# BANGLADESH JOURNAL OF SUGARCANE

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# BANGLADESH JOURNAL OF SUGARCANE

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## EDITOR'S NOTE

We are pleased to see the publication of the Second volume of the Bangladesh Journal of Sugarcane. It is our pride that the young scientists of the Sugarcane Research Institute has taken a very correct step to share their knowledge of sugarcane research achievement with national and international community. They deserve commendation from all of us.

The present days of the century demands sharing of knowledge. The publications of the materials is one of the best method of communication with those who are staying away from us. We are very happy to see the way our young scientists are sharing their knowledge and communicating among themselves the best possible way they can. This is a very healthy sign of development of sugarcane science and technology in Bangladesh.

The research materials presented in this volume essentially includes information relating to the planting method of sugarcane with relay crop, stability analysis for yield and quality of sugarcane clones, damage assessment for Top Shoot Borers, split application result with nitrogen, post harvest deterioration, flowering effect of cane on quality of juice, incidence and distribution of some sugarcane diseases during the early stage of plantation.

We feel this information, based on local studies, would add to increase to some extent the horizon of knowledge of those extension officers who are engaged in cane development works for the benefit of the sugarcane growers and sugar industry in Bangladesh.

Initially, we recognize our drawbacks and deficiencies, but with time this journal would undoubtedly continue to grow and serve the sugarcane growers and sugar industry in the years to come.

We are dedicated and determined to raise the status of the journal to international standard and make it a practical and productive guide for all those who are involved in practical cane growing here and abroad. We would always welcome your suggestions and constructive criticism.

MAY ALLAH ALMIGHTY BLESS US ALL FOR THE DEVELOPMENT OF SUGARCANE SCIENCE AND TECHNOLOGY NATIONALLY AND INTERNATIONALLY.

M. SHAHJAHAN
Director and Editor

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# Planting method of sugarcane in relay intercropping with paddy in Bangladesh

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## ABSTRACT

An experiment was conducted on the method of relay cropping of sugarcane in transplanted Aman paddy field. The planting methods involved were-flat, high beded, oblique, plough furrow, cane after paddy and only sugarcane.

There was no significant effect on the yield of paddy among the treatments. The 16 inches vacant space after each 4 rows of paddy had no significant effect on the yield of paddy. Among the planting methods high beded method of cane planting produced significantly higher cane yield (40.67 TCA) followed by oblique, flat and furrow method of planting. Poorest yield (31.54 TCA) was obtained when canes were planted after harvesting paddy. Highest combined net return (Tk. 12,828.72) was obtained from paddy and high beded method ; paddy-flat method of cane planting was close to it (Tk. 12,783.66). Although highest benefit cost ratio (Tk. 1:4.08) was obtained from paddy and flat method of planting, paddy - high beded method secured second position (Tk. 1:3.97).

High beded, flat, oblique and furrow method of cane planting may be recommended in succession for paddy cane relay planting in the Sugarcane Research Institute field conditions.

## INTRODUCTION

Higher prices of agricultural commodities prompted the farmers to grow short duration crop than sugarcane requiring 13-16 months to harvest. Increased demand of agricultural products encourages the farmers to adopt intensive farming rather than extensive one.

To make a short crop available and to make cane cultivation productive, remunerative and viable intercropping of sugarcane was introduced. Nearly all the farmers of Bangladesh are rice farmer and the major cropping system is also based upon it. Rice occupies most of the area around mill zone which are also suitable for sugarcane cultivation. Thus to make cane cultivation more remunerative around mill zone intro-

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duction of paddy cane relay intercropping system was felt essential. Paddy-sugarcane is a special cultivation method developed in Taiwan that rendered sugarcane a firm footing where it faces keen competition with rice and Tobacco (Fu, 1958). This is the most intensive method of paddy-sugarcane cultivation and a new system in the sugar world (Chang, 1957).

To implement the concept of paddy-sugarcane a suitable method is required to be found out which does not affect the yield of both paddy and cane crop. Experiments were conducted in Taiwan on a number of methods of planting cane in the paddy field. Chang (1960) reported that there was no significant difference between the yield of flooded paddy and cane planted obliquely and that of high beded system. Results of several experiments on the method of planting paddy-cane reported by Sun (1961), Chang (1960) and Fu (1958) revealed that there was no significant difference on flooded, high beded and Hei-Ko method of paddy-cane planting.

The present research work was undertaken to find out the best adaptible method of cane planting and to compare the economic benefit of paddy-cane relay intercropping with that of clean crop of paddy and cane.

## MATERIALS AND METHODS

The experiment was conducted at the Sugarcane Research Institute farm in 1976-77 following randomized complete block design (RCB) with 4 replication. IR-20, a HYV rice was transplanted at the age of 30 days where spacings between rows and plants were 8 inches and 6 inches respectively. After planting each 4 rows of rice a gap of 16 inches was kept vacant for planting of sugarcane setts in different methods in the flowering stage of paddy. A control plot of rice was maintained where paddy seedlings were planted normally on the same date without keeping any extra space and cane were planted after harvesting paddy. In another treatment only sugarcane was grown in its optimum time following normal cultural practices. The rice crop was fertilized at the rate of 2 md Urea, 2 md TSP and 1 md MP per acre. All normal cultural practices including irrigation were followed. The rice crop was harvested 123 days after transplanting.

Sugarcane setts containing three eye buds of Co. 1158 variety were planted in the following methods :

(1) Flat method
(2) Oblique method
(3) High beded method
(4) Plough furrow method
(5) Normal cane (fallow during T. Aman season)
(6) Cane after harvesting T. Aman.

1. **Flat method** : In this method sugarcane setts were planted horizontally on the soft mud without any land preparation in the vacant spaces in the end to end method keeping the eyebuds side ways. The setts were planted on 1st November, 1976.

One third of the recommended dose ( 3 md Urea, 3 md. TSP & 2 md. MP ) of Urea and MP and entire quantity of TSP were applied as basal dose in the side band method at the time of planting. This is the most common and oldest paddy — cane method in Taiwan (Fu, 1958).

2. **High beded method :** A raised bed of about 1''-1½'' high and 6'' width were constructed accumulating soft mud from the 16'' gap along the middle of the vacant space after each 4 rows of rice. Cane setts were planted on the beds in the end to end method keeping the eye buds side ways. The beds were constructed to save the eye buds from rotting due to submergence in case of heavy rainfall and also to ensure quick germination.

3. **Oblique method :** Sugarcane setts were planted obliquely at a 45° angle after each four rows of rice. In this method, one eyebud was put under the mud. The eyebud situated at the middle of the sett remained just in touch with the wet ground and the upper one in the open air. The bottom eye bud placed under the mud mostly failed to germinate but the upper two germinated satisfactorily. When the field dried to some extent, the obliquely planted setts were pressed to the ground by foot and allowed to produce sett roots from the upper two nodes.

Table 1. Dates of planting/harvesting, spacing, fertilizer dose and variety of cane and paddy.

| Treatments | Date of planting | | Spacing | Date of harvesting | Variety | Fertilizer dose/acre. |
|---|---|---|---|---|---|---|
| | Cane | Paddy | | | | |
| Only cane (Fallow during T. Aman Season) | 8th Nov. '76 | — | Cane—4' rows | Cane—7th Jan. '78 | Cane — Co1158 | Cane<br>Urea 3 md<br>TSP 3 md<br>MP 2 md |
| Paddy + flat method of cane planting | 1st Nov. '76 | 26th July'76 | Paddy rows—8'' plant.—6'' | Paddy 26th Nov. '76 | Paddy IR—20 | Paddy<br>Urea 2 md<br>TSP 2 md<br>MP 1 md |
| Paddy + high beded method of cane planting | ,, | ,, | ,, | ,, | ,, | ,, |
| Paddy + plough furrow method of cane planting | 8th Nov. '76 | ,, | ,, | ,, | ,, | ,, |
| Only paddy followed by only cane. | 28th Nov. '76 | ,, | ,, | ,, | ,, | ,, |

4. **Plough furrow method :** As soon as the soil of the plot became dried and workable condition prevailed to some extent but the paddy was still in the field this method of planting cane was followed. One wooden plough was drawn by hand on

the vacant space in between four rows of paddy to construct a furrow. Normal basal dose of Urea, TSP and MP fertilizers were placed in these furrows and the plough was worked again to mix them. Planting of cane was done on 18th November, 1976 and the setts were covered by a thin layer of soil.

5. **Normal Cane** : The plot under this treatment were kept fallow during T. Aman growing season. As the soil became workable the land was prepared properly by power tiller and all normal procedures of cane planting were followed.

6. **Cane after harvesting T. Aman Paddy** : This was the normal practice of cane planting followed by cane growers. In this method sugarcane setts were planted on 28th November, 1976, immediately after harvesting paddy. All normal land preparation and planting practice were followed.

The rice stubbles were removed by plough and spade immediately after rice was harvested.

The cane crop received recommended doses of fertilizers at the rate of 3 md Urea, 3md. TSP and 2 md. MP per acre. All normal cultural practices for cane were followed which includes three weeding, three mulching, two Irrigation and frequent control measures against insects and diseases. The crop was harvested on 7th January, 1978.

Data of planting and harvesting, fertilizer dose and row spacing of paddy and sugarcane were shown in Table 1. Data on yield of paddy, sugarcane and germination %, number of tiller per acre, number of millable cane per acre, plant height, sucrose content and pink borer infestation of sugarcane were recorded. Appropriate statistical and economical analysis for yield components of sugarcane were made to isolate desirable treatments. The benefit cost ratio per unit of investment were also calculated.

## RESULTS AND DISCUSSION

**Yields of Paddy** : Highest yield of 1.92 MT/acre were produced when paddy were grown normally without keeping any vacant space and also where the cane setts were planted in flat method (Table 2). Poorest yield of 1.78 MT/acre were produced where canes were planted in furrow method. But there was no significant difference in the yield of paddy in any of the treatments. Chang (1957) reported that intercropping cane into the spring crop of rice has no significant effect upon the yield of rice.

**Germination of cane** : Highest germination of sugarcane were obtained when sugarcane was plante on high bed (65%) followed by flat method of planting (61%) and were statistically identical. All other treatments were found to differ significantly from each other. Poorest germination (46%) were produced where cane setts were planted in the trench following normal cane planting procedures after the harvest of paddy (Table 2). Fu (1958) reported that in case of odd climate condition like excess rainfall or flood germination of cane was found guaranteed in oblique method of planting.

**Tiller production of cane :** High beded planting method of cane produced highest number of tillers ($97.92 \times 10^3$) per acre which were identical to that produced by oblique, flat and furrow method (Table 2). Cane setts planted early in the season following normal method produced higher number of tillers than that of canes planted after harvesting paddy. Chang (1960) reported that the important tillering period of spring paddy cane is about 20 days to one month after the harvesting of rice. He also reported that the quick growth after harvest of rice is the main reason of good yield of cane.

**Production of millable cane :** Sugarcane planted in the high beded method induced highest number of millable cane ($44.24 \times 10^3$) which were identical to that produced by flat method of cane planting and were superior to all other treatments. Planting cane obliquely or in the furrow produced equal number of cane and was superior to the rest of the treatments except that mentioned above. Poorest number of millable canes were produced when the setts were planted after harvesting paddy following normal planting procedures (Table 2). The above results almost corresponds with the pattern of germination and tiller production of the cane as influenced by the methods of planting. Chang (1960) reported about 16.7% of primary stalks, 54.7% of secondary stalks and 28.6% of tertiary stalks in the component of millable cane. There was no significant effect on the height of cane plants grown under different treatments (Table 2).

**Yield of cane :** The high beded method of cane planting out yielded all other treatments by producing 40.67 ton cane per acre (TCA).

Flat, oblique and plough furrow method produced indentical yield and was similar to that produced by only cane planted in the normal method (control). Cane planted after harvesting of rice produced the lowest yield of 31.54 TCA (Table 2). Fu (1958) reported that the yield of paddy-cane methods were significantly higher than that of cane planted after harvesting rice. The highest yield obtained from high beded method of cane planting was supported by its increased germination, more tiller and millable cane production. Chang (1960) reported that there was no significant difference between the yield of flooded paddy cane planted obliquely and that of high beded-paddy-cane planted flatwise. Sun (1961) reported a number of experimental results of different planting methods of autumn paddy cane in saline soils. He stated that if 100 is the index of planting cane after harvesting paddy then high beded paddy cane produces 134.8% cane and significantly superior to other methods. But Fu (1958) reported that among different cultural methods of paddy sugarcane highest yield was obtained by flooded paddy cane (oblique method) which was 108.33 TCH (Ton cane/ha) followed by high beded method (105.25 TCH). Poorest yield (80.12 TCH) was obtained when canes were planted after harvesting rice. He also reported that high beded method of cane planting was advantageous in poorly drained regions.

Relay interplanting method raise the unit yield of cane about 30/60% per month than a normal crop with a growing period of 17 months (Chang, 1957).

Table 2. Yield of cane, paddy and yield contributing factors of cane under paddy-cane relay interplanting system.

| Treatments. | Germination (%) | No. of tiller ($10^3$ /ac) | No. of millable cane ($10^3$ /ac) | Cane height (Ft) | Yield of cane (TCA) | Recoverable sucrose (%) | Pink borer infestation (%) | Yield of paddy MT/ac |
|---|---|---|---|---|---|---|---|---|
| Flat method | 61.23ab | 87.64a | 43.58a | 9.08 | 38.24ab | 9.81 | 4.36 | 1.92 |
| High beded | 64.65a | 97.92a | 44.24a | 9.29 | 40.67a | 9.81 | 2.85 | 1.78 |
| Oblique planting | 51.80bcd | 94.09a | 40.84ab | 9.32 | 38.54ab | 10.06 | 4.81 | 1.85 |
| Plough furrow method | 58.05abc | 87.87a | 42.38ab | 9.21 | 38.03ab | 10.28 | 4.37 | 1.79 |
| Normal cane (control) | 47.77cd | 67.45b | 39.34bc | 9.46 | 36.99ab | 10.11 | 1.92 | fallow during T. Aman season |
| Normal paddy followed by cane, | 46.24d | 52.52c | 35.96c | 9.16 | 31.54b | 10.45 | 2.70 | 1.92 |
| S.E. of mean | 3.49 | 3.18 | 1.25 | N.S. | 2.23 | N.S. | N.S. | N.S. |

Figures in the colum followed by similar letters do not differ significantly at 5% level.

**Recoverable sucrose :** The sucrose content of cane under different treatments of the experiment were found to show no effect (Table-2).

**Pink borer infestation :** Paddy and sugarcane being the member of same family was found to be attacked by same insect. The pink borer, a pest of paddy was found to migrate to sugarcane as alternate host. But the rate of infestation was found insignificant as compared to the control (cane after harvesting paddy). Highest pink borer infestation was found in the canes planted obliquely (4.81%) followed by plough furrow (4.37%) and flat (4.36%) method of planting. Less number of infestation (1.92%) were found where paddy was not grown and cane setts were planted normally.

**Economics :** The combined highest return of paddy-cane planting system was obtained when the canes were planted on high bed (Tk. 12,828,72) followed by flat method (Tk. 12,783.66). The combined yields of all interplanting methods were found close to each other and higher than that obtained from cane after paddy and only cane plantation method. Chang (1957) reported that comparing the profit returns of different planting systems the single crop of spring and autumn rice and one crop of winter wheat as 100, the index for interplanting cane with spring rice is 164. The later system not only brought more profit but also gives more sugarcane harvesting area, more total sugar production and more rice production.

**Highest benefit :** Cost ratio per taka investment was obtained in the flat method of cane planting (Tk. 1:4.08) and high beded method was found very close to it (Tk. 1:3.97) followed by oblique method (Tk. 1:3.96). The least return per taka investment was obtained when only cane was grown (Tk. 1:3.20).

Although high beded method produced highest tonnage of cane the expenditure involved for constructing high bed has brought down the benefit cost ratio to second position. Comparatively low cost of production was involved in the flat method of planting.

Table 3. Economics of paddy cane relay interplanting system.

| Treatments (method of cane planting) | Cost of cultivation | | Total cost (Tk.) | Sale proceeds | | Total sale proceed (Tk.) | Net return (Tk.) | Benefit cost ratio/Tk. investment. |
|---|---|---|---|---|---|---|---|---|
| | Paddy (Tk.) | Cane (Tk.) | | Paddy (Tk.) | Cane (Tk.) | | | |
| Flat method | 1130.60 | 3021.20 | 4151.80 | 6174.72 | 10760.74 | 16935.46 | 12,783.66(2) | 4.08(1) |
| High beded method | 1130.60 | 3190.00 | 4320.60 | 5724.48 | 11424.84 | 17149.32 | 12,828.72(1) | 3.97(2) |
| Oblique method. | 1130.60 | 3120.00 | 4250.60 | 5949.60 | 10845.16 | 16794.76 | 12,544.16(3) | 3.86(3) |
| Plough furrow method. | 1130.60 | 3225.00 | 4355.60 | 5755.64 | 10701.64 | 16453.23 | 12,102.63(4) | 3.78(4) |
| Normal cane (fallow during T. Aman season) | — | 3260.00 | 3260.00 | — | 10408.99 | 10408.99 | 7,148.99(6) | 3.20(6) |
| Paddy followed by cane. | 1271.93 | 3260.00 | 4531.93 | 6174.72 | 8875.36 | 15050.08 | 10,518.15(5) | 3.32(5) |

Paddy @ Tk. 3216 and Cane @ Tk. 281.40/MT.

Figures in the parentheses indicate the relative rank of cropping system.

The results of the above experiment indicated the suitable method of planting sugarcane in T. Aman paddy field. This has not only increased the cane yield but also shortened the growing period of cane from 16 months to 13 months. Chang & Lin (1960) reportened that under this new system of paddy cane cultivation the farmer might produce one crop of rice with one crop of cane within one year. It is the most effective method to shorten the growing period of sugarcane.

Among the planting methods studied, high beded method of cane interplanting with paddy produced higher cane yield, net return and economic benefit followed by flat and oblique methods of planting. The farmers may choise any one of the above methods depending on the suitabiiity of the land and variety of paddy and sugarcane grown. Thus it is assumed that the system of interplanting cane with paddy may prove most promising in the years to come,

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# Stability analysis for yield and quality of some sugarcane clones

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## ABSTRACT

Varietal trial experiments with some advance lines of sugarcane were conducted at 4 different cane growing zones of Bangladesh with a view to screening out the most stable genotypes. Experimental results revealed that the genotypes I-156/66, I-2/66 and I-92/66 showed almost stable cane yield at all the places. For recoverable sucrose content I-112/67, I-170/67 and I-144/66 showed better stable performance at all environments. But in considering both yield and quality I-112/67 was found to show better stability at all the locations.

## INTRODUCTION

The expression of a phenotypic character is dependent upon the interaction of genotype and environment. At different environments the expression of a character may be varied. This differential response of a genotype due to environmental variation is a problem for selecting genotypes. In any successful breeding programme it is necessary to screen and identify phenotypically stable genotype which could perform persistent performance under a wide range of environments. The statistical analysis used by Finlay & Wilkinson (1963) and Eberhurt & Russell (1966) is useful tool for determing the phenotypic stability of a genotype. Finlay and Wilkinson (1963) used simple linear regression as a quantitative measure of phenotypic stability to describe varietal adaptability in a range of environments. According to them absolute phenotypic stability of a line would be expressed by $b = 0$ and the ideal variety in respect of adaptation would be the one having the maximum yield potential in the most favourable environment. Lateron Eberhurt and Russell (1966) suggested that in addition to mean and regression, deviation from regression should be considered. According to them an ideally adaptable variety would be the one having mean value, unit regression co-efficient ($b = 1.0$) and a deviation from regression as small as possible ($S^2di \rightarrow 0$).

Genetically sugarcane is highly heterozygous. Environmental influence on the expression of characters of this crop is prominent. Selection of genotypes under a wide range of environment is important for developing stable sugarcane varieties. The present

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investigation was undertaken with a view to screening out sugarcane clones which were phenotypically stable at all the cane growing zones of Bangladesh.

## MATERIALS AND METHODS

The study was undertaken during the year 1977-78 simultaneously at the experimental farms of Sugarcane Research Institute, Ishurdi, Carew & Co. Ltd., Darsana, Rajshahi Sugar Mills, Rajshahi and Thakurgaon Sugar Mills, Dinajpur. Experimental materials included at each location were I-2/66, I-149/66, I-156/66, I-170/67, I-134/70, I-92/66, L, Jaba-C, I-112/67 and Co. 1158. The experiment was laid out in randomized block design at each zone. Equal normal cultural practices were followed. For this study observations were made only on yield of cane per acre and percentage of recoverable sucrose content.

The statistical analysis of stability were performed by utilizing the methods of Eberhurt and Russell (1966). The model suggested by them to compare genotypes with regard to stability of performance is $Yij = Mi + Bilj + dij$, (i = 1, 2, ..... v, J = 1, 2, .....N) where Yij denotes the mean value of the ith variety at the jtr environment, *M*i refers to the mean of the ith variety over all environment, *B*i is the regression co-efficient that measures the response of the ith variety to varying environments, Ij is the environmental index obtained as the mean of all varieties at the jth environment minus grand mean and dij denotes the deviation from regression of the ith variety at the jth environment, V being the total number of varieties and N the number of different environments included in the investigation. In this method a variety simultaneously satisfying the following properties is defined as a stable and desirable variety : (1) its mean ($\bar{Y}i$) is greater than grand mean (*M*), (ii) the value of its estimated regression co-efficient (Bi) on varying environments is approximating to unity, and (iii) the estimated value of mean deviation from regression ($S^2di$) for the variety is as small as possible.

## RESULTS AND DISCUSSION

The data on yield and quality were analysed separately for partitioning the explainable and non-explainable parts of the genotype environment interaction. The varietal differences were found highly siginificant in individual location and also when pooled over the four locations (Table 1). Genotype Environment interaction was also found statistically significant indicating the phenotypic unstability of the genotypes under varying environments (Table 1). Similar results were also observed by S. Subba Rao *et al.*, (1978) in studying the genotypic stability of sorghum varieties.

Stability parameters shown in the Table-2 indicated that the clones I-156/66, I-2/66 and I-92/66 showed higher cane yield than the grand mean, almost unit regression values and smaller deviation from regression results. The strains I-149/66 and I-170/67 out yielded the grand mean but showed greater 'b' and smaller deviation from regression values. In case of the strain I-112/67 almost similar cane yield with the grand mean, unit 'b' & smaller diviation from regression values were observed (table 2). For the percentage of recoverable sucrose content I-112/67, I-170/67 and I-149/66

were found to exceed the grand mean. In case of unit regression (b) and smaller deviation from regression ($S^2$ di) value these three strains showed desirable performance indicating their stable adaptability.

Table 1. Pooled analysis of variance.

| Source of variation | df | M.S. Yield in TCA | M.S. Recoverable sucrose content (%) |
|---|---|---|---|
| Replication within location | 12 | 52.71** | 0.018 |
| Location | 3 | 493.87** | 0.957** |
| Location (Lender) | 1 | 37.32 | 0.071** |
| Genotype | 9 | 114.35** | 0.108** |
| Location X Genotype | 27 | 68.61** | 0.019** |
| Regression | 9 | 72.74** | 0.076 |
| Pooled deviation | 20 | 9.92 | 0.005 |
| Error | 108 | 14.99 | 0.010 |

** = Significant at 1% level.

Table 2. Stability parameters for yield and quality of some sugarcane clones.

| Genotypes | Yield in (TCA) | | | Percentage of Quality (Recoverable sucrose content) | | |
|---|---|---|---|---|---|---|
| | $\bar{Y}$ | b | $S^2di$ | $\bar{Y}$ | b | $S^2di$ |
| Co.1158 | 35.08 | 1.08 | 2.48 | 9.84 | 1.0879 | —0.0087 |
| I-2/66 | 38.43 | 1.27 | —14.86 | 9.30 | 0.8908 | —0.0098 |
| I-149/66 | 37.92 | 2.61 | —12.09 | 10.69 | 1.3362 | —0.00 .1 |
| I-156/66 | 41.04 | 0.52 | —10.98 | 9.80 | 0.8099 | —0.0003 |
| I-170/67 | 36.98 | 2.14 | 10.54 | 10.58 | 0.8525 | —0.0034 |
| I-134/70 | 34.67 | 1.03 | —11.64 | 9.93 | 1.1787 | —0.0064 |
| I-92/66 | 39.06 | 1.54 | —13.13 | 9.81 | 0.7631 | —0.0090 |
| L-Jaba-A | 34.06 | —0.45 | 26.83 | 9.95 | 1.3418 | 0.0053 |
| L-Jaba-C | 33.96 | —0.35 | 2.24 | 10.04 | 0.6823 | —0.0084 |
| I-112/67 | 36.67 | 0.56 | —9.03 | 11.09 | 1.1333 | —0.0065 |
| Grand Mean | 36.79 | | | 10.10 | | |

In conclusion considering both yield and quality I-112/67 may be considered as stable genotype for all locations and further observations are needed for the strains I-149/66 and I-170/66.

## Acknowledgement

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# assessment of loss caused by top shoot Brer (*Scirpophaga excerptalis* Walk) and stem Borer (*Chilo tumidicostalis* Hamps. and *Chilo auricilius* Dudgeon)

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## ABSTRACT

An experiment on assessment of loss caused by Top Shoot Borer (**Scirpophaga excerptalis** Walk.) and Stem Borers (**Chilo tumidicostalis** Hampson and **Chilo auricilius** Dudgeon) was carried out. The Top Shoot Borer (TSB) infested canes contain 2% less sucrose than the Stem Borer (SB) infested canes. It would be economic if the control measures are taken when there are 5% infestations by each of TSB and SB in respect of the cane weight and sucrose content together. When the cane weight is alone considered, it would not be economic to engage labourers if SB and TSB infestations are below 20% and 10% respectively. Thus it is suggested that mechanical control operation would be profitable to keep infestation below economic injury level.

## INTRODUCTION

Pests cause severe damage to crops to such an extent and frequency that they often result in economic and social changes in many places (Rai and Rai, 1979). It has been estimated that a large amount of losses are caused by weeds (33%), followed by plant diseases (20%), insects (25%) and rodents (6%). Records of variable damages caused by borers were available. Schaff (1975) reported in Jamica that bored internodes produced 45% less sugar than undamaged internodes. Studies elsewhere in Mexico showed an average loss of 300g of sugar per metric ton of cane for every 1% of internodes infested; this combined with loss of nearly 15,000 tons from 9,00,000 tons of cane (Humbert, 1976). Economic losses caused by the pest amount to some 20% of the total production of sugarcane. (Planal Sugar Annual Report p-40. 1977).

Damage to a particular crop is the sum total of the effects of all the prevailing pests. The sugarcane crop is affected by four species of stem borers, one species of top shoot borer, one species of root borer, two or more species of white grubs and three species of sap suckers (Karim and Islam, 1976). Apart from the damage caused by various major and minor pests the loss due to TSB was reported earlier (Miah *et al.*, 1980). The present paper describes the damage caused by SB and economic injury level of SB & TSB.

## MATERIALS AND METHODS

Ten infested and non infested plants of several commercially cultivated sugarcane varieties were weighed and crushed individually and sugar recovery studied with polarimeter. The decrease in cane weight and sucrose content of these varieties cultivated at Sugarcane Research Institute (SRI) experiment farm was recorded. Since infestation level differs with varieties the loss of cane was calculated according to the following formula (Miah *et al.*, 1980). Percent cane loss$= \frac{A-(B+C)}{A} \times 100$, where

A= Estimated weight of millable healthy cane in the field

B= Total weight of infested canes,

C= Total weight of infestation free cane

Again,

B= a x b x c, where

a= Total no, of cane in the area,

b= Percent infested canes.

c= weight of infested canes,

Loss in terms of sugar was assessed as follows :

Percent sugar loss $= \frac{A_1-(B_1+C_1)}{A_1} \times 100$, where

$A_1$= Estimated sugar produced from one acre @ 11% available sugar.

$B_1$= Sugar from infestation free cane @ 11% available sugar.

$C_1$= Sugar from infested cane and $B_1 = A_1 - C_1$.

Again $C_1$= a x 0.14x0.09, where a= Expected weight of infested cane.

0.14= Weight reduction factor of infested cane.

0.09= Percent available sugar in infested cane.

## RESULTS AND DISCUSSION

Loss of TSB and SB may be termed as two dimensional because the infestation reduces yield as well as the sucrose content. Moreover, the rate of reduction varies with the intensity of attack as well as the tolerance which is an important component of varietal resistance, Loss caused to the several cane varieties by SB and TSB was reported earlier which showed that on an average 2% sucrose is reduced by Top Shoot Borer (Miah, *et al.*, 1980). Therefore, it was apparent that TSB was more damaging than the other if infested at later stage of growth.

Growers are affected by these insects because of reduced weight of canes. The loss in weight per cane varies from 0.1 lb to 0.7 lb with varieties (Miah, *et al.*, 1980). Considering 400 mds as total yield of canes per acre, extent of infestation upto 100% and average weight loss 14% the loss per acre would be 56 mds due to one species of insect only. This agrees with the results obtained in Louisiana, where 1.5 tons of cane per acre were reduced due to borer infestation. (Hensely, S.D. 1971).

Last year, it was observed in the farmers fields of Carews & Co. Darsana, that 80% canes were infested by several plant boring insects (personal observation). In such a case, the grower may apprehend a minimum loss of 48 mds of canes/acre which would be equal to Tk. 576/-. Since Top shoot borer infested canes had about 2% less sucrose, production of sugar from one acre of such heavily infested cane field would be reduced by a factor, 24.3%.

The damage caused by TSB and SB are shown in tables 1 & 2, which show that total loss in terms of cane and sugar increased with the increasing level of infestation.

Table 1. Assessment of loss due to top shoot borer infestation.

| Infested cane sticks. | Cane loss by weight % | Sugar loss by weight % | Loss due to TSB attack (Taka) | | |
|---|---|---|---|---|---|
| | | | Cane loss | Sugar loss | Total loss |
| 100 | 14.0 | 29.6 | 672 | 5209.60 | 5881.60 |
| 90 | 12.5 | 26.7 | 600 | 4699.20 | 5299.20 |
| 80 | 11.3 | 23.7 | 540 | 4171.20 | 4711.20 |
| 70 | 9.5 | 20.7 | 456 | 3643.20 | 4099.20 |
| 60 | 8.5 | 17.8 | 408 | 3132.80 | 3540.80 |
| 50 | 7.0 | 14.8 | 336 | 2604.80 | 2940.80 |
| 40 | 5.5 | 11.9 | 264 | 2094.40 | 2358.40 |
| 30 | 4.3 | 8.9 | 204 | 1566.40 | 1770.40 |
| 20 | 3.0 | 5.9 | 144 | 1038.40 | 1182.40 |
| 10 | 1.5 | 3.0 | 72 | 528.00 | 600.00 |
| 5 | 0.8 | 1.5 | 36 | 264.00 | 300.00 |
| 0 | 0.0 | 0.0 | 0 | 0.00 | 0.00 |

* Basic parameters of calculations :

a) Yield/acre—400 mds.
b) Available sugar—11%
c) Yield of sugar/400 mds cane—44 md.
d) Price of cane Tk. 12.00/md.
e) Price of sugar—Tk. 10.00/seer.

The profit of pest control measures and the economic threshold of adopting plant protection measures vary with the several inputs in the different countries. In Bangladesh mechanical control measures for SB & TSB are usually followed, which require during one crop season 10 labourers for one acre of land.

This costs about Tk. 100. Therefore, the use of labour would be economic if the infestation is 5% or above (table 1 & 2). It is worth mentioning that overall loss in-

cluding cane and sugar due to 5% infestation exceeds Tk. 100/-. But if the benefit of farmer alone is considered, then the grower may not apparently be benefitted by engaging labourers if SB & TSB infestations are below 20% and 10% respectively towards the end of the season. But the infestation towards the end resulted from the infestation during the earlier part of the season. Therefore, mechanical control would pay in the long run because pest control operation, in stead of increasing the yield saves the loss of yield which would otherwise have occurred owing to pest attack (Rai and Rai, 1979). Thus it is suggested that mechanical control operation in the early stage of plant growth would be profitable to keep infestation below economic injury level.

Table 2. Assessment of loss due to stem borer infestation.

| Infested cane stick. | Cane loss by weight % | Sugar loss by weight % | Loss due to SB attack (Taka) | | |
|---|---|---|---|---|---|
| | | | Cane Loss | Sugar loss | Total loss |
| 100 | 7.33 | 18.00 | 351.84 | 3056.00 | 3407.84 |
| 90 | 6.60 | 15.70 | 316.80 | 2764.00 | 3080.80 |
| 80 | 5.86 | 13.89 | 278.40 | 2444.00 | 2722.40 |
| 70 | 5.13 | 12.16 | 246.24 | 2140.00 | 2386.24 |
| 60 | 4.47 | 10.41 | 214.56 | 1832.00 | 2046.56 |
| 50 | 3.67 | 8.68 | 176.16 | 1528.00 | 1704.16 |
| 40 | 2.93 | 6.93 | 140.64 | 1220.00 | 1360.64 |
| 30 | 2.19 | 5.22 | 105.12 | 920.00 | 1025.12 |
| 20 | 1.46 | 3.48 | 70.08 | 612.00 | 682.08 |
| 10 | 0.73 | 1.75 | 35.04 | 308.00 | 343.04 |
| 5 | 0.30 | 0.86 | 17.28 | 142.00 | 159.28 |
| 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Basic parameters of calculations :

a) Yield/acre —400 mds.
b) Available sugar—11%
c) Yield of sugar/400 mds cane — 44 mds.
d) Price of cane—Tk. 12.00/md.
e) Price of sugar—Tk. 10.00/seer.

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# Studies on split application of Nitrogen in Sugarcane

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## ABSTRACT

Studies on split application of nitrogen in sugarcane in its growing period were conducted during 1974—1975 and 1975—1976 cropping years at North Bengal Sugar Mills (NBSM) and Sugarcane Research Institute (SRI) farms respectively in order to determine the critical period and correct prescription of the recommended dose of 110 lbs. N/acre.

In both the years, split application of 110 lbs. N, 50% after 45 days, 50% after 120 days of planting improved cane yield and total sugar production though other factors like germination, cane height, weight per stalk, tillers per clump and recovery (%) of sugar were influenced differentially by different treatments. Results of the experiments indicated that the critical period for N application in sugarcane was within first 120 days after planting.

## INTRODUCTION

Sugarcane is a biennial crop having great demand for nutritive elements for its proper growth and development. Timely fertilization is the key to maximum benefit from the added fertilizers ( De Geus 1967, and Srivastava, 1971 ). Although sugarcane remains in the field for more than one year, it needs timely fertilization during its growing period for better cane yield and % recovery. Fertilization of sugarcane in early stage of its growth is advocated by many investigators (De Geus, 1967 ; Srivastava, 1971 ; Mohan Rao and Narasimham, 1956). The proper time for application of nitrogenous fertilizers is an important factor in determining their effectiveness in the nutrition of sugarcane and also for maximum return from application per unit of applied nitrogen. Untimely application often leads to considerable loss of this element through leaching, surface run off, and volatilization as gaseous ammonia and thereby results in poor crop response (Singh, 1974). Srivastava (1971) reported that although sugarcane is a long

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duration crop, the period of formative phase itself is relatively short and the foraging capacity is low at the early stage of cane plant. Therefore, to hasten the build up of shoot population, and proper plant growth, the cane plants require nitrogenous fertilizer at the formative stage of the crop.

Extensive researches have conducted in these lines in may cane growing countries and comprehensive recommendations about the use of N–fertilizers have been formulated in order to get maximum benefit by the use of applied nitrogen. But very little research work regarding the time of application of nitrogenous fertilizer to sugarcane were made in the past in Bangladesh. An attempt has, therefore, been made to find out the critical period for application of 110 lbs. N/acre in sugarcane.

## MATERIALS AND METHODS

The experiments were conducted during 1974-1975 and 1975-1976 cropping season under irrigated condition at NBSM and SRI farms, respectively. Both NBSM and SRI farm soils belong to a typical soil physiographic unit of the Ganges river flood plain. The characteristic of the NBSM soil is sandy clay texture, pH 8.0 organic matter 1.33% total N 0.061% while that of SRI is clay texture having pH 7.8, total N 0.097% and organic matter 1.66%. The soils are very soft when wet but become compact, hard and crack when dry.

The experiments were laid out in later part of November in both years. Variety of cane Co. 1158 was used in both cases. All materials and methods were kept constant. The treatments consisted of spliting the usually applied dose of 110 lbs. N/acre as follows :

$T_1$—Normal practice i.e. 33.3% of N at planting, 33.3% after 1st heavy shower and 33.3% in June.

$T_2$—100% of N at planting.

$T_3$—50% at planting and 50% after 120 days of planting.

$T_4$—50% after 45 days and 50% after 120 days of planting.

$T_5$—20% at planting, 30% after 45 days and 50% after 120 days of planting.

$T_6$—20% at planting 30% after 45 days and 50% after 250 days of planting.

In both the cases, the experiments were laid out in randomized block design. Six treatments were replicated 4 times. Three buded equal number of assorted setts were planted end to end in each plot at the rate of approximately 60 maunds/acre. Spacing of cane rows was 3.5', and the distances between blocks and between plots were 6' and 5' respectively. Present doses of 110 lbs. $P_2O_5$ and 97 lbs. $K_2O$ per acre basis were applied in all the plots. Before Planting sugarcane, soil samples were collected and analysed for N and other related properties.

From the experiments, germination, tillers per clump, total millable cane, weight per stalk, cane height, yield of cane, recovery (%) of sugar and total sugar production were studied.

## RESULTS AND DISCUSSION

Data of cane yield, other yield components and % sugar recovery are presented in tables 1 and 2 for first and second years' experiments respectively while figure I shows total sugar production for both the years.

Table 1. Effect of different treatments on yield, some yield contributing factors and % recovery of sugarcane during 1974—1975 at NBSM farm ( Date presented are average of 4 observations).

| Treatments | Germination (%) | No. of tliliers per clump | Cane height (ft.) | Weight/ stalk (kg) | No. of millable cane/acre | Yield of cane (TCA) | Recovery of sugar (%) |
|---|---|---|---|---|---|---|---|
| $T_1$ | 36.16 | 3.59 | 8.67 | 0.654 | 48932 | 32.00b* | 9.09 |
| $T_2$ | 30.76 | 4.11 | 8.17 | 0.622 | 47480 | 29.54c | 9.17 |
| $T_3$ | 37.85 | 3.97 | 8.75 | 0.619 | 56241 | 34.81ab | 8.86 |
| $T_4$ | 34.36 | 4.31 | 8.93 | 0.660 | 55611 | 36.72a | 9.02 |
| $T_5$ | 34.88 | 3.70 | 9.00 | 0.717 | 48545 | 34.79ab | 9.11 |
| $T_6$ | 32.05 | 3.77 | 8.50 | 0.648 | 45592 | 29.54c | 9.04 |

* Figures bearing same letters do not differ at 5% level.

Table 2. Effect of different treatments on yield, some yield contributing factors and % recovery of sugarcane during 1975—1976 at SRI farm ( Data presented are average of 4 observations.)

| Treatments | Germination (%) | No. of Tillers per clump | Cane height (ft) | Weight/ stalk (kg) | No. of millable cane/acre | Yield of cane (TCA) | Recovery of sugar (%) |
|---|---|---|---|---|---|---|---|
| $T_1$ | 43.98 | 4.40 | 9.46 | 1.035 | 45502 | 46.94 | 9.43 |
| $T_2$ | 45.97 | 5.12 | 9.85 | 1.031 | 45484 | 46.73 | 9.45 |
| $T_3$ | 43.19 | 4.92 | 9.88 | 1.018 | 47698 | 48.40 | 9.08 |
| $T_4$ | 46.48 | 4.69 | 9.70 | 1.015 | 48134 | 48.72 | 9.25 |
| $T_5$ | 44.49 | 4.86 | 9.59 | 1.014 | 46373 | 46.89 | 9.14 |
| $T_6$ | 42.36 | 4.47 | 9.35 | 1.029 | 43941 | 45.08 | 9.41 |

Though the yield components like number of tillers, cane height, weight per stalk and number of millable cane do not always bear any distinct relationship with the yield of sugarcane, they go a longway in explaining many observations and a study on them is always desirable to evaluate the overall effects of any treatments. The treatment variation with respect to percent germination (maximum at $T_3$ and $T_4$ and minimum at $T_2$ and $T_6$ for 1974 - 1975 and 1975 - 1976 respectively ) is easily acceptable when we consider that this factor is more dependent on soil moisture, texture, etc. rather than on the nutrients availability of the soil (Tisdale and Nelson, 1969). During first year, though $T_2$ has the second highest tiller number, it produced the highest in the next year i. e. 1975 - 1976. Similar results of enhanced tillering due to higher amount of N application at initial stage have also been reported by Dillewijn, (1952). $T_1$ produced

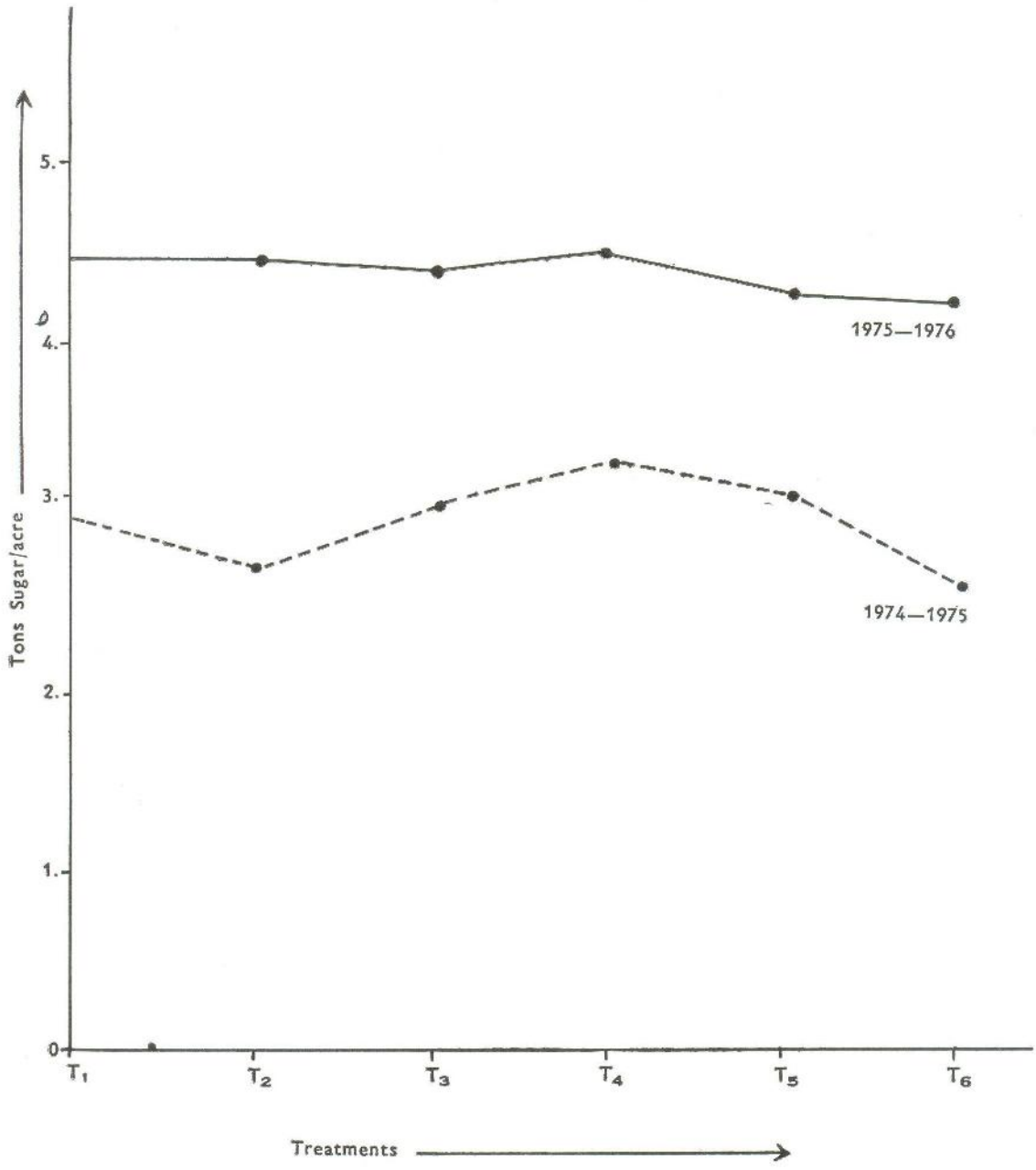


Fig. 1. Effect of different treatments on Tons Sugar per acre produced during 1974—1975 and 1975—197 cropping seasons.

lowest tiller numbers in both the years suggesting the influence of fertility or nitrogen availability with this parameter and inferiority to all other treatments. The next two parameters in the table 1 and 2 i. e. cane height and weight per stalk show the least relationship between the treatments effect of the two years as is evident by the data. $T_5$ produced maximum cane height and weight per stalk in the first year while $T_3$ and $T_1$ showed the same effects for the next year. Similarly $T_2$ and $T_3$ of the former year produced results equivalent to those of $T_1$ and $T_5$ of the later year when considered in terms of smallest cane height and lightest weight per stalk.

The treatment effect has become more stabilized on number of millable canes. In both the years, $T_3$ and $T_4$ produced the highest and second highest results, though interchangeably and the lowest number was produced at $T_6$. The cane yield, due to treatment effect, is identical for both the years, $T_4$ producing the highest, $T_3$ the second highest and $T_6$ the lowest. The yield difference due to treatments for the year 1974 - 1975 is significant at 5% level though that of the subsequent year is not statistically significant. In a similar type of experiment on nitrogen nutrition of sugarcane, Mohan Rao and Narasimham (1976) reported highest yields of cane and sugar production when the N - fertilizer was applied 50% at 45 days and the rest 50% at 90 days after planting. Mohan Rao and Suryanarayana (1960) suggested that the nitrogen should be applied in two equal instalments, the 1st at 45 days after planting and the remaining between 90 - 120 days after planting depending upon the availability of irrigation water for best yield and sugar.

The split effect of N on % recovery of sugar was also studied and the results of the two experiments are again in harmony with each other. $T_2$ in both cases produced highest recovery. Late application of N on lowering sucrose recovery is a well established fact and in many countries including certain states of even neighbouring India, Taiwan etc. laws are in force prohibiting application of N within certain periods before harvest (De Geus, 1967; Mohan Rao and Narasimham, 1956 and Tandan and Misra, 1956).

Figure 1 shows total sugar production per acre. Though there is a difference in the base lines of the two graphs, their trend is almost same and the total sugar production for both the years is highest at $T_4$. The highest during 1975 - 1976 is 4.51 tons sugar per acre (TSA) and the lowest 4.24 TSA whereas the highest for the year 1974 - 1975 is only 3.31 TSA, a figure even lower than the lowest figure of the later year indicating higher yield of the 1975 - 1976 experiment due to better care and management and this also explains the difference in the base lines of the two graphs.

976 The above mentioned results indicated that spliting nitrogen into two equal halves and applying the 1st half after 45 days and the rest half after 120 days of planting seems to be the best for both cane yield and total sugar production when compared with the present practice of applying $\frac{1}{3}$rd at planting, $\frac{1}{3}$rd after 1st heavy shower and the rest $\frac{1}{3}$rd in June. The results further indicated that the critical period for N application in sugarcane would be within 120 days of planting under Bangladesh conditions. Further works are needed to confirm these findings.

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# Preventing Post-Harvest Deterioration of Sugarcane

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## ABSTRACT

An experiment was conducted at the Sugarcane Research Institute (SRI) to study, in quantitative term, the prevention of deterioration of sugarcane after harvest. Stale cane, suffers from gradual qualitative deterioration in terms of increased brix, reduced cane weight, pol, purity and recoverable sugar. But these qualities were retained when stale cane were subjected to the three treatments, namely spraying with water or formalin and covering with sugarcane trash, were found statistically effective in preventing the deterioration of cane as compared with the cane left uncared (check). These treatments were proved to be highly effective in reducing the qualitative losses under different weather conditions.

## INTRODUCTION

The sugar loss due to staleness over a period of six days varies from 34% to 54% under Bangladesh agroclimatic conditions (Haque *et al.*, 1979). Different scientists have viewed the phenomenon from different angles. Some attributed the deterioration to the organisms *Leuconostoc* entering the cut end and hence suggested spraying disinfectants like formalin (Parthasarathy, 1972 ; Bose *et al.*, 1974) while others considered it to be a physiological process of drying-up and suggested water spraying (Singh and Chatterjee, 1962 and Kapur and Kumar, 1976) or covering with suitable means e. g. trash (Fogliata, 1977).

Post harvest deteriorations of sugarcane, though a more acute problem in Bangladesh than any other countries of the world, have not been widely investigated and virtually no work was done in the past on the preventing measures. The present investigation was, therefore, undertaken to study the effectiveness of some of the most common and easily available processes in preventing the post harvest deterioration of sugarcane.

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## MATERIALS AND METHODS

The experiment was conducted at SRI farm. The cane variety Co. 1158, planted on 15th November, 1976 was grown under rainfed conditions from planting to harvest and all standard managements, fertilizations and other intercultural practices were followed.

The experiment consisted of these independent trials at intervals of 40 days in order to represent early (December), mid (late January) and late (early March) crushing season. Consequently, the age of the crop varied from 388 days to 453 days.

Each of the above mentioned trials followed the same procedures out lined below :—

Random samples of 504 canes, representing average cane stand of the field, were harvested, detrashed, grouped, equally into 84 bundles. Weight of each bundle was recorded. Twelve such bundles representing 4 treatments with 3 replications were reweighed and chemically analysed for brix, pol, purity and recovery on each day at 24 hours interval starting from the date of harvest as 00 hours over a period of 7 days.

The treatments were :

$T_0$—Control i. e. cane left in the sun without any care.

$T_1$—Cut ends of the cane sprayed with 1% formalin solution once on the first day.

$T_2$—Canes sprayed with water at 24 hours invertal for the whole period of trial.

$T_3$—Canes covered with about 3'' thick sugarcane trash.

For control or any treatment, the weight loss due to staleness was obtained by substracting the final weight of canes at the time of chemical analysis from the initial weight of respective bundles. For brix, pol, purity or % recovery, the records obtained from the samples analysed on starting day were taken as initials. Loss in tons cane/a was calculated on the basis of assuming cane yield of 30 tons/a.

The effectiveness of any treatment in reducing deterioration was obtained through the quantitative difference between any parameter (pol, purity or % recovery etc.) of control and of a particular treatment (sprayed or covered.)

## RESULTS AND DISCUSSION

The effects of staleness on weight, brix, pol, % purity, % recovery, TSA as well as on total sugar production were reported earlier (Haque *et al*,. 1979). The present work concerned with the effectiveness of some easily available practices on some of the above mentioned factors of sugar production over a variable weather conditions are summarized in Tables 1-6.

Table 1 shows that on 6th day of staleness, assuming a meagre yield of 30 TCA, about 2.5 TCA or more than 8% of the cane is lost in $T_0$, where no preventive measures

were adopted. On the other hand, in $T_3$ the loss is only 1.755 TCA or about 5.85% and more than 2% of the lost cane was saved just by covering the cane with trash. Other treatments namely spraying with formalin or water also resulted in substantial saving in the loss of cane. This loss in cane weight when coupled with the loss in sucrose recovery (%) manifests itself in huge loss of sngar as reported by Haque *et al.*, (1979) but the reduction in these losses by means of simply shading the canes or by spraying them with either water (regularly) or with fungicides (just once) was quite evident as seen from the same table.

Table - 1. Effects of different treatments in preventing loss in tons cane per acre (assuming 30 TCA) as affected by different duration of staleness in the early crushing season.

| Treatments staleness (days) | Cane loss per acre (Tons) | | | | |
|---|---|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ | $T_3$ | Mean |
| 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1 | 0.735 | 0.612 | 0.666 | 0.660 | 0.668 a* |
| 2 | 0.747 | 0.621 | 0.879 | 0.747 | 0.748 a |
| 3 | 0.990 | 0.795 | 0.934 | 0.942 | 0.915 a |
| 4 | 1.938 | 1.140 | 1.077 | 1.356 | 1.378 b |
| 5 | 2.391 | 1.848 | 1.713 | 1.707 | 1.915 c |
| 6 | 2.469 | 2.034 | 1.782 | 1.755 | 2.010 c |
| Mean | 1.324a | 1.007c | 1.007c | 1.024b | |

*Figures accompanied by the same letter are not significantly different at .05 level as per DNMR-test.

So far as the treatment effects are considered, keeping the canes covered with trash was found to be superior to the other two treatments. Spraying with water or formalin also significantly (1% level) decreased cane loss in almost equal magnitude. Covering the harvested canes with trash (Fogliata, 1977) or spraying them with formalin (Krishnamurti, 1959 and Bose *et al.*, 1974) or with water (Kapur and Kumar, 1977) was reported to reduce post harvest deterioration significantly and recommended for large scale usage. Of these, effectiveness of spraying water in preventing post harvest deterioration of sugarcane is a well studied and established phenomenon. Kapur and Kumar (1977) observed that daily spraying of water to the heaped stalk of harvested, topped and stripped off canes reduced the deterioration in terms of sugar content, purity and reducing sugar. The other two treatments, shading with trash or spraying with fungicides, though did not differ much from each other, also reduced the loss in comparison with check. These two processes have been studied in rather detail for their effectiveness in reducing the deterioration.

Effects of the treatments in preventing deterioration of qualitative factors like brix, pol, % purity and % recovery were also studied and are reported here (Table 2). The trend of effects of the treatments on these factors too was similar. In all the cases i.e., in brix, pol, purity or % recovery, staleness resulted in a successive deterioration of the parameters and shading or spraying prevented the same. The effects of different treatments on % recovery may be cited as an example. In $T_0$, % recovery came down from 7.80% to 4.00% at the end of staleness duration studied but the same decreased only

Table 2. Effects of different treatments in preventing deterioration of Brix, Pol, Purity and Recovery as affected by different duration of staleness in the early crushing season.

| Treatments Staleness (days) | Brix | | | | | Pol | | | | | Purity (%) | | | | | Recovery (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ | $T_3$ | Mean | $T_0$ | $T_1$ | $T_2$ | $T_3$ | Mean | $T_0$ | $T_1$ | $T_2$ | $T_3$ | Mean | $T_0$ | $T_1$ | $T_2$ | $T_3$ | Mean |
| 0 | 16.40 | 16.77 | 16.62 | 16.75 | 16.62cd | 14.34 | 14.74 | 14.55 | 14.66 | 14.57a | 87.43 | 87.89 | 87.55 | 87.53 | 87.59a | 7.80 | 7.97 | 7.73 | 7.81 | 7.83a* |
| 1 | 16.65 | 16.42 | 16.43 | 16.72 | 16.55cd | 14.39 | 14.44 | 14.34 | 14.61 | 14.44a | 86.39 | 87.92 | 87.26 | 87.41 | 87.24ab | 7.46 | 7.82 | 7.65 | 7.73 | 7.65a |
| 2 | 16.60 | 16.83 | 16.48 | 16.77 | 16.67c | 14.25 | 14.73 | 14.34 | 14.64 | 14.49a | 85.88 | 87.49 | 86.99 | 87.25 | 86.90ab | 6.85 | 7.24 | 6.85 | 7.24 | 7.05b |
| 3 | 17.09 | 16.45 | 16.45 | 16.36 | 16.59cde | 13.60 | 14.05 | 13.66 | 13.34 | 13.51b | 76.09 | 85.45 | 83.00 | 81.57 | 81.52c | 5.55 | 6.68 | 6.41 | 6.15 | 6.20c |
| 4 | 17.39 | 16.81 | 16.88 | 17.05 | 17.03b | 12.31 | 13.84 | 13.76 | 13.86 | 13.44b | 70.85 | 82.42 | 81.53 | 81.30 | 79.02d | 4.78 | 6.29 | 6.26 | 6.17 | 5.88c |
| 5 | 17.62 | 16.78 | 17.26 | 17.05 | 17.18a | 12.17 | 13.57 | 13.30 | 13.31 | 13.09c | 69.02 | 80.88 | 77.09 | 78.05 | 76.26e | 4.44 | 5.81 | 5.40 | 5.56 | 5.30d |
| 6 | 16.96 | 17.27 | 17.12 | 16.63 | 16.99ab | 11.41 | 13.80 | 13.31 | 12.92 | 12.86d | 67.26 | 79.92 | 76.49 | 77.71 | 75.34e | 4.00 | 5.50 | 5.45 | 5.35 | 5.10d |
| Mean | 16.95 | 16.74 | 16.74 | 16.76 | | 13.12bc | 14.66a | 13.89b | 13.91b | | 77.56c | 84.56a | 82.84ab | 82.97ab | | 5.84c | 6.77a | 6.53ab | 6.57ab | |

*Figures followed by same letter are not significantly different at 0.05 level as per DNMR-test.

upto 5.35% for the same period when covered with trash. Thus, a net saving of about 17% in the recovery is done through this treatment. Similarly, when almost 20% loss is caused in % purity over a period of 6 days of staleness with no preventive measures, only 10 - 12% loss would occur if any preventive measure is taken. Same was the case with pol and a significant check in its qualitative deterioration with any treatment was observed (Table 2). Changes in brix is not as clear as those in other factors. This factor has shown rather an erratic pattern due to staleness and the effects of the treatments were not significant. Except on brix, the preventive effects were found to be highly significant on all other factors and these results were in conformity with the observations made by Bose *et. al.*, (1974). They studied the effects of spraying formalin as a measure to arrest the deterioration of harvested sugarcane on storage. They reported much less fall in purity of the juice from stored cane treated with formalin in comparison with the cane kept without any treatment.

To study the trend of the effects of the treatments under weather conditions, the experiment was repeated exactly in the same pattern during mid and late crushing seasons. Data obtained were almost identical and are presented in tables 3-6. The only variation observed was amongst the treatments but the trend was the same. It is worth noting that covering with trash, which was found to be the best in preventing the loss due to staleness during the early crushing season, lost its importance in other two crushing periods. During the mid season, spraying with water ($T_2$) was found to be the best followed by trash covering. In late crushing season, formalin spray ($T_1$) out yielded the other two treatments. The reason behind these variations of the treatments in reducing the loss in TCA during different period of crushing could not be ascertained. However, age of canes or climatic factors prevalent during the period of study or a combination of both might have some bearing on the findings. However, it was clear that staleness ($T_0$) significantly affected sugar producing parameters when compared with the normal one. Any treatment such as spraying with water ($T_2$) or formalin ($T_1$) or covering with trash ($T_3$) can most significantly prevent that deterioration if practiced throughout the crushing season (irrespective of early, mid or late part). Moreover the cost involvement is also minimum.

Table - 3. Effects of different treatments in preventing loss in tons cane per acre (assuming 30 TCA) as affected by different durations of staleness in the mid crushing season.

| Treatments staleness (days) | Cane loss per acre ( Tons ) | | | | |
|---|---|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ | $T_3$ | Mean |
| 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1 | 0.687 | 0.501 | 0.534 | 0.477 | 0.550e* |
| 2 | 1.176 | 1.014 | 0.851 | 0.915 | 0.989d |
| 3 | 1.653 | 1.473 | 1.377 | 1.335 | 1.460c |
| 4 | 1.791 | 1.653 | 1.401 | 1.434 | 1.570c |
| 5 | 1.896 | 1.821 | 1.698 | 1.755 | 1.792b |
| 6 | 2.541 | 2.178 | 2 157 | 2.076 | 2.238a |
| Mean | 1.392a | 1.234ab | 1.145abc | 1.142abc | |

*Figures followed by same letter are not significantly different at .05 level as per DNMR-test.

Table 4. Effects of different treatments in preventing deterioration of Brix, Pol, Purity and Recovery as affected by different duration of staleness in the mid crushing season.

| Treatments Staleness days) | Brix | | | | | Pol | | | | | Purity (%) | | | | | Recovery (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ | $T_3$ | Mean | $T_0$ | $T_1$ | $T_2$ | $T_3$ | Mean | $T_0$ | $T_1$ | $T_2$ | $T_3$ | Mean | $T_0$ | $T_1$ | $T_2$ | $T_3$ | Mean |
| 0 | 17.19 | 17.41 | 17.77 | 17.53 | 17.43i | 15.50 | 15.56 | 15.91 | 15.84 | 15.70a | 90.19 | 89.35 | 89.57 | 90.36 | 89.95a | 7.63 | 7.76 | 7.79 | 7.79 | 7.74a* |
| 1 | 17.96 | 17.68 | 17.70 | 18.04 | 17.82b | 15.69 | 15.81 | 15.96 | 16.21 | 15.97a | 88.46 | 89.10 | 90.19 | 89.85 | 89.48ab | 7.33 | 7.39 | 7.55 | 7.60 | 7.46ab |
| 2 | 17.55 | 18.09 | 18.29 | 18.02 | 17.99c | 15.36 | 16.17 | 16.12 | 15.86 | 15.88a | 87.52 | 89.36 | 88.13 | 87.99 | 88.25abc | 6.61 | 7.35 | 7.46 | 7.14 | 7.13bc |
| 3 | 18.55 | 18.30 | 18.70 | 18.08 | 18.41d | 15.70 | 16.18 | 16.29 | 15.74 | 15.98a | 84.67 | 88.41 | 87.15 | 87.06 | 86.81c | 6.56 | 7.16 | 7.40 | 7.09 | 7.05c |
| 4 | 18.22 | 18.27 | 18.20 | 17.56 | 18.06e | 14.63 | 15.61 | 15.20 | 14.83 | 15.07b | 80.27 | 85.44 | 83.55 | 84.57 | 83.45d | 5.85 | 6.91 | 6.63 | 6.43 | 6.41d |
| 5 | 18.69 | 18.55 | 18.40 | 18.52 | 18.54f | 14.69 | 15.67 | 15.19 | 15.47 | 15.26b | 78.67 | 84.52 | 82.62 | 83.56 | 82.34d | 5.67 | 6.64 | 6.25 | 6.31 | 6.22d |
| 6 | 19.17 | 18.80 | 18.37 | 18.90 | 18.81g | 14.16 | 15.15 | 14.83 | 14.93 | 14.77b | 73.92 | 80.66 | 80.75 | 78.97 | 78.57e | 4.95 | 6.00 | 5.97 | 6.82 | 6.68e |
| Mean | 18.19 | 18.16 | 18.19 | 18.09 | | 15.13 | 15.74 | 15.64 | 15.56 | | 83.38a | 86.78b | 85.99bc | 86.04bc | | 6.37c | 7.00a | 6.99a | 6.88.ab | |

*Figures followed by same letter are not significantly different at 0.05 level as per DNMR—test.

Table 5. Effects of different treatments in preventing loss in tons cane per acre (assuming 30 TCA) as affected by different durations of staleness in the late crushing season.

| Treatments staleness (days) | Cane loss per acre (Tons) | | | | |
|---|---|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ | $T_3$ | Mean |
| 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1 | 0.735 | 0.537 | 0.450 | 0.420 | 0.5355e* |
| 2 | 1.215 | 0.567 | 0.816 | 0.597 | 0.7986e |
| 3 | 1.578 | 1.212 | 1.254 | 1.071 | 1.2790d |
| 4 | 2.751 | 2.753 | 2.232 | 1.833 | 2.392c |
| 5 | 2.991 | 2.841 | 2.895 | 2.457 | 2.7960b |
| 6 | 3.417 | 3.351 | 3.060 | 2.718 | 3.1365a |
| Mean | 1.812a | | 1.609b | 1.530b | 1.299c |

Table - 6. Effects of different treatments in preventing deterioration of Brix, Pol, Purity and Recovery as affected by different duration of staleness in the late crushing season.

| Treatments Staleness (days) | Brix | | | | | Pol | | | | | Purity (%) | | | | | Recovery (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ | $T_3$ | Mean | $T_0$ | $T_1$ | $T_2$ | $T_3$ | Mean | $T_0$ | $T_1$ | $T_2$ | $T_3$ | Mean | $T_0$ | $T_1$ | $T_2$ | $T_3$ | Mean |
| 0 | 18.65 | 18.45 | 18.47 | 18.80 | 17.48a | 16.46 | 16.27 | 16.34 | 16.56 | 16.41a | 88.23 | 88.19 | 88.43 | 88.13 | 88.24a | 7.99 | 7.94 | 8.04 | 7.98 | 7.99a* |
| 1 | 18.43 | 18.53 | 18.62 | 18.67 | 17.82b | 15.94 | 16.29 | 16.20 | 16.38 | 16.20a | 86.47 | 87.89 | 87.01 | 87.76 | 87.28a | 7.40 | 7.73 | 7 69 | 7.87 | 7.67a |
| 2 | 18.55 | 19.12 | 18.78 | 18.43 | 17.99c | 14.98 | 16 10 | 15.26 | 15.25 | 15.40b | 80.74 | 84.22 | 81.19 | 82.68 | 82.20b | 6.48 | 7.20 | 6.66 | 6.88 | 6.80b |
| 3 | 18.77 | 19.42 | 19.30 | 19.33 | 18.41d | 14.87 | 15.96 | 15.31 | 15.67 | 15.45b | 78.74 | 82.19 | 79.33 | 81.07 | 80.33b | 6.25 | 6.83 | 6.43 | 6.74 | 6.56b |
| 4 | 20.43 | 20.05 | 19.67 | 19.00 | 18.06e | 15.23 | 15.46 | 14.71 | 14.85 | 15.08b | 74.52 | 77.10 | 74.78 | 78.15 | 76.13c | 5.47 | 5.79 | 5.79 | 6.09 | 5.78c |
| 5 | 20.43 | 20.28 | 20.27 | 19.67 | 18.54f | 14.04 | 14.58 | 13.75 | 14.49 | 14.22c | 68.71 | 71.79 | 68.49 | 73.65 | 70.66d | 4.65 | 5.18 | 4.51 | 5.55 | 4.97d |
| 6 | 20.37 | 21.07 | 20.50 | 20.23 | 18.81g | 13.63 | 15.07 | 13.99 | 15.03 | 14.43c | 66.78 | 71.53 | 68.26 | 73.29 | 69.96d | 4.21 | 5.79 | 4.99 | 5.81 | 4.69d |
| Mean | 18.19a | 18.16a | 18.19a | 18.09ab | | 17.74b | 15.68a | 15.08a | 15.46a | | 77.74b | 80.41a | 78.21b | 80.67a | | 6.06bc | 6.49ab | 6.16bc | 6.73a | |

*Figures followed by same letter are not significantly different at 0.05 as per DNMR—test.

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# Study on the effect of flowering of cane on the quality of juice

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## ABSTRACT

Comparative studies between flowered and nonflowered cane of ISD-9/57 were conducted at two stages of flowering in respect of fibre % cane, sugar recovery % cane, sucrose (true) % cane, juice extraction % cane, purity (apparent) % cane. Differences between flowered and nonflowered canes were observed in juice quality upto 60 days from the date of initiation of inflorescence where flowering canes show superiority. The difference was found more at the inflorescence emergence stage which decreased with the increase of flower age.

## INTRODUCTION

Most of the sugarcane varieties flower freely under natural conditions in Bangladesh. Arvier (1968) reported that natural flowering occurs in only 13% of stalks. According to Parthasarathy (1972), fertility of soil, irrigation, drainage, application of nitrogenous fertilizers and time and dose of the same etc. affect flowering of sugarcane. Hernandez (1965) reported that several important factors caused flowering. But according to him, the most important factors for flowering were optimum temperature and light condition at appropriate time in the cane growing cycle. The sugarmen believe flowering reduces the quality of juice and yield of sugar.

The farmers are most interested to crush their canes before flowering starts resulting in heavy pressure to the Mill Management. Several workers reported that flowering had a beneficial effect on yield, particularly early in the season (Anon, 1973) and no adverse effects even late in the season (Anon. 1973; Arvier, 1968; Hernandez, 1965). In Bangladesh, a thorough comparative study between flowered and nonflowered cane in respect of quality of juice has not yet been done. Thus, the present study was undertaken to investigate the effect of flowering of cane on the quality of juice.

## MATERIALS AND METHODS

The commercial variety ISD-9/57 was used for the present investigation. The plant samples were collected from the Farm, Sugarcane Research Institute, Ishurdi, Pabna, where about 75% plants flowered and the rest remained vegetative till harvesting. The

plants were grown under normal field condition with recommended doses of manures and fertilizers. A good number of plants of approximately same aged from the same field were tagged before flowering. In each case, ten healthy stalks of flowered and nonflowered canes were taken from the tagged plants and their fresh weights were recorded. Then both the flowered and nonflowered canes were cut at each internode from top to bottom for chemical analysis. In this study, the flowered canes were compared with nonflowered ones at two different stages of flower development.

The stages were (a) at the time of inflorescence emergence and (b) 60 days after emergence of inflorescence. To fully explore the effect of flowering, fibre % cane, juice extraction % cane, purity (apparent) % cane, sugar recovery % cane, sucrose (true) % cane and weight of stalks were determined. The chemical analysis was done following Horne's Dry Lead Method (Horne, 1903).

## RESULTS AND DISCUSSION

Differences were observed between flowered and nonflowered canes in respect of all the factors investigated. Results of the experiment shown in the table. The fibre content in flowered cane was 3.39% over nonflowered ones at the time of flower emergence and 4.66% after 60 days of flowering. The upper internodes of flowered canes contained higher percentage of fibre in comparison with the lower internodes. A similar result was found by Hernandez (1965), where total percentage of fibre in flowered canes was 4.03% higher than in the nonflowered canes. The present finding, however, differs with the report of Hernandez (1965) who reported that there was no difference in the total fibre content at the time of flowering. In flowering cane, the juice extraction was 1.64% higher at the emergence of inflorescence and 1.62% lower after 60 days of flowering. This was possibly due to the increase of fibre content in flowered canes. It was found that fibre content increased with increase of flower age. There was a positive correlation between flower age and fibre content.

Hernandez (1965) found 17% less juice in flowered canes at the later stage of flower development. Since, the juice extraction reduced with the increase of flower age, the same would be reduced with the further gradual increase of flower age. The apparent purity of flowered canes at inflorescence emergence stage found to be 2.02% higher than that of the juice of nonflowered canes, whereas the same was 0.75% less in flowered cane after 60 days of flowering. This indicated that the purity decreased with the increase of flower age. A similar result was found by Hernandez (1965) who reported that purity of juice was 2.09% less from the upper internodes and 5.23% less in lower internodes of flowered canes.

In flowered canes true sucrose was 2.85% higher than in the nonflowered canes at the emergence of inflorescence, while the same was 2.64% higher after 60 days of flowering. The present finding agrees with the report of Hernandez (1965). He found average true sucrose to be 2.89% higher in the flowered canes than in the nonflowered canes. In one report it was stated that the sucrose yield was higher in flowering canes than in the vegetative stalks at flower emergence and anthesis and no significant difference was observed in later stage (Anon, 1973) and also the difference was maintained throughout the experimental period. Sugar recovery in flowered canes was higher than in the nonflowered canes at both the stages and the

difference was greater at the inflorescence emergence stage. It was found to be 5.99% higher at the infloresce emergence stage, while 0.95% after 60 days of flowering. This indicated that the sugar recovery gradually decreased with the increase of flower age.

The fall off in sugar content was reported to be due to the appearance of side-shoots when harvesting was delayed till November or December (Arvier, 1968). The fresh weight of the stalks of flowered cane was 12.63% and 25% higher overn onflowered canes at inflorescence emergence stage and after 60 days of flowering respectively. This increase in weight was mainly due to 2 to 4 additional internodes. The extracted sucrose from these additional internodes results in the higher yield in flowered canes.

Table. Comparative analysis of flowered and nonflowered canes in respect of wt. of stalk, extraction of juice % cane, purity (apparent) % cane, sugar recovery % cane, true sucrose % cane and fibre % cane.

| Factors for Analysis | At the time of emergence of inflorescence. | | | After 60 days of emergence of inflorescence | | |
|---|---|---|---|---|---|---|
| | Non-flowered cane | Flowered cane | % increase over non-flowered cane | Non-flowered cane | Flowered cane | % increase/decrease over nonflowered cane |
| No. of stalks | 10 | 10 | — | 10 | 10 | — |
| Wt. of stalks (lb) | 20.20 | 22.75 | + 12.63 | 20.00 | 25.00 | + 25.00 |
| Extraction of juice % cane | 0.61 | 0.62 | + 1.64 | 0.62 | 0.61 | —1.62 |
| Purity (apparent) % cane | 79.30 | 80.90 | + 2.02 | 80.80 | 80.20 | —0.75 |
| Sugar recovery % cane | 10.02 | 10.62 | + 5.99 | 10.61 | 10.71 | + 0.95 |
| Sucrose (true) % cane | 12.47 | 12.95 | + 3.85 | 12.92 | 13.26 | + 2.64 |
| Fibre % cane. | 14.47 | 14.96 | + 3.39 | 15.26 | 15.97 | + 4.66 |

Since, true sucrose, sugar recovery, stalks weight etc. in flowered canes were higher than in the nonflowered canes upto 60 days of flowering. The quality of juice and yield of sugar were also higher. Apparent purity and juice extraction etc. were higher at the stage of emergence of inflorescence and less after 60 days of flowering. The fibre percentage was higher at both the stages which partially reduced the juice extraction % cane. From the above experimental results, it was found that differences appeared between flowered and nonflowered canes in juice quality at both the stages of flower development upto 60 days from the date of initiation of inflorescence where flowering canes show superiority. It was also found that the difference was greater at the inflorescence emergence stage than at the later stage and the difference gradually decreased with the increase of flower age. The result was confirmed with the report of Hernandez (1965) who stated that the differences appeared at various stages of flower development and intensified in specimens with old flowers. Arvier (1968) found no apparent adverse effect on yield within a month of appearance of inflorescence.

The flowering had a beneficial effect on yield, particularly early in the season and had no adverse effect even late in season (Anon, 1973). It is, thus suggested that the flowering had no adverse effect on the quality of juice upto 60 days of flowering and it is better to harvest canes as early as possible after the emergence of inflorescence. Further investigation is necessary to determine the quality of juice beyond 60 days of flowering.

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# Assessment of Losses Caused By Top Borer, *Scirpophaga excerptalis* Walker on Millable Sugarcane

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## ABSTRACT

The weight loss due to attack of top borer, *Scirpophaga excerptalis* Walk. was studied for 6 varieties of millable sugarcane. The changes on the length and circumference due to attack of this pest were also studied. It was found that the loss of weight ranged from 6.50 to 50.17 per cent within the varieties studied. The changes in weight due to attack of top borer were found statistically signficant within the varieties, except BS-96. The length of the attacked canes were also found to be reduced significantly. The circumference of the infested canes was found to increase due to the stunted growth at the top. Canes of the variety BS-96 were more tolerant to the top borer than ISD-2/54.

## INTRODUCTION

Top borer, *Scirpophaga* spp. are the most injurious insect affecting sugarcane in South and South-East Asia (Carl, 1962 ; Gupta, 1959 ; Gupta *et al.*, 1965 ; Gupta, 1962 ; Huque and Agarwala, 1955 ; Kalra and Chaudhury, 1964a ; Kalra and Sidhu, 1965 ; Pemberton, 1962 ; Rao and Chandy, 1957 ; Venkatraman, 1961). In Bangladesh this insect is the most damaging pest of sugarcane (Alam, 1967 ; Rahman, 1970, 1976 ; Rahman *et at.*, 1979). The young larvae after tunneling through the mid-rib of the leaf, travel down towards the growing point which is burrowed through (Fletcher and Ghosh. 1920 ; Gupta, 1959 ; Hazelhoff, 1932 ; Patel, 1963). Usually, though not always (Kalra and Chaudhury, 1964b), the growing point is destroyed. Young stalks die, older stalks often dies but may survive by developing side shoots. The first noticeable sign of damage is the characteristic 'deadheart' followed by damage to the base of the spindle leaves (Fletcher and Ghosh, 1920 ; Holloway *et al.*, 1928 ; Ruinard, 1958).

Loss in the weight of cane results from cane tissue being eaten, from desication and from impaired growth. A significant number of sugarcane plants are destroyed by the top borer. Various workers have assessed the losses caused by the top borer (Agarwala and Prasad, 1956 ; Gupta and Avasthi, 1954, 1956 ; Gupta *et al.*, 1965 ;

Kalra and Chaudhury, 1964a ; Kalra and Sidhu, 1965 ; Rajani, 1961 ; Siddiqi, 1961). But their estimates differ considerably probably due to the differences in the technique of sampling and the material contained in the samples. Efforts were, therefore, made to achieve a workable measure for loss in yield due to top borer infestation under normal conditions of cane cultivation.

## MATERIAL AND METHODS

The experiments were carried out at the sugarcane fields of Rajshahi University Rural and Agricultural Development Project. During the harvesting period sample of 36 infested and 36 uninfested sugarcane plants of the same variety were randomly sampled. During sampling, the top borer affected plants which were apparently free from the attack of other pests or pathogens were taken. Similar procedures were followed in the selection of the uninfested canes. The sampled canes were cleaned and measured lengthwise and circumferencewise (one at the base, one at the middle and one at the top of the cane). Then the mean values of the circumference was calculated. Each sample of 36 canes were grouped into 6 and weighed with a spring balance ( capacity 23 kg ). The observations were made for 6 varieties namely, ISD-9/57, Co. 1158, Bo-67, BS-96, ISD-2/54 and I-30/60.

The average weight in Kg, average length in M (metre) and average circumference in cm with their standard error (S. E.) were calculated. The differences in weight, length and circumference between infested and uninfested canes were analysed statistically by using thet-test. The assessment of loss in percentage were calculated by the formula :

$$\frac{\bar{X}_1 - \bar{X}_2}{\bar{X}_1} \times 100 = A,$$ where, A = assessment of loss in percentage,

$\bar{X}_1$ = the mean of the measurements for the healthy canes, and $\bar{X}_2$ = the mean of the measurements for the infested canes.

## RESULTS AND DISCUSSION

The effect of infestation by *S. excerptalis* on the weight, length and circumference of different varieties of sugarcane and assessment of loss in percentage have been shown in tables 1, 2 and 3. From the tables it is found that the assessment of weight loss in percentage due to infestation of top borer was found maximum (50.17) for variety ISD-2/54 and minimum (6.50) for variety BS-96. The loss percentage in length due to infestation were also found maximum (40.74) and minimum (5.14) for the above varieties respectively. But the change in percentage of circumference between infested and uninfested canes were maximum (10.09) and minimum (1.94) for the varieties BS-96 and ISD-2/54 respectively. The t-test shows significant differences both in weight and length for all the treated varieties except BS-96.

In view of the severity of damage caused by top borer, *S. excerptalis* many workers observed the loss of cane in the field. Gupta and Avasthi (1954) recorded inver-

relationship between infestation and loss in yield. The overall loss in yield of millable cane was reported as high as 30 percent in years of severe attack of top borer (Kalra, 1960; Venkatraman, 1961). In Bihar, Agarwala and Prasad (1956) recorded a loss of yield 7.47 to 7.68 percent by this insect. Rajani (1961) used a sample of 30 canes for the determination of the losses in yield after comparing healthy canes with the top borer attacked ones and concluded that in severely affected canes top borer caused loss in yield upto 20 percent. Siddiqui (1961) recorded the same as 5.51 to 9.80 percent, whereas Gupta (1965) observed the top borer affected millable canes to suffer 25 percent loss in yield.

Table 1. Effect of infestation by *S. excerptalis* F. on the different varieties of sugarcane.

| Variety | Category of cane sampled I= infested U= Uninfested | Average weight in Kg. of a Single cane ± S. E. | Assessment of loss in percentage | Calculated value of 't' |
|---|---|---|---|---|
| ISD—9/57 | I | 0.40 ± 0.04 | 31.03 | 4.50*** |
| | U | 0.58 ± 0.02 | | |
| Co.-1158 | I | 0.63 ± 0.04 | 18.18 | 4.67*** |
| | U | 0.77 ± 0.01 | | |
| BO—67 | I | 0.33 ± 0.03 | 31.58 | 5.00*** |
| | U | 0.48 ± 0.02 | | |
| BS—96 | I | 1.15 ± 0.07 | 6.50 | 1.09 |
| | U | 1.23 ± 0.05 | | |
| ISD—2/54 | I | 0.06 ± 0.03 | 50.17 | 17.40*** |
| | U | 1.20 ± 0.02 | | |
| I—30/60 | I | 0.53 ± 0.05 | 34.57 | 7.00*** |
| | U | 0.81 ± 0.01 | | |

*p ∠ 0.05 **P ∠ 0.01 *** ∠ 0.001

Tabulated value of t are 2.000, 2,660 and 3.460 for 0.05, 0.01 and 0.001 Probability at 60 d. f.

Table 2. Effect of infestation by *S excerptalis* F. on the length of different varieties of sugarcane,

| Variety | Category of cane sampled I= infested U= uninfested | Average length in M of single cane ± S. E. | Assessment of loss in percentage | Calculated value of 't' |
|---|---|---|---|---|
| ISD—9/57 | I | 1.34 ± 0.07 | 19.76 | 5.50*** |
| | U | 1.67 ± 0.01 | | |
| Co.1158 | I | 2.20 ± 0.10 | 16.18 | 4.30*** |
| | U | 2.41 ± 0.03 | | |
| BO—67 | I | 1.43 ± 0.02 | 22.70 | 8.30*** |
| | U | 1.85 ± 0.06 | | |
| BS—96 | I | 3.14 ± 0.13 | 5.14 | 1.41 |
| | U | 3.31 ± 0.04 | | |
| ISD-2/54 | I | 1.60 ± 0.60 | 40.74 | 3.06** |
| | U | 2.70 ± 0.11 | | |
| —30/60 | I | 1.94 ± 0.08 | 25.95 | 5.67*** |
| | U | 2.62 ± 0.11 | | |

P ∠ 0.05 **P ∠ 0.01 ***P ∠ 0.001

abulated value of t are 2.000, 2.660 and 3.460 for 0.05,0.01 and 0.001 probability at 60 d.f.

Table 3. Effect of infestation by *S excerptalis* F. on the circumference of different varieties of sugarcane.

| Varieties | Category of cane sampled I =infested U =unfested | Average circumference in cm of a single cane ± S. E. | Assessment of change in percentage | Calculated value of 't' |
|---|---|---|---|---|
| ISD—9/57 | I | 6.20 ± 0.40 | 9.15 | 0.88 |
| | U | 5.68 ± 0.43 | | |
| Co.1158 | I | 5.54 ± 0.27 | 6.42 | 1.24 |
| | U | 5.92 ± 0.17 | | |
| BO—67 | I | 5.06 ± 0.24 | 3.90 | 0.66 |
| | U | 5.37 ± 0.22 | | |
| BS—96 | I | 6.77 ± 0.28 | 10.09 | 1.90 |
| | U | 7.53 ± 0.28 | | |
| ISD—2/54 | I | 6.82 ± 0.11 | 1.94 | 0.48 |
| | U | 6.69 ± 0.27 | | |
| I—30/60 | I | 6.37 ± 0.16 | 10.20 | 2.68* |
| | U | 5.78 ± 0.18 | | |

*P $\angle$ 0.05, Tabulated value of t= 2.000 with 60 d.f

The present findings of weight loss due to attack of top borer was found to be similar with the findings of Rajani (1961) and Gupta (1965). No report was available on the change of length and circumference due to attack of top borer. It was found that the reduction in weight and length were significant in all the varieties under study excepting BS-96. Again the circumference was generally found to increase with the attack of top borer. But no definite correlation was found between level of infestation and the circumference change. The increase of circumference with the attack of top borer in some varieties namely. ISD-9/57, ISD-2/54 and I-30/60 (table-3) may probably be due to stunted growth at the top of the sugarcane plant.

So, from the above observation, it is assumed that the canes of the variety BS-96 was more tolerant to the top borer, whereas ISD-2/54 was more susceptible to the same pest.

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# Survey of Sugarcane diseases in early stages of plantation, its incidence and distribution in the Sugar Mills Zone in Bangladesh.

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## ABSTRACT

A preliminary survey of the diseases of sugarcane in early period of plantation showed that grassy shoot disease (GSD) symptoms resembling white leaf, smut, leaf spot, mosaic and pokka boeng disease were common in different mlils zones. The occurrence of these diseases varied, however, in different varieties and mill zones. Red rot, was not evident at the time of survey. This was perhaps due to carrying out of survey on younger crops. The occurrence of GSD and symptoms resembling white leaf diseases were noticed in Co.1158 and ISD-2/54 in all mills zones. Smut and mosaic were also noticed in Co.1158 and ISD-2/54 in the souther zone. Incidence of mosaic was moderate to severe in Co.975, Co.1158, ISD-1/53 variety at MKSM and in I-112/67 and I-156/66 in the mills trial plot at Jaipurhat Sugar Mills and Thakurgaon Sugar Mills. Symptoms resembling pokka boeng were noticed in ratoon crops of BO-70 and ISD-5/55 in non-supervised plot at Jaipurhat Sugar Mills. Leaf spot diseases were noticed in all varieties, specially in plots which were inter-cropped with mustard.

## INTRODUCTION

Sugarcane is one of the major cash crop in Bangladesh where an attempt is being made to produce sufficient sugar and 'gur' to fullfil minimum per capita requirements. However, diseases of sugarcane are hampering this programme. So far twenty one diseases have been recorded in Bangladesh (Annual Report, Special Issue 1973-78, SRI, Ishurdi).

Grassy shoot disease which is potentially a serious one in the early stage of cane, is characterised by excessive and premature tillering accompanied by suppressed plant growth and marked reduction in root system (Singh, 1963). Smut in sugarcane was found in all areas and high incidence was recorded in ratoon cane in the variety Co. 1158. (Annual Report 1973-1978. Special issue, SRI, Ishurdi), Chona (1956) reported a reduction in yield of 70 percent in some ratoon crops in India.

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Various leaf spot diseases are not considered to be of great economic importance at present in Bangladesh although in some countries these may reduce both cane and sugar yields of susceptible varieties. In Louisiana, Abbot (1951) compared the yield of cane and sugar recovery in the brown-spot susceptible variety CO-36-105 and found that both were markedly lower in severely diseased plots. Sett rots are important in that they cause germination failure which results in poor stands in commercial cane. Considering all these facts a survey was conducted on disease incidence on the cane plantation and constrains due to manpower and available time dictated the survey to be carried out during the month of November, December and January 1979-80 in only 3 of the 15 sugar mills zones. This paper describes the results of initial survey aimed at determining the distribution and severity of some more common diseases in Bangladesh.

## MATERIALS AND METHODS

There are 15 sugar mills and approximately 200 thousand acres of land are under cultivation in the mill zones of Bangladesh. The present survey was conducted in 3 mill zones, namely, Thakurgaon, Mobarakganj and Jaipurhat Sugar Mills Ltd. representing northern, southern and central cane growing areas respectively. The following categories of crops were sampled :

Supervised plants (SP)
Supervised ratoons (SR)
Non-Supervised plants (NP)
Non-supervised ratoons. (NR)

In addition, several categories in mills farm, like nursery plots, mills trial plots and commercial plots were included. Low and high land plantings were considered proportionately.

The zones selected for survey were divided into 4 sectors such as north, south, east and west as suggested by Hutchinson (1979). In each sector, 4 locations were selected. Twenty plots were chosen in each location in such a manner that on an average all categories and varieties were represented. However, it was flexible in that if the categories were not equally represented within a single location, an attempt was made to sample an equal number of plot of each category within the sector as a whole. For example, the distribution of plots in 4 locations within a representative sector was as follows :

| Category | No. of Plots at Location | | | | Total |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | |
| SP | 5 | 7 | 6 | 2 | 20 |
| SR | 7 | 3 | 4 | 6 | 20 |
| NP | 3 | 4 | 5 | 8 | 20 |
| NR | 5 | 6 | 5 | 4 | 20 |
| | 20 | 20 | 20 | 20 | 80 |

The disease incidence was assessed as the percentage of inspected stools which was based on a multiple of 100 stools. Five hundred stools representing approximately 1/20 acre were considered to be representative sample size. To provide a representative sample of the whole plot, the rows inspected were such that they were more or less evenly distributed across the plot. The 20 plots at each location were inspected in a single day. It was possible to make inspection of each plot during the survey period.

## RESULTS AND DISCUSSION

The results are presented in table 1. The degree of incidence stated as slight moderate etc. are expressed in the table. The main constraint of the experiment was that a range of commercial varieties was often not available in a particular location. As expected, very few ratoon crops were available for inspection.

Table 1. Incidence of disease in different sugar mills during November—January (1979-1980).

| Mills. | Veriety | Disease and degree of infection. | | | | | |
|---|---|---|---|---|---|---|---|
| | | White leaf. | GSD | Smut | Leaf spot | Mosaic | Pokka boeng. |
| Central zone (JSM Ltd.) | Co.975 | — | — | — | M | — | — |
| | Co.1158 | VSL | VSL | VSL | M | — | — |
| | ISD-1/53 | — | — | — | — | — | — |
| | ISD-2/54 | VSL | VSL | VSL | VSL | — | — |
| | ISD 5/55 | — | — | — | M | — | SEV |
| | ISD-9/57 | — | — | — | M | — | — |
| | Bo-17 | — | — | — | M | — | — |
| | Bo-67 | — | — | — | M | — | — |
| | Bo-70 | — | — | — | M | M | SEV |
| | I-156/66 | — | — | — | M | VSEV | — |
| | I-112/67 | VSL | — | — | M | VSEV | — |
| | L. Jaba-C | — | — | — | M | — | — |
| Northern zone (TSM Ltd.) | Co.1148 | — | — | — | M | — | — |
| | Co.1158 | VSL | — | — | M | — | — |
| | ISD-1/53 | — | — | — | M | — | — |
| | ISD-2/54 | — | — | — | M | — | — |
| | BO-70 | — | — | — | M | — | — |
| | BO-71 | — | — | — | M | — | — |
| | I-156/66 | — | — | — | M | — | — |
| | L. Jaba-C | — | — | — | M | — | — |
| Southern zone (MKSM Ltd) | Co.975 | — | — | VSL | VSL | M | — |
| | Co.1158 | SL | M | VSL | VSL | M | — |
| | ISD-1/53 | — | — | — | — | SEV | — |
| | ISD-2/54 | SEV | M | VSL | VSEV | — | — |
| | I-112/67 | — | — | — | — | SL | — |
| | L. Jaba-C. | — | — | — | VSEV | — | — |

Degree of infection :

| | | | | | |
|---|---|---|---|---|---|
| 1. Very slight | = | 0.5% | VSL | = | Very slight |
| 2. Slight | = | 0.5-1% | SL | = | Slight |
| 3. Moderate | = | 1.0-5% | M | = | Moderate |
| 4. Severe | = | 5.0-20% | SEV | = | Severe |
| 5. Very severe | = | More than 20% | VSEV | = | Very severe. |

In the central zone (Jaipurhat Sugar Mills Ltd), slight infection of white leaf, GSD and smut were noticed in the varieties Co. 1158 and ISD-2/54. Severe GSD and smut symptoms had developed in a particular plot of Co. 1158 ratoon cane which may cause severe losses in yield. Rao and Prokasham (1956) reported losses in yield due to smut infection ranging from 39 to 59 percent in plant cane as compared to 52 to 73 percent in ratoon crop. Moderate leaf spotting and sett decaying were noticed in all varieties namely Co. 975, Co. 1158, ISD-1/53, ISD-5/55, ISD-9/57, BO-17, BO-57, BO-70, I 156/66, I-112/67 and Latereejaba-C. Leaf spot diseases were noticed in all the varieties specially in plots which were intercropped with mustard. Very slight white leaf infection was noticed in I-112/67 and very severe mosaic infection (100%) in mills trial plot. However, only 4% mosaic was recorded in foundation plots which had been planted from clean seed material derived from a plot where careful roguing was carried out. This provided convincing evidence that this disease could be controlled to a large extent by using mosaic free materials. This is in agreement with the observation of Steib & Chilton (1968) who stated that removal of primary infection by digging of the whole stalk in early spring plus an early July roguing of infected stools with a sugarcane knife was the most effective technique used in controlling mosaic. The early July roguing apparently removed the secondary spread which occurred between April and early June. This seemed desirable because (a) removal of infected stalks, early results in elimination of source of inoculum from the area and (b) an earlier roguing makes the jobs in July easier when temperature is high. Shaffer (1939) was able to maintain the moderately susceptible Co. 290 free of mosaic by roguing but was less successful with the more susceptible Co. 281. Moderate infection of mosaic in Bo. 70 in the nursery crop and very severe mosaic infection were noticed in I-156/66 in mills trial plot. Pokka boeng incidence was noticed in ratoon crop of Bo-70 and IsD-5/55 in non- supervised plot at Jaipurhat Sugar Mills Ltd.

In the northern zone (Thakurgaon Sugar Mills Ltd), very slight white leaf infection was noticed in Co.1158. Moderate leaf spot and sett rot were found in all the varieties viz: Co.1148, ISD- 1/53, BO- 70, BO-71,I-156/66, I-112/67 and L.Jaba-C.This mill zone was late planted and thus only limited disease could be expected in the very young plants.

In the southern zone (Mobarakganj Sugar Mills Ltd), slight white leaf and smut infection were recorded in Co. 1158 and ISD-2/54. Moderate GSD and mosaic infection was noticed in Co. 1158. Very severe white leaf, leaf spot, mesaic and very slight smut was recorded in Co. 975. Very severe mosaic and leaf spot infection were noticed in ISD-1/53. Slight mosaic infection was noticed in I-112/67 which had not developed symptoms fully in the early stages. Sett-decaying infection was recorded in all varieties namely Co. 975, Co. 1158, ISD-1/53, ISD-2/54, I-112/67 and L. Jaba. However, further works on the incidence of diseases in different zones will confirm the distribution and severity of some more common diseases and resistance potential of several cultivated varieties to the prevailing diseases in Bangladesh.

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