INFLUENCE OF INTEGRATED NUTRIENT MANAGEMENT PRACTICES ON THE JUICE AND GOOR QUALITY OF SUGARCANE

Md. Shamsul Arefin[1*], Md. Mokhlesur Rahman[2], Md. Abdul Alim[3] and Md. Ariful Islam[4]
[1]Physiology and Sugar Chemistry Division, Sugar Crop Res. Inst., Ishurdi, Pabna, Bangladesh
[2]Dept. Agricultural Chemistry, Agricultural University, Mymensingh-2202, Bangladesh
Dept. of Food Technology and Rural Industries, Agricultural Univ., Mymensingh, Bangladesh
[4]Pulses Research Centre, Agricultural Research Institute, Ishurdi, Pabna, Bangladesh

ABSTRACT
Sugarcane is one of the most important sugar and *goor* yielding cash crop in Bangladesh. A field trial was carried out to evaluate the effect of different sources of fertilizers on the quality of sugarcane in Bangladesh. A field experiment was conducted at Bangladesh Sugarcrop Research Institute (BSRI), Iswardi, Pabna during 2013-2014 cropping season. There were seven treatments *viz*., T_1 = Control, T_2 = 165:55:120:30:10:2.5:4 kg NPKSMgZnB ha^{-1}, T_3 = Poultry Litter (PL) @ 5 t ha^{-1} + 95:51:87:9:10:2.5:4 kg NPKSMgZnB ha^{-1}, T_4 = Cow Dung (CD) @ 15 t ha^{-1} + 36:52:60:17:10:2.5:4 kg NPKSMgZnB ha^{-1}, T_5 = Press Mud (PM) @ 15 t ha^{-1} + 10:50:43:0:10:2.5:4 kg NPKSMgZnB ha^{-1}, T_6 = Mustard Oil Cake (MOC) @ 0.5 t ha^{-1} + 140:54:115:25:10:2.5:4 kg NPKSMgZnB ha^{-1} and T_7 = GM (Green Manure) @ 5 t ha^{-1} + 140:53:100:28:10:2.5:4 kg NPKSMgZnB ha^{-1} were used in this experiment. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Results showed that the increasing trend of juice quality parameters *viz.,* brix (21.37%), pol in cane (15.25%) and sugar yield (15.56 t ha^{-1}) were recorded with T_3 treatment (PL @ 5 t ha^{-1} + 95:51:87:9:10:2.5:4 kg NPKSMgZnB ha^{-1}). All the data of *goor* quality parameters revealed that maximum sucrose (76.29%), colour transmittance (54.80%) and *goor* recovery (11.16%) were observed in T_3 treatment (PL @ 5 t ha^{-1} + 95:51:87:9:10:2.5:4 kg NPKSMgZnB ha^{-1}), which was similar to T_4 treatment (CD @ 15 t ha^{-1} + 36:52:60:17:10:2.5:4 kg NPKSMgZnB ha^{-1}). The results of this study revealed that experimental treatment - PL @ 5 t ha^{-1} + 95:51:87:9:10:2.5:4 kg NPKSMgZnB ha^{-1} followed by CD @ 15 t ha^{-1} + 36:52:60:17:10:2.5:4 kg NPKSMgZnB ha^{-1} provided an opportunity to supply raw material with juice and *goor* quality of sugarcane grown in High Ganges River Floodplain soils to sugar industry and *goor* makers.Keywords: Sugarcane, Integrated nutrient, Quality, Bangladesh*Md. Shamsul Arefin: e-mail – arefinbsri@gmail.com

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is a tropical and subtropical giant grass belonging to the grass family of plants, Gramineae. Sugarcane juice is used for making white sugar and *goor*. Minimum per capita consumption of sugar is 13.0 kg or its equivalent quantity of 17.0 kg *goor* (FAO, 2009). The total requirement of sugar is 1.95 million tons or 2.55 million tons of *goor* for 142 million people in the country for the 21st century. Therefore, there is a big gap of 1.35 million tons of sugar or *goor* in the country. In Bangladesh, sugar production is much less than that in other sugar producing countries due to low cane yield and sugar recovery per cent. The production of sugarcane is fluctuated from year to year due to fluctuation of area under sugarcane cultivation. From this aspect, it is urgently needed to increase the yield of sugarcane. Farmers generally use inorganic fertilizers for crop production due to easy access and scarcity of organic fertilizers. Improper and imbalanced use of fertilizers along with cultivation of exhaustive crop like sugarcane causes detrimental effect of soil properties. Further use of excess nitrogenous fertilizer may cause nitrate contamination in surface and ground water (Nurunnobi, 2015). Hence, the combined application of organic and inorganic sources of plant nutrients may be done in such a way that the soil fertility is maintained without compromising yield loss. Integrated nutrient management involves the integrated use of chemical fertilizers along with organic fertilizers to increase production and improve soil health without environmental hazard. The concept of integrated nutrient management (INM) included appropriate crop rotations, cover crops, manures, crop residues, fertilizers and conservation tillage (Gopalasundaram *et al*., 2012). Soil fertility status of Bangladesh is decreasing day by day due to intensive cultivation of high yielding crop varieties, little use of organic materials, improper soil and crop management practices as well as use of higher doses of chemical fertilizers (Alam, 2013). Singh *et al.* (2014) reported that imbalanced and inadequate use of nutrients resulted in deterioration of soil health and multiple nutrient deficiencies and decline poor cane yield. Quality traits *viz.,* brix, pol, purity, commercial cane sugar and its accumulation in sugarcane were higher with the application of three-fourth of recommended rate of NPK fertilizer (169-84-126) + 20 tons press mud ha^{-1} (Soomro *et al.,* 2013). Incorporating press mud into the soil increased sugar yield and cane juice quality (Sarwar *et al.,* 2010). This study investigated the effects of INM strategy on the quality of sugarcane as compared to traditional nutrient management with an objective to know the effect of either alone or in combination of organic and inorganic fertilizers. To achieve the research goal, the present study was designed to investigate the effect of integrated nutrient management practices on the quality of juice and *goor* in sugarcane in Bangladesh.

METERIALS AND METHODS

Experimental setup and treatments:

The experiment was conducted in the experimental field of Bangladesh Sugarcrop Research Institute (BSRI), Iswardi, Pabna during 2013-14 cropping season. Seven (7) treatments such as

T_1 = Control,
T_2 = 165:55:120:30:10:2.5:4 kg NPKSMgZnB ha^{-1},
T_3 = Poultry Litter (PL) @ 5 t ha^{-1} + 95:51:87:9:10:2.5:4 kg NPKSMgZnB ha^{-1},
T_4 = Cow Dung (CD) @ 15 t ha^{-1} + 36:52:60:17:10:2.5:4 kg NPKSMgZnB ha^{-1},
T_5 = Press Mud (PM) @ 15 t ha^{-1} + 10:50:43:0:10:2.5:4 kg NPKSMgZnB ha^{-1},
T_6 = Mustard Oil Cake (MOC) @ 0.5 t ha^{-1} + 140:54:115:25:10:2.5:4 kg NPKSMgZnB ha^{-1} and
T_7 = GM (Green Manure) @ 5 t ha^{-1} + 140:53:100:28:10:2.5:4 kg NPK S Mg Zn B ha^{-1}

were considered in this experiment. The experiment was laid out in randomized complete block design (RCBD) with three replications. The unit plot size was 8 m × 6 m. The land preparation was uniform in this experiment. The plot was laid out as per experimental treatments and design. Poly bag settlings were planted in November following spaced transplanting (STP) method. The settlings raised in poly bag were transplanted in trenches at a distance of 45 cm. In this experiment, the rates of fertilizers for different treatments were calculated both on the basis of recommended chemical fertilizer dose (RFD) for high yield goal (HYG) and integrated plant nutrition system (IPNS) based on the chemical composition of each organic waste material along with its decomposition of major nutrient contents. Fertilizers were applied at rates of 165 kg N, 55 kg P, 120 kg K, 30 kg S, 10 kg Mg, 2.5 kg Zn and 4 B ha^{-1} as recommended dose of sugarcane crop. Cow dung, poultry litter, press mud, mustard oil cake and green manure (*Dhaincha*) were applied as organic manure. All the organic sources and full dose of P, S, Mg, Zn and B were applied in trenches and mixed with soil prior to transplanting of settlings. The basal dose of N (1/3rd) was applied as side dressing at 30 days after transplanting (DAT). The rest amounts of N and K were applied as top dressing in two equal splits at 120 and 180 DAT. After each application, fertilizers were incorporated into the soil by spade. In case of green manuring treatments, seeds of *dhaincha* were sown in between two rows of sugarcane at the rate of 25 kg ha^{-1} in the month of April. After 45 days, *dhaincha* was cut into small pieces and mixed into soil by spade. Irrigation was applied in trenches just after transplanting of the settlings in the plots under STP method to ensure quick and maximum establishment. Also supplementary irrigation was applied after 15, 60, 90 and 120 DAT when moisture reached to 60% depletion of the field capacity. The soil in trenches was loosened twice at 30 and 60 days after transplanting to prevent the settlings suffering from soil compaction. All the plots were kept weed free up to 140 DAT, as the period is considered to be the critical period for crop-weed competition in sugarcane field. Pest and disease management were done following the cultural and chemical practices as recommended by Bangladesh Sugarcrop Research Institute (BSRI). Prior to planting, regent 3G was applied @ 33 kg ha^{-1} in trenches to control termite. To prevent borers, furadan 5G was applied @ 40 kg ha^{-1} in two times (90 and 150 DAT) for each time. Apart from cultural control, mechanical and chemical control measures were done for insect-pests and disease management as and when required. Earthing-up was done three times on 120, 150 and 180 DAT. This operation converted the ridges into furrow and furrow into ridges. Tying was done in two times, first in July and then September to keep the clump straight to protect cane stalks from lodging against the possibility of strong wind. The dried leaves were removed from plants and green leaves on plants were tied together by taking all the canes in one bundle. Cross tying was done by binding two clumps of adjacent rows together. Regarding of the planting date and method, the crop was harvested manually at its physiological maturity stage.

Sugarcane quality parameters: Cane samples were randomly taken from different parts of the plot and made total number of stalks to 20. Cane samples were crushed by BSRI developed modern cane crusher. Juice samples extracted by means of a power driven sugarcane crusher from 10 canes were selected at random from the net plot area at harvest. Sugarcane juice was chemically analyzed for the following quality parameters:

Brix (%): Percentage of total soluble solids present in cane juice

Pol (%) in juice: Percentage of pure sucrose content in cane juice.

Purity (%) of juice: Percentage of pure sucrose in dry matter = □ 100--------

Pol (%) in cane: Percentage of pure sucrose content in whole cane.

Total Soluble Solids (TSS) or Brix: Brix readings of the filtered juice samples were recorded with the help of brix hydrometer standardized for 20^{o}C. Juice temperatures were also recorded for necessary temperature corrections (Chen, 1985).

Pol in juice: Juice samples were clarified as per Horne's dry basic lead acetate method with the help of digital polarimeter (Model: ATAGO AP 300, Japan). Pol readings so recorded were correlated with observed degrees brix with the help of Schmitzs table so as to obtain the values of pol in juice, which was synonymously used for sucrose content in juice (Anon, 1970).

Purity of juice: Purity of juice values was computed as per the following formulae.

$$\text{Purity (\%)} = \frac{\text{Pol in juice (\%)}}{\text{Brix (\%)}} \times 100$$

Pol in cane: Pol in cane was estimated by Horne's dry basic lead acetate method using polarimeter (Model: ATAGO AP 300, Japan). The corrected pol reading was obtained by comparing the

pol reading measured with the corresponding corrected brix reading referring to Schmitz table and the values were computed as per the following formulae (Anon, 1970). 100 – (F + 5)
Pol (%) in cane = Pol (%) in juice × -----------100------------
Where, F = Fibre in cane (%); 5 = constant
Reducing sugars: Lane and Eynon (original) method was used to determine reducing sugars as described by Varma (1988). Reducing sugar was calculated by the usual formulae: FF 100
Reducing sugars (%) = ---×-----×DF----TV 1000
Where, TV = Titre value; FF = Fehling factor and DF = Dilution factor
Phosphate: Phosphate content of the cane juice was determined by ammonium molybdate method (Varma, 1988).
Fibre: Fibre content of the cane was calculated by using the following formula:
Dry weight of the washed shredded cane (g)
Fibre (%) =--------× 100------
Fresh weight of the shredded cane (g)
Sugar yield: Sugar yield was calculated with cane yield and recoverable sucrose using the following formula (Anon, 1970).
Cane yield (t ha^{-1}) × Recoverable sucrose
Sugar yield (t ha^{-1}) = -------
100 Analysis of *goor* quality parameters:
Goor samples prepared in the laboratory of Physiology and Sugar Chemistry Division at harvest as per the method standardized at Bangladesh Sugarcrop Research Institute (BSRI), Ishurdi, Pabna were analyzed and graded according to quality parameters. The chemical analysis was carried out for certain characteristics to determine the quality and grading according to net rendament values.
Sucrose: Sucrose content was determined by digital polarimeter (Model: ATAGO AP 300, Japan) as done for sucrose of sugarcane juice.

Reducing sugars: Reducing sugars were estimated by titrating *goor* solution dissolved in 100 mL water and clarified with dry basic lead acetate with 10 mL of Fehling's A + B solution according to Lane and Eynon volumetric method (Varma, 1988). FF 100---------- Reducing sugars (%) = ---------× ---------- × DF
TV 1000 Where, TV = Titre value; FF = Fehling factor and DF = Dilution factor
Colour transmittance: For colour transmittance in 0.25 N solution of *goor* samples, 6.5 g *goor* was dissolved in 100 mL of water (Jabber, 1982).
Ash: Sulphated ash content in *goor* was calculated. Carbonated ash content was usually determined by making a deduction of 10% of sulphated ash. Ash content was expressed as per cent *goor* basis as indicated below (Jabber 1982):
Weight of ash
Ash (%) = ----------- × 100
Weight of *goor* sample
pH: Thirteen grams of *goor* were dissolved in water and made up to 100 mL volume. pH solution was determined by pH meter (Model: Hanna, China).
G*oor* recovery: *Goor* recovery was calculated by using the following formulae (Anon, 1970):

Weight of total *goor*
G*oor* recovery (%) = --- × 100

Weight of total cane
Grading based on net rendament (NR) value: Net rendament values were calculated by substituting the values in the formula given below:
Net rendament (NR) value = Sucrose (%) – [RS (%) + (3.5 × Ash (%)]
Based on NR values, *goor* samples were classified and graded according to scale proposed by Jabber (1982).
Statistical analysis:
The data were statistically analyzed through "Statistix 10" computer software. The differences between treatment means were compared using a LSD test at $P < 0.05$ (Gomez and Gomez, 1984).

RESULTS AND DISCUSSIONE

effects of integrated nutrient management practices on juice quality of sugarcane Total soluble solids (TSS) or Brix: Different rates of integrated use of organic and inorganic fertilizers application had no significant effect on total soluble solid (TSS) or brix of sugarcane juice in 2013-14 cropping season (Fig. 1). Brix varied from 20.60 to 21.37%. The highest brix (21.37%) was recorded in treatment T_3 (PL @ 5 t ha^{-1} + 95:51:87:9: 10:2.5:4 kg NPKSMgZnB ha^{-1}) while the lowest TSS or brix (20.73%) was found in treatment T_6. However, the use of higher dose of chemical nitrogen decreased total soluble solids. This might be due to dilution caused by higher dose of chemical nitrogen or due to increase in ash in cane juice. Similar findings were claimed by Bangar *et al.* (1994) and Bokhtiar and Sakurai (2007), who proved that increasing press mud increased juice brix.

Pol in juice: Pol in juice did not significantly influenced by different integrated nutrient management practices (Fig. 1). Among all the treatments, the highest value of pol in juice (19.31%) was found in T_3 treatment. Higher results, although not significant, were obtained in the treatments that received poultry litter (PL) with chemical fertilizers (PL @ 5 t ha^{-1} + 95:51:87:9:10:2.5:4 kg NPKSMgZnB ha^{-1}). The values of pol in juice were decreased in the plots where green manuring (GM) was done. Bokhtiar and Sakurai (2005) reported same results, those who mentioned that the decline in pol in juice occurred due to more N from incorporated *C. juncea* as green manure so that increased the concentration of N made plant succulent, which in turn diluted the sucrose.

Purity: Purity of juice did not significantly influence by different integrated fertilizer management (Fig. 1). Results showed that the treatment T_7 gave maximum purity (90.71%) among all the experimental treatments. While the treatment T_2 gave minimum purity (88.86%). Similar trend of the obtained values was recorded as in total soluble solids and sucrose as indicated by Mohammad (1989) and Bokhtiar *et al.* (2008). They found that reduction in purity was dependent upon sucrose and brix values. Similar conclusion was drawn by Bangar *et al.* (1994) while comparing with press mud as organic nitrogen fertilizer.

Pol in cane: Different integrated fertilizer treatments did not influence juice quality of sugarcane as indicated pol in cane (Table 1). Pol in cane of sugarcane ranged from 14.64 to 15.25%. The results revealed that the treatment T_3 contained the highest pol in cane (15.25%) and it was statistically similar to all other experimental treatments. However, the lowest pol in cane (14.64%) was found in treatment T_1. Pol in cane had no significantly differ with different nutrient managements. Higher results were obtained in the treatments that received chemical fertilizers in combination with poultry litter (PL @ 5 t ha^{-1} + 95:51:87:9:10:2.5:4 kg NPK SMgZnB ha^{-1}). The values of pol in cane were decreased in the plots where green manuring (GM) was applied than organic treated plots. Same results were reported by Bokhtiar and Sakurai (2008), who mentioned that the decline in pol in cane occurred due to more N from incorporated *C. juncea* as green manure so that increased concentration of N made plant succulent, which in turn diluted the sucrose.

Phosphate: Phosphate content in juice significantly varied among the experimental treatments (Table 1). Treatment T_4 gave maximum phosphate content (334.33 mg L^{-1}) followed by T_3 (331.67 mg L^{-1}) and T_6 (329.67 mg L^{-1}) treatments, which were statistically similar. The treatments T_3, T_6 and T_7 with the values of 331.67, 329.67 and 327.33 mg L^{-1}, respectively were observed similar effect on phosphate content of sugarcane juice. Treatment T_1 (control) produced the lowest phosphate content (319.33 mg L^{-1}) in sugarcane juice. However, the lower dose of chemical nitrogen in combination with organic fertilizer increased phosphate content in sugarcane juice.

Reducing sugars: Reducing sugars exhibited significant differences among the fertilizer management practices (Table 1). It was found that the content of reducing sugars in sugarcane juice ranged from 0.20 to

0.30%. The treatment T_3 produced the lowest content of reducing sugars (0.20%) and was statistically similar to the treatment T_4 (0.21%). The highest content of reducing sugars (0.30%) was recorded significantly in T_1 treatment. The highest content of reducing sugars in T_1 treatment was due to unripened cane as well as low recovery, while the lowest content of reducing sugars (0.20%) was due to higher purity and sugar recovery. Similar trend was reported by Hussain *et al.* (2007), who found that the higher reducing sugars in juice also increased its concentration in *goor*.

Fibre: Different fertilizer management treatments had significant effect on fibre content of sugarcane (Table 1). Among the fertilizer management treatments, T_1 (control) gave the highest content of fibre (16.55%), which was statistically as par with T_2 (16.37%) and T_5 (16.36%) treatments. The lower fibre content value (16.37%) was produced in T_2 treatment, which was statistically as par with T_5 (16.36%), T_6 (16.32%) and T_4 (16.20%) treatments. Furthermore, the lowest fibre content (16.08%) was recorded by the treatment T_7 fertilizer management treatment followed by T_3 treatment (16.09%). These were in agreement with the findings of Bokhtiar *et al.* (2008), who stated that the integrated use of organic and inorganic fertilizers decreased fiber content in cane.

Sugar yield: Sugar yield was significantly influenced by the application of integrated nutrient management practices (Table 1). Higher sugar yield was produced by fertilizer treated plots than control plot (T_1). The highest sugar yield (15.56 t ha^{-1}) was recorded in the treatment T_3 and was significant over all the experimental treatments. Sugar yield in T_3, T_4 and T_6 treatments with values of 15.56, 14.83 and 13.80 t ha^{-1}, respectively were statistically as par. The treatments T_2, T_5 and T_7 were also similar on sugar yield with the values of 9.59, 10.62 and 10.80 t ha^{-1}, respectively. Sugar yield (6.66 t ha^{-1}) was recorded in the treatment T_1 (control), which was significantly lower as compared to the fertilizer treatments. The treatments were in order of $T_3>T_4>T_6>T_7>T_5>T_2>T_1$. The results were in agreement with the findings of Bokhtiar *et al.* (2008), who mentioned that press mud application with inorganic fertilizer increased sugar yield. Bangar *et al.* (1994) reported the increase in sugar yield with varying levels of organic fertilizer application along with chemical fertilizer.

Effects of integrated nutrient management practices on *goor* quality of sugarcane

Physical properties of *goor*: The results in Table 2 revealed that physical properties of *goor* were significantly influenced by the application of integrated nutrient management practices. In case of texture of *goor,* treatments T_2, T_3, T_4, T_5, T_6 and T_7 showed hard and T_1 showed moderately soft texture of *goor*. Treatments T_2, T_3, T_4, T_5 and T_6 produced good crystalline nature of *goor* in respect of crystalline in nature of *goor*. While treatments T_1 and T_7 recorded non-crystal and moderately crystal in nature in both seasons. Again, the golden colour of *goor* revealed in T_2, T_3, T_4, T_5, T_6 and T_7 treatments and T_1 noted brown colour of *goor* in solid state. On the contrary, sweety taste of *goor* was obtained by the treatments T_2, T_3, T_4, T_5, T_6 and T_7 but in T_1 treatment, slightly salty taste of *goor* was found.

Chemical properties of *goor*

Sucrose: Sucrose content of *goor* was significantly influenced by different integrated nutrient management practices (Table 3). The highest sucrose content of *goor* (76.29%) was noticed in treatment T_3 and was statistically similar to treatment T_4 (75.60%). The lower sucrose content of *goor* (74.91%) was observed in treatment T_6, which was statistically similar to the treatment T_4. While the treatment T_1 (control) showed the lowest sucrose content of *goor* (68.02%). These results indicated minimum sucrose content in *goor* samples in chemical fertilizers alone and maximum sucrose content in integrated nutrient management practices. Similar findings were reported by Keshaviah (2011).

Reducing sugars: Reducing sugars of *goor* were significantly influenced by the application of different fertilizers (Table 3). Among all the experimental treatments, T_3 treatment gave minimum reducing sugars (5.36%) in *goor* and it was statistically similar to the treatments T_4, T_6 and T_7. On the other hand, the control treatment (T_1) produced maximum reducing sugars (5.85%) in *goor,* which was as par to the treatments T_2, T_4, T_6 and T_7. The highest reducing sugars in T_1 treatment was due to unripened cane, while the lowest reducing sugars in T_3 treatment were due to higher purity. Similar trend was observed by Hussain *et al.* (2007), who found that the highest reducing sugars in juice increased its concentration in *goor*. Organic sources of nutrients have brought about reduced content of reduced sugars owing to their steady and continuous supply of nutrients particularly nitrogen, which was responsible for reducing sugar content. The inorganic nitrogen at sugar accumulation stage resulted in accumulation of reducing sugars at higher concentration. Same trend of results was observed by Keshaviah (2011).

Colour transmittance: Colour transmittance of *goor* significantly differed by the application of different fertilizers treatments (Table 3). Colour transmittance of *goor* was maximumin treatment T_3 (54.80%) and it was statistically similar to treatment T_4. The treatments T_4, T_6 and T_7 with the respective values of 53.88, 53.66 and 52.98% were found statistically similar. The lowest colour transmittance of *goor* (46.10%) was found in the treatment T_1 (control). The use of organic fertilizer in combination with chemical fertilizers increased sucrose content and decreased reducing sugars level in *goor*. This might be due to concentration caused by higher dose of organic nitrogen or due to increase in colour transmittance in *goor*. pH: pH of *goor* was significantly influenced by different integrated nutrient management treatments (Table 3). Maximum pH value (5.65) of *goor* was observed in the treatment T_4 and T_6, which was statistically similar to all other treatments except the control treatment T_1. Similarly, minimum pH value (5.36) of *goor* was obtained from the treatment T_1 (control) but it was similar to T_2, T_5 and T_7 treatments. Ash: From Table 3, it was noticed that significant differences were found among the treatments to ash content in *goor* and ranged from 2.85 to 3.75%. The treatment T_1 recorded significantly the highest ash content (3.75%) and was statistically similar to T_2, T_5 and T_7 treatments and the lowest ash content (2.85%) was observed in treatment T_3, which was statistically similar to T_4 treatment. The increasing dose of organic fertilizers decreased ash content in juice. Similar but significant trend was recorded for ash content of *goor*. This showed that higher concentration of ash in juice also increased ash in *goor* and higher concentration of ash in juice was directly propotional to higher doses of mineral fertilizers. These results of ash content in juice were contrary to Bangar *et al.* (1994), who concluded an increase in ash with increasing press mud. But these results were analogous to Hussain *et al.* (2007), who proved that higher concentration of ash in *goor* was due to its higher concentration in juice. *Goor* recovery: The results were significantly influenced by the practice of integrated nutrient management treatments (Table 3). The treatment T_3 produced significantly the highest *goor* recovery (11.16%) among all the experimental treatments, which was statistically similar to the treatment T_4 (10.70%). While the control treatment T_1 gave significantly the lowest *goor* recovery (10.01%) but it was statistically similar to all the treatments except T_3. These results were in conformity with the findings of Hussain *et al.* (2007). Grading based on net rendament (NR) value: In Table 4, experimental results reflected that the data of NR values were found significant differences with each other. Based on NRV, *goor* was classified into different classes such as A_1 to A_5. The treatment T_3 produced significantly the highest net rendament (NR) value of *goor* (57.80) among all the experimental treatments. The second and third highest NR values were observed in T_4 (57.13) and T_6 (56.85) treatments. Again, the treatment T_1 (control) gave the lowest value (52.19) of NR. *Goor* quality was higher with more of A_1 quality *goor* with organic nutrient management practices. Similar results were reported by Keshaviah (2011).

CONCLUSION It is concluded that *goor* quality parameters *viz*., sucrose, reducing sugars, colour transmittance, pH and ash varied significantly with different fertilizers treatments. The highest *goor* quality parameters were found from experimental treatment when the sugarcane crop received PL @ 5 t ha^{-1} + 95:51:87:9:10:2.5:4 kg NPKSMgZnB ha^{-1}. The results of this study revealed that experimental treatment - PL @ 5 t ha^{-1} + 95:51:87:9:10:2.5:4 kg NPKSMgZnB ha^{-1} followed by CD @ 15 t ha^{-1} + 36:52:60:17:10:2.5:4 kg NPKSMgZnB ha^{-1} provided an opportunity to supply raw material with good juice and *goor* quality of sugarcane grown in High Ganges River Floodplain soils to sugar industry and *goor* makers.

Table 1. Effect of integrated nutrient management practices on juice quality parameters of sugarcan

Treatments	Juice quality parameters				
	Pol in cane (%)	Phosphate (mg L^{-1})	Reducing Sugars (%)	Fibre (%)	Sugar yield (t ha^{-1})
T_1	14.64	319.33 e	0.30 a	16.55 a	6.66 c
T_2	14.78	322.00 de	0.28 b	16.37 ab	9.59 b
T_3	15.25	331.67 ab	0.20 e	16.09 c	15.56 a
T_4	15.12	334.33 a	0.21 e	16.20 bc	14.83 a
T_5	14.91	324.67 cde	0.26 c	16.36 ab	10.62 b
T_6	14.78	329.67 abc	0.23 d	16.32 b	13.80 a
T_7	14.74	327.33 bcd	0.25 c	16.08 c	10.80 b
LSD at 0.05	NS	6.03	0.02	0.224	2.88

Figure(s) having common letter(s) in a column did not differ significantly at 5% level of significance

Table 2. Effect of integrated nutrient management practices on physical properties of *goor*

Treatments	Physical properties of *goor*			
	Texture	Crystalline in nature	Colour in solid state	Taste
T_1	Moderately Soft	Non-crystal	Brown	Slightly salty
T_2	Hard	Good crystal	Golden	Sweety
T_3	Hard	Good crystal	Golden	Sweety
T_4	Hard	Good crystal	Golden	Sweety
T_5	Hard	Good crystal	Golden	Sweety
T_6	Hard	Good crystal	Golden	Sweety
T_7	Hard	Moderately Crystal	Golden	Sweety

Table 3. Effect of of integrated nutrient management practices on chemical properties of *goor*

Treatments	Chemical properties of *goor*					
	Sucrose (%)	Reducing Sugars (%)	Colour transmittance (0.25 N)	pH	Ash (%)	*Goor* Recovery (%)
T_1	68.02 f	5.85 a	46.10 e	5.36 b	3.75 a	10.01 b
T_2	69.66 e	5.75 a	51.91 d	5.42 ab	3.57 ab	10.13 b
T_3	76.29 a	5.36 b	54.80 a	5.63 a	2.85 d	11.16 a
T_4	75.60 ab	5.52 ab	53.88 ab	5.65 a	3.12 cd	10.70 ab
T_5	71.01 d	5.76 a	52.18 cd	5.40 ab	3.70 a	10.15 b
T_6	74.91 b	5.56 ab	53.66 b	5.65 a	3.29 bc	10.41 b
T_7	72.81 c	5.69 ab	52.98 bc	5.47 ab	3.47 ab	10.24 b
LSD at 0.05	1.34	0.38	0.95	0.27	0.33	0.74

Table 4. Net rendament values of *goor* as influenced by integrated nutrient management practices

Treatments	Net rendament values (NRV)	Grading
T_1	52.19 g	B (Medium)
T_2	52.99 f	B (Medium)
T_3	57.80 a	B (Medium)
T_4	57.13 b	B (Medium)
T_5	53.73 e	B (Medium)
T_6	56.85 c	B (Medium)
T_7	54.97 d	B (Medium)
LSD at 0.05	0.051	-

REFERENCES

Alam MJ 2013. Productivity of sequential intercropping in paired row sugarcane. PhD Dissertation, Department of Agronomy, Bangladesh Agricultural University, Mymensingh. pp. 1-136.

Anonymous, 1970. *Laboratory Manual for Queensland Sugar Mills*. 5th edn. Division of Mill Technology Brisbane, Queensland. pp. 94-143.

Bangar K.S., B.B. Parmar and A. Maini 1994. Effect of fertilizers nitrogen and press mud cake on growth, yield and quality of sugarcane. *Crop Res.* (Hisar) 8(1): 23-27.

Bokhtiar S.M., G.C. Paul and K.M. Alam 2008. Effects of organic and inorganic fertilizers on growth, yield, juice quality and residual effects on ratoon crops of sugarcane. *J. Plant Nutri.* 31: 1832-1843.

Bokhtiar S.M. and K. Sakurai 2005. Effect of application of inorganic and organic fertilizers on growth, yield and quality of sugarcane. *Sugar Tech.* 7: 33-37.

Bokhtiar S.M. and K. Sakurai 2007. Integrated use of organic manures and chemical fertilizers on growth, yield and quality of sugarcane in high ganges river floodplain soils of Bangladesh. *J. Commun. Soil Sc. & Plant Anal.* 36: 13-14 1823-1837.

Chen J.C.P. 1985. *Cane Sugar Handbook*. 11th edn. A Wiley-Interscience Publication, John Wiley & Sons, New York. pp. 1101-1103.

Food and Agriculture Organization (FAO). 2009. Food and Agriculture Organization of the United Nations: Economic and Social Department: The Statistical Division. p. 567.

Gomez K.A. and A.A. Gomez 1984. *Statistical Procedures for Agricultural Research.* 2nd edn., A Wiley-Interscience publication, New York, USA. pp. 442-443.

Gopalasundaram P., A. Bhaskaran and P. Rakkiyappan 2012. Integrated Nutrient Management in Sugarcane. *Sugar Tech.* 141: 3-20.

Hussain F., M.A. Sarwar and A.A. Chattha 2007. Screening of some sugarcane genotypes for goor quality. *J. Anim. Plant Sci.* 17: 76-78.

Jabber M.A. 1982. Jaggery (*Goor*): Manufacture and Quality Control. MS Thesis, Department of Food Technology, University of Mysore, Karnataka, India. pp. 1-75.

Keshavaiah K.V. 2011. Effect of organic and integrated nutrient management on growth, yield and quality of sugarcane and jaggery in cauvery command area. PhD Thesis, Department of Agronomy, College of Agriculture, Dharwad University of Agricultural Science, Dharwad. pp. 1-168.

Mohammad B.D. 1989. Effect of nitrogen fertilizer and harvest time on yield and quality of sugarcane. M. Sc. Thesis, Agron. Dept. Assiut University, Egypt.

Nurrunnobi S.M. 2015. Effects of integrated use of organic and inorganic sources of nutrition for yield maximization of rice. MS Thesis, Department of Soil Science, Bangladesh Agricultural University, Mymensingh. pp. 1-59.

Sarwar M.A., M. Ibrahim, M. Tahir, K. Ahmad, Z.I. Khan and E.E. Valeem 2010. Appraisal of press mud and inorganic fertilizers on soil properties, yield and sugarcane quality. *Pakstan J. Bot.* 422: 1361-1367.

Singh K., O.P. Choudhary, K. Singh, H. Singh, S. Singh and R.S. Singh 2014. Identification of integrated nutrient management for sustain soil health and sugarcane yield in South Western Punjab. *J. Environ. Biol.* 36: 551-555.

Soomro A.F., S. Tunio, F.C. Oad and I. Rajper 2013. Integrated effect of inorganic and organic fertilizers on the yield and quality of sugarcane (*Saccharum Officinarum* L). *Pakstan J. Bot.* 454: 1339-1348.

Varma N.C. 1988. System of technical control for cane sugar factories in India. The Sugar Technologists Association of India, Revised edn., Kanpur, India. pp. 17-35.