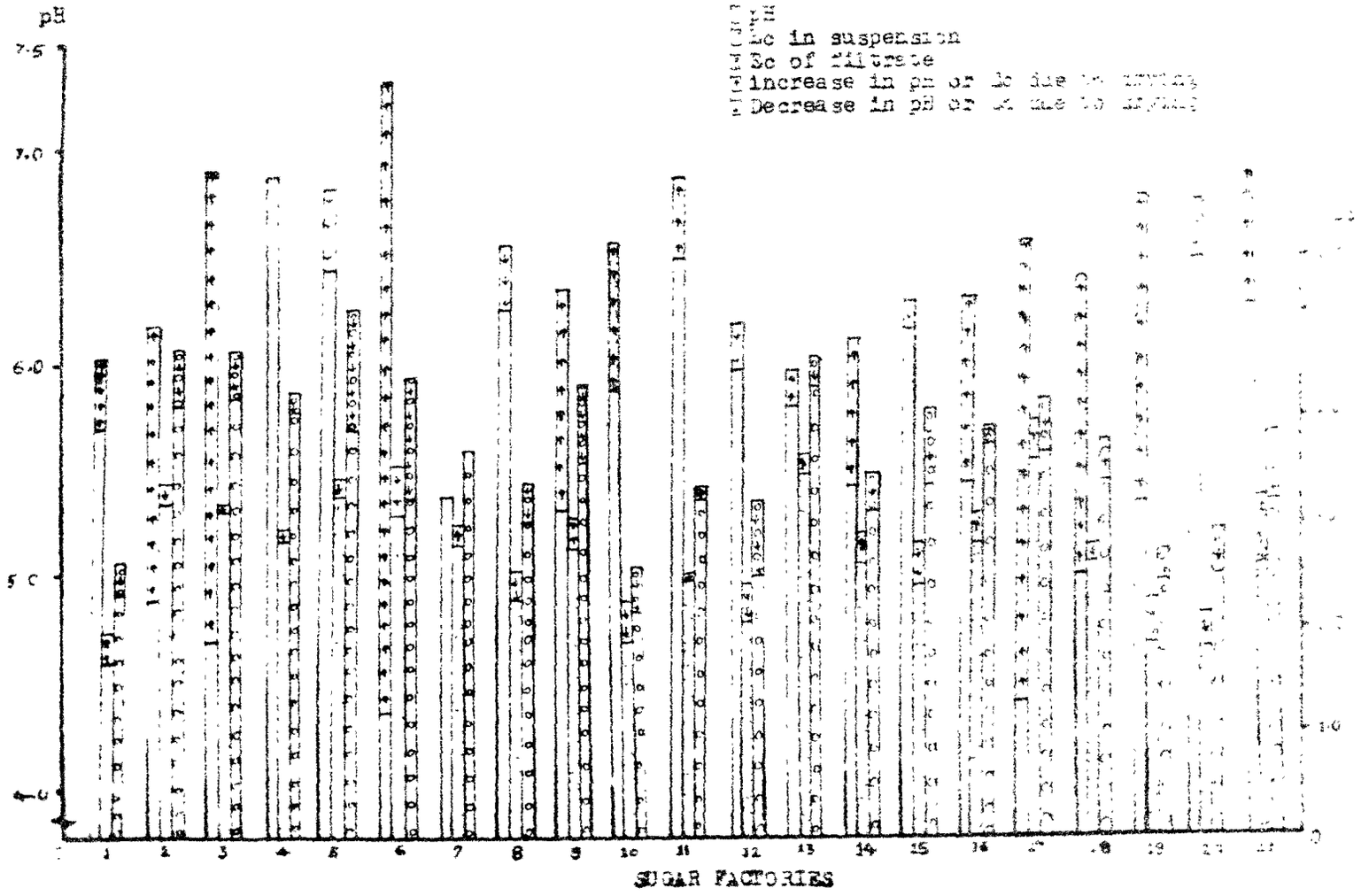
Table 5 : Moisture content, pH and electrical conductivity of fresh press mud cake samples (Mean of five months).

Sr. No.	Name of the sugar factory	Moisture	pH	Electrical conductivity	
				in suspension	of filtrate
		%		mmhos/cm	
1.	Dnyaneshwar	67.79	5.70	1.73	2.60
2.	Godavari-I	72.07	4.92	3.35	4.58
3.	Godavari-S	73.95	4.72	3.12	4.59
4.	Kopargaon	46.92	*6.86	2.96	4.21
5.	Rahuri	16.61	*6.80	3.39	5.00
6.	Sangamner	73.81	4.35	3.53	4.36
7.	Shrigonda	62.57	5.38	2.73	3.67
8.	Satpuda	18.41	*6.52	2.51	3.34
9.	Vasant	65.33	5.30	2.54	4.24
10.	Kolhapur	72.52	4.98	2.19	2.84
11.	Panchganga	43.20	*6.50	2.42	3.22
12.	Datta	22.06	*6.18	2.41	3.13
13.	Kalambar	75.91	5.56	3.45	4.49
14.	Kakasaheb Wagh	65.46	5.43	2.62	3.46
15.	Niphad	15.86	*6.30	2.80	4.03
16.	Terana	69.32	5.46	2.81	3.78
17.	Chhatrapati	78.03	4.40	3.83	3.28
18.	Krishna	66.10	5.00	2.74	3.41
19.	Shriram	69.68	5.34	2.18	2.68
20.	Siddheshwar	16.27	*6.77	2.18	2.94
21.	Yashwant	49.38	*6.28	3.18	3.83
	Mean	54.35	5.66	2.80	3.70

* = 1:7.5 (PMC:Water ratio).

Rest = 1:2.5 (PMC:Water ratio).

FIG.4 : pH AND ELECTRICAL CONDUCTIVITY (Ec) OF [illegible] SUGAR FACTORIES IN MAHARASHTRA STATE.



when it comes out from the factory. Higher moisture content in the press mud cake produced at the sugar factory faces a problem of transport before it subjected to drying.

4.1.2 Organic carbon content of press mud cake :

The values for organic carbon content of PMC are reported in Table 6. The organic carbon content ranged from 26.37 to 38.44 per cent in PMC received from different factories. The mean value for all the factories in Maharashtra was 33.98 per cent.

It was observed that the differences were highly significant for the carbon content from the various sugar factories. There was no significant difference in organic carbon content in samples received at monthly interval.

Bawasakar (1968), Mesbahul, et al. (1974) and Patil (1975) in their study also reported that press mud cake contained more than 20 per cent of organic carbon.

4.1.3 Total nitrogen content of press mud cake :

The chemical composition of press mud cake in respect of total nitrogen content is reported in Table 7. It was observed that the range of total nitrogen content was from 1.39 to 1.96 per cent. The mean value for all the factories and months was 1.63 per cent indicating that there was large variation amongst different factories which might be ascribed

Table 6 : Organic carbon content of press mud cake.

Sr. No.	Name of the sugar factory	Per cent on oven dry basis					Mean for sugar factory
		Dec 77	Jan 78	Feb 78	Mar 78	Apr 78	
1.	Dnyaneshwar	36.77	41.19	38.44	37.90	37.90	38.44
2.	Godavari-I	35.56	36.78	36.32	35.05	34.11	35.56
3.	Godavari-S	35.60	35.60	34.11	37.90	36.00	35.84
4.	Kopargaon	29.71	23.24	22.07	24.63	32.21	26.37
5.	Laburi	25.89	26.48	23.37	36.00	34.42	29.23
6.	Sangamner	40.01	36.78	34.74	37.90	37.36	37.36
7.	Shrigonda	35.60	34.13	30.00	38.84	39.48	35.61
8.	Satpuda	21.48	29.05	29.05	33.79	35.37	29.75
9.	Vasant	32.36	43.84	38.11	32.21	36.88	36.88
10.	Kolhapur	30.60	35.30	36.53	33.47	38.00	34.78
11.	Panchganga	25.01	31.19	33.54	32.21	24.32	29.25
12.	Datta	37.66	38.25	36.32	38.53	38.53	37.86
13.	Kalambar	35.89	36.78	38.53	33.16	28.74	34.62
14.	Kakasaheb Wagh	37.27	37.27	35.26	38.21	38.21	37.24
15.	Niphad	31.99	32.07	31.77	31.90	32.21	31.49
16.	Terana	33.54	35.89	34.11	34.11	37.26	34.98
17.	Chhatrapati	34.14	36.77	34.95	35.69	33.16	34.94
18.	Krishna	32.95	36.90	36.90	38.21	38.53	36.70
19.	Shriram	35.89	37.66	30.30	30.00	33.47	33.46
20.	Siddheshwar	26.77	32.29	34.42	32.27	35.69	32.20
21.	Yashwant	29.42	32.66	28.11	30.32	32.21	30.54
Mean for month		32.58	34.77	33.19	34.44	34.96	33.98

	Sugar factory	Month
'F' test	**	*
S.E. ±	1.673	0.670
C.D. at 5 %	3.673	1.792
C.D. at 1 %	4.756	-

* Significant at 5 % level.

** Significant at 1 % level.

Table 7 : Total nitrogen content of press mud cake.

Sr. No.	Name of the sugar factory	Per cent on oven dry basis					Mean for sugar factory
		Dec 77	Jan 78	Feb 78	Mar 78	Apr 78	
1.	Dnyaneshwar	1.77	1.60	1.73	1.85	1.70	1.73
2.	Godavari-I	1.57	1.76	1.60	1.56	1.37	1.57
3.	Godavari-S	1.58	1.31	1.66	1.60	1.61	1.55
4.	Kopargaon	1.27	1.56	1.55	1.59	1.50	1.49
5.	Rahuri	1.63	1.37	1.62	1.34	1.52	1.50
6.	Sangamner	1.80	1.40	1.82	1.43	1.61	1.61
7.	Shrigonda	1.82	1.55	1.79	1.74	1.62	1.70
8.	Satpuda	1.99	1.96	2.08	1.92	1.84	1.96
9.	Vasant	1.83	1.25	1.40	1.82	1.56	1.56
10.	Kolhapur	1.41	1.75	1.82	1.53	1.43	1.59
11.	Panchganga	1.57	1.92	2.16	1.42	1.89	1.79
12.	Datta	1.79	1.17	1.18	1.56	1.24	1.39
13.	Kalambar	1.63	1.59	1.40	1.35	1.42	1.48
14.	Kakasaheb Wagh	1.77	1.77	1.75	1.85	1.74	1.78
15.	Niphad	1.72	1.67	1.78	1.70	1.71	1.72
16.	Terana	1.61	1.48	1.61	1.33	1.56	1.52
17.	Chhatrapati	1.50	1.63	1.56	1.56	1.25	1.50
18.	Krishna	1.95	1.75	1.75	1.98	1.73	1.75
19.	Shriram	1.90	1.51	1.99	1.17	1.35	1.58
20.	Siddheshwar	1.82	1.87	1.99	2.20	1.48	1.87
21.	Yashwant	1.76	1.75	1.66	1.65	1.58	1.68
Mean for month		1.70	1.60	1.70	1.61	1.56	1.63

	Sugar factory	Month
'F' test	**	*
S.E. ±	0.0765	0.0373
C.D. at 5 %	0.205	0.0999
C.D. at 1 %	0.265	-

* Significant at 5 % level.

** Significant at 1 % level.

to the variation in soil, climate, cane varieties grown and package of practices adopted. But less remarkable variation in total nitrogen contents was noticed in monthly interval. The mean values for total nitrogen for months ranged from 1.56 to 1.70 per cent. Similar observations regarding total nitrogen content of press mud cake were made by Samuel's, et al. (1955) in studies in Puerto Rico. Alexander (1972) reported that the filter mud from South African sugar factories contained 1.69 per cent total nitrogen. Patil (1975) and Prasad (1976) also reported that press mud cake contained 2.02 and 1.71 per cent total nitrogen, respectively.

4.1.4 Total P_2O_5 content of press mud cake :

The values for total P_2O_5 content of PMC obtained from various sugar factories are reported in Table 8.

It was observed that press mud cake of different factories contained large amount of P_2O_5 ranging from 1.84 to 3.31 per cent indicating the large variation. This may be due to variation in soil types and cane varieties. There was no much variation in total P_2O_5 of PMC received during monthly intervals. It ranged from 2.46 to 2.69 per cent. The mean value for all the sugar factories and months being 2.52 per cent. From these figures it was revealed that press mud cake contained appreciable amount of P_2O_5. This

Table 8 : Total P_2O_5 content of press mud cake.

Sr. No.	Name of the sugar factory	Per cent on oven dry basis					Mean for sugar factory
		Dec 77	Jan 78	Feb 78	Mar 78	Apr 78	
1.	Dnganeshwar	2.75	2.87	2.89	2.82	2.72	2.79
2.	Godavari-L	2.72	2.19	3.27	2.02	3.41	2.72
3.	Godavari-S	2.08	2.47	2.52	2.12	3.17	2.47
4.	Kopargaon	2.97	3.11	2.92	2.77	2.92	2.94
5.	Rahuri	3.12	3.80	2.31	2.47	2.62	2.86
6.	Sangamner	1.92	2.06	1.94	2.13	2.01	2.01
7.	Shrigonda	2.92	1.75	2.02	1.92	2.17	2.16
8.	Satpuda	3.14	3.51	3.17	3.22	3.51	3.31
9.	Vasant	2.43	2.13	2.37	3.07	2.50	2.50
10.	Kolhapur	2.25	2.02	2.17	2.02	2.47	2.19
11.	Panchganga	1.92	2.17	2.47	2.37	3.33	2.45
12.	Datta	2.02	1.65	1.71	1.82	2.02	1.84
13.	Kalambar	2.17	2.29	2.62	2.87	3.36	2.66
14.	Kakasaheb Wagh	2.46	2.46	2.97	2.11	2.31	2.46
15.	Niphad	2.57	2.82	2.32	2.57	2.57	2.57
16.	Terana	2.52	2.08	2.21	2.61	2.67	2.42
17.	Chhatrapati	1.99	2.04	2.08	2.06	1.77	1.99
18.	Krishna	2.13	2.22	2.22	2.06	2.47	2.22
19.	Shriram	2.62	2.87	3.12	2.67	2.97	2.85
20.	Siddheshwar	3.32	3.14	2.82	3.80	2.62	3.14
21.	Yashwant	2.47	1.98	1.77	2.31	2.97	2.30
Mean for month		2.50	2.46	2.47	2.47	2.69	2.52

	Sugar factory	Month
'I' test	**	N.S.
S.E. ±	0.155	0.0758
C.D. at 5 %	0.415	-
C.D.at 1 %	0.438	-

** Significant at 1 % level.

N.S. Non-significant.

is due to the addition of tripal super phosphate (TSP) in the process of juice clarification which ultimately remains as residue in the filter mud. Mesbahul, et al. (1974) from Rajshah Sugar Mills (Haryana) in Bangladesh observed that press mud cake contained 2.16 per cent P. Patil (1975) also observed similar results (1.95 per cent P_2O_5) in press mud cake from Kolhapur. The press mud cake used in one of the experiments conducted at Sugarcane Research Station, Padegaon contained 3.88 per cent P_2O_5 indicating that it is the rich source of phosphate (Anon. 1977).

4.1.5 Total K_2O content of press mud cake :

The total K_2O content of press mud cake from different sugar factories and during monthly intervals of crushing season differed widely, the data of which are presented in Table 9.

K_2O content of PMC in different factories ranged between 0.38 to 0.76 per cent and during monthly intervals it was from 0.51 to 0.59 per cent. The mean value for all the sugar factories was 0.55 per cent. Studies carried out by Samuel's (1955), Chopra (1959), Alexander (1972), Mesbahul, et al. (1974), Patil (1975), Prasad (1976) showed large variation in K_2O content of press mud cake, ranging from 0.27 to 0.71 per cent.

Table 9 : Total K_2O content of press mud cake

Sr. No.	Name of the sugar factory	Per cent on oven dry basis					Mean for sugar factory
		Dec 77	Jan 78	Feb 78	Mar 78	Apr 78	
1.	Dnyaneshwar	0.53	0.55	0.44	0.37	0.30	0.44
2.	Godavari-L	0.40	0.47	0.48	0.45	0.30	0.40
3.	Godavari-S	0.83	0.77	0.76	0.64	0.53	0.71
4.	Kopargaon	0.48	0.52	0.52	0.53	0.45	0.50
5.	Rahuri	0.62	0.73	0.60	0.62	0.62	0.64
6.	Sangamner	0.74	0.72	0.70	0.56	0.68	0.68
7.	Shrigonda	0.72	0.60	0.66	0.58	0.48	0.61
8.	Satpuda	0.50	0.62	0.52	0.46	0.46	0.51
9.	Vasant	0.96	0.65	0.61	0.62	0.71	0.71
10.	Kolhapur	0.50	0.54	0.55	0.45	0.50	0.51
11.	Panchganga	0.74	0.55	0.44	0.47	0.54	0.55
12.	Datta	0.46	0.46	0.50	0.42	0.43	0.46
13.	Kalambar	0.47	0.77	0.49	0.45	0.52	0.54
14.	Kakasaheb Wagh	0.76	0.76	0.70	0.76	0.83	0.76
15.	Niphad	0.60	0.56	0.75	0.60	0.55	0.61
16.	Terana	0.46	0.70	0.55	0.46	0.49	0.53
17.	Chhatrapati	0.49	0.46	0.55	0.45	0.50	0.49
18.	Krishna	0.38	0.35	0.38	0.35	0.44	0.38
19.	Shriram	0.42	0.47	0.55	0.66	0.47	0.51
20.	Siddheshwar	0.62	0.51	0.50	0.49	0.42	0.51
21.	Yashwant	0.53	0.55	0.55	0.40	0.44	0.49
Mean for month		0.58	0.59	0.56	0.51	0.51	0.55

	Sugar factory	Month
'F' test	**	**
S.E. ±	0.0298	0.0146
C.D. at 5 %	0.0797	0.0390
C.D. at 1 %	0.1033	0.0506

** Significant at 1 % level.

4.1.6 pH value of press mud cake :

The pH values for the air dried press mud cake are reported in Table 10 and graphically shown in Fig. 4.

The pH of PMC of different factories ranged from 5.34 to 6.90 and from 6.29 to 6.50 during monthly intervals. The mean value for sugar factories and monthly intervals being 6.44 indicated that the differences were highly significant in both the cases. The pH of the press mud cake was thus below 7.00 and this may be due to the double sulphitation process adopted in clarification of juice and quantity of triple super phosphate added in the process.

4.1.7 Electrical conductivity of press mud cake :

Electrical conductivity (Ec) in suspension and of the filtrate of the same is reported in Table 11 and graphically presented in Fig. 4.

It would be observed that differences in the values of electrical conductivity for sugar factories and for the monthly interval were highly significant. The mean values for various sugar factories were from 1.61 to 3.60 mmhos/cm and for monthly interval were from 2.47 to 2.98 mmhos/cm. Mean value for sugar factories and monthly interval was 2.69 mmhos/cm.

The data presented in Table 12 and graphically shown in Fig. 4. showed that all the values for electrical conductivity

Table 10 : pH (1:7.5) of press mud cake.

Sr. No.	Name of the sugar factory	Air dry basis					Mean for sugar factory
		Dec 77	Jan 78	Feb 78	May 78	Apr 78	
1.	Dnyaneshwar	5.7	6.6	6.0	5.7	6.0	6.00
2.	Godavari-I	6.1	5.8	5.7	6.2	6.9	6.14
3.	Godavari-S	6.8	6.9	7.0	6.7	7.0	6.88
4.	Kopargaon	6.8	6.9	6.7	7.0	6.8	6.84
5.	Rahuri	7.0	6.7	6.2	6.1	6.2	6.44
6.	Sangamner	7.6	7.4	7.1	7.2	7.3	7.32
7.	Shrigonda	5.7	5.6	5.3	5.0	5.1	5.34
8.	Satpuda	6.7	6.4	6.2	6.0	6.0	6.26
9.	Vasant	6.3	6.3	6.2	6.5	6.3	6.32
10.	Kolhapur	6.6	6.5	6.6	6.6	6.5	6.56
11.	Panchganga	7.1	7.1	6.6	6.4	7.1	6.86
12.	Datta	5.8	6.0	6.2	5.9	5.9	5.96
13.	Kalambar	6.1	6.2	5.5	5.3	6.6	5.94
14.	Kakasaheb Wagh	6.1	6.1	5.3	6.6	6.4	6.10
15.	Niphad	6.2	6.2	6.2	5.9	6.4	6.18
16.	Terana	6.7	6.2	5.9	5.8	6.9	6.30
17.	Chhatrapati	6.6	6.8	6.4	6.8	6.3	6.58
18.	Krishna	6.7	6.4	6.4	5.9	6.6	6.40
19.	Shriram	6.7	6.5	6.7	7.1	7.0	6.80
20.	Siddheshwar	6.7	6.5	6.6	6.6	6.2	6.52
21.	Yashwant	6.6	6.7	7.2	7.1	6.9	6.90
Mean for month		6.50	6.47	6.29	6.30	6.50	6.44

	Sugar factory	Month
'I' test	**	**
S.E. ±	0.131	0.0639
C.D. at 5 %	0.350	0.171
C.D. at 1 %	0.434	0.221

** Significant at 1 % level.

Table 11 : Electrical conductivity (in suspension) of press mud cake.

Sr. No.	Name of the sugar factory	mmhos/cm					Mean for sugar factory
		Dec 77	Jan 78	Feb 78	Mar 78	Apr 78	
1.	Dnyaneshwar	2.72	1.75	1.92	1.78	1.42	1.92
2.	Godavari-L	3.13	3.66	3.28	3.56	2.22	3.17
3.	Godavari-S	2.74	3.66	2.74	3.56	3.01	3.14
4.	Kopargaon	2.74	2.74	3.28	3.28	2.64	2.94
5.	Rahuri	2.46	2.74	3.28	4.10	3.56	3.23
6.	Sangamner	2.19	3.01	3.28	3.83	3.08	3.08
7.	Shrigonda	2.19	3.28	3.28	3.28	2.74	2.95
8.	Satpuda	2.74	2.19	2.06	2.19	1.91	2.22
9.	Vasant	2.74	2.74	3.83	2.74	3.01	3.01
10.	Kolhapur	1.59	1.31	1.59	1.91	1.64	1.61
11.	Panchganga	2.19	3.66	1.64	2.74	3.28	2.70
12.	Datta	1.91	1.78	2.74	2.05	2.05	2.11
13.	Kalambar	2.74	3.94	3.28	4.38	3.56	3.58
14.	Kakasaheb Wagh	2.89	2.89	2.28	3.01	3.28	2.87
15.	Niphad	2.39	1.91	2.46	2.74	2.46	2.39
16.	Terana	2.74	3.83	3.56	3.01	2.19	3.07
17.	Chhatrapati	3.60	2.46	4.38	2.91	4.65	3.60
18.	Krishna	2.46	2.64	2.64	3.56	1.91	2.64
19.	Shriramp	1.91	1.91	1.31	2.19	1.91	1.85
20.	Siddheshwar	1.91	1.79	1.31	2.46	1.48	1.79
21.	Yashwant	1.91	2.46	3.01	3.28	2.46	2.62
Mean for month		2.47	2.68	2.72	2.98	2.59	2.69

	Sugar factory	Month
'F' test	**	**
S.E. ±	0.228	0.218
C.D. at 5 %	0.609	0.584
C.D. at 1 %	0.789	0.756

** Significant at 1 % level.

Table 12 : Electrical conductivity (of filtrate) of press mud cake.

Sr. No.	Name of the sugar factory	mmhos/cm					Mean for sugar factory
		Dec 77	Jan 78	Feb 78	Mar 78	Apr 78	
1.	Dnyneshwar	3.28	2.19	2.36	2.19	1.78	2.36
2.	Godavari-I	4.04	4.38	4.38	4.38	3.01	4.04
3.	Godavari-S	3.83	4.38	3.56	4.92	4.10	4.16
4.	Kopargaon	4.38	3.83	3.83	4.38	3.91	4.07
5.	Rahuri	2.46	3.83	4.38	4.38	4.38	3.87
6.	Sangamner	2.74	3.56	4.38	2.19	3.22	3.22
7.	Shrigonda	2.74	3.83	4.10	4.38	3.56	3.72
8.	Satpuda	3.83	2.74	3.01	3.28	2.05	2.98
9.	Vasant	3.56	3.28	4.38	3.01	3.56	3.56
10.	Kolhapur	2.05	1.91	1.91	2.74	2.19	2.16
11.	Panchganga	3.01	4.10	2.19	3.28	3.83	3.28
12.	Datta	2.32	2.32	3.01	2.46	2.46	2.51
13.	Kalambar	3.56	4.92	3.83	4.92	4.38	4.32
14.	Kakasaheb Wagh	3.04	3.04	2.32	3.01	3.83	3.05
15.	Niphad	3.38	2.74	3.38	3.56	3.83	3.38
16.	Terana	3.28	4.92	4.65	3.56	3.01	3.88
17.	Chhatrapati	3.15	3.01	4.92	2.19	5.47	3.75
18.	Krishna	3.50	3.72	3.72	4.92	2.74	3.72
19.	Shriram	2.74	2.32	1.64	3.01	2.32	2.41
20.	Siddheshwar	2.74	2.63	2.46	2.60	2.74	2.63
21.	Yashwant	2.46	3.61	4.10	3.56	2.74	3.29
Mean for month		3.15	3.39	3.45	3.47	3.29	3.35

	Sugar factory	Month
'F' test	**	N.S.
S.E. ±	0.295	0.144
C.D. at 5 %	0.789	-
C.D. at 1 %	1.022	-

** Significant at 1 % level.

N.S. Non-significant.

were more in filtrate than in suspension. The range of electrical conductivity for different factories ranged from 2.16 to 4.32 mmhos/cm and for monthly intervals being 3.15 to 3.47 mmhos/cm indicated that there were more differences in factories than in the monthly intervals. The mean value for factories and monthly intervals was 3.35.

The electrical conductivity for factories and monthly intervals in filtrate was higher by 0.66 units than the Ec in suspension.

4.1.8 $CaCO_3$ content of press mud cake :

The chemical composition of press mud cake in respect of total $CaCO_3$ content is reported in Table 13.

The range of $CaCO_3$ content in different factories was found to be from 2.92 to 6.82 per cent. The differences were significant. This may be as a consequence of the variation in the quantity of lime solution used in buffer tank and free lime contents of different soils. But there was no such difference in the $CaCO_3$ content in case of monthly intervals. The range being from 4.41 to 5.30 per cent. The mean value for the different factories and for monthly intervals was 4.74 per cent. From these observations, it was clear that the press mud cake also contained appreciable amount of $CaCO_3$ and it could be a source of Ca. Similar observations were reported by Seshadri, et al. (1968). He reported

Table 13 : $CaCO_3$ content of press mud cake.

Sr. No.	Name of the sugar factory	Per cent on oven dry basis					Mean for sugar factory
		Dec 77	Jan 78	Feb 78	Mar 78	Apr 78	
1.	Dnyaneshwar	3.7	4.4	4.4	4.2	5.5	4.44
2.	Godavari-I	3.7	3.7	2.3	3.7	4.9	3.66
3.	Godavari-II	4.0	7.5	4.1	4.5	4.5	4.92
4.	Kopargaon	8.2	5.9	7.7	6.2	6.1	6.82
5.	Rahuri	3.5	4.9	5.3	3.9	5.3	4.58
6.	Sangamner	7.2	5.0	5.7	5.9	5.9	5.94
7.	Shrigonda	5.4	3.6	2.8	2.8	5.2	3.96
8.	Satpuda	3.5	5.7	4.9	4.4	5.3	4.76
9.	Vasant	3.8	2.3	2.7	3.1	3.0	2.98
10.	Kolhapur	4.0	4.0	5.0	5.2	4.3	4.50
11.	Panchganga	6.5	5.1	5.6	4.0	6.6	5.56
12.	Datta	2.7	2.5	3.0	3.4	3.0	2.92
13.	Kalambar	7.0	4.7	3.6	2.2	6.3	4.78
14.	Kakasaheb Wagh	4.3	4.3	4.2	4.3	4.5	4.32
15.	Niphad	4.8	4.7	3.8	4.7	6.2	4.84
16.	Cerana	7.2	5.0	3.3	4.6	5.6	5.14
17.	Chhatrapati	3.5	3.5	3.0	4.4	3.3	3.54
18.	Krishna	4.3	5.0	5.0	5.0	5.6	4.98
19.	Shriram	5.2	3.5	4.8	6.6	7.3	5.48
20.	Siddheshwar	5.5	5.6	4.7	6.0	5.5	5.46
21.	Yashwant	4.1	6.4	8.7	3.5	7.5	6.04
Mean for month		4.86	4.63	4.50	4.41	5.30	4.74

	Sugar factory	Month
'T' Test	*	N.S.
S.E. ±	0.565	0.275
C.D. at 5 %	1.512	-

* Significant at 5 % level.

N.S. Non-significant.

that carbonation mud can be used as a substitute for lime stone in the production of sinter and pallets from iron Ore fines in steel industries. Markus (1977) also pointed out that the fired lime in pig and brioler chicken rations can be replaced with dried carbonation press mud. Further, Vernois (1971) in his studies reported that lime could be recovered from filter cake.

4.2 Field experiment : Studies on the residual effect of application of press mud cake on soil properties, yield and quality of sugarcane :

The regular experiment on the studies on application of graded levels of press mud cake was conducted on Adsali crop of sugarcane with Co.740 during 1975-77 at Sugarcane Research Station, Padegaon, the data of which in brief is reported in Appendix IV. It was found that the press mud cake was equally efficient to fertilizer treatments as all the treatments of press mud cake had given good effects on yield, quality of sugarcane and on the soil properties. These treatments increased the availability of P_2O_5 and K_2O, and the organic carbon content of soil. The net economic profit given by the press mud cake treatments was to the extent from 7.60 to 25.26 per cent more as compared to recommended dose of inorganic fertilizers (Patil, et al., 1978). It was also observed that the quality of juice was

improved as evidenced from low N/P_2O_5 ratio of juice and higher purity over the recommended dose (Bawasakar, et al. 1978). Press mud cake being organic in nature. It was therefore felt necessary to study residual effect of PMC on soil properties and succeeding sugarcane crop. Hence the same experiment was continued at the same site with the same randomization during Adsali season of 1977-78. The results are reported here.

4.2.1 Residual effect of press mud cake and inorganic fertilizers on soil properties :

The residual effect of press mud cake and inorganic fertilizers on soil properties was studied before planting, at earthing up, at grand growth and at harvest of the sugarcane and the data in respect of organic carbon, total nitrogen, C/N ratio, available P_2O_5, available K_2O, soil reaction and electrical conductivity are presented in Tables 14, 15, 16, 17, 18, 19 and 20, respectively.

4.2.1.1 Effect on organic carbon content of soil :

The data presented in Table 14 would reveal that the organic carbon content of soil was significantly more due to application of press mud cake treatments over the inorganic fertilizers at all the stages of crop growth. There was a linear increase in organic carbon content of soil with the increased doses of press mud cake. The

maximum organic carbon (0.96 %) content of soil was observed in highest dose of press mud cake (25 t/ha) at earthing up and lowest (0.75 %) in the treatment of 400 kg N alone at harvest.

Table 14 : Residual effect of press mud cake and inorganic fertilizer on organic carbon content soil at different growth stages of sugarcane.

Sr. No.	Treatments	Per cent on oven dry basis			
		Before planting	At earthing up	At grand growth	At harvest
1.	400 kg N/ha alone	0.72	0.78	0.79	0.75
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	0.71	0.80	0.83	0.79
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	0.70	0.83	0.81	0.77
4.	Press mud cake @ 12.5 t/ha	0.78	0.86	0.88	0.82
5.	Press mud cake @ 18.5 t/ha	0.87	0.93	0.87	0.82
6.	Press mud cake @ 25.0 t/ha	0.87	0.96	0.88	0.90
	'F' test		**	*	**
	S.E. ±		0.024	0.016	0.013
	C.D. at 5 %		0.075	0.050	0.041
	C.D. at 1 %		0.108	-	0.058

** Significant at 1 % level.

* Significant at 5 % level.

It was further observed that the organic carbon content of soil reduced with the advancement in the age of crop. This

may be attributed to decomposition of organic matter resulting in mineralization and utilization by the crop. Similar results were reported by Patil (1975), Bawasakar et al. (1978).

4.2.1.2 Effect on total nitrogen content of soil :

The data presented in Table 15 would reveal that the different treatments of press mud cake and inorganic fertilizers influenced the total nitrogen content of soil differently.

Table 15 : Residual effect of press mud cake and inorganic fertilizer on total nitrogen content of soil at different growth stages of sugarcane.

Sr. No.	Treatments	Per cent on oven dry basis			
		Before planting	At earthing up	At grand growth	At harvest
1.	400 kg N/ha alone	0.053	0.067	0.064	0.054
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	0.058	0.070	0.061	0.060
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	0.057	0.067	0.065	0.061
4.	Press mud cake @ 12.5 t/ha	0.060	0.070	0.066	0.066
5.	Press mud cake @ 18.5 t/ha	0.065	0.072	0.072	0.064
6.	Press mud cake @ 25.0 t/ha	0.068	0.074	0.068	0.071
	'F' test		N.S.	N.S.	N.S.
	S.E. ±		0.0022	0.0035	0.0036

N.S. = Non-significant.

There was linear trend of total nitrogen content of soil (0.070, 0.072 and 0.074 per cent) with increased dose of press mud cake (12.5, 18.5 and 25.0 t/ha) at earthing up

stage. But the same trend could not be maintained with the advancement in crop age. This may be due to more utilization of nitrogen by the crop at grand growth stage (Bawasakar, et al. 1978). The nitrogen content at harvest was reduced, in general as compared to early growth period; however, it was observed that the total nitrogen content at harvest of the crop was at higher level (0.066, 0.064 and 0.071 %) in press mud cake treatments as compared to inorganic fertilizer treatments (0.054, 0.060 and 0.061 %) indicating that press mud cake could be more effective for maintaining soil fertility at higher level in respect of total nitrogen over longer period. This may be due to organic nitrogen content of press mud cake. Similar observations were noted by Lad and Patel (1954).

4.2.1.3 Effect of C/N ratio of soil :

The data reported in Table 16 in respect of C/N ratio of soil at different growth stages of crop, would indicate that the C/N ratio in press mud cake treatments was not much influenced and maintained more or less same trend. At grand growth stage, amongst the press mud cake treatments lower C/N ratio (12.08) was observed in the treatment of 18.5 t/ha of press mud cake and higher (13.33) at the same period in treatment of 12.5 t/ha of PMC.

Table 16 : Residual effect of press mud cake and inorganic fertilizers on C/N ratio of soil at different growth stages of sugarcane.

Sr. No.	Treatments	Before planting	At earthing up	At grand growth	At harvest
1.	400 kg N/ha alone	13.58	11.64	12.34	13.89
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	12.24	11.43	13.61	13.17
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	12.28	12.39	12.46	12.62
4.	Press mud cake @ 12.5 t/ha	13.00	12.29	13.33	12.42
5.	Press mud cake @ 18.5 t/ha	13.38	12.92	12.08	12.81
6.	Press mud cake @ 25.0 t/ha	12.79	12.97	12.94	12.67

Before earthing up stage, amongst the inorganic fertilizer treatments lower C/N ratio (11.43) was observed in the treatment of 400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha, and at harvest, higher C/N ratio (13.89) was noticed in the treatment of 400 kg N/ha alone indicating that there was more variation in these treatments.

4.2.1.4 Effect on available P_2O_5 content of soil :

The data reported in Table 17 would indicate that the different press mud cake treatments showed higher available P_2O_5 content of soil than inorganic fertilizer treatments at all the growth stages of sugarcane.

Table 17 : Residual effect of press mud cake and inorganic fertilizers on available P_2O_5 content of soil at different growth stages of sugarcane.

Sr. No.	Treatments	mgm/100 gm on oven dry basis			
		Before planting	At earthing up	At grand growth	At harvest
1.	400 kg N/ha alone	0.31	0.64	0.40	0.36
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	0.55	1.31	0.72	0.54
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O /ha	0.94	1.26	1.14	0.75
4.	Press mud cake @ 12.5 t/ha	1.02	1.33	0.69	1.15
5.	Press mud cake @ 18.5 t/ha	1.68	1.15	0.89	1.06
6.	Press mud cake @ 25.0 t/ha	2.19	1.77	1.22	1.57
	'F' test		**	**	**
	S.E. ±		0.144	0.112	0.179
	C.D. at 5 %		0.453	0.354	0.565
	C.D. at 1 %		0.644	0.504	0.803

** Significant at 1 % level.

Amongst the press mud cake treatments highest (2.19 mg/100 g) content of available P_2O_5 was at initial stage with the treatment of 25.0 t/ha of PMC. But with the advancement in crop age, available P_2O_5 content was reduced, lowest (0.69 mg/100 g) being in the treatment of 12.5 t/ha of PMC at grand growth. It may be owing to more utilization of P_2O_5 by the crop. With the increase in dose of press mud cake, the available P_2O_5 content of the soil was increased, in general.

Amongst the inorganic fertilizer treatments, the linear trend of available P_2O_5 content of soil was observed with the increasing doses of fertilizers. Maximum (1.31 mg/100 g) P_2O_5 content was found in treatment of 400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha at earthing up stage and lowest (0.36 mg/100 g) in treatment of 400 kg N/ha alone at harvest.

From the data it was observed that the residual effect of press mud cake in respect of available P_2O_5 content was increased; this may be obviously due to higher organic P_2O_5 content of PMC which might have contributed in increasing the availability of phosphate. Similar observations were made by Prasad (1974). The increase in the availability of P_2O_5 was also noticed by Patil (1975) and Bawasakar, et al. (1978).

4.2.1.5 Effect on available K_2O content of soil :

The data in respect of available K_2O content of soil are presented in Table 18.

From the data, it could be seen that the available K_2O content of soil was increased with the advancement in crop age and with the increasing levels of inorganic fertilizer and press mud cake treatments though the differences were not significant.

Table 18 : Residual effect of press mud cake and inorganic fertilizers on available K_2O content of soil at different growth stages of sugarcane.

Sr. No.	Treatments	mgm/100 g on oven dry basis			
		Before planting	At earthing up	At grand growth	At harvest
1.	400 kg N/ha alone	10.30	13.00	17.88	18.08
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	12.41	13.33	19.50	19.17
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	11.83	14.75	20.50	19.42
4.	Press mud cake @ 12.5 t/ha	11.08	14.00	19.25	18.25
5.	Press mud cake @ 18.5 t/ha	10.83	13.33	20.00	18.08
6.	Press mud cake @ 25.0 t/ha	12.00	15.00	17.72	19.50
	'F' test		N.S.	N.S.	N.S.
	S.E. ±		0.890	0.996	0.928

N.S. = Non-significant.

Amongst the inorganic fertilizer treatments the increase in available K_2O was from 10.30 mg/100 g in the treatment of 400 kg N/ha at before planting to 20.50 gm/100 g in treatment of 560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha at grand growth stage.

It was further noticed that amongst the press mud cake treatments the increase in available K_2O was from 10.83 mg/100 g in treatment of 18.5 t/ha before planting to 20.0 mg/100 g in the same treatment at grand growth stage. These results

corroborate with the results reported by Golden (1975) and Patil (1975).

4.2.1.6 Effect on soil reaction :

The data in respect of effect of inorganic fertilizer and press mud cake treatments on soil reaction are presented in Table 19.

Table 19 : Residual effect of press mud cake and organic fertilizers on soil reaction at different growth stages of sugarcane.

Sr. No.	Treatments	Before planting	At earthing up	At grand growth	At harvest
1.	400 kg N/ha alone	7.66	7.57	7.77	7.77
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	7.66	7.60	7.87	7.80
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	7.66	7.57	7.87	7.83
4.	Press mud cake @ 12.5 t/ha	7.63	7.53	7.90	7.80
5.	Press mud cake @ 18.5 t/ha	7.70	7.57	7.80	7.90
6.	Press mud cake @ 25.0 t/ha	7.66	7.53	7.77	7.83
	'F' test		N.S.	N.S.	N.S.
	S.E. ±		0.033	0.0457	0.042

N.S. = non-significant.

The differences in the values of soil pH were found to be non-significant indicating that the soil reaction was not influenced by any of the treatments.

4.2.1.7 Effect of electrical conductivity of soil :

The data pertaining to electrical conductivity are presented in Table 20.

Table 20 : Residual effect of press mud cake and inorganic fertilizers on electrical conductivity of soil at different growth stages of sugarcane.

Sr. No.	Treatments	Before planting	At earthing up	At grand growth	At harvest
			mhos/cm		
1.	400 kg N/ha alone	0.22	0.25	0.21	0.16
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	0.17	0.24	0.21	0.15
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	0.19	0.25	0.21	0.16
4.	Press mud cake @ 12.5 t/ha	0.18	0.24	0.20	0.14
5.	Press mud cake @ 18.5 t/ha	0.20	0.24	0.22	0.14
6.	Press mud cake @ 25.0 t/ha	0.21	0.25	0.21	0.16
	'F' test		N.S.	N.S.	N.S.
	S.E. ±		0.012	0.0057	0.011

N.S. = Non-significant.

From the data it is seen that the differences were not significant in all the treatments, but with the advancement in age of sugarcane crop the electrical conductivity decreased in all the treatments. Considerable decrease in electrical conductivity was observed in the treatments of press mud cake, at harvest. Amongst the PMC treatments maximum decrease was

noted in PMC at the rate of 12.5 t/ha and 18.5 t/ha from earthing up to harvest by 0.10 unit. Similar results were reported by Zende (1968) in the pot culture studies carried out with different agricultural waste products in reclamation of saline alkali soil and he found the reduction of total soluble salts from 1.70 to 1.32 per cent.

Bawasakar, et al. (1978) also observed reduction in electrical conductivity in soil due to incorporation of press mud cake.

4.2.2 Residual effect of press mud cake and inorganic fertilizers on the nutrient uptake by the sugarcane crop :

The plant samples of stem and crown (green leaves) collected from different treatments at grand growth stage and at harvest were analysed for the nutrient content and the data pertaining to total nitrogen, P_2O_5 and K_2O are presented in Tables 21 and 22, respectively. Similarly, uptake per hectare and per ton of sugarcane at harvest are presented in Table 23.

4.2.2.1 Total N, P_2O_5 and K_2O content of sugarcane stem and crown at grand growth stage :

The data presented in Table 21 showed that the differences in the total N, P_2O_5 content of stem and crown were statistically significant.

Table 21 : Residual effect of press mud cake and inorganic fertilizers on the nutrient contents of sugarcane at grand growth stage.

Sr. No.	Treatments	Symbol	Stem			Crown		
			N	P_2O_5 %	K_2O	N	P_2O_5 %	K_2O
1.	400 kg N/ha alone	A	0.26	0.14	0.24	0.64	0.12	0.45
2.	400 kg N + 170 kg P_2O_5 + 170 Kg K_2O/ ha	B	0.43	0.19	0.31	0.80	0.20	0.51
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	C	0.41	0.18	0.27	0.76	0.18	0.51
4.	Press mud cake @ 12.5 t/ha	D	0.44	0.20	0.32	0.71	0.17	0.59
5.	Press mud cake @ 18.5 t/ha	E	0.45	0.19	0.31	0.73	0.17	0.53
6.	Press mud cake @ 25.0 t/ha	F	0.48	0.23	0.42	0.97	0.19	0.59
	'F' test		**	**	*	**	**	N.S.
	S.E. ±		0.021	0.0095	0.030	0.029	0.009	0.032
	C.D. at 5 %		0.066	0.030	0.093	0.091	0.029	-
	C.D. at 1 %		0.094	0.043	N.S.	0.130	0.042	-

** Significant at 1 % level.

* Significant at 5 % level.

N.S. Non-significant.

Higher N, P_2O_5 and K_2O contents were found in the treatments of press mud cake indicating that there was more uptake of these nutrients by the cane than other treatments. Maximum uptake of N (0.48 %) in the stem and in the crown (0.97 %) was observed in treatment of press mud cake applied at the rate of 25 t/ha and minimum i.e. 0.26 and 0.64 per cent being in treatment of 400 kg N/ha alone.

More or less same trend in P_2O_5 content of stem and crown was observed in different treatments except the treatment of 400 kg N/ha alone. P_2O_5 content of stem and crown was found in the following descending order.

Stem : F > D > B=E > C > A

Crown : B > F > C > D=E > A

As regards the total K_2O content of stem and crown it was observed that the PMC at the rate of 25 t/ha gave maximum K_2O content (0.42 %) in the stem and (0.59 %) in crown in the PMC at the rate of 12.5 t/ha and 25.0 t/ha. Thus the residual effect of press mud cake treatment showed more utilization of nutrients by the crop than inorganic fertilizer treatments.

All the treatments showed more contents of N and K_2O in crown than in stem. However, more P_2O_5 content was noticed in stem than crown.

4.2.2.2 Nutrient contents of sugarcane at harvest :

From the data presented in Table 22 it could be seen that the total nitrogen content of stem and crown at harvest was more in the treatments of press mud cake than in the inorganic fertilizer treatments. The highest nitrogen content (0.31 % in stem and 0.46 % in corwn) was found in the treatment of 25.0 t/ha of press mud cake and lowest (0.13 % in stem and 0.33 % in crown) in the treatment of 400 kg N/ha alone.

As regards P_2O_5 content of stem and crown at harvest it was observed that the higher content of P_2O_5 was found in the treatments of press mud cake than in the inorganic fertilizer treatments indicating more utilization of P_2O_5 by stem and crown.

Maximum K_2O content (0.73 %) in stem was observed in the treatment of 400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha and maximum (0.79) in crown in the treatment of 25.0 t/ha of press mud cake.

400 kg N/ha alone showed minimum N P K content in stem as well as in crown. The treatment differences for N and P_2O_5 were statistically significant for the K_2O content of stem.

4.2.2.3 Nutrient uptake per hectare and per ton of sugarcane at harvest :

Uptake of nitrogen, P_2O_5 and K_2O by the sugarcane crop at harvest was calculated and reported in Table 23 and graphically shown in Fig. 5-A.

Table 22 : The residual effect of press mud cake and inorganic fertilizers on the nutrient contents of sugarcane at harvest.

Sr. No.	Treatments	Symbol	Stem			Crown		
			N	P_2O_5	K_2O	N	P_2O_5	K_2O
			%			%		
1.	400 kg N/ha alone	A	0.13	0.09	0.41	0.33	0.08	0.54
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	B	0.20	0.14	0.73	0.36	0.13	0.69
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	C	0.23	0.16	0.55	0.40	0.13	0.69
4.	Press mud cake @ 12.5 t/ha	D	0.24	0.15	0.49	0.40	0.14	0.71
5.	Press mud cake @ 18.5 t/ha	E	0.22	0.16	0.47	0.38	0.15	0.71
6.	Press mud cake @ 25.0 t/ha	F	0.31	0.20	0.57	0.46	0.16	0.79
	'F' test		*	**	N.S.	**	**	**
	S.E. ±		0.028	0.014	0.074	0.017	0.0042	0.033
	C.D. at 5 %		0.089	0.045	-	0.049	0.013	0.105
	C.D. at 1 %		0.065	0.064	-	0.070	0.019	0.149

** Significant at 1 % level.

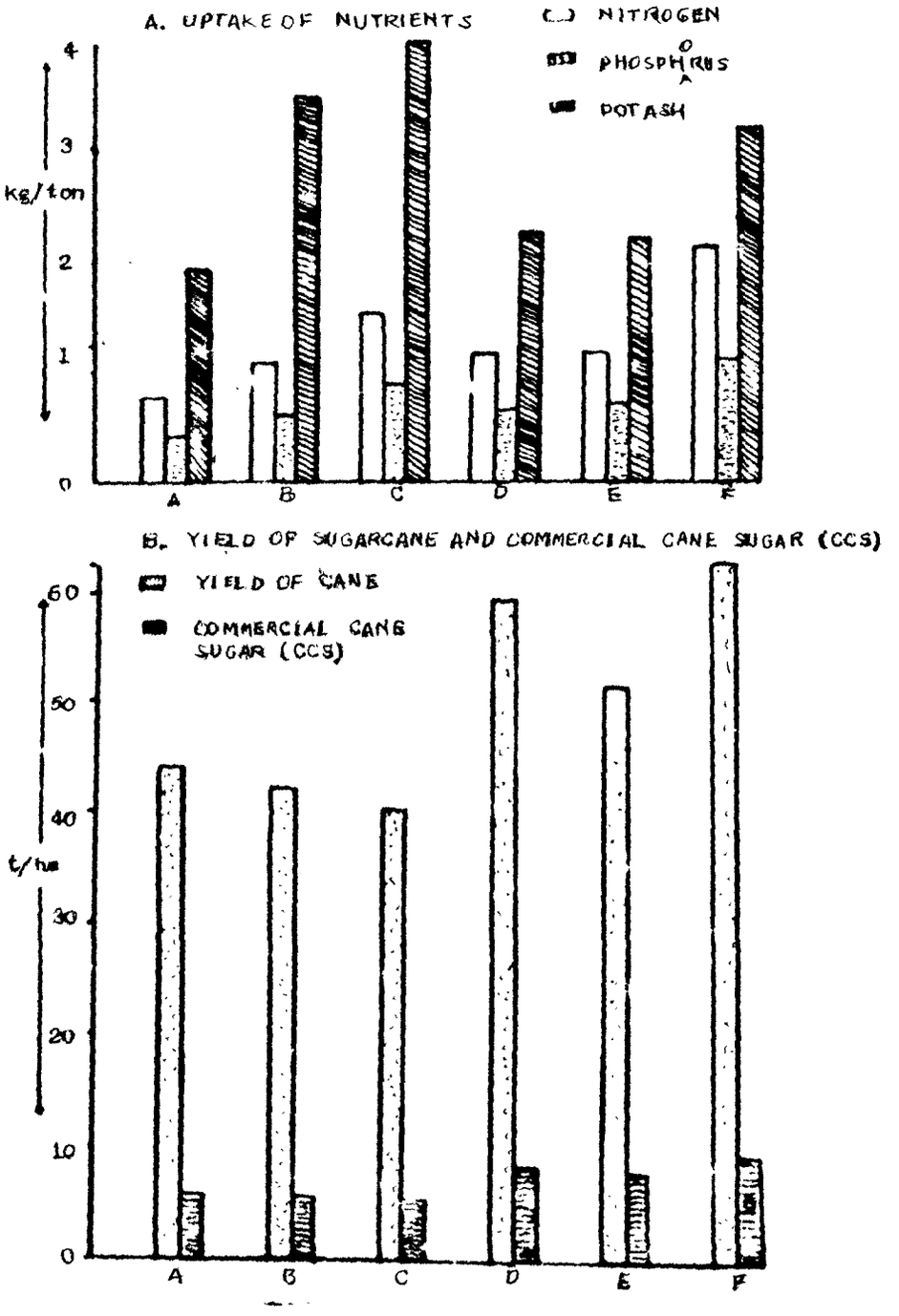
* Significant at 5 % level.

N.S. Non-significant.

Table 23 : Uptake of nutrients by the sugarcane at harvest (Average of three replications).

Sr. No.	Treatments	Symbol	Yield	: Total uptake by sugarcane			: Total uptake		
			MT/ha	kg/ha			kg/t		
				N	P_2O_5	K_2O	N	P_2O_5	K_2O
1.	400 kg N/ha alone	A	44.27	32.98	17.00	82.32	0.74	0.38	1.86
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	B	41.97	47.10	25.47	146.30	1.12	0.61	3.48
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	C	40.18	59.49	34.43	160.61	1.48	0.86	4.00
4.	Press mud cake @ 12.5 t/ha	D	58.95	66.53	37.96	132.07	1.13	0.64	2.24
5.	Press mud cake @ 18.5 t/ha	E	52.45	56.41	35.96	115.72	1.08	0.69	2.21
6.	Press mud cake @ 25.0 t/ha	F	62.53	112.82	69.21	199.32	1.80	1.11	3.19

FIG. 5 : UPTAKE OF NUTRIENTS, YIELD OF SUGARCANE, AND COMMERCIAL CANE SUGAR (CCS) AT HARVEST, AS INFLUENCED BY PRESS MUD CAKE AND INORGANIC FERTILIZERS.



A: 400 Kg N/ha, B : 400 Kg N + 170 Kg P_2O_5 + 170 kg K_2O /ha
C: 560 Kg N + 340 kg P_2O_5 + 170 Kg K_2O/ha, D: PMC @ 12.5 t/ha
E: PMC @ 18.5 t/ha, F: PMC @ 25.0 t/ha.

From the data reported in Table 23 it was observed that with the increasing doses of inorganic fertilizers and press mud cake treatments, the uptake of N, P_2O_5 and K_2O per hectare was increased except the application of press mud cake at the rate of 18.5 t/ha.

Maximum uptake of 112.82 kg N, 69.21 kg P_2O_5 and 199.32 kg K_2O per hectare was recorded in the treatment of 25.0 t/ha of press mud cake and minimum being in the treatment of 400 kg N/ha alone. It was further observed that higher uptake of nutrients in press mud cake treatments might be due to more availability of N, P_2O_5 and K_2O by the incorporation of press mud cake which as a consequences reflected in more utilization of nutrients from the soil than the inorganic fertilizers. Similar observations in respect of uptake of nutrients by sugarcane were made by Singh (1974), Patil (1975), Prasad (1976) also reported that the phosphorus in filter cake was more effective than triple super phosphate in increasing the leaf P. Bawasakar, et al. (1978) also observed that the press mud cake was the better supplier of P_2O_5 as revealed from the higher uptake of it in sugarcane.

Uptake of nutrients kg/t was found in the following order of merit.

N	:	F > C > D > B > E > A
P_2O_5	:	F > C > E > D > B > A
K_2O	:	C > B > F > D > E > A

It was observed that absorption of N, P_2O_5 and K_2O per hectare was less in the treatment of 400 kg N/ha alone, because of the fact that P_2O_5 and K_2O was not supplied through this treatment. The maximum uptake of N (1.80 kg/t) and P_2O_5 (1.11 kg/t) was noticed in the treatment of 25.0 t/ha of press mud cake. Maximum uptake of K_2O (4.00 kg/t was recorded in the treatment of 560 kg N, + 340 kg P_2O_5 + 170 kg K_2O per hectare.

4.2.3 Residual effect of press mud cake and inorganic fertilizers on yield and quality of sugarcane :

4.2.3.1 Effect on yield contributing parameters and yield of cane :

It could be seen from the data reported in Table 24 and graphically shown in Fig. 5-B, that the effects of different treatments of press mud cake and inorganic fertilizers on the germination at 8th week, tillering at 16th week, number of internodes and average weight of cane at harvest were not significant. However, the differences in press mud cake treatments for millable heights and girth of cane were significant indicating that these two factors contributed towards the increase in yields over inorganic fertilizer treatments. The effect of incorporation of press mud cake at the rate of 12.5 t/ha and 25.0 t/ha were highly significant over inorganic fertilizer treatments in respect of number of millable canes and yield of sugarcane.

Table 24 : Residual effect of press mud cake and inorganic fertilizers on yield contributing parameters and yield of sugarcane.

Sr. No.	Treatments	Symbol	Germination at 8th week	Tillering ratio at 16th week	Millable height (cm)	No.of internodes at harvest	Girth of cane at harvest (cm)	Av.wt. of cane at harvest (Kg)	No.of millable canes at harvest/ha	Yield of cane t/ha
1.	400 kg N/ha alone	A	48.78	1.90	192.33	27.33	7.33	0.81	63543	44.27
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	B	50.43	2.38	205.00	26.00	7.20	0.90	66177	41.97
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	C	53.05	1.73	199.00	26.67	8.10	0.91	66711	40.18
4.	Press mud cake @ 12.5 t/ha	D	52.11	2.08	207.67	26.00	8.33	0.93	74302	58.95
5.	Press mud cake @ 18.5 t/ha	E	50.57	2.07	203.67	27.67	8.17	0.91	66065	52.45
6.	Press mud cake @ 25.0 t/ha	F	52.68	2.19	229.33	30.67	8.53	1.08	82483	62.53
	'F' test		N.S.	N.S.	*	N.S.	*	N.S.	**	**
	S.E. ±		1.963	0.165	5.655	1.340	0.252	0.053	1847	2.878
	C.D. at 5 %		-	-	17.820	-	0.795	-	5823	9.067
	C.D. at 1 %		-	-	-	-	-	-	8279	12.895

** Significant at 1 % level. * Significant at 5 % level.

N.S. = Non-significant.

Highest millable height (229.33 cm), number of internodes (30.67), girth (8.53 cm), average weight of cane (1.08 kg) and number of millable canes per hectare (82483) were observed in the treatment of 25.0 t/ha of press mud cake which contributed in increase in the cane yield significantly. The highest yield i.e. 62.53 t/ha was also recorded in the application of 25.0 t/ha of press mud cake and was significantly superior over the treatments of application of inorganic fertilizers alone.

Similar results were recorded at Bandhanpuri (Anon. 1956-57), Misra(1968) also recorded the beneficial effect of organics like press mud cake on the yield of sugarcane. Rao et al. (1970) reported that by application of filter press mud at the rate of 10 tons per acre increase in the yield by about 3 tons over 200 lb/a. The increase to the extent of 30 per cent as a result of addition filter mud at the rate of 100 Mt/ha were recorded by Aloma (1970) and he further observed the beneficial residual effects of press mud over 5 years. Similar results were also recorded by Samuel's et al. (1955), Alexander (1972), Patil (1975), Prasad (1976).

Patil et al. (1978) observed increase in the yields over inorganic fertilizers due to application of press mud cake.

4.2.3.2 Effect on quality of juice at harvest :

The quality of juice at harvest of sugarcane crop as judged from the Brix, Sucrose, purity, commercial cane sugar (CCS) is reported in Table 25 and chemical composition of juice viz., total N, total P_2O_5 and mineral matter (ash) content is reported in Table 26.

It was observed that the maximum brix (21.37), sucrose (19.97 %), the purity (93.45 %) and commercial cane sugar in juice (14.37 %) were recorded in the treatment of press mud cake applied at the rate of 18.5 t/ha. The improvement in quality of juice might be obviously due to higher organic total P_2O_5 content of press mud cake. The improvement in quality of juice by application of organics like press mud cake was observed by Singh and Singh (1973), Patil (1975).

The maximum (8.83) CCS t/ha was produced by press mud cake at the rate of 25.0 t/ha whereas minimum (5.63 t/ha) being in the treatment of 560 kg N + 340 kg P_2O_5 + 170 kg K_2O per hectare.

The quality of juice as affected by its chemical composition in respect of total nitrogen, total P_2O_5 and mineral matter (ash) content and N/P_2O_5 ratio is presented in Table 26.

Table 25 : Residual effect of press mud cake and inorganic fertilizers on quality of juice at harvest.

Sr. No.	Treatments	Symbol	Brix	Sucrose %	Purity %	CCS in juice %	CCS t/ha	Yield t/ha
1.	400 kg N/ha alone	A	20.35	18.57	91.16	13.20	5.84	44.27
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	B	21.21	19.46	91.76	13.88	5.83	41.97
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	C	21.21	19.58	92.34	14.01	5.63	40.18
4.	Press mud cake @ 12.5 t/ha	D	21.04	19.23	91.42	13.70	8.08	58.95
5.	Press mud cake @ 18.5 t/ha	E	21.37	19.97	93.45	14.37	7.54	52.45
6.	Press mud cake @ 25.0 t/ha	F	21.37	19.73	92.31	14.12	8.83	62.53
	'F' test		N.S.	N.S.	N.S.	N.S.	-	**
	S.E. ±		0.279	0.285	0.749	0.233	-	2.878
	C.D. at 5 %		-	-	-	-	-	9.067
	C.D. at 1 %		-	-	-	-	-	12.895

** Significant at 1 % level.

N.S. = Non-significant.

Table 26 : The residual effect of press mud cake and inorganic fertilizers on chemical composition of juice at harvest.

Sr. No.	Treatments	Symbol	Total N	Total P_2O_5	N/P_2O_5 ratio	Mineral matter (ash) in juice
			mg/100 ml			gm/lit
1.	400 kg N/ha alone	A	36.93	27.07	1.37	5.80
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	B	44.07	32.50	1.36	6.53
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	C	40.13	27.07	1.48	6.27
4.	Press mud cake @ 12.5 t/ha	D	50.73	38.90	1.22	4.47
5.	Press mud cake @ 18.5 t/ha	E	51.40	41.90	1.23	5.30
6.	Press mud cake @ 25.0 t/ha	F	60.13	51.93	1.16	4.67
	'F' test		**	**	*	N.S.
	S.E. ±		1.98	2.73	0.061	0.510
	C.D. at 5 %		6.24	8.60	0.19	-
	C.D. at 1 %		8.87	12.23	-	-

** Significant at 1 % level.

* Significant at 5 % level.

N.S. Non-significant.

It could be seen that the maximum nitrogen content in juice (60.13 mg/100 ml) and P_2O_5 content (51.93 mg/100 ml) was in the treatment of 25.0 t/ha of press mud cake.

Parthasarathi (1972) reported that higher P_2O_5 content

in juice was better for good quality of juice. He further noted that minimum of 300 mg of P_2O_5 content per litre of juice was desirable for good quality of juice. Prasad (1976) observed that increase in N and P_2O_5 in juice gave better quality of juice. Higher N and P_2O_5 content of juice was recorded in all the treatments of press mud cake over inorganic fertilizer treatments reflecting in lowering down the N/P_2O_5 ratio of juice. The lowest (1.16) ratio was observed in the treatment of 25.0 t/ha of press mud cake indicating that the juice quality was superior over all other treatments. This low ratio had a direct influence on recovery of sugar. Similar observations were made by Kadrekar (1955), Chinchorkar (1970) and Kakade (1971) and adduced that when the N/P_2O_5 ratio in juice was below 1.5, the juice was supposed to be of better quality. Patil, et al. (1978) observed the similar response to the press mud cake treatment in respect of N/P_2O_5 ratio of juice.

It was also observed from the Table 26 that the mineral matter (ash) content in the juice was lower in press mud cake treatment ranging from 4.47 to 5.30 g/lit of juice over inorganic fertilizer treatments which ranged from 5.80 to 6.53 gm/lit of juice.

The recovery of cane is inversely proportional to the mineral matter content in juice (Kadrekar, 1955). The lower content of mineral matter in respect of press mud cake treatments resulting in to better sugar recovery and good quality of juice established its preponderance over inorganic fertilizer treatments.

4.3 Incubation studies :

The incubation studies on the basis of the treatments of the field experiment are presented in Table 4 . In these studies the rate of mineralization of nitrogen, organic carbon, availability of P_2O_5 and K_2O, changes in the soil reaction, effect on $CaCO_3$ content and electrical conductivity of soil were studied.

The soil with different treatments was incubated for a period of 90 days. The soil samples were taken initially after 2 days and there after at 15 days interval and analysed for NH_4^+-N NO_3^--N available P_2O_5, available K_2O, pH, electrical conductivity and $CaCO_3$ content in the soil.

4.3.1 Effect on chemical properties of soil :

4.3.1.2 Mineralization of nitrogen :

4.3.1.2(a) Release of NH_4^+-N in the soil (Ammonification) :

The values obtained for NH_4^+-N periodically under different treatments are reported in Table 27 and graphically presented in Fig. 6-A.

It was observed that the values for NH_4^+-N were higher up to 15 days from the period of incubation in inorganic fertilizer treatments but these values decreased thereafter up to the end of incubation period indicating the N form $(NH_4)_2SO_4$ being inorganic and in readily available form and was released as NH_4^+-N in the very short period. Schreven

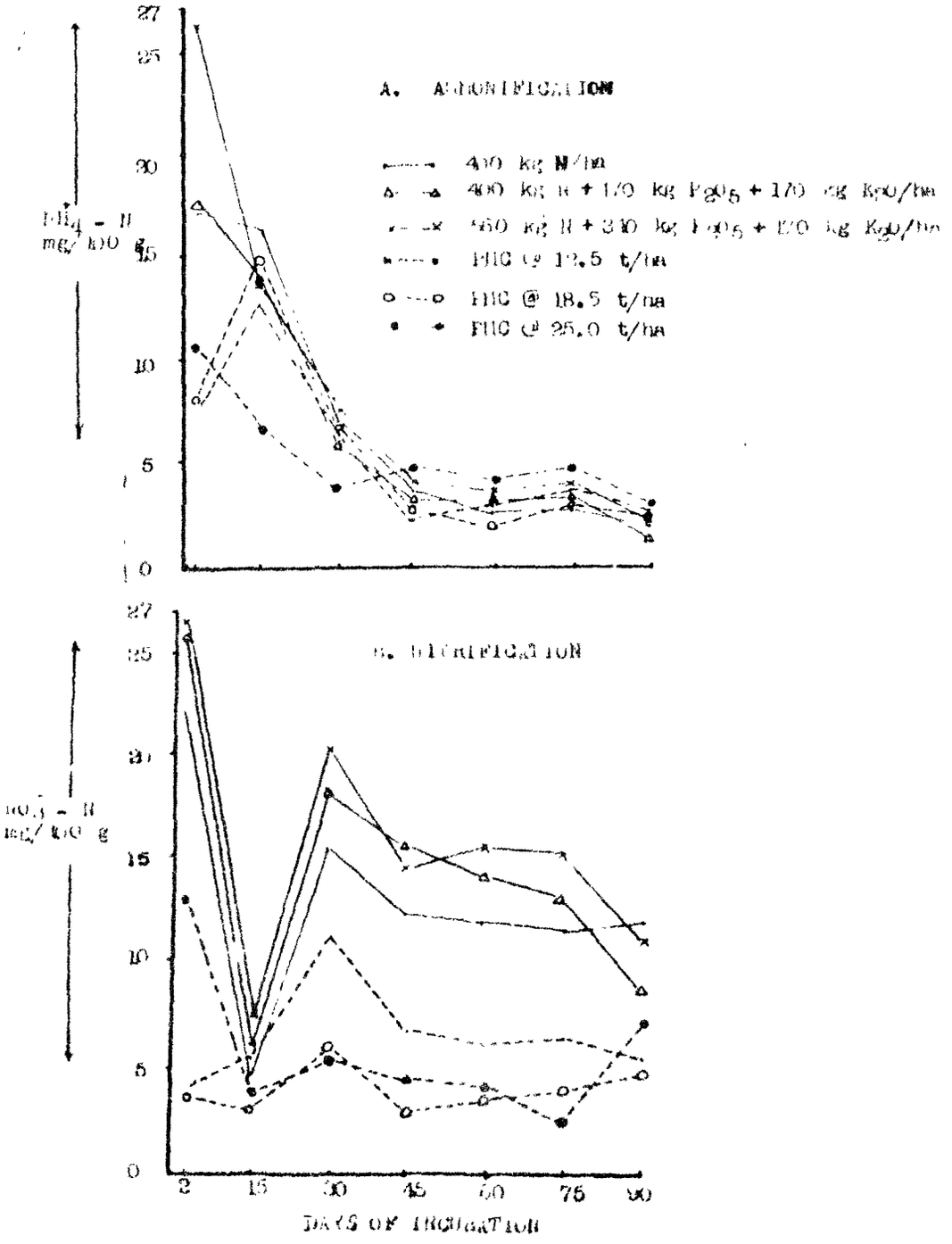
Table 27 : The effect of addition of press mud cake and fertilizers on mineralization of nitrogen-ammoniacal nitrogen in mg/100 g (Average of three replications).

Sr. No.	Treatments	Symbol	Days of incubation						
			2	15	30	45	60	75	90
1.	400 kg N/ha alone	A	16.95	16.25	6.59	3.48	2.52	2.88	1.93
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	B	17.43	13.70	5.79	2.88	3.17	3.15	1.65
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	C	26.30	13.64	7.22	4.05	3.77	3.91	2.38
4.	Press mud cake @ 12.5 t/ha	D	7.18	13.11	6.61	2.59	2.90	3.75	2.37
5.	Press mud cake @ 18.5 t/ha	E	8.09	14.71	6.33	2.78	2.12	3.23	2.47
6.	Press mud cake @ 25.0 t/ha	F	10.47	6.46	3.83	4.82	3.73	4.60	2.39
	'F' test		**	N.S.	N.S.	*	N.S.	N.S.	N.S.
	S.E. ±		0.740	2.990	0.750	0.480	0.388	0.692	0.425
	C.D. at 5 %		2.280	-	-	1.480	-	-	-
	C.D. at 1 %		3.200	-	-	-	-	-	-

** Significant at 1 % level. * Significant at 5 % level.

N.S. = Non-significant.

FIG 6 : CHANGES IN NH_4^+ -N AND NO_3^- - N IN SOIL TREATED WITH PRESS MUD CAKE AND INORGANIC FERTILIZERS



and Sieban (1972) noted that the N mineralization decreased the amount of NH_4^+-N fixed after addition of $(NH_4)_2SO_4$.

The highest value for NH_4^+-N (26.30 mg/100 g soil) was recorded initially in the treatment of 560 kg N + 340 kg P_2O_5 + 170 kg K_2O per hectare and lowest (7.18 mg/100 g) in the treatment of 12.5 t/ha of PMC. The highest value (2.47 mg/ 100 g) in the treatment of 18.5 t/ha of PMC and the lowest (1.65 mg/100 g soil) were recorded in the treatment of 400 kg N + 170 kg P_2O_5 + 170 kg K_2O per hectare at the end of incubation period.

In the treatments of press mud cake, the high values were noted upto 30 days of incubation and thereafter the values remained more or less constant indicating the slow release of nitrogen through the press mud cake. This is due to organic nature of N in press mud cake. More availability of N at the end of incubation period was also noticed. The higher values were recorded in press mud cake treatments than inorganic fertilizer treatments.

From the statistical analysis of the data, it was revealed that there was no significant difference between different treatments of inorganic fertilizers and press mud cake during periods of incubation except at 2 days and 45 days of incubation. The data would indicate that the press mud cake treatments could supply the N in the soil over a longer period due to its high nitrogen and organic carbon content.

Chan (1970) also reported similar results and postulated that the amounts of mineralization of N was closely related to the amount of organic carbon content of soil.

4.3.1.2 (b) Release of NO_3^--N in the soil (Nitrification) :

The values for NO_3^--N obtained periodically under different treatments are given in Table 28 and graphically shown in Fig. 6-B.

It would be seen from the data that the NO_3^--N formation in all the treatments of inorganic fertilizers was more than the press mud cake treatments at all the periods. More or less constant values of NO_3^--N were observed in the press mud cake treatments indicating the slow nitrification of press mud cake than the inorganic fertilizer treatments. More accelerating nitrification was observed in the inorganic fertilizer treatments followed by the treatment of 12.5 t/ha of press mud cake.

In press mud cake treatments, 125 t/ha of press mud cake showed more nitrification. This might be due to more amount of N was required to be adjusted through $(NH_4)_2SO_4$. Sinha (1961) reported that press mud cake applied in different proportions with sulphate of ammonia showed more satisfactory nitrification.

The levels of NO_3^--N at the end of incubation period were observed to be in the following descending order.

$$A > C > B > F > D > E$$

Table 28 : Effect of addition of press mud cake and fertilizers on mineralization on nitrogen-nitrate nitrogen in mg/100 g soil (Average of three replications).

Sr. No.	Treatments	Symbol	Days of incubation						
			2	15	30	45	60	75	90
1.	400 kg N/ha alone	A	21.86	4.04	15.39	12.43	11.96	11.59	11.85
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	B	25.67	5.75	18.20	15.33	14.14	13.14	9.13
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	C	26.62	7.04	20.29	14.82	15.74	15.49	11.58
4.	Press mud cake @ 12.5 t/ha	D	4.10	4.44	11.31	6.80	6.20	6.54	5.81
5.	Press mud cake @ 18.5 t/ha	E	3.97	3.32	5.69	3.24	3.83	3.85	4.84
6.	Press mud cake @ 25.0 t/ha	F	13.21	3.44	5.28	4.62	4.34	2.46	7.24
	'F' test		**	N.S.	**	**	**	**	N.S.
	S.E. ±		0.504	1.382	1.345	1.463	1.474	1.146	2.317
	C.D. at 5 %		1.552	N.S.	4.146	4.508	4.542	3.533	N.S.
	C.D. at 1 %		2.176	N.S.	5.812	6.321	6.368	4.951	N.S.

** Significant at 1 % level. N.S. = Non-significant.

4.3.1.1 Mineralization of organic carbon in the soil :

The organic carbon values obtained periodically under the different treatments are reported in Table 29 and graphically presented in Fig. 7-A.

From the data it was seen that there was high organic carbon content in all the treatments of press mud cake than inorganic fertilizer treatments indicated that addition of press mud cake increased the level of organic carbon content of soil. Patil (1975), Yelwande (1977) and Bawasakar, et al. (1978) made similar observations. Upto 30 days of incubation period, there was increase in organic carbon content of soil and thereafter the organic carbon content decreased gradually with the advancement of incubation period indicating better microbial decomposition of organic matter in press mud cake at the end of incubation period.

The levels of organic carbon content at different periods of incubation differed significantly. The organic carbon content of soil at the end of incubation period was found to be in the following descending order.

$$F > E > D > C > B > A$$

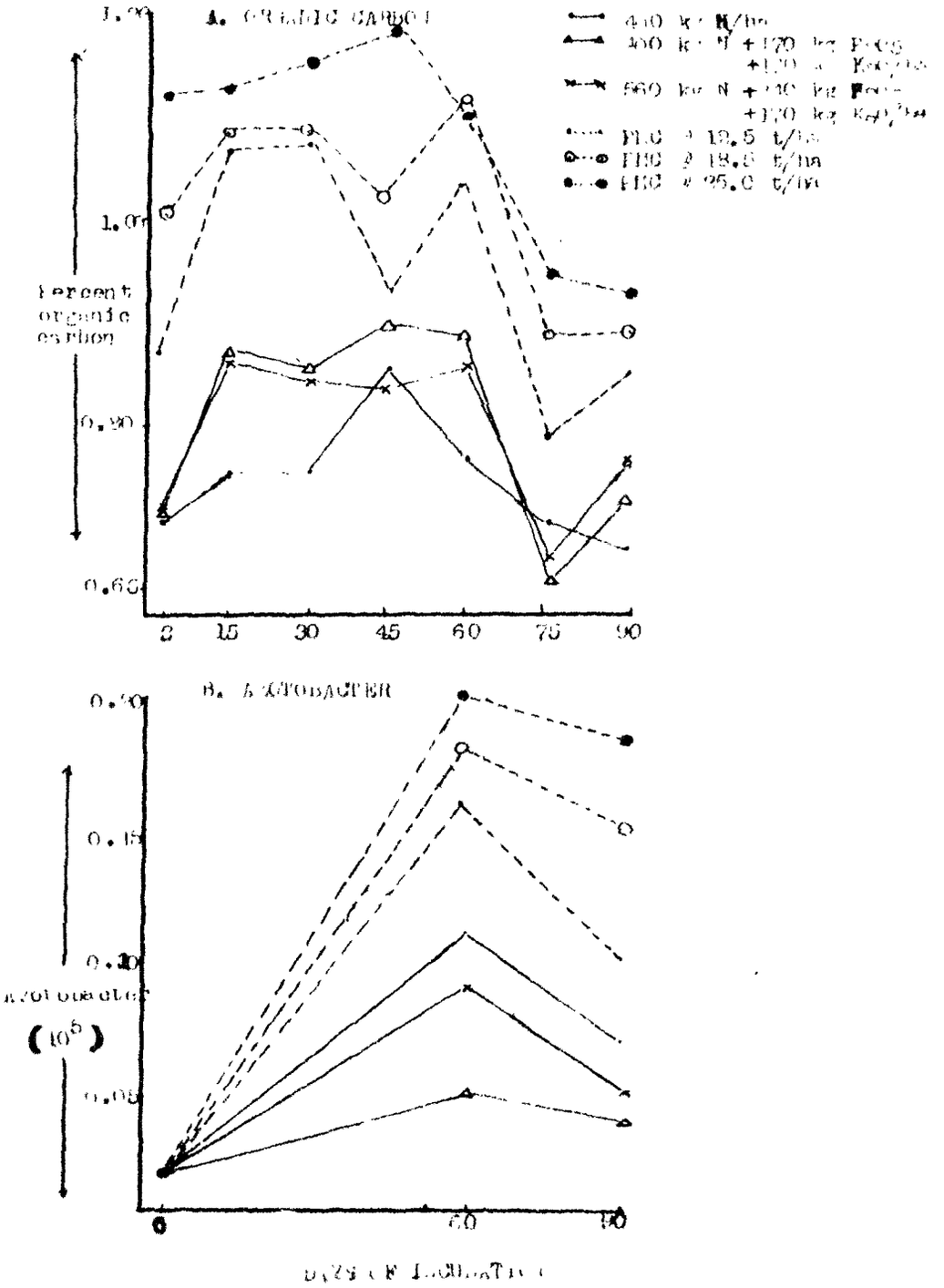
The treatment, 25.0 t/ha of press mud cake showed the highest (0.93 %) organic carbon content in the soil than all other treatments. Lowest organic carbon content (0.69 %) was observed in the treatment of 400 kg N/ha alone .

Table 29 : The effect of addition of press mud cake and fertilizers on mineralization of organic carbon percentage in soil (Average of three replications).

Sr. No.	Treatments	Symbol	Days of incubation						
			2	15	30	45	60	75	90
1.	400 kg N/ha alone	A	0.71	0.76	0.76	0.86	0.77	0.71	0.69
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	B	0.71	0.87	0.85	0.90	0.89	0.65	0.74
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	C	0.72	0.87	0.85	0.84	0.86	0.68	0.75
4.	Press mud cake @ 12.5 t/ha	D	0.87	1.06	1.07	0.93	1.03	0.79	0.83
5.	Press mud cake @ 18.5 t/ha	E	1.02	1.08	1.08	1.02	1.11	0.89	0.89
6.	Press mud cake @ 25.0 t/ha	F	1.12	1.12	1.15	1.18	1.10	0.95	0.93
	'F' test		**	**	**	**	**	**	**
	S.E. ±		0.0434	0.0507	0.0252	0.0561	0.0472	0.0229	0.0301
	C.D. at 5 %		0.1337	0.1560	0.0777	0.1730	0.1450	0.0706	0.0927
	C.D. at 1 %		0.1875	0.2190	0.1089	0.2420	0.2040	0.0989	0.1300

** Significant at 1 % level.

FIG 7 : CHANGES IN ORGANIC CARBON CONTENT AND AZOTOBACTER POPULATION IN SOIL TREATED WITH PRESS MUD CAKE AND INORGANIC FERTILIZERS



The mineralization of organic carbon was 0.24, 0.19 and 0.25 per cent in treatments of 12.5 t/ha, 18.5 t/ha and 25.0 t/ha of press mud cake, respectively.

4.3.1.3 Available P_2O_5 content in the soil :

The press mud cake is commonly used as a rich source of phosphorus and potash and organic carbon. As reported by Patil, et al. (1978) that when press mud cake was applied to soil no P and K fertilizers were required to be applied to sugarcane crop. Hence the incubation studies were conducted to ascertain availability of phosphorus and potash in soil.

The data in respect of available P_2O_5 are presented in Table 30 and also graphically shown in Fig. 8-A.

It could be seen from the data that the availability of P_2O_5 in the soil increased with the advancement of incubation period. From 45 days of incubation period there was gradual increase. At the end of incubation period the highest level of available P_2O_5 (5.99 mg/100 g) was noticed in 18.5 t/ha of PMC over all other treatments. The availability of P_2O_5 was as per the following descending order.

$$E > F > C > B > D > A$$

The maximum availability of P_2O_5 was observed in PMC treatments than inorganic fertiliser treatments. This may be due to addition of large amount of P_2O_5 through PMC as Prasad (1974) and Hagihara (1974) reported the increased

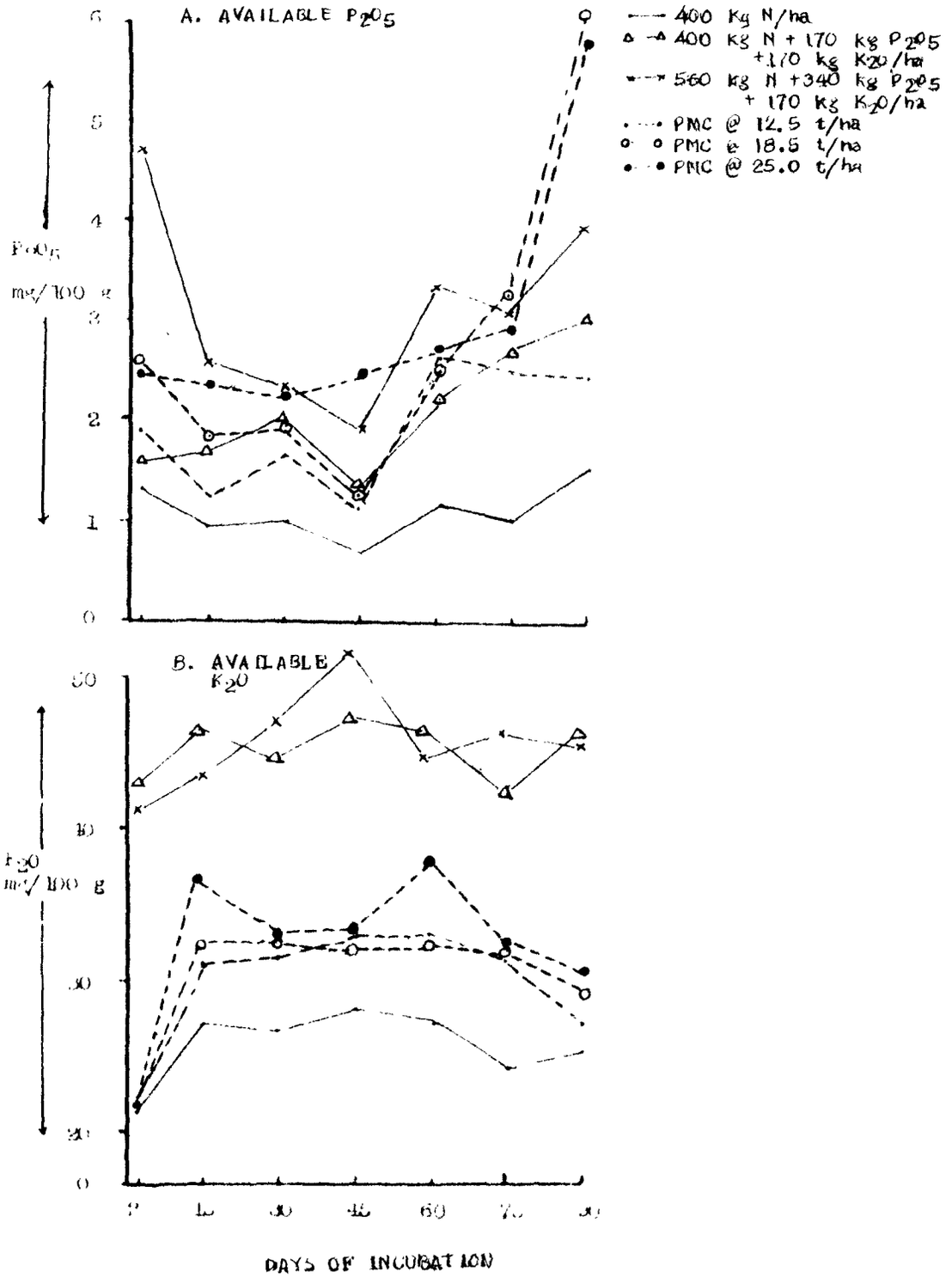
Table 30 : Changes in the available P_2O_5 content in the soil with the addition of press mud cake and fertilizers in mg/100 g soil (Average of three replications).

Sr. No.	Treatments	Symbol	Days of incubation						
			2	15	30	45	60	75	90
1.	400 kg N/ha alone	A	1.30	0.90	0.95	0.65	1.17	0.97	1.41
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	B	1.62	1.65	2.00	1.27	2.23	2.83	2.93
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	C	4.67	2.61	2.25	1.87	3.24	2.96	3.87
4.	Press mud cake @ 12.5 t/ha	D	1.87	1.22	1.64	1.13	2.61	2.42	2.35
5.	Press mud cake @ 18.5 t/ha	E	2.63	1.78	1.98	1.20	2.25	3.19	5.99
6.	Press mud cake @ 25.0 t/ha	F	2.47	2.33	2.27	1.47	2.63	2.67	5.65
	'f' test		**	*	N.S.	*	**	N.S.	N.S.
	S.E. ±		0.460	0.319	0.422	0.176	0.270	0.937	1.055
	C.D. at 5 %		1.417	0.984	N.S	0.542	0.831	N.S.	N.S.
	C.D. at 1 %		1.987	N.S.	N.S.	N.S.	1.166	N.S.	N.S.

** Significant at 1 % level. * Significant at 5 % level.

N.S. = Non-significant.

FIG 8 : CHANGES IN AVAILABLE P_2O_5 AND K_2O IN SOIL TREATED WITH PRESS MUD CAKE AND INORGANIC FERTILIZERS



availability due to incorporation of PMC in the soil. Golden (1975) made the similar observation that application of PMC increased the extractable phosphorus without affecting the pH of soil.

4.3.1.4 Available K_2O content of soil :

The available K_2O was determined periodically and results are presented in Table 31 and graphically shown in Fig. 8_B.

It was observed from the data that there was increase in availability of K_2O with the advancement of incubation period. Maximum availability of K_2O was found in the treatments of 400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha and 560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha. This may be due to the inorganic nature of the potassic fertilizer added. Amongst the PMC treatments, there was no significant difference in available K_2O. The availability of K_2O in all the treatments remained more or less steady throughout the incubation period. However, maximum remarkable availability of K_2O was revealed at 45 days of incubation in all the treatments. The available K_2O content of soil at the end of incubation period was found to be in the following descending order.

$$C > B > F > E > D > A$$

Highest level of available K_2O was observed in the treatments of 560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha and

Table 31 : Changes in the available K_2O content in the soil with the addition of press mud cake and fertilizers in mg/100 g soil (Average of three replications).

Sr. No.	Treatments	Symbol	Days of incubation						
			2	15	30	45	60	75	90
1.	400 kg N/ha alone	A	21.00	27.67	26.83	28.08	26.50	24.17	24.75
2.	400 kg N + 170 P_2O_5 + 170 kg K_2O/ha	B	43.33	46.33	44.58	47.08	44.92	42.00	45.25
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	C	41.33	43.50	47.08	51.50	44.17	46.33	45.58
4.	Press mud cake @ 12.5 t/ha	D	21.50	31.42	31.92	33.00	32.08	31.42	27.08
5.	Press mud cake @ 18.5 t/ha	E	20.92	32.00	32.50	32.50	31.92	31.33	28.42
6.	Press mud cake @ 25.0 t/ha	F	21.12	36.83	32.50	33.00	37.83	32.00	30.17
	'F' test		**	**	**	**	**	**	**
	S.E. ±		1.678	3.235	1.009	0.545	1.771	1.535	1.074
	C.D. at 5 %		5.172	9.909	3.110	1.679	5.459	4.729	3.309
	C.D. at 1 %		7.251	13.976	4.590	2.350	7.651	6.632	4.640

** Significant at 1 % level.

400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha. These two treatments were highly significant over all other treatments. Higher available potash was observed in application of PMC @ 25.0 t/ha amongst the press mud cake treatments, but differences in these treatments were found to be not significant.

Increased availability of K_2O in soil was reported by Prasad (1974) due to application of PMC. Golden (1975) also made similar observations and reported that application of PMC increased the extractable K. Patil (1975) and Bawasakar et al. (1978) also reported that with the increased doses of PMC there was linear increase in available K_2O.

4.3.1.5 Changes in soil reaction :

Changes in soil reaction during the incubation period are reported in Table 32.

It was observed from the table that neither application of inorganic fertilizers nor the increasing doses of PMC influenced the pH of the soil as very negligible differences in pH between various treatments were noticed. However, effect of long range application of PMC on the soil reaction need to be studied.

4.3.1.6 Effect on electrical conductivity of soil :

The data in respect of electrical conductivity of soil are reported in Table 33. It was observed that the differences due to application of inorganic fertilizers were

Table 32 : The effect of addition of press mud cake and fertilizers on soil reaction (Average of three replications).

Sr. No.	Treatments	Symbol	Days of incubation						
			2	15	30	45	60	75	90
1.	400 kg N/ha alone	A	7.73	7.73	7.63	7.63	7.67	7.63	7.77
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	B	7.70	7.73	7.63	7.60	7.57	7.67	7.80
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	C	7.673	7.67	7.57	7.57	7.63	7.63	7.73
4.	Press mud cake @ 12.5 t/ha	D	7.77	7.63	7.70	7.67	7.63	7.73	7.80
5.	Press mud cake @ 18.5 t/ha	E	7.77	7.67	7.67	7.60	7.70	7.70	7.87
6.	Press mud cake @ 25.0 t/ha	F	7.77	7.67	7.70	7.70	7.67	7.73	7.90
	'F' test		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
	S.E. ±		0.045	0.033	0.036	0.041	0.0561	0.0304	0.071

N.S. = Non-significant.

Table 33 : The effect of addition of press mud cake and fertilizers on electrical conductivity of soil in mmhos/cm (Average of three replications).

Sr. No.	Treatments	Symbol	Days of incubation						
			2	15	30	45	60	75	90
1.	400 kg N/ha alone	A	0.49	0.66	0.78	1.02	1.09	1.06	0.91
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	B	0.84	0.93	1.00	1.24	1.22	1.15	1.37
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	C	0.97	0.97	1.16	1.32	1.28	1.27	1.82
4.	Press mud cake @ 12.5 t/ha	D	0.41	0.61	0.73	0.84	1.02	0.73	0.84
5.	Press mud cake @ 18.5 t/ha	E	0.34	0.53	0.64	0.88	0.96	0.60	0.70
6.	Press mud cake @ 25.0 t/ha	F	0.40	0.53	0.57	0.57	0.66	0.61	0.64
	'f' test		*	**	**	*	N.S.	**	**
	S.E. at ±		0.123	0.051	0.054	0.134	0.130	0.184	0.156
	C.D. at 5 %		0.378	0.158	0.168	0.414	-	0.567	0.479
	C.D.at 1 %		-	0.222	0.235	-	-	0.795	0.674

** Significant at 1 % level. * Significant at 5 % level.

N.S. = Non-significant.

significant over PMC treatments. Higher values ranging from 0.91 to 1.82 mmhos/cm were observed in inorganic fertilizer treatments, while lower values ranging from 0.64 to 0.84 mmhos/cm were observed in treatments of press mud cake at the end of incubation period. It was further observed that with the application of increased doses of inorganic fertilizers there was linear increase in electrical conductivity while in the treatments of PMC there was linear decrease in electrical conductivity with increased doses. Zende (1968) reported that the incorporation of PMC reduced total soluble salts from 1.70 to 1.32 per cent at the end of incubation period. Bawasakar, et al. (1978) in their field experiment observed the reduction in salt content due to application of PMC over inorganic fertilizer treatments.

4.3.1.7 Effect on $CaCO_3$ content of soil :

The data in respect of periodical $CaCO_3$ content of soil presented in Table 34 revealed that neither the application of inorganic fertilizers nor the application of PMC doses influenced the $CaCO_3$ content of soil as the very negligible differences between the various treatments were observed. The level of $CaCO_3$ content in the soil remained more or less steady throughout the incubation period.

4.3.2. Effect on biological properties of soil :

The effect of application of inorganic fertilizers and PMC on soil microflora was studied before commencement of

Table 34 : Effect of addition of press mud cake and fertilizers on calcium carbonate per cent of soil (Average of three replications).

Sr. No.	Treatments	Symbol	Days of incubation						
			2	15	30	45	60	75	90
1.	400 kg N/ha alone	A	7.80	8.93	8.80	8.53	8.57	8.67	7.83
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	B	8.40	8.90	8.43	8.90	8.40	8.63	8.47
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	C	8.43	9.07	8.90	8.73	8.80	8.23	8.53
4.	Press mud cake @ 12.5 t/ha	D	8.60	9.30	9.03	8.90	8.50	8.47	8.37
5.	Press mud cake @ 18.5 t/ha	E	8.53	9.26	8.93	8.17	8.50	9.13	8.47
6.	Press mud cake @ 25.0 t/ha	F	8.47	9.53	9.30	9.17	8.60	8.47	8.03
	'F' test		N.S.	**	N.S.	N.S.	N.S.	N.S.	N.S.
	S.E. ±		0.187	0.125	0.209	0.308	0.104	0.205	0.340
	C.D. at 5 %		-	0.387	-	-	-	-	-

** Significant at 1 % level. N.S. = Non-significant.

incubation, at 60 and 90 days of incubation.

The data in this respect are reported in Table 35. It would reveal that the fungi, actinomycetes and azotobacter population decreased whereas the bacterial and total microflora increased remarkably at 90 days of incubation in different fertilizers and PMC treatments. The Azotobacter population is graphically presented in Fig. 7-B.

It was also interesting to note that the incorporation of PMC showed spectacular increase in Azotobacter population over the inorganic fertilizer treatments. This is an additional advantage of nitrogen fixation through non-symbiotic bacteria on application of PMC in soil.

The maximum population of microflora at 90 days of incubation indicated better microbial decomposition of organic matter from PMC eventually resulted in increased availability of nutrients. It may be therefore inferred from this, that it is necessary to incorporate the PMC in to the soil 60 to 90 days before planting for better results.

Table 35 : Effect of addition of press mud cake and fertilizer on soil microflora at different periods of incubation.

Sr. No.	Treatments	Total microflora (10^5)		Fungi (10^5)		Actinomycetes (10^5)		Bacteria (10^5)		Azotobacter (10^5)	
	Days	60	90	60	90	60	90	60	90	60	90
	Before incubation	5.17		4.25		0.25		0.65		0.02	
1.	400 kg N/ha alone	39.86	63.72	3.00	1.50	1.25	0.75	35.50	61.40	0.11	0.07
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	32.55	93-66	3.50	1.25	1.75	1.00	27.25	91.37	0.05	0.04
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	28.60	78.17	1.75	1.75	1.50	1.12	25.25	75.25	0.10	0.05
4.	Press mud cake @ 12.5 t/ha	48.66	58.97	7.00	1.12	1.50	1.00	40.00	56.75	0.16	0.10
5.	Press mud cake @ 18.5 t/ha	27.53	63.81	1.75	1.67	1.00	0.87	24.50	61.12	0.18	0.15
6.	Press mud cake @ 25.0 t/ha	26.70	61.30	4.75	1.50	1.25	1.25	20.50	58.37	0.20	0.18

CHAPTER 5

SUMMARY AND CONCLUSIONS

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Press Mud Cake is a bye-product of sugar industries. It is organic in nature and quite rich in Nitrogen, Phosphorus and Potash. Recycling of this organic waste in agriculture would help in efficient utilization of natural resources instead of more dependence on fertilizer. The sugar factories are facing the problem of disposal of this press mud cake. Recently few progressive farmers are using it as a source of organic matter to minimize the use of fertilizer.

It is, therefore, felt necessary to analyse the press mud cake for its quality and its effect on soil properties and ultimately on yield and quality of sugarcane.

In order to study the quality of press mud cake large number of samples were collected from various sugar factories of Maharashtra at about monthly intervals during crushing season of 1977-78. These samples were analysed for moisture, pH, electrical conductivity, organic carbon, total nitrogen, total P_2O_5, total K_2O and $CaCO_3$.

To study the residual effect of press mud cake on soil property, yield and quality of sugarcane and uptake of nutrients; a field experiment on adsali sugarcane with CO.740 was conducted at Sugarcane Research Station, Padegaon, during 1975-77 with six treatments : three levels of inorganic fertilizers and three levels of press mud cake treatments.

The residual effect (without any addition of fertilizer

or press mud cake) on Adsali Sugarcane with CO.740 was studied at the site during 1977-79 by following the same randomization and with the same treatments in the previous experiment. The various biometric observations, soil studies and uptake studies at various stages of crop growth were recorded and yield of sugarcane and quality of juice at harvest were studied.

Incubation studies were carried out on the basis of the treatments of the field experiment to study the mineralization of nutrients especially Nitrogen, Phosphorus and Potash. During the incubation period, soil samples were collected at an interval of 15 days upto 90 days and they were analysed for organic carbon, NH_4^+-N, NO_3^--N, available P_2O_5 and K_2O, pH, electrical conductivity and $CaCO_3$. Soil microflora before the start of incubation, at 60 days and at 90 days of incubation was also studied.

The findings of the present investigation carried out under laboratory and field conditions are summarized below :

5.1 Quality of Press Mud Cake :

1. The maximum fresh moisture of press mud cake samples was 78.03 per cent.

2. When moisture content of fresh press mud cake was high the pH of it was low whereas the electrical conductivity was high.

3. The mean pH of fresh press mud cake samples from various factories was 5.66.

4. The electrical conductivity of fresh press mud cake

samples determined from the filtrate was more than that of in suspension.

5. The organic carbon, total nitrogen, total P_2O_5, total K_2O, pH, electrical conductivity and $CaCO_3$ contents differed widely in press mud cake samples received from various sugar factories of Maharashtra. There was no much difference due to monthly intervals during the crushing period.

The chemical composition of air dried press mud cake from various sugar factories of Maharashtra studied in this investigation are summarised below :

Sr. No.	Chemical composition in respect of	Range for various factories	Range for monthly intervals	Overall mean
1.	Organic carbon (%)	26.37-38.44	32.58-34.96	33.98
2.	Total Nitrogen (%)	1.39- 1.96	1.56- 1.70	1.63
3.	Total P_2O_5 (%)	1.84- 3.31	2.46- 2.69	2.52
4.	Total K_2O (%)	0.38- 0.76	0.51- 0.59	0.55
5.	pH (PMC:Water 1:7.5 ratio)	5.34- 6.90	6.29- 6.50	6.44
6.	Electrical conductivity in suspension (mmhos/cm)	1.61- 3.60	2.47- 2.98	2.62
7.	Electrical conductivity of filtrate (mmhos/cm)	2.16- 4.32	3.15- 3.47	3.35
8.	$CaCO_3$ (%)	2.92- 6.82	4.41- 5.30	4.74

5.2 Residual effect of press mud cake and inorganic fertilizers

5.2.1 Soil studies :

1. Maximum organic carbon content of soil was noticed in press mud cake treatments over inorganic fertilizer treatments. Linear increase was observed with the increased doses of press

mud cake. The organic carbon content of soil was reduced with the advance age of the crop.

2. Press mud cake treatments showed linear increase in total nitrogen content of soil. With the advance age of the crop the nitrogen content was reduced.

3. The C/N ratio was not much influenced by press mud cake treatments but remained more or less steady.

4. The phosphate availability increased in the residual effect of the press mud cake treatments.

5. The available K_2O content was increased with increasing doses of inorganic fertilizers as well as press mud cake treatments.

6. The soil reaction was not much influenced by inorganic fertilizer and press mud cake treatments.

7. The electrical conductivity was decreased in all the treatments with the advance age of crop. Maximum decrease in electrical conductivity was noticed in the treatment of 12.5 t/ha and 18.5 t/ha of press mud cake at harvest.

5.2.2 Nutrient content and uptake per hectare :

1. Maximum nitrogen content in stem and in crown at grand growth and at harvest was noticed in the treatment of press mud cake applied at the rate of 25.0 t/ha.

2. All the treatments showed more or less same trend

in respect of P_2O_5 content of stem and crown at grand growth stage; however, highest P_2O_5 content in stem and crown at harvest was noticed in the treatment of 25.0 t/ha of press mud cake.

3. Maximum K_2O content in stem and crown was found in treatments of 12.5 t/ha and 25.0 t/ha of press mud cake at grand growth stage. However, at harvest, treatment of 400 kg N + 170 kg P_2O_5 + 170 kg K_2O per hectare showed the highest K_2O content in stem and crown.

4. With the increasing doses of inorganic fertilizer treatments and press mud cake treatments the uptake of N, P_2O_5 and K_2O at harvest was increased.

5. Maximum uptake of N and P_2O_5 per ton was recorded in the treatment of 25.0 t/ha of press mud cake. The highest K_2O uptake per ton was observed in the treatment of 560 kg N + 340 kg P_2O_5 + 170 kg K_2O per hectare.

5.2.3 Yield and quality of sugarcane

1. Increased yields were noticed in press mud cake treatments over inorganic fertilizer treatments.

Highest millable height, number of internodes, girth, average weight of cane and number of millable canes per hectare were recorded in treatment of 25.0 t/ha of press mud cake which contributed in increase in the cane yield to the maximum extent i.e. 62.53 t/ha.

2. Commercial cane sugar was also found to have been increased with the use of press mud cake over inorganic fertilizers.

3. Maximum brix, sucrose, purity and commercial cane sugar in juice were observed in the treatment of 18.5 t/ha of press mud cake which indicated the improvement in juice quality over inorganic fertilizers.

4. Press mud cake treatments showed lowest N/P_2O_5 ratio and less ash (mineral matter) per litre of juice which showed that these treatments produced good quality of juice as against inorganic fertilizer treatments.

5.3 Soil incubation studies :

1. Ready availability of NH_4^+-N was observed upto 15 days of incubation period in inorganic fertilizer treatments. However, the availability of NH_4^+-N was recorded more or less constant throughout the incubation period in press mud cake treatments indicating slow release of NH_4^+-N. Higher availability of NH_4^+-N was noticed in press mud cake treatments at the end of incubation period.

2. More accelerated nitrification was noticed in inorganic fertilizer treatments than press mud cake treatments throughout the incubation period.

3. High organic carbon content was found in all the press mud cake treatments than inorganic fertilizer treatments throughout the incubation period. Upto 30 days of incubation

period there was increase in organic carbon content and thereafter gradual decrease in organic carbon content was noticed with the advancement of incubation period.

4. Phosphate availability was greater in press mud cake treatments and it was increased with the advancement of incubation period.

5. Availability of K_2O was more in inorganic fertilizer treatments. The maximum availability was noticed at 45 days of incubation period.

6. The soil reaction was not much affected throughout the incubation period.

7. Linear decrease in electrical conductivity of soil was noticed with increased doses of press mud cake treatments.

8. The level of $CaCO_3$ content in the soil remained more or less (7.80 to 9.53) throughout the incubation period.

9. Press mud cake treatments showed spectacular increase in Azotobacter population over the inorganic fertilizer treatments. This is an additional advantage of N-fixation through non-symbiotic bacteria on application of press mud cake in soil.

Based on the above investigation, it is concluded that press mud cake is a good source of organic nutrients especially nitrogen and phosphate. PMC produced by the various sugar factories in Maharashtra varies to certain extent in

its quality. The PMC is a good source of organic matter to the crop like sugarcane and it not only supplies nutrients to the crop but also builds up the fertility as indicated by its residual effect. PMC not only increases the yield of second crop taken after main crop but also improves the quality. The use of optimum quantity of PMC to the crop like sugarcane may be encouraged. The increase in the microflora especially of Azotobacter in soil was also noticed with the application of press mud cake to soil.

Guideline for future work on press mud cake :

The studies on the application of PMC to short duration irrigated and rainfed crops may be initiated since PMC has a special role as organic source and in nutrient supply and soil fertility built up. In order to hasten mineralization process, waxy portion from PMC may be required to be removed. The studies in that direction are also required to be carried out. Similarly the availability of micronutrient status needs to be assessed.

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* Original not seen.

APPENDIX

Appendix - I

Statewise sugarcane, sugar and estimated press mud cake (PMC) production during 1977-78.

Sr. No.	State	* Sugarcane production '000' MT	* Sugar produced '000' MT	** Estimated PMC production '000' MT According to 2.5 %	** Estimated PMC production '000' MT According to 3.0 %
1.	Assam	1430	7	35.75	42.90
2.	Andhra Pradesh	13268	405	331.70	398.04
3.	Bihar	4958	286	123.95	148.74
4.	Goa	-	9	-	-
5.	Gujarath	3487	309	87.18	104.61
6.	Haryana	8970	148	224.25	269.10
7.	Kerala	410	23	10.25	12.30
8.	Maharashtra	23320	2096	583.00	699.60
9.	Madhya Pradesh	2394	69	59.85	71.82
10.	Karnataka	11120	571	278.00	333.60
11.	Nagaland	-	8	-	-
12.	Orissa	2600	17	65.00	78.00
13.	Punajab	6520	99	163.00	195.60
14.	Pandicherry	187	23	4.68	5.61
15.	Rajasthan	2825	45	70.63	84.75
16.	Tamilnadu	17160	466	429.00	514.80
17.	Uttar Pradesh	80756	1862	2018.90	2422.68
18.	U.P. East	-	475	-	-
19.	U.P. West	-	624	-	-
20.	U.P. Central	-	763	-	-
21.	West Bengal	1812	14	45.30	54.36
	Others	411	-	10.28	12.33
Total for India		181628	6457	4540.70	5448.84

* Indian Sug. 1978, 28(7) : 489-521.

** Calculated on the basis of Shri M.K. Patil Co-op. Sug. 8(4) : 183-189.

Appendix - II

Number of sugar factories in operation, sugar, molasses, estimated bagasse and press mud cake, production in India and Maharashtra State during 1977-78.

Sr.No.	Particulars	India	Maharashtra
1.	* Number of sugar factories in operation	286	66
2.	* Cane crushed ('000' MT)	67288	19245
3.	* Sugars produced ('000' MT)	6457	2096
4.	Molasses available('000' MT)	2971	-
5.	** Estimated bagasse production (30 % cane crushed)	20186.40	5773.50
6.	** Estimated press mud cake production		
	(2.5 %) ('000'MT)	1682.20	481.13
	(3.0 %) ('000'MT)	2018.64	577.35

* Indian Sug. 1978, 28(7) : 489-521.

** Calculated on the basis of Shri M.K. Patil, Co-op. Sug. 8(4) : 183-189.

A p p e n d i x - III

Climatic parameters during the experimentation at the Meteorological Observatory at the Sugarcane Research Station, Padegaon.

Sr. No.	Month	Temperature °C		Humidity %		Evapo-ration per day	Rain-fall	No.of rainy days
		Max.	Min.	8am	3pm	mm	mm	
1.	August, 1977	29.9	21.2	87	63	4.9	50.7	15
2.	September	30.5	19.6	89	52	5.8	31.2	10
3.	October	32.2	17.3	86	39	5.8	61.9	7
4.	November	29.5	18.4	90	53	3.8	129.6	10
5.	December	27.1	10.5	93	42	3.1	9.6	2
6.	January,1978	28.5	10.9	91	39	3.7	4.0	2
7.	February	31.2	11.8	87	28	5.6	1.7	1
8.	March	34.4	14.9	70	19	8.5	4.2	2
9.	April	37.4	19.7	69	22	5.5	22.7	3
10.	May	36.9	21.7	74	30	9.6	102.7	10
11.	June	30.9	21.7	87	59	5.4	60.1	13
12.	July	28.8	21.6	85	63	5.1	15.8	12
13.	August	27.6	21.2	87	71	4.2	79.8	26
14.	September	30.2	19.9	90	56	5.1	157.4	16
15.	October	30.4	17.9	90	42	4.9	74.2	7
16.	November	30.1	16.6	91	46	3.7	66.2	5
17.	December	28.2	12.0	90	41	3.5	1.0	1
18.	January,1979	30.1	13.2	87	35	4.5	Nil	-
19.	February,1979	31.5	11.3	82	25	6.5	Nil	-
							872.8	142

A p p e n d i x - IV

* (a) Effect of graded levels of PMC and inorganic fertilizers on yield and quality of sugarcane (Adsali-1975)

Sr. No.	Treatments	Symbol	Germination at 8th week (%)	Av.No.of tillers/ hill	Plant population at harvest (000)	Yield (t/ha)	Sucrose (%)	Purity (%)	CCS (t/ha)
1.	400 kg N/ha alone	A	78.44	1.72	100.6	107.59	19.88	91.55	15.26
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	B	86.20	1.77	112.3	121.43	18.96	93.11	17.41
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	C	81.83	1.76	116.3	125.53	19.66	93.64	17.81
4.	Press mud cake @ 12.5 t/ha	D	86.57	1.73	104.4	116.11	20.26	94.85	17.02
5.	Press mud cake @ 18.5 t/ha	E	87.66	2.16	107.6	105.11	20.23	89.54	15.21
6.	Press mud cake @ 25.0 t/ha	F	86.76	1.72	102.2	107.82	19.10	93.26	15.03
	S.E. ±		-	-	-	5.60	0.44		
	C.D.		-	-	-	N.S.	0.62		

Appendix - IV (a)

* Patil, et al. (1978). Indian Sug. 27 (10) ; 711-714.

Appendix - IV. b

* (b) Economics of incorporation of graded levels of press mud cake and inorganic fertilizers.

Sr. No.	Treatments	Symbol	Income from sugarcane Rs./ha	Cost of production of sugarcane Rs./ha	Net profit Rs./ha	Increase in net profit over treatment 2. (recommended dose)	% increase in net profit over recommended dose (Tr. 2)
1.	400 kg N/ha alone	A	15063	9587	5476	-289	-5.01
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	B	17000	11235	5765	-	-
3.	560 kg N + 340 kg P_2O_5 + 170 kg K_2O/ha	C	17574	13157	4417	-1348	-23.38
4.	Press mud cake @ 12.5 t/ha	D	16255	9033	7222	+1467	+25.26
5.	Press mud cake @ 18.5 t/ha	E	14804	8601	6203	+438	+7.60
6.	Press mud cake @ 25.0 t/ha	F	15095	8336	6759	+994	+17.24

Appendix-IV(b)

* Patil, et al. (1978). Indian Sug. 27(10) : 711-714.

A p p e n d i x - IV(c)

** (c) Effect of PMC and inorganic fertilizers on chemical properties of soil.

Sr. No.	Treatments (symbol)	Org.carbon %			NO_3^--N mg/100 g			Av.P_2O_5 mg/100g			Av.K_2O mg/100 g			Ec mmhos/cm		
		E.U.	G.G.	H.	E.U.	G.G.	H.	E.U.	G.G.	H.	E.U.	G.G.	H.	E.U.	G.G.	H.
1.	A	0.75	0.80	0.94	6.9	1.6	2.2	5.0	3.75	5.50	18.75	18.25	18.25	0.46	0.16	0.19
2.	B	0.75	0.80	0.86	8.2	1.4	2.2	5.0	5.00	5.00	21.25	23.25	23.75	0.45	0.19	0.19
3.	C	0.76	0.82	0.92	4.5	1.1	1.9	5.0	2.50	5.00	20.75	22.00	22.50	0.44	0.27	0.22
4.	D	0.89	0.84	0.82	2.5	0.5	1.6	7.5	5.00	9.00	20.00	17.00	23.25	0.32	0.19	0.20
5.	E	0.71	0.88	0.98	1.4	0.2	1.9	5.5	3.75	10.25	16.00	18.25	25.00	0.30	0.23	0.21
6.	F	0.89	0.83	1.07	1.5	0.7	1.6	9.0	3.75	10.00	18.25	18.75	23.75	0.27	0.21	0.19

E.U. = At earthing up, C.G. = At grand growth. H = At harvest.

** Bawasakar, et al. (1978). Indian Sug. 27(12) : 807-810.

A p p e n d i x - IV(d)

** (d) Total nutrient contents at different growth stages in sugarcane and uptake kg/t at harvest.

Sr. No.	Treatments (Symbol)	N (%)			P_2O_5 (%)			K_2O (%)			Uptake at harvest kg/t		
		I.U.	G.G.	H.	I.U.	G.G.	H.	I.U.	G.G.	H.	N	P_2O_5	K_2O
1.	A	1.16	1.00	0.85	0.25	0.39	0.56	1.64	2.46	1.06	1.09	0.93	1.79
2.	B	0.98	0.92	0.95	0.24	0.41	0.48	1.52	2.35	1.01	0.79	0.93	2.51
3.	C	0.88	1.18	0.82	0.23	0.44	0.50	1.67	2.22	1.00	0.91	0.80	2.22
4.	D	0.94	0.98	0.81	0.21	0.45	0.49	2.11	2.19	1.03	0.84	0.84	2.20
5.	E	0.90	0.96	1.08	0.25	0.48	0.52	1.58	2.29	1.09	1.05	1.13	2.93
6.	F	0.72	0.92	0.80	0.25	0.50	0.59	1.52	2.49	0.99	1.27	1.32	2.71

Appendix - IV(d)

I.U. = At earthing up. G.G. = At grand growth. H = At harvest.

** Bawasakar, et al. (1978). Indian Sug. 27(12) : 807-810.

A p p e n d i x - IV (e)

** (e) Chemical analysis of juice at harvest.

Sr. No.	Treatments	Symbol	N	P_2O_5	N/P_2O_5 ratio
			mg/100 g		
1.	400 kg N/ha alone	A	66.5	49.6	1.4
2.	400 kg N + 170 kg P_2O_5 + 170 kg K_2O/ha	B	53.8	45.6	1.3
3.	560 kg N + 340 Kg P_2O_5 + 170 kg K_2O/ha	C	59.5	52.1	1.1
4.	Press mud cake @ 12.5t/ha	D	53.1	49.2	1.2
5.	Press mud cake @18.5t/ha	E	68.5	59.7	1.1
6.	Press mud cake @25.0t/ha	F	70.1	46.7	1.5

** Bawasakar, et al. (1978). Indian Sug. 27(12):807-810.