BIBLIOGRAPHY

KUDAN, JAYSON D. OCTOBER 2010. Performance Evaluation of Sugar Beet (Beta vulgaris L.) Varieties as Affected by Organic Fertilizers Under La Trinidad, Benguet Condition. Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The study was conducted at the Balili Experimental Farm, Benguet State University, La Trinidad, and Benguet from January to March 2010 to identify the variety of sugar beet suited under La Trinidad, Benguet condition and determine the organic fertilizer best for sugar beet production in the locality.

Results revealed that there were no significant differences between the two varieties tested on vegetative growth, root size and weight, non-marketable and marketable yield. However, Detroit Amelioree had significantly higher computed marketable yield per hectare at 25.86 tons compared to Detroit Dark Red. Plants applied with either Siglat, chicken manure + 14-14-14 or NBEM had significantly higher marketable yield than those applied with BSU compost.

No distinct differences were observed between the two varieties applied with the various fertilizers in sugar content, skin and flesh color, and in market preference.

The highest return on investment at 139.26% was obtained from Detroit Amelioree applied with Siglat(2.17%N, 3.19% P_2O_5, 2.27% K_2O) organic fertilizer, thus growing this variety and application of said fertilizer is desired for greater yield and profit.

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INTRODUCTION

Sugar beet (*Beta vulgaris L.)* growing for sucrose production became successful in the United States starting about 1870. Earlier attempts of sugar beet production were not totally successful. Once a viable industry was established, sugar beets were grown in 26 states (Cattanach, 1991).

The Goosefoot or Pigweed Family (*Chenopodiaceae)* is composed of three species with different growth habits. Beet (*Beta vulgaris L*.) belongs to the Crassa group, Chard (*Beta vulgaris L)* to the Cicla group and spinach (*Spinacea oleracea L.).*

Sugar beet is grown predominantly in regions with temperate climates, Mediterranean or Arid ones. Today, sugar consumption has been growing at roughly the rates as world population growth (2% per year). There are substantial differences are cultural in nature, but per capita consumption also is correlated with wealth and is highest in Europe and lowest in China and Africa (Kaffa, 2000).

Beet has always been a vital source of energy enriched with nutrients and fiber. It is biennial and available almost throughout the year. Be it the modified root itself or chard like edible green leaves both are incredibly contributing to a healthy metabolism. While Beta vulgaris is widely being relished in the form of salad with spicy and lemon like flavor and pickles, the edible green leaves too are loaded with rich vitamin like vitamin C, folate and betaine in large quantities. Vitamin A, thiamin, riboflavin, niacin, vitamin B6, and pantothenic acid are also present in small amounts. It also constitutes traces of a-carotene. The crop is also known for being rich in nutrients (potassium, iron, magnesium, manganese, phosphorus, and copper) and small amounts of calcium sodium, zinc, and selenium. As for the calorie, it contains calorific value of 43.0 per 100 gm edible portion. With regards to health benefits, it has been found useful in the treatment of colon cancer and birth related defects. It is a natural cleanser which removes toxins from the body and nourishes the bloodstream. Also useful in the treatment of liver related dysfunctions like jaundice, cirrhosis, etc. beet juice is a good source of energy and is essential for human body. It is not advisable to feed beet to infants below six months old but it is of good use to women under menstruation. (Cattanach, 1991).

In the Philippines, vegetable production contributes much to the economy. One of the most important crops being especially in the high elevation is sugar beet. The production of such crop provides better income to vegetable growers. It commands a high price in the market. In the country, it is eaten as a vegetable food.

Sugar beet is mainly produced in Benguet and Mountain Province but there is need to promote production of the crop on account of being high in economic and nutritive value.

Varieties of sugar beet need to be tested in the locality and with the trend now of practicing organic farming, organic fertilizers ought to be evaluated as to their effect on sustaining crop growth and development.

The study was conducted at the Balili Experimental Farm, Benguet, State University, La Trinidad, Benguet from January to March 2010 to identify the variety of sugar beet suited under La Trinidad, Benguet condition and determine the organic fertilizer best for sugar beet production in the locality.

REVIEW OF LITERATURE

Description of the Crop

Sugar beet is a hardy biennial vegetable that can be grown in temperate and semi- temperate countries, depending of the variety. The crop produces a dense canopy of leaves and large root in which sugar is stored. It has a cluster of dark-green leaves and a top short stem called crown. Beneath the crown is the creamy-white cone shape root. The elongated upper part of the root is called the beet. The root tapers down to form a thin taproot, which extend up to 0.6 to 1.5 cm into the soil. The long taproot can obtain water that lies far below the ground.

Root size, before dormancy, is dependent on a number of factors. The most important of these include length of growing season, care of the growing crop, soil fertility, and moisture. In Arizona, under normal growing condition, most plants will attain a root size of 3/4 to 11/2 inches at crown. Under Oregon condition, most plants will attain a root size of 3/8 to 3/4 inch. In commercial beet production, the root is harvested after the first growing season, when the root is at maximum size (1-2kg) storage root whose dry mass is 15-20 % sucrose by weight. The beet root if not harvested during its second growing season, the nutrients will be utilized for flowering and seed production (Kaffa and Jackson, 2000).

Importance of Varietal Selection

Selection of a variety to be planted is one of the most important decisions that commercial vegetable growers make each season considering the yield performance. The variety has the potential to produce crops at least equivalent to those already grown. It must also perform well under wide range of environmental conditions usually encountered on individual farms and must also have the characteristics desired by packers, shippers, whole sellers, and consumers. Included among these qualities are size, shape, color, flavor, and nutritional quality (Lorenz and Maynard, 1988).

Sunil (1990) mentioned that varietal evaluation is a process in crop breeding program, which provide comparison of promising lines with the local check in order to establish the superiority of the lines developed by breeders. He emphasized that it is only through evaluation that breeders determine the performance of developed lines in terms of yield, quality, adaptability, stress, and insect pests and diseases resistance.

To be successful crop growers, a farmer should have a good control of the variety and the environment. A variety for example may have a potential for high yield but if not provided with adequate water and fertilizer or weeds are not controlled, it will not give high yield. The expression of the genetic potential of a variety is controlled over a wide range of environmental conditions (Wallace, 1969).

On the other hand, quality is defined as any of the features that make something excellent or superior (Kader, 1985). For fresh horticultural commodities, quality is a combination of characteristics attributes and properties that give the commodity value to humans for food (fruits and vegetables) and enjoyment. Producers are concerned that their commodities have good appearance and few visual defects but for them useful cultivars must score high on yield, disease resistance, ease of harvest, and shipping quality. To receiver's and market distributors, appearance quality is most important. They are also keenly interested on firmness and long storage life. Consumers consider good quality of fruits and vegetables to be presentable, firm and offer good flavor and nutritive value. Consumers buy based on appearance and satisfaction, purchases are dependent upon good quality. Finally, varieties can be evaluated according to the different quality factors namely: appearance; texture; flavor; nutritive value; and safety (Kader, 1985).

Edmund and Andrews (1957) said that varieties differ in productivity as an expression of their hereditary genes influence by the environment. The variety best adapted to the environment reflects the high yield potential as mentioned by Villareal (1969). The importance of varietal trial is to evaluate the yield of new varieties in areas with specific climatic conditions. Each cultivar has its own characteristics and yield potential.

Selection of a cultivar for production should be based on the optimal yield and profit that can be obtained. According to Wolford and Banks (2005), the market availability of seeds and equipment resources that are available to the growers and cultural conditions of the cite, should be taken into considerations.

Bautista and Mabesa (1969) added that the success in vegetable production is greatly affected by the farmers' control of the varieties and environment. Most of the time, right varieties selected would minimize the problems related to water and fertilizer management. While growing, the wrong variety would probably cause insect pests and disease infestation/infection resulting to crop failure.

On the other hand, Del Rosario (1977) concluded that picking the right variety minimize problems associated with water and fertilizer management.

Organic Fertilizer

Organic fertilizer comes from manures of animals like pig, chicken, carabao, cow, horse, and while leaves of plants, rice straw, corn stover, rice hull, etc., are plant matter.

The use of organic fertilizer results in better soil structure and soils with sufficient amount of organic matter retain more water for plant use.

Pig and poultry manure are the common sources of organic fertilizer which provides needed nutrients to plant in small quantity. According to estimates, the manure produced by 20-30 pigs a year could produce the same result as one ton of ammonium sulfate.

Organic fertilizer/organic manure are generally the most valuable soil conditioner. The materials from organic fertilizer generally have low content of nitrogen (N), phosphorus (P) and potassium (K) but they also supply other essential micronutrients. As soil conditioners, organic fertilizer helps prevent soil erosion, crushing and cracking of soil. They retain soil humidity and improved the internal drainage of the soil (Sangatanan, 2000).

Nitrogen and other nutrient elements contained in organic fertilizer are released slowly. Thus, their continuous application helps build up the soil, particularly when this is done for over a long period of time.

Organic fertilizer such as compost, animal manure, azolla, ipil-ipil, industrial wastes, and oil seed meals can be used in place of chemical fertilizer. Organic fertilizer should serve as a supplement to inorganic fertilizer. It improves the physical make-up of the soil making it improves and rich in organic matter.

Effect of Organic Fertilizer

The color of the soil changes from light to dark. It promotes good physical condition. The organic matter makes the soil friable and loose, resulting in the better soil aeration and drainage, and making it easier for the roots to grow. In sandy soils, the organic matter may help bind together the sand particles and increased its water holding capacity. The physical condition of organic matter itself is also ideal for mixing it with chemical fertilizer before application. The cation exchange capacity of the soil is increased and its nutrient availability is enhanced with the application of organic acids in humus that aids in extracting plant nutrients from mineral soil. Organic materials supply energy and building constituents for the multiplication of beneficial soil micro-organisms (Sangatanan, 2000).

MATERIALS AND METHODS

Materials

The materials used in the study were sugar beet seeds, farm tools, inorganic and organic fertilizers, Vernier caliper and weighing scale.

Methods

Experimental design and treatments. The experiment was laid out in a factorial randomized complete block design (RCBD) with four replications. The treatments were as follows:

Factor A	Variety
V_1	Detroit Dark Red
V_2	Detroit Ameliorée

Factor B	Organic Fertilizer
O_1	Chicken dung - 6.0t/ha + 14-14-14- 740 kg/ha (farmers' application practice)
O_2	Siglat (2.17%N, 3.19%P_20_5,2.27%k_20)-3.0t/ha
O_3	NBEM (2.8% N,3.95%P_20_5,3.66%K_20)-3.0t/ha
O_4	BSU compost (2.0%N,2.7%P_20_5,2.4%K_20) – 3.0t/ha

Land preparation. An area of 160 m^2 was thoroughly prepared and divided into four blocks. Each block was further divided into eight plots with a dimension of 1m x 5m each.

Soil analysis. Soil samples were taken before the application of fertilizer for analysis at the soils laboratory in Baguio City.

Fertilizer application and planting. The organic fertilizers described in the treatments were applied after preparing the area and mixed thoroughly with the soil. Two seeds were sown in furrows at a distance of 10 cm between hills and 10 cm between rows. Thinning was done to retain one plant per hill when the plants developed four leaves.

Care and maintenance. Irrigation was done after sowing and at three days interval until plant establishment and at five days interval thereafter. All the other cultural practices required by the crop were employed.

Data gathered

The data gathered and subjected to variance and mean separation test by Duncan's Multiple Range Test (DMRT) were as follows:

1. Percentage emergence. This was computed using the formula:

Emergence (%) = Number of seedlings emerged ÷Number of seeds sown x 100

2. Average number of leaves per plant. Leaves of ten sample plants were counted at harvest.

3. Final height of plants at harvest (cm). Ten sample plants were measured from the base of the leaf petioles to the tip of the leaves at harvest.

4. Root length (cm). The length of ten sample roots were measured using a foot rule from the base to the tip of the root.

5. Root diameter (cm). The diameter of ten sample roots were measured at the mid-section with a vernier caliper.

6. Average root weight (cm). Ten randomly selected roots were weighed and their weight was divided by ten.

7. Non-marketable yield (kg). This was the weight of rotten, malformed and small roots.

8. Marketable yield (kg). This was the weight of saleable roots without defects.

9. Computed yield (t/ha). The marketable yield per plot was converted to tons per hectare by multiplying the marketable yield by 2,000 which is the number of 1x5 m plot per hectare and divided by 1000 which is the weight of one ton.

10. Market preference. Traders in the market were asked on which variety is more saleable.

11. Sugar content (Percentage). The sugar content of sample storage roots was taken using a refractometer.

12. Skin and flesh color. This was determined visually.

13. Economic analysis. All the cost of inputs such as seeds, fertilizers, labor and others were recorded and so with the sales to compute the profit. The return on investment (ROI) was taken using the formula:

$$\text{ROI (\%)} = \frac{\text{Gross Income} - \text{Total Expenses}}{\text{Total Expenses}} \times 100$$

14. Documentation of the study. A pictures was taken on root yield.

RESULTS AND DISCUSSION

Percentage Emergence, Number of Leaves, and Final Height

Effect of variety. Table 1 shows the emergence percentage number of leaves per plant, and final height at harvest. There were no significant differences between the two varieties tested on these parameters. This means that the both varieties have similar vegetative characteristics.

Effect of organic fertilizer. There were no significant differences in the emergence percentage, number of leaves per plant, and final height at harvest as affected by the fertilizers applied (Table 1)

Interaction effect. There were no significant interaction between variety and organic fertilizers on the emergence percentage, number of leaves per plot, and final height.

Table 1. Percentage emergence, average number of leaves per plant, and final height

TREATMENT	EMERGENCE (%)	NUMBER OF LEAVES	FINAL HEIGHT (cm)
Variety			
Detroit Dark Red	95.89a	18.25a	48.15a
Detriot Amelioree	96.43a	18.31a	48.04a
Organic Fertilizer			
Chicken dung+14-14-14	95.65a	18.58a	48.48a
Siglat	97.21a	18.34a	48.14a
NBEM	97.36a	18.16a	48.07a
BSU compost	94.41a	18.04a	47.71a

In a column, means with a common letter are not significantly different at 5% level by DMRT

Average Root Length, Diameter, and Weight

Effect of variety. There were no significant differences between the two varieties on root length, diameter, and weight as presented in Table 2. Nevertheless, Detroit Amelioree tended to have longer, wider, and heavier root weight.

Effect of organic fertilizer. Table 2 shows that there were no significant differences on root size and weight. However, application of Siglat tended to increase root length, diameter, and weight.

Interaction effect. There were no significant interaction effect between variety and organic fertilizer on the root length, diameter, and average weight.

Table 2. Root length, diameter, and average weight

TREATMENT	LENGTH (cm)	DIAMETER (cm)	WEIGHT (g)
Variety			
Detroit Dark Red	5.21a	5.12a	235.93a
Detroit Amelioree	5.22a	5.14a	242.31a
Organic fertilizer			
Chicken dung + 14-14-14	5.18a	5.07a	239.00a
Siglat	5.47a	5.36a	243.63a
NBEM	5.19a	5.10a	237.13a
BSU compost	5.05a	4.98a	236.7a

In a column, means with a common letter are not significantly different at 5% level by DMRT

Non-marketable, Marketable,
and Computed yield

Table 3. Non-marketable, marketable, and computed yield

TREATMENTS	NON-MARKETABLE (Kg/ 1x 5m plot)	MARKETABLE (Kg/ 1x 5m plot)	COMPUTED YIELD (T/Ha)
Variety			
Detroit Dark Red	1.73a	12.47a	24.59b
Detroit Amelioree	1.74a	12.95a	25.86a
Organic fertilizer			
Farmer's practice	1.76a	12.84a	25.41b
Siglat	1.50a	13.32a	26.27a
NBEM	1.62a	12.61ab	25.21ab
BSU compost	2.04a	12.06b	24.01b

In column, means with a common letter are not significantly different at 5% level by DMRT

Effect of variety. Table 3 shows that there were no significant differences between the two varieties tested on the non-marketable and marketable yield. However, Detroit Amelioree had significantly higher computed marketable yield per hectare compared to Detroit Dark Red.

Effect of organic fertilizer. No significant differences were observed on the non-marketable root yield as affected by the fertilizer treatments as shown in Table 3. The highest marketable yield obtained from the application of Siglat was comparable to those with the application of chicken dung+14-14-14 or NBEM but significantly higher than that with the application of BSU compost (Table 3). On the other hand, computed marketable yield was higher with the application of Siglat comparable to that with the application of NBEM but significantly higher than those with the application of the rest of the fertilizers as shown in Table 3.

Interaction effect. Figure 1 shows that Detroit Amelioree applied with chickendung + 14-14-14 had the highest computed marketable yield comparable to the yield obtained from the same variety and applied with either Siglat or NBEM and the yield from the Detroit Dark Red and applied with Siglat or NBEM but significantly higher than the yield from the other treatment combinations.

Skin and Flesh Color

The skin and the flesh of the roots regardless of the variety and fertilizer applied were similar having purple color.

Market Preference

The marketable roots from the varieties applied with any of the fertilizers were saleable in the market.

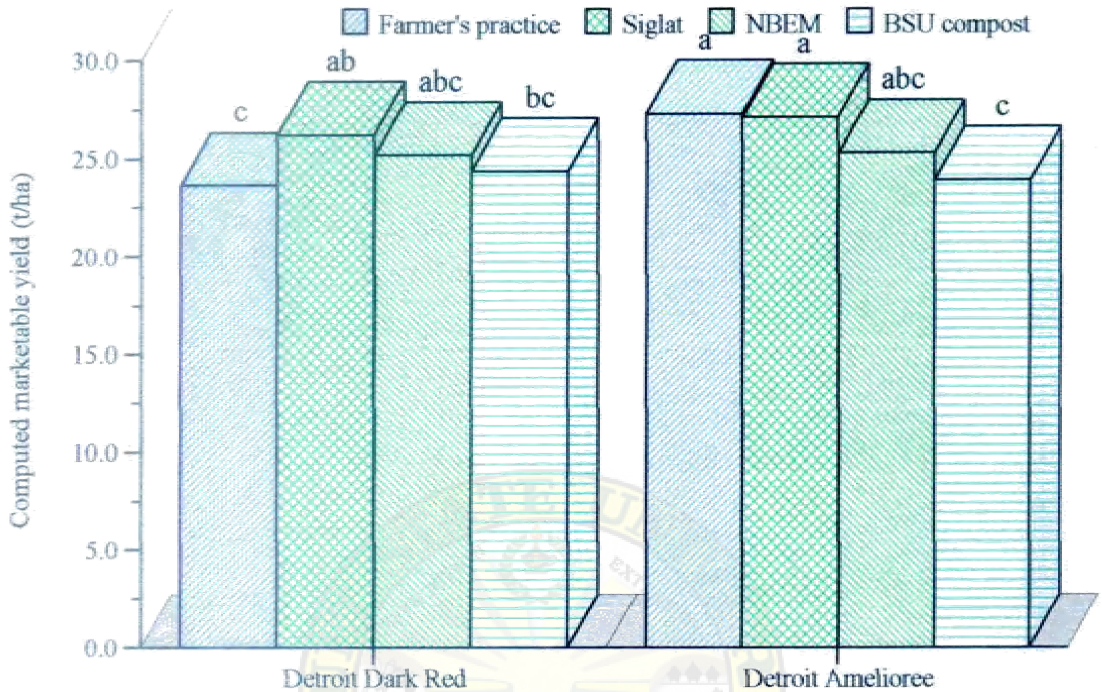

Figure 1. Computed marketable yield as affected by variety and organic fertilizer (bars with a common letter are not significantly different at 5% level by DMRT)

Sugar Content

Effect of variety. The sugar content did not differ significantly between the two test varieties ranging from 9.4 to 9.5% as shown in Table 4.

Effect of the of oganic fertilizer. There were no significant differences in the sugar content of the roots as affected by the fertilizer applied Table 4 .

Interaction Effect. No significant interaction effects were observed on the sugar content.


Chicken dung and 14-14-14


Siglat


NBEM


BSU compost

Roots harvested from Detroit Dark Red applied with different fertilizers


Chicken dung and 14-14-14


Siglat


NBEM


BSU compost

Roots harvested from Detroit Amelioree applied with different fertilizers

Figure 2.Sample roots harvested from sugar beet varieties applied with different fertilizers.

Table 4. Sugar content

TREATMENT	PERCENTAGE
Variety	
Detroit Dark Red	9.52
Detroit Ameloiree	9.42
Organic fertilizer	
Chicken dung+14-14-14	9.40
Siglat	9.54
NBEM	9.53
BSU compost	9.42

In a column, means with a common letter are not significantly different at 5% level by DMRT

Economic Analysis

Table 6 shows that the highest return on investment (ROI) was obtained from Detroit Ameliorее applied with Siglat at 139.26% followed by Detroit Dark Red applied with Siglat 130.41%, while the lowest ROI at 96.54% was taken from Detroit Dark Red applied with chicken dung and 14-14-14.

Soil Analysis

The soil in the experiment area had an analysis of 1.0 % organic matter, 162 ppm phosphorus, and 174 pmm potassium.

Table 5. Return on Investment (ROI)

PERTICULARS	Detroit Dark Red				Detroit Amelioree			
	Chiken dung +14-14-14	Sigat	N-BEM	BSU Compost	Chiken dung +14-14-14	Siglat	N-BEM	BSU Compost
Marketable Yield (kg/per 20 m^2)	48.15	52.04	50.03	47.07	54.06	54.04	50.058	47.080
Sales(Php)	1,059.3	1,144.88	1,100.66	1,035.54	1,189.32	1,188.88	1,101.1	1,033.76
Expenses (Php):								
Labor	375	375	375	375	375	375	375	375
Seeds	24.02	24.02	24.02	24.02	24.02	24.02	24.02	24.02
14-14-14	39.96	-	-	-	39.96	-	-	-
Chicken Dung	28.80	-	-	-	28.80	-	-	-
Organic Fertilizer	-	27	27	27	-	27	27	27
Gasoline	55.12	55.12	55.12	55.12	55.12	55.12	55.12	55.12
Transport	15.75	15.75	15.75	15.75	15.75	15.75	15.75	15.75
Total Expenses (Php)	538.65	496.89	496.89	496.89	538.95	496.89	496.89	496.89
Net Profit (Php)	520.65	647.99	603.77	538.65	650.37	691.99	604.21	536.87
ROI (%)	96.54	130.41	121.51	108.40	120.67	139.26	121.60	108.04
Rank	8	2	4	6	5	1	3	7

Note: The selling price was 22 pesos per kilogram

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted at the Balili Experimental Farm, Benguet State University, La Trinidad, Benguet from January to March, 2010 to identify the variety of sugar beet suited under La Trinidad, Benguet condition and to determine the organic fertilizer best for sugar beet production in the locality.

Results showed that there were no significant differences between the two varieties as well as the fertilizers used on the growth and yield components. However, Detriot Amelioree significantly had higher computed marketable yield at 25.86 t/ha and application of Siglat, NBEM or following the farmers fertilizers application practice of using chicken dung + 14-14-14 significantly effected higher marketable yield. Sugar content did not significantly vary as affected by variety or fertilizer. Likwise, root, skin and flesh color, and market preference were similar.

The highest return on investment (ROI) at 139.26 % was obtained from Detroit Amelioree and application of Siglat (2.17% N, 3.19% P_2O_5, 2.27% K_2O).

Conclusion

Based from the results of the study, it is concluded that Detroit Amelioree applied with Siglat had the highest marketable yield and from which the highest ROI was derived.

Recommendation

It is therefore recommended that Detroit Amelioree be grown in the locality with the application of Siglat to improve sugar beet production.

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APPENDICES

Appendix Table 1. Percentage emergence

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
V_1O_1	93.41	96.14	95.06	96.42	381.57	95.39
O_2	97.22	95.40	96.47	96.40	385.49	96.37
O_3	98.38	97.76	98.29	96.91	391.33	97.83
O_4	94.22	91.20	92.36	98.04	375.82	93.96
Sub-total	383.23	380.05	382.18	387.77	1534.21	95.89
V_2O_1	91.66	96.32	96.80	98.81	383.59	95.89
O_2	98.80	97.16	97.66	98.60	392.22	98.06
O_3	98.04	96.19	97.07	96.26	387.56	96.89
O_4	96.81	94.35	95.34	92.97	379.47	94.87
Sub-total	392.31	384.02	386.87	386.64	1542.84	96.43
TOTAL	775.54	764.07	769.05	7774.41	3077.5	96.16

TWO-WAY TABLE (Variety x Fertilizer)

FERTILIZER	DETROIT DARK RED	DETROIT AMELIOREE	TOTAL	MEAN
Chicken dung +14-14-14	381.57	393.59	765.16	95.65
Siglat	385.49	392.22	777.71	97.21
NBEM	391.33	387.56	777.89	97.36
BSU compost	375.82	379.59	755.29	94.41
TOTAL	1534.21	1542.84	3077.05	
MEAN	95.00	96.43		96.17

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULAR	
					0.05	0.01
Replication	3	1.818	0.606			
Factor A	1	3.525	3525	1.0918 ^{ns}	4.26	7.82
Factor B	3	43.190	14.397	4.4597*	3.03	4.72
A x B	3	9.964	3.321	1.0288 ^{ns}	3.03	4.72
Error	21	77.477	3.228			
TOTAL	31	134.155				

*=Significant
^{ns} =Not significant

Coefficient of variation (%) = 1.87

Appendix Table 2. Average number of leaves per plant

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
V_1O_1	18.00	18.90	19.00	19.00	74.50	18.63
O_2	17.90	18.70	19.10	18.20	73.90	18.48
O_3	18.00	18.30	18.20	18.30	72.80	18.20
O_4	17.90	18.60	16.40	17.90	70.80	17.70
Sub-total	61.08	74.04	72.07	73.04	292.0	18.25
V_2O_1	18.40	18.90	18.20	18.60	74.10	18.53
O_2	18.70	18.60	16.90	18.60	72.80	18.20
O_3	17.80	18.10	18.10	18.50	72.50	18.13
O_4	18.50	18.40	18.20	18.40	73.03	18.25
Subtotal	73.34	74.00	71.04	74.01	292.4	18.27
TOTAL	134.12	148.04	143.11	147.05	584.4	18.26

TWO-WAY TABLE (Variety x Fertilizer)

FERTILIZER	DETROIT DARK RED	DETROIT AMELIOREE	TOTAL	MEAN
Chicken dung +14-14-14	74.50	74.10	148.06	18.57
Siglat	73.90	72.80	146.07	18.33
NBEM	72.80	72.50	145.03	18.16
BSU compost	70.80	73.03	143.08	17.98
TOTAL	292.00	292.04	584.04	
MEAN	18.25	18.27		18.26

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULAR	
					0.05	0.01
Replication	3	1.818	0.606			
Factor A	1	0.025	0.025	0.11^{ns}	4.26	8.02
Factor B	3	1.303	0.434	1.83^{ns}	3.07	4.87
A x B	3	1.068	0.356	1.49^{ns}	3.07	4.87
Error	21	4.999	0.238			
TOTAL	31	9.215				

^{ns} =Not significant

Coefficient of variation (%) = 2.98

Appendix 3. Final height at harvest (cm)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
V_1O_1	46.50	48.47	49.10	48.62	192.69	48.17
O_2	47.57	48.34	47.46	48.38	191.75	47.14
O_3	53.15	47.00	47.60	47.66	195.41	48.85
O_4	47.76	46.10	48.30	48.45	190.61	47.65
Sub-total	194.98	189.91	192.46	193.11	770.46	48.15
V_2O_1	48.21	48.41	48.79	49.76	195.17	48.79
O_2	48.19	47.76	48.37	49.01	193.33	48.33
O_3	48.51	48.01	48.06	44.54	189.12	47.28
O_4	48.05	47.60	48.16	47.28	191.09	47.77
Sub-total	192.96	191.78	193.38	190.59	768.71	48.04
TOTAL	387.94	381.69	385.84	383.07	1539.17	48.09

TWO-WAY TABLE (Variety x Fertilizer)

FERTILIZER	DETROIT DARK RED	DETROIT AMELOREE	TOTAL	MEAN
Chicken dung +14-14-14	162.69	195.17	387.86	48.48
Siglat	191.75	193.33	385.08	48.13
NBEM	195.41	189.12	384.53	48.06
BSU compost	190.61	191.09	381.07	47.71
TOTAL	770.46	768.71	1539.17	
MEAN	48.15	48.01		48.09

ANALYSIS OF VARIANCE

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULAR 0.05	TABULAR 0.01
Replication	3	1.818	0.606			
Factor A	1	0.025	0.025	0.11^{ns}	4.32	8.02
Factor B	3	0.024	0.434	1.83^{ns}	3.07	4.87
A x B	3	1.068	0.356	1.49^{ns}	3.07	4.87
Error	21	2.057	2.057			
TOTAL	31	9.215				

^{ns}=Not significant

Coefficient of variation(%)=2.98

Appendix 4. Average root length (cm)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
V_1O_1	4.28	5.74	5.10	4.90	20.56	5.14
O_2	4.75	6.00	5.16	5.90	21.81	5.42
O_3	5.10	5.00	4.98	5.14	20.22	5.06
O_4	4.98	5.52	5.24	5.00	20.74	5.19
Sub-total	19.11	22.26	20.48	20.94	83.33	5.21
V_2O_1	4.76	5.74	5.41	4.98	20.89	5.22
O_2	5.96	5.73	4.91	5.16	21.76	5.44
O_3	5.33	5.62	4.81	5.52	21.28	5.32
O_4	4.91	5.00	4.73	4.98	19.62	4.91
Sub-total	20.96	22.09	19.86	20.64	83.55	5.22
TOTAL	40.07	44.35	40.08	41.58	166.88	5.21

TWO-WAY TABLE (Variety x Fertilizer)

FERTILIZER	DETROIT DARK RED	DETROIT AMELIOREE	TOTAL	MEAN
Chicken dung +14-14-14	20.56	20.89	41.45	5.18
Siglat	21.81	21.76	43.57	5.44
NBEM	20.22	21.28	41.05	5.18
BSU compost	20.74	19.62	40.36	5.04
TOTAL	83.33	83.55	166.88	
MEAN	5.21	5.22		5.22

ANALYSIS OF VARIANCE

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULAR 0.05	TABULAR 0.01
Replication	3	1.259	0.420			
Factor A	1	0.002	0.002	0.01^{ns}	4.32	8.02
Factor B	3	0.674	0.225	2.07^{ns}	3.07	4.87
A x B	3	0.310	0.103	0.95^{ns}	3.07	4.87
Error	21	2.276	0.108			
TOTAL	31	4.520				

^{ns} = Not significant

Coefficient of variation (%) = 6.31

Appendix 5. Average root diameter (cm)

REPLICATION	REPLICATION I	II	III	IV	TOTAL	MEAN
V_1O_1	4.75	5.60	4.99	4.76	20.10	5.03
O_2	4.65	5.92	5.10	5.80	21.47	5.37
O_3	4.99	4.98	4.82	5.10	19.89	4.97
O_4	4.86	5.45	5.13	4.96	20.40	5.10
Sub-total	19.25	21.95	20.04	20.62	81.86	5.12
V_2O_1	4.62	5.61	5.30	4.94	20.47	5.12
O_2	5.80	5.64	4.48	5.12	21.44	5.36
O_3	5.20	5.55	4.72	5.40	20.87	5.22
O_4	4.82	4.96	4.65	4.97	19.40	4.85
Sub-total	20.44	21.76	22.55	20.43	82.18	5.14
TOTAL	39.69	43.71	42.59	41.05	164.04	5.13

TWO-WAY TABLE (Variety x Fertilizer)

FERTILIZER	DETROIT DARK RED	DETROIT AMELIOREE	TOTAL	MEAN
Chiken dung +14-14-14	20.10	20.47	40.57	5.07
Siglat	21.47	21.44	42.91	5.36
NBEM	19.89	20.87	40.76	5.09
BSU compost	20.40	19.40	39.08	4.97
TOTAL	81.86	82.18	164.04	
MEAN	5.21	5.14		5.13

ANALYSIS OF VARIANCE

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULAR 0.05	TABULAR 0.01
Replication	3	1.381	0.460			
Factor A	1	0.003	0.003	0.03^{ns}	4.32	8.02
Factor B	3	0.666	0.222	2.34^{ns}	3.07	4.87
A x B	3	0.259	0.086	0.91^{ns}	3.07	4.87
Error	21	1.990	0.0095			
TOTAL	31	4.229				

^{ns} = Not significant

Coefficient of variation (%) = 6.00

Appendix 6. Average root weight (g)

REPLICATION	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
V_1O_1	234.0	248.0	239.0	214.0	935.0	233.57
O_2	208.0	251.0	249.0	250.0	958.0	239.50
O_3	238.0	230.0	216.0	248.0	932.0	233.00
O_4	227.0	244.0	241.0	241.0	950.0	237.50
Sub-total	907.0	973.0	945.0	953.0	3775	235.93
V_2O_1	244.0	248.0	248.0	237.0	977.0	244.25
O_2	239.0	253.0	249.0	250.0	991.0	247.75
O_3	239.0	248.0	237.0	241.0	965.0	241.25
O_4	237.0	240.0	232.0	235.0	944.0	236.00
Sub-total	959.0	989.0	966.0	936.0	3877	242.03
TOTAL	1866	1962	1911	1889	7652	239.12

TWO-WAY TABLE (Variety x Fertilizer)

FERTILIZER	DETROIT DARK RED	DETROIT AMELIOREE	TOTAL	MEAN
Chicken dung +14-14-14	935	977	1912	239
Siglat	958	991	1949	243.62
NBEM	932	965	1897	237.12
BSU compost	950	944	1894	236.74
TOTAL	3775	3877	7652	
MEAN	235.93	242.03		239.12

ANALYSIS OF VARIANCE

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULAR 0.05	TABULAR 0.01
Replication	3	531.750	177.250			
Factor A	1	325.124	235.275	2.84^{ns}	4.32	8.02
Factor B	3	239.250	79.750	0.70^{ns}	3.07	4.87
A x B	3	172.125	57.375	0.50^{ns}	3.07	4.87
Error	21	2405.250	114.536			
TOTAL	31	3673.500				

^{ns} = Not significant

Coefficient of variation (%) = 4.48

Appendix 7. Sugar content (Brix)

REPLICATION	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
V_1O_1	10	9.07	9.08	9.08	37.23	9.31
O_2	9.08	10.01	9.08	10	38.17	9.54
O_3	10.03	10	9.04	9.06	38.13	9.53
O_4	9.06	9.08	10	10	38.14	9.54
Sub-total	38.17	38.16	37.02	38.14	151.67	9.47
V_2O_1	9.09	9.09	9.06	10	37.24	9.31
O_2	10.03	9.05	10	9.07	38.15	9.53
O_3	9.05	9.08	10	10	38.13	9.53
O_4	9.08	9.09	9.06	10	37.23	9.42
Sub-total	37.25	36.31	38.12	39.07	150.75	9.42
TOTAL	75.42	74.47	75.14	77.21	302.42	9.45

TWO-WAY TABLE (Variety x Fertilizer)

FERTILIZER	DETROIT DARK RED	DETROIT AMELIOREE	TOTAL	MEAN
Chicken dung +14-14-14	37.23	37.24	74.47	9.31
Siglat	38.17	38.15	76.32	9.54
NBEM	38.13	38.13	76.26	9.53
BSU compost	38.14	37.23	75.37	9.42
TOTAL	151.67	150.75	302.42	
MEAN	9.47	9.42		9.45

ANALYSIS OF VARIANCE

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULAR 0.05	TABULAR 0.01
Replication	3	2.170	0.423			
Factor A	1	0.084	0.084	0.3144^{ns}	4.26	7.82
Factor B	3	0.130	0.043	0.1618^{ns}	3.03	4.72
A x B	3	0.083	0.028	0.1029^{ns}	3.03	4.72
Error	21	6.416	0.267			
TOTAL	31	6.712				

^{ns} = Not significant

Coefficient of variation (%) = 5.46

Appendix 8. Non-marketable yield (kg/1x5 m plot)

REPLICATION	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
V_1O_1	1.50	2.35	1.60	1.50	6.95	1.74
O_2	2.00	1.20	1.50	1.10	5.80	4.45
O_3	1.75	1.90	1.30	1.40	6.35	1.59
O_4	3.00	1.75	2.80	1.00	8.55	2.14
Sub-total	8.25	7.02	7.02	5	27.65	1.73
V_2O_1	1.75	1.30	2.20	1.60	7.15	1.79
O_2	1.50	1.15	1.75	1.80	6.20	1.55
O_3	1.30	1.45	1.90	1.95	6.60	1.65
O_4	2.00	2.10	2.50	1.30	7.90	
Sub-total	6.55	6.00	8.35	39.07	27.85	1.74
TOTAL	14.08	13.02	15.37	77.21	55.5	1.73

TWO-WAY TABLE (Variety x Fertilizer)

FERTILIZER	DETROIT DARK RED	DETROIT AMELIOREE	TOTAL	MEAN
Chicken dung +14-14-14	6.95	7.15	14.01	1.76
Siglat	5.80	6.20	12.00	1.50
NBEM	6.35	6.60	12.95	1.60
BSU compost	8.55	7.90	16.45	2.05
TOTAL	27.65	27.85	55.05	
MEAN	1.73	1.74		1.73

ANALYSIS OF VARIANCE

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULAR 0.05	TABULAR 0.01
Replication	3	1.270	0.423			
Factor A	1	0.001	0.001	0.01^{ns}	4.32	8.02
Factor B	3	1.382	0.461	2.06^{ns}	3.07	4.87
A x B	3	0.084	0.028	0.13^{ns}	3.07	4.87
Error	21	4.705	0.224			
TOTAL	31	7.442				

^{ns} = Not significant Coefficient of variation (%) = 27.29

Appendix 9. Marketable yield (kg/1x5 m plot)

REPLICATION	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
V_1O_1	11.00	12.50	11.65	13.00	48.15	12.04
O_2	13.00	14.00	12.70	12.60	52.40	13.10
O_3	12.50	11.90	12.10	12.80	50.30	12.58
O_4	11.30	13.00	12.00	12.40	48.70	12.18
Sub-total	47.08	51.04	48.45	50.08	199.55	12.47
V_2O_1	14.00	13.75	12.85	14.00	54.60	13.65
O_2	14.90	12.50	12.90	13.90	54.20	13.55
O_3	12.75	12.75	12.30	12.75	50.55	12.64
O_4	11.60	12.00	12.20	12.00	47.80	11.95
Sub-total	53.25	51.00	50.25	52.65	207.15	12.94
TOTAL	100.33	102.04	98.07	102.73	406.07	12.71

TWO-WAY TABLE (Variety x Fertilizer)

FERTILIZER	DETROIT DARK RED	DETROIT AMELIOREE	TOTAL	MEAN
Chicken dung +14-14-14	48.15	54.60	102.75	12.84
Siglat	52.40	54.20	106.60	13.32
NBEM	50.30	50.55	100.85	12.61
BSU compost	48.70	47.80	96.05	12.06
TOTAL	199.55	207.15	406.25	
MEAN	12.47	12.95		12.71

ANALYSIS OF VARIANCE

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULAR 0.05	TABULAR 0.01
Replication	3	2.169	0.723			
Factor A	1	1.805	1.805	3.85^{ns}	4.32	8.02
Factor B	3	6.609	2.203	4.70*	3.07	4.87
A x B	3	3.909	1.303	2.78^{ns}	3.07	4.87
Error	21	9.80	0.469			
TOTAL	31	24.332				

* = Significant
^{ns}=Not significant

Coefficient of variation (%) = 5.39

Appendix 10. Computed marketable yield (t/ha)

REPLICATION	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
V_1O_1	22.00	23.30	23.30	26.00	94.06	23.65
O_2	26.20	28.00	25.40	101.8	101.8	26.02
O_3	25.00	23.80	24.20	100.6	100.6	25.15
O_4	22.60	26.00	24.00	97.04	97.04	24.35
Sub-total	95.08	101.1	96.09	100.6	397.4	24.83
V_2O_1	28.00	27.50	25.70	28.00	109.2	27.03
O_2	29.80	25.00	25.80	27.80	108.4	27.01
O_3	25.50	25.50	24.60	25.50	101.1	25.28
O_4	23.20	24.00	24.40	24.00	95.06	23.09
Sub-total	106.05	102.00	100.05	105.03	414.8	25.92
TOTAL	201.13	203.01	196.14	208.09	812.2	25.38

TWO-WAY TABLE (Variety x Fertilizer)

FERTILIZER	DETROIT DARK RED	DETROIT AMELIOREE	TOTAL	MEAN
Chicken dung +14-14-14	94.06	109.20	203.26	25.41
Siglat	101.80	108.40	210.20	26.27
NBEM	100.60	101.10	201.70	25.21
BSU compost	97.04	95.76	193.00	24.01
TOTAL	393.5	413.76	808.16	
MEAN	24.59	25.86		25.22

ANALYSIS OF VARIANCE

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULAR 0.05	TABULAR 0.01
Replication	3	8.331	2.777			
Factor A	1	8.925	8.925	4.84*	4.32	8.02
Factor B	3	25.793	8.598	4.66*	3.07	4.87
A x B	3	19.776	6.592	3.57*	3.07	4.87
Error	21	38.727	1.844			
TOTAL	31	101.552				

* = Significant

Coefficient of variation (%) = 5.35