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Effect of NPK Fertilizers and Cowdung in Combination with Foliar Spray of Chemicals on the Growth and Quality of Jute Plant

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Abstract: The experiment was performed in the experimental land of the Institute of Biological Sciences, Rajshahi during the period of April-May, 2000 and 2001. The physicochemical compositions of jute leaves under different foliar treatments were investigated at the mature stage. The results obtained showed significantly increase in most of the chemical composition under different treatments. The soil of the cultivated land as well as jute leaves obtained from experimental land became less acidic as compared to those of control field after application of NPK-fertilizers and cowdung in combination with foliar spray. The highest percentage of increase of jute plant and physico-chemical composition of leaves as compared to those of control were as follows: length of jute plant 38.35%, area of jute leaf 160.00%, specific gravity 6.48%, dry matter 27.78%, ash content 18.55%, total chlorophyll 42.17%, total sugar 69.47%, reducing sugar 48.15%, non-reducing sugar 72.90%. Only the moisture content of jute leaves from control jute plant was about to higher as compared to that from experimental jute leaves.

Key words: Physico-chemical compositions, treated jute leaves

Introduction

In agriculture, interaction between fertilizer and moisture plays a significant role. The choice and the dosages of fertilizers are related to the soil condition and irrigation potential. By application of a balance dosage of fertilizers, jute leaves yield can be increased by 100% under rain-fed conditions and 150% under irrigated conditions (Ullal and Narasimhanna, 1978).

Arnon and Stout (1939) have shown that the elements having a rock in plant metabolism will justify the essentiality of an element. Micro-nutrients play a major role in building up of the functional units of chloroplasts which is the major component for photosynthesis and some of the micro-nutrients function as catalyst for some important endogenous reactions (Epstein, 1972).

Micro-nutrients are utilized by plants in important life supporting processes or activities and are removed by plants from the soil, thus it becomes essential to replenish them with suitable balanced nutrient fertilizers to avoid nutrient deficiency. Further balance between macro and micronutrients are very much important for plants to avoid antagonistic activities which may lead to poor growth and yield affecting quality of leaf. Maximum synergistic effects are obtained if balance is achieved between micronutrients.

Chemical fertilizers particularly nitrogen and potassium play a crucial role in growth of jute plant. Nitrogen has also play a significant role in the construction of aminoacid compounds and proteins (Miller and Donahue, 1990 and Salisbury and Ross, 1992), whilst potassium has its role in electron (e^{-1}) transport in the photosynthetic e^{-1}transport chain in supplying assimilates to Overnell (1975) and Suksri (1998) in addition. The improvement of soil fertility with the use of soil amendments such as organic matter, crop residues and other source e.g, cattle manure, poultry manure is urgently needed. The investigation reported here aims to improve the quality of jute leaves particularly growth of jute plant with respect to chemical components.

In the present study, we first time studied the effects of NPK-fertilizers in combination with foliar spray of urea and chemicals on jute plant and quality of jute leaves. The overall experimental data indicated that treatment of jute plant cultivated lands with NPK-fertilizers and cowdung as well as by foliar spray of urea, chemicals and mineral mixtures might be helpful in improving the quality of jute plant and jute leaves.

Materials and Methods

The experiment was carried out at the experimental land of the Institute of Biological Sciences, Rajshahi University, Bangladesh during the season April-May, 2000 and 2001. The experiment was laid in a randomized complete block design (RCBD) with ten treatments and one control. The plot sizes being used were 4×5 m with a walking path between the plots of 0.50 m. The treatments being used denoted as T1 is control while T2, T2, T3, T4, T5, T6, T7, T8, T9, T10 and T11 are the experimental. Before sowing of jute seed, cow-dung and NPK-fertilizers were applied at the ground level. Each plot received cow-dung at the rate of 250 kg ha^{-1} and NPK-fertilizers 200 kg ha^{-1}.

Firstly, after 30 days of sowing foliar spray of 0.1% of urea solution and 0.1% KNO_3 solution were performed on jute leaves in different blocks systematically.

Secondly, after 50 days of sowing foliar spray of 0.1% of chemicals were applied on jute leaves. The NPK-fertilizers were applied in the form of urea (N), triple super phosphate (P) and murate of potash (K) in a broadcast method and as chemicals KCl, $Ca_3\ (PO_4)_2$ and Na_2HPO_4 were used. The experiment was repeated in two seasons.

After 70 days of sowing mature jute leaves were collected from each plot and analyzed for its physico-chemical composition in triplicate.

The physical properties were determined by the following procedure viz. length of jute plant (by meter scale), area of jute leaf (using graph paper), specific gravity (Kalimuddin, 1976), pH (Jackson, 1973), TTA (Osar, 1965), moisture content and dry matter (by conventional procedure), ash (AOAC, 1980), chlorophyll (Mahadevan and Sriddhar, 1982), total sugar (Jayaraman, 1981), reducing sugar (Miller, 1972) and non-reducing sugar (Ranganna, 1979).

The data obtained was statistically analyzed by the method of Analysis of variance (ANOVA) and the differences due to treatment means were determined using Dancan's multiple range test (DMRT) by MSTAT programme (Nissen, 1988).

Results and Discussion

The physico-chemical compositions of control and treated jute leaf at mature stage were analyzed and the results are summarized in Table 1 to Table 5.

Length of jute plant, area of leaf and specific gravity

The physical properties of jute leaf under different treatments analyzed by the method of Analysis of variance (ANOVA) and the results obtained showed significant difference among the treatments.

The experimental data obtained in the present study clearly demonstrated that the length of jute plant was increased significantly after treatment with NPK-fertilizers and foliar spray of mineral mixture. Among the treatments T10 was found to be best and was recorded about 38% increase in length (Table 1) as compared to that of control (T1). In order of magnitude, the order of length was found as- T10>T6>T4≥T8=T11≥T5>T3≥T9≥T2>T7>T1, but T4, T8 and T11 and T2, T3 and T9 are intercorrelated among the treatments at 5% level of significance by DMRT.

Perusal of the mean values (Table 1) revealed that leaf area of different treatments varied from 58.51±0.15 to 152.10±0.08 cm^2. The present data clearly indicated that the size of leaf increased about 36-160% after treated the soil with different NPK-fertilizers as well as cowdung and foliar spray of mineral mixtures. The leaf area of different treatments was in order of- T10>T6>T11>T8>T7>T4>T9>T5>T3>T2>T1. It can be concluded from the results that the size of the

Table 1: Length of jute plant, area of jute leaf and specific gravity of jute leaves juice under different treatments

Treatments	Length of jute plant (m)	(%) increase	Area of jute leaf (cm^2)	(%) increase	Specific gravity
T1	2.79±0.12a	-	58.51±0.15a	-	1.08±0.002
T2	3.65±0.23c	30.82	79.75±0.13b	36.32	1.09±0.003
T3	3.70±0.14d	32.62	92.22±0.12c	57.64	1.11±0.004
T4	3.76±0.13f	34.67	118.68±0.15f	102.87	1.10±0.012
T5	3.73±0.12e	33.69	110.50±0.20d	88.88	1.13±0.002
T6	3.79±0.13g	35.84	135.00±0.13j	130.76	1.12±0.005
T7	3.58±0.09b	28.32	119.00±0.18g	103.42	1.09±0.004
T8	3.75±0.15ef	34.41	120.96±0.17h	106.76	1.12±0.001
T9	3.68±0.21cd	31.89	113.56±0.19e	94.12	1.11±0.003
T10	3.86±0.14h	38.35	152.10±0.08k	160.00	1.15±0.002
T11	3.74±0.12ef	34.01	127.75±0.15i	118.38	1.14±0.002

In columns, common letter is not significantly different at 5% level of significance by DMRT (Duncan's multiple range test)
T1: Control; T2: Control + Cow-dung; T3: Control + Cow-dung + KNO_3; T4: Control + Cow-dung + Urea; T5: Control + Cow-dung + KNO_3 + Minerals* ; T6: Control + Cow-dung + Urea + Minerals* ; T7: Control + NPK-fertilizers; T8: Control + NPK-fertilizers + KNO_3 ; T9: Control + NPK-fertilizers + Urea; T10: Control + NPK-fertilizers + KNO_3+ Minerals* ; T11: Control + NPK-fertilizers + Urea + Minerals* ; *KCl, $Ca_3(PO_4)_2$, Na_2HPO_4

leaf affected highly after treatment with NPK-fertilizers as well as with the foliar spray of mineral mixtures.

Results (Table 1) with reference to specific gravity indicated that specific gravity of jute leaves juice varied from 1.08±0.02 to 1.15±0.02. The highest specific gravity (1.15±0.02) of jute leaves juice was recorded in treatment T10 followed by T11 and so on in decreasing order. The sequence of specific gravity was in the order of- T10>T11>T5>T8=T6>T9=T3>T4>T7=T2>T1 but treatments T2 and T7, T3 and T9, T6 and T8 were jointly affected at 5 % level of significance by DMRT. The results clearly indicated that the specific gravity of jute leaves juice increased slightly by the application of different chemicals, which might be due to increase in concentration of soluble materials in leaf. Karim ***et al.*** (1996) reported that specific gravity of tomato flesh increased with the advancement of maturity.

pH and TTA of soil and leaf extract

The pH of the control soil and that of NPK-fertilizer as well as cow-dung applied soil were found to be varied between 5.72 to 6.21. The pH values of soil extract was in order of- T11>T6>T10>T4>T8≥T3>T5=T9≥T2>T7>T1. As shown in Table 2, pH values of jute leaves extract for different treatments were found in order of- T6>T10>T5>T4≥T8>T11>T3≥T9≥T7>T2>T1. Again the pH of jute leaves extract from control and that of treated plants varied between 5.8 to 6.27. It was also found from the present data that the pH of the cultivated land soil became less acidic as compared to that of control field after application of NPK-fertilizers as well as cow-dung. At the same time the pH of the leaf extract also became less acidic with application of NPK-fertilizers and cow-dung in the soil as well as by foliar spray of mineral mixtures. Interestingly the changes in pH of the soil as well as plant leaves showed good correlation after different treatments.

Data (Table 2) revealed that the maximum (29.35 ± 0.04) TTA was found in treatment T10 while the minimum TTA (18.75 ± 0.03) of soil extract was found in T1 (control). The order of TTA in soil

Table 2: pH and TTA of soil extract and leaf extract of jute leaves under different treatments

Treatments	pH of soil extract	pH of leaf extract	TTA of the soil (ml of 0.1N NaOH required/ 100 gm of leaf extract)	TTA of the leaf (ml of 0.1N NaOH required/ 100 gm of leaf extract)
T1	5.72±0.20a	5.80±0.13a	18.75±0.03a	19.53±0.12a
T2	5.95±0.05c	5.98±0.09b	19.02±0.06b	23.24±0.05b
T3	5.99±0.06de	6.02±0.14d	22.32±0.04e	25.31±0.13d
T4	6.03±0.13f	6.13±0.15fg	20.41±0.02c	28.11±0.06f
T5	5.98±0.07cd	6.16±0.06h	19.25±0.03b	24.85±0.04c
T6	6.13±0.09h	6.27±0.07j	24.75±0.07f	29.55±0.03g
T7	5.85±0.15b	6.01±0.13c	21.12±0.08d	22.16±0.02b
T8	6.00±0.09e	6.12±0.08f	25.42±0.05g	32.14±0.08i
T9	5.97±0.16cd	6.00±0.12cd	26.13±0.04h	27.22±0.13e
T10	6.11±0.13g	6.19±0.13i	29.35±0.04j	30.15±0.09h
T11	6.21±0.20i	6.08±0.08e	27.13±0.06i	33.48±0.05j

In columns, common letter is not significantly different at 5% level of significance by DMRT (Duncan's multiple range test) extract was found as- T10>T11>T9>T8>T6>T3>T7>T4>T5≥T2>T1 whereas T2 and T5 were jointly affected at 5% level of significance by DMRT. The highest TTA value (Table 2) of jute leaf extract was recorded in treatment T11 (33.48±0.05) and the lowest was in T1 (19.535±0.12). TTA values of leaves extract were found in order of- T11>T8>T10>T6>T4>T9>T3>T5>T7≥T2>T1 but T2 and T7 were jointly affected at 5% level of significance by DMRT. From the results it may be concluded that the decrease in acidity after different treatments may be due to more metabolic activities.

Moisture, dry matter and ash content

Moisture plays an important role in the growth activities of plants, herbs, etc. Water is indispensable to absorption and transportation of food to carry on photosynthesis, metabolism of materials and the regulation of temperature. The moisture of plants, as in all other living systems, contributes as much as to the essential properties of life as to the more constituents like protein, carbohydrate etc. Moisture is also essential for most of the physiological reactions in plant tissue and its absence, life does not exist (Rangaswami, 1976). Fonseca ***et al.*** (1972) observed that water in the leaves improve their quality and better consumption. Moisture content of jute leaf varied between 78.35±0.41 to 82.80±0.19% (Table 3). The highest moisture content (82.80±0.19 %) was found in T1 and the lowest amount (78.35±0.41%) was found in treatment T10. The order of moisture content was found as- T1>T2>T7≥T3>T5=T8>T4=T10>T9=T6=T11 whereas treatments T6, T9 and T11; T4 and T10 and T5 and T8 were intercorrelated at 5% level of significance by DMRT. Results revealed that the moisture content of jute leaves decreased slightly after application of NPK-fertilizers as well as foliar spray of urea and mineral mixtures which may be due to accumulation of solid materials in leaf. Sarker ***et al.*** (1989); Abdullaev ***et al.*** (1966) and Quader ***et al.*** (1990) reported that 0.5% urea combined with NPK-fertilizers spray in mulberry leaf decreased moisture content.

Dry matter content of jute leaf indicated that the dry matter content in T1 was 17.20±0.02 gm%, but it varied between 18.69±0.03 to 21.72±0.05 gm% under different treatments (Table 3). The maximum dry matter content was recorded in treatment T11 (21.72 ± 0.05 gm%) and the highest percentage of increase was 27.75 gm% (T11). The mean values of dry matter for different treatments were found in order of- T11=T10>T6>T9>T4>T8=T5>T3=T7>T2>T1 but T3 and T7, T4 and T8 and T10 and T11 were jointly correlated at 5 % level of significance by DMRT. Results indicated that the dry matter content of jute leaf increased remarkably by the application of chemical substances which were in consistent with that reported for mango leaf (Jahangir, 1997).

Results (Table 3) indicated that the ash content of jute leaf varied from 2.75±0.05 to 3.56±0.03 in control and treated plants. The maximum ash content (3.26±0.03 gm%) was found in treatment T11 and minimum amount (2.75±0.05 gm%) was in T1. The mean values for the ash content in different treatments was found in order of-T11>T10>T8>T6>T5>T9≥T7>T4=T3>T2>T1 but T3, T4, T7 and T9 were intercorrelated at 5% level of significance by DMRT. Again, it may be concluded that as most of the inorganic constituents are present in ash, therefore, the increasing amount of ash in different treatments might be due to accumulation of chemicals.

Table 3: Moisture, dry matter and ash contents of jute leaf under different treatments

	Moisture		Dry matter		Ash	
Treatments	(gm%)	(%) decrease	(gm%)	(%)increase	(gm%)	(%)increase
T1	82.80±0.19f	-	17.20±0.02a	-	2.75±0.05a	-
T2	81.31±0.23e	1.80	18.69±0.03b	9.41	2.88±0.02b	4.73
T3	80.12±0.14cd	3.23	19.88±0.02c	17.23	2.94±0.01c	6.91
T4	79.05±0.24b	4.52	20.95±0.02e	24.36	2.98±0.02c	8.36
T5	79.51±0.31c	3.97	20.49±0.05d	20.83	3.03±0.05i	10.18
T6	78.79±0.15a	4.84	21.21±0.05g	25.39	3.09±0.06f	12.36
T7	80.75±0.26d	2.48	19.25±0.07c	12.53	2.99±0.04cd	8.73
T8	79.34±0.22c	4.18	20.66±0.03d	21.66	3.08±0.06g	12.00
T9	78.99±0.31a	4.60	21.01±0.04f	24.64	3.00±0.05d	9.09
T10	78.35±0.41b	5.37	21.65±0.05h	27.68	3.20±0.04h	16.36
T11	78.28±0.16a	5.46	21.72±0.05h	27.75	3.26±0.03i	18.55

In columns, common letter is not significantly different at 5% level of significance by DMRT (Duncan's multiple range test)

Total chlorophyll, chlorophyll-a and chlorophyll-b contents

Chlorophyll is the green pigment universally present in all the photosynthetic tissues. Chlorophyll-a and chlorophyll-b occur in higher plants. Chlorophyll estimates may also be required to relate other biochemical changes in the plant tissue. The highest total chlorophyll content was recorded in treatment T6 (224.03±0.03 mg%) and the lowest was recorded in T1 (157.58±0.05 mg%) (Table 4). The order of total chlorophyll content was found as-T6>T5>T4>T11>T9>T8>T7>T3=T10>T2>T1 whereas T3 and T10 were jointly affected at 5% level of significance by DMRT. Further, the total chlorophyll content of jute leaf increased rapidly about (10-42%) under different treatments.

As presented in Table 4 the maximum (159.48±0.03 mg%) chlorophyll-a content was found in treatment T6 and minimum (110.34±0.04 mg%) was found in leaves of control plant. Significantly, chlorophyll-a content was found to be increased due to application of NPK-fertilizer and cow-dung in the soil as well as foliar spray of urea and mineral mixtures. The sequence of chlorophyll-a content was in order of-T6>T5>T4>T11>T9=T10>T3>T8≥T7=T2>T1 but T9 and T10; T8, T7 and T2 were intercorrelated at 5% level of significance by DMRT (Table 4).

Results (Table 4) revealed that chlorophyll-b content also varied significantly among different treatments. The highest chlorophyll-b content was recorded in treatment T6 (64.55±0.04 gm%) and the lowest amount (47.24±0.05 %) was in T1. The sequential order of chlorophyll-b content was found as- T6>T8=T7>T4>T5=T9=T11>T3>T10=T2>T1 whereas T8 and T7; T5, T9 and T11; T10 and T2 were jointly affected at 5% level of significance by DMRT. Like chlorophyll-a, chlorophyll-b content of jute leaves also increased by about 14-34% under different treatments.

Total sugar, reducing sugar and non-reducing sugar contents: The total carbohydrate percentage reflects the physiological activity of the plant, whereas its total weight per plant represents the accumulated results of the metabolic activity (Hassanein, 1962). Carbohydrate of jute leaf plays an important role for the growth of plant. Protein or other elements of jute leaf are also synthesized from carbohydrate (Anonymous, 1975). Carbohydrates have two major biological functions, as a storage form of fuel and as structural element. Glucose, fructose and

Table 4: Total chlorophyll, Chlorophyll-a and Chlorophyll-b contents of the jute leaf under different treatments

	Total Chlorophyll		Chlorophyll-a		Chlorophyll-b	
Treatments	(mg%)	(%) increase	(mg%)	(%) increase	(mg%)	(%) increase
T1	157.58±0.05a	-	110.34±0.04a	-	47.24±0.05a	-
T2	173.19±0.02b	9.91	119.52±0.02b	8.32	53.67±0.02b	13.61
T3	190.80±0.01c	21.08	134.32±0.06c	21.73	56.48±0.01c	19.56
T4	206.48±0.03g	30.73	144.76±0.05f	31.19	61.72±0.05e	30.65
T5	211.44±0.06h	34.18	150.59±0.04g	36.48	60.85±0.03d	28.81
T6	224.03±0.03i	42.17	159.48±0.03h	44.54	64.55±0.04g	34.64
T7	192.56±0.04d	22.19	130.22±0.04b	18.02	62.34±0.02f	31.96
T8	194.89±0.04e	23.68	132.44±0.04bc	20.03	62.45±0.06f	32.19
T9	195.91±0.03e	24.32	135.63±0.03d	22.92	60.28±0.02d	27.60
T10	189.69±0.01c	20.38	134.77±0.02d	22.14	54.92±0.03b	16.26
T11	197.19±0.06f	25.14	137.83±0.03e	24.91	59.36±0.05d	25.60

In columns, common letter is not significantly different at 5% level of significance by DMRT (Duncan's multiple range test)

starch serve as important source of energy for vital activities. Some carbohydrates have highly specific functions, ribose in the nucleoprotein of the cell, mannose as prosthetic polysaccharide of albumins and globulins.

The order of total sugar (Table 5) was found as- T10>T4>T5=T8>T6≥T9=T4>T3≥T7>T2=T1 whereas T1 and T2, T7 and T3, T9 and T4 and T5 and T8 were intercorrelated at 5% level of significance by DMRT. The maximum total sugar content was recorded in T10 (3.22±0.06 gm%) and minimum was in T1 (1.90±0.12 gm%). It may be concluded from the present data (Table 5) that the total sugar content of jute leaf increased significantly after different treatments. The increase in sugar content might be due to rapid conversion of starch to sugar. Quader (1989) reported that the total sugar content of mulberry leaves increased under different foliar treatments.

Reducing sugar content (Table 5) was found in order of- T10>T11>T6>T8>T9=T5>T4=T3>T2≥T7=T1 whereas T1, T2, T3 and T4 were intercorrelated at 5% level of significance by DMRT. As presented in Table 5 the maximum reducing sugar content was obtained in treatment T10 (0.40±0.02 gm%) which was about 48% higher as compared to that of control (T1). It can be concluded from the present data that the reducing sugar content of jute leaves increased rapidly after treatments with NPK-fertilizer and cow-dung as well as with the foliar spray of urea and mineral mixtures. The change of reducing sugar might be due to enzymatic conversion of starch to reducing sugars and also conversion of some non-reducing sugars to reducing sugar (Ferdaus and Haque, 1989).

Non-reducing sugar (sucrose) content of jute leaves (Table 5) was found in order of- T10>T11=T8=T5>T6≥T9≥T4>T3>T7=T2>T1 whereas T2 and T11; T4, T9 and T6; T5, T8 and T11 were intercorrelated at 5% level of significance by DMRT. The results (Table 5) revealed that non-reducing sugar content varied from 1.55±0.02 to 2.68±0.03 gm%. The highest percentage of increase of non-reducing sugar content was found in treatment T10 which was about 73% higher as compared to that of control (T1). The results indicated that the non-reducing sugar content of jute leaves increased very significantly under different treatments. The result is in consistent with the results reported for sucrose content of mulberry leaves (Bahlul, 1990) under different foliar treatments.

Table 5: Total sugar, reducing sugar and non-reducing sugar contents of jute leaf under different treatments

	Total sugar		Reducing sugar		Non-reducing sugar	
Treatments	(gm%)	(%) increase	(gm%)	(%) increase	(gm%)	(%) increase
T1	1.90±0.12a	-	0.27±0.01a	-	1.55±0.02a	-
T2	2.20±0.03a	15.79	0.30±0.03ab	11.11	1.81±0.02b	16.77
T3	2.68±0.13b	41.05	0.32±0.05b	18.52	2.24±0.03c	44.52
T4	2.93±0.15c	54.21	0.33±0.06b	22.22	2.47±0.05d	59.35
T5	3.12±0.14d	64.21	0.34±0.01c	25.93	2.64±0.02f	70.32
T6	3.10±0.09cd	63.15	0.36±0.02e	33.35	2.60±0.04e	67.74
T7	2.24±0.15ab	17.89	0.29±0.04a	7.41	1.85±0.03b	19.35
T8	3.11±0.13d	63.68	0.35±0.03d	29.63	2.62±0.01f	69.03
T9	3.01±0.08c	58.42	0.34±0.05c	25.93	2.54±0.03de	63.87
T10	3.22±0.06f	69.47	0.40±0.02g	48.15	2.68±0.03g	72.90
T11	3.14±0.04e	65.26	0.38±0.03f	40.74	2.62±0.06f	69.03

In columns, common letter is not significantly different at 5% level of significance by DMRT (Duncan's multiple range test)

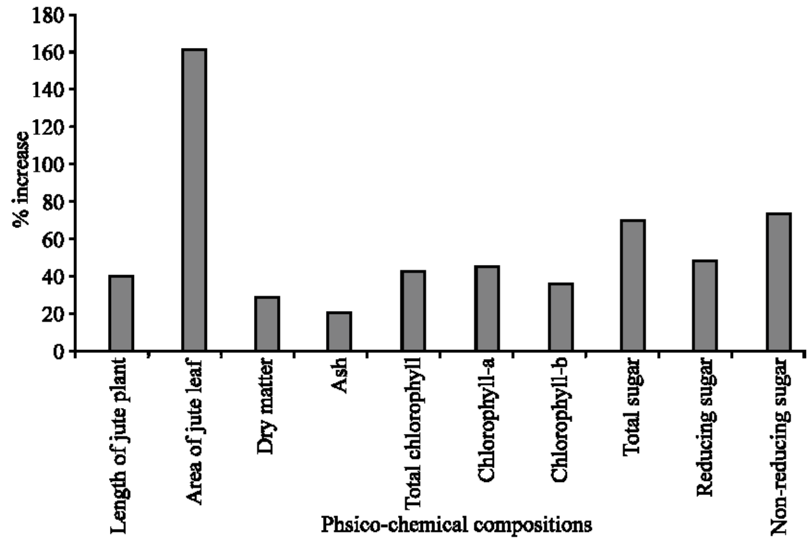

Fig. 1: Comparative study of analyzed physico-chemical compositions in jute leaves

Fig. 1 summarizes the analytical data on the increase in highest percentage of different parameters of jute leaves composition including length of jute plant and area of jute leaves as compared to those of untreated plant and leaves. Strikingly, the area leaf showed highest increase (160%) followed by non-reducing sugar (72.90%), then total sugar (69.47%) and then so on in decrease order.

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