BIBLIOGRAPHY

WAYAN, ALONES S. AUGUST 2009. Evaluation of Sorghum Entries Intercropped with Bush Bean Under La Trinidad Condition. Benguet State University, La Trinidad, Benguet.

Adviser: Esther Josephine D. Sagalla, MSc.

ABSTRACT

This study was conducted to identify the most suitable cropping system for sorghum; to determine the best sorghum entry based on the yield and resistance to disease; and to determine the interaction between cropping system and sorghum only under La Trinidad, Benguet condition.

Monocropping of sorghum resulted in higher plant survival, wider stems and high grain and stalk yield. Intercropping of sorghum with bush bean on the other hand, resulted in greater resistance to corn borer.

Entries ICSU 700 and ICSU 93046 had the highest stalk yield and tolerance to kernel smut and corn borer. In addition, SPV 422 had wide stems and had the highest grain yield per plot.

TABLES OF CONTENTS

INTRODUCTION

Sweet sorghum (*Sorghum bicolor*) is an important substitute for staple food in developing countries or in areas with limited supply of rice. Additionally sorghum is a good substitute for corn as feed for animal production purposes (Aday, 2008).

However sorghum when planted needs high amount of nitrogen fertilizers to produce high yield (Ahmad *et al*, 2007) thus, if planted as monocrop and if planted continuously, it may become a major cause of declining soil fertility. One good strategy to produce and benefit the sorghum while conserving the productivity of the soil is intercropping.

Intercropping is a wise management system for increasing income in sorghum production and increasing soil productivity. Economic analysis of intercropping sorghum with different legumes reveal higher net income compared to sole cropping of sorghum (Ahmad *et al*, 2007)

In addition, legumes such as bush bean which fix atmospheric nitrogen, serve as good intercrops to meet the nitrogen requirements of sorghum. Higher yield of sorghum intercropped with legumes resulted in studies done at Pakistan over time due to efficient utilization of soil nutrients (Ahmad *et al*, 2007).

Limited research work, however, has been done to explore the potential benefit of intercropping sorghum and bush bean in La Trinidad thus; it is the aim of this study to specifically look into the feasibility of sorghum intercropping.

The study was conducted to:

1. identify the most suitable cropping system for sorghum;

2. determine the best sorghum entry based on yield and resistance to disease; and

3. determine the interaction between cropping system and sorghum entries.

The study was conducted at Balili, La Trinidad, Benguet condition from October 2008 to April 2009.

REVIEW OF LITERATURE

Description of Intercropping

Intercropping is growing of two or more crops together on the same piece of land (Bautista, *et al* 1983). Gupta (1986) define it as a planting of two or more species simultaneously in alternate rows or in separate rows on the same field. Crops need not be sown at the same time and their harvest time may differ, but they usually are simultaneous for most of their growing period.

Intercropping utilize the garden area even more intensively. It is essentially a system whereby a smaller quick growing vegetable is planted in the same area and time as one larger and more slowly developing. Intercropping is the most manageable kind of double copping under ordinary condition of soil and moisture (Bautista, *et a*l 1983).

Intercropping offers two important advantages to subsistence oriented farm household. First, it enhances the diversity of farm products, a very desirable feature for a farm. Secondly, intercropping increases the stability of farm productivity so that the yield even during dad times is still enough to satisfy the minimum requirement (Gomez and Gomez 1983). Gupta (1986) added that another advantage of intercropping is increased productivity of complimentary component crop. Well designed intercropping combines component crops that use growth resources more fully than would single crop.

Crop Combinations in Intercropping

Bautista *et.al* (1983) stated that the crops used as intercrops to coconut are fruit crops such as Lansones, Banana, Pineapple; Plantation crops such as black pepper, coffee, cacao; Vegetable crops such as Bush sitao, cowpea, ginger, gabi, sitao, eggplant,

patola and agronomic crops such as cassava and peanut. This intercropping resulted to increased yield of coconut due to more careful attention given to weeding, cultivation and fertilization of the intercrop. ICRISAT (1981) added that the best intercrops to use are beans, tomatoes, cabbage and corn. Moreover, for sorghum the recommended intercrops are grain legumes such as cowpea, mungbean, black bean, or groundnut, which do not generally affect the yield but help to obtain additional return.

Wood (2008) stated that the most common combinations for intercropping are maize-beans, maize-soybean, maize-rice, maize-sorghum, sorghum-millet, sweet potato-sugarcane and cotton-peanut. The net result of such combinations can vary widely from productive to unproductive compared to sole planting of some crops. Fertilization of plants as well as many other factors influences the result.

PCARRD (1986) stated that intercropping with corn-ipil-ipil has increased corn yield in Cebu from 300- 1500 kg/ ha because soil fertility was improved and soil erosion was reduced. Wood (2008) added that greater crop density and protection against wind and water erosion are achieved.

Bautista, *et al* (1983) mention that intercropping of leguminous and non-leguminous vegetables is an example of a good cropping system that will conserve and improve the nutritional status of the soil, add organic matter to improve soil structure, protect the land from erosion for maximum crop growth and development, and, ultimately, give high yield.

Ahmad, *et al* (2007) stated that the highest gross benefits of RS 5920 ha $^{-1}$ was obtained from Sorghum + Cowpeas intercropping system followed by Sorghum + Sespania (RS 42057 ha $^{-1}$). However, the sorghum + chisterbean intercropping system

gave the minimum gross benefits of RS 38100 ha $^{-1}$. The total variable cost of intercropping of sorghum + cowpeas, sorghum + sesbania and sorghum + mungbean was cost of RS.6820, 5920 and 5859 ha $^{-1}$, respectively.

Effect of Intercropping

Gomez and Gomez (1983) reported that competition effect is most pronounced in intercropping or relay cropping, when two or more species compete not only for sunshine and carbon dioxide in the air but also for water and nutrients. Wood (2008) added that crops of different maturities have varying peak requirements for water, fertilizer, light and space. Thus, there may be less competition between different crops than there is in planting of identical plants. Moreover, disease and insect infestation of intercropped plants tend to be less.

PCARRD (1983) reported that intercropping significantly affected the net income derived per unit area. Gupta (1986) mentioned that the beneficial effect of mixed or intercropping system maybe increased because one crop might survive and give a good harvest and income. Intercropping legumes such as cowpea, peanut, mungbean, and string bean to corn resulted to high profit.

PCARRD (1983) observed that intensive cropping of soybean, mungbean, peanut and sorghum for five consecutive planting resulted in reduction of grain yield, plant height and crop stand. The yield reduction was attributed mainly to increased incidence of stem and root rotting coupled with early and severe incidence of foliar diseases. The injuries of intensive cropping could be partially alleviated by sequential cropping. The yield of sorghum and stylo were higher in monocropping than in growing them as intercrops. Stylo plants intercropped with sorghum were taller because of limited light

intensity; the herbage yield of stylo was increased by extending a plant growth period by three weeks after harvesting the sorghum intercrop.

PCARRRD (1986) found that multiple cropping promoted great diversity of insect pest types which tend to resulted in biological stability. Some insect served as predator of other insect pest therefore controlling pest outbreak. Wood (2008) added that multiple cropping ensures greater use of available solar energy in the dry season, improved pest control, greater insurance against crop failure, better nutrional balance for families because of the wider variety of food produced, and a more stable farm income.

Legumes as Intercrop

Legumes are good for intercropping despite the low nutrient consumption. In addition, legumes supply nitrogen to the soil because it is associated with nitrogen fixing bacteria. Legumes as intercrop can capture light that filters down through the canopy to shade the ground. The shading discourages weeds from growing (Bautista, *et al*., 1983).

Uses of Sorghum

Sweet sorghum is used as base material for fermentation and brewing, as edible syrups and crystalline dextrose, as cheap source of ethanol in the production of biofuel (Aday, 2008).

Grain sorghum is used to replace corn grits in the brewing and distilling industries, and in the manufacture of alcohol. The grain of waxy varieties was used for extraction of starch to manufacture a satisfactory substitute for minuto tapioca. Other important uses are manufacture of starch, glucose, oil, gluten feeds and other products similar to those produced in the wet milling of corn (Martin, *et a*l., 1996). Aday (2008)

added that the grain sorghum is used for human food. Elsewhere it is generally feed to livestock or poultry.

MATERIALS AND METHODS

Land Preparation and Experimental Design

An area of 360m² was thoroughly prepared and was divided into three blocks. Each block was further subdivided into 12 plots each measuring 1m x 10m. The treatments were laid-out following split-plot design with three replications.

The treatments were:

Main Plot (Cropping system)

Code	Description
CS_1	Sorghum only
CS_2	Sorghum + bush bean

Sub Plot (Sorghum Entries)

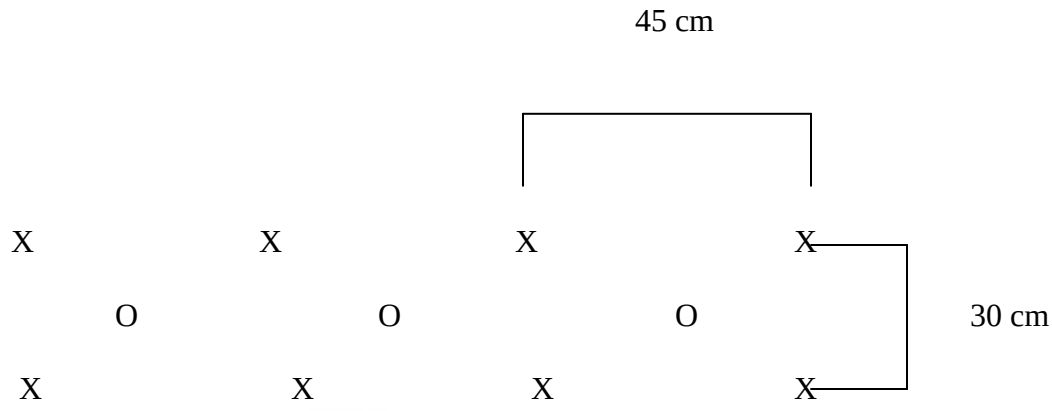
Code	Entry
E_1	SPV 422
E_2	M552
E_3	ICSU 700
E_4	ICSU 93046
E_5	ICBR 93034
E_6	Bakakew

Sowing and Management

Two to three seeds per hill were planted at a distance of 30 cm x 45 cm between two rows and hills. Bush bean seed were planted between rows of sorghum.

Illustration:

Legend: x-bush bean o-sorghum



All recommended cultural management was uniformly followed in all treatments such as irrigation, hilling up, weeding, and others.

Data Gathered

A. Sorghum

1. Plant survival. The data was computed using the formula:

$$\% \text{ Plant Survival} = \frac{\text{Number of plant survival}}{\text{Total number of plant}} \times 100$$

2. Plant vigor. The plants were rated at 45, 60, 75 and 90 DAP using the following scale (CIP, 1984):

Scale	Description	Remarks
1	Plants are weak with few stems and leaves; very pale	Poor vigor
2	Plants are weak with few thin	Less vigorous

	stems and leaves	
3	Better than less vigorous	Vigorous
4	Plants are moderately strong with robust stems and leaves	Moderately vigorous
5	Plants are strong with robust stem and leaves; leaves are light to dark Green in color	Highly vigorous

3. Number of days from sowing to emergence. This was recorded by counting the number of days from sowing to emergence when at least 50% of the seed sown has emerged.

4. Number of days from sowing to tilling. This was taken by counting the number of days from sowing to tilling when at least 50% or more produce tillers.

5. Number of tillers. This was taken when the flag leaf of the sorghum came out using ten sample hills.

6. Number of days from sowing to heading. This was recorded by counting the number of days from sowing to heading when at least 50% or more of the plant produced head.

7. Number of days from sowing to ripening. This was done when 50% of the grains in the panicle matured.

8. Number of days from sowing to harvesting. This was recorded by counting the number of days from sowing to harvesting.

9. Stem diameter (cm). The stem diameter was measured at the internodes of the fifth leaf down from the flag leaf taken from ten randomly picked plants per plot using Vernier caliper.

10. Final plant height (cm). This was measured from the base to the tip of ten sample plants randomly picked per plot at harvest

11. Insect infestation (corn borer). Insect infestation was rated at 45, 60, 75and 90 DAP using the following scale (Tugui-in, 1997):

Scale	Description	Remarks
1	Sound	Healthy, no insect change
3	Slight	1 to 3 leaves dam
5	Moderate	4 to 6 leaves damage
7	Severe	More damaged
9	Skeletonized	Plants is fully damaged

12. Disease infection (kernel smuts). This was recorded by observing the disease affecting the sorghum plant. Disease infestation was recorded by using the following scale (Catalino, 1996):

Scale	Description	Remarks
1	Resistant	No infection
2	Moderate	Severe infection
3	Weak	Highly infected

13. Length of panicle (cm). This was measured from the base to the tip of the panicles of ten samples per plot at harvest.

14. Stalk yield (kg). The weight of stalks per plot was taken.

15. Weight of 100 grains (gm). This was obtained by average weighing in grams 100 grains (14% moisture content) per plot.

16. Total yield of sorghum per plot (kg). This was taken by weighing and recording the yield per plot.

17. Stalk sugar content. The sugar content of the stems of ten sample plants was taken using digital refractometer.

18. Grain moisture content. This was taken after subjecting the grains to 100 ^{o}C in 24 hours. The moisture content was computed using the formula:

$$MC = \frac{\text{Fresh weight - Oven dry weight}}{\text{Oven dry weight}} \times 100$$

B. Bush Bean

1. Total weight of marketable green pods (kg). The marketable green pods were harvested at maturity and their weight was recorded for yield computation. Pods were considered marketable if they are straight, tender and free from insect damage and diseases.

2. Total weight of non- marketable pods (kg). Non-marketable pods include those that were abnormal in shape, over matured and affected by pest and diseases.

Data Analysis

All the quantitative data were analyzed using analysis of variance (ANOVA) for split plot design with three replications. The significant differences among the treatment means were tested using the Duncan's Multiple Range Test (DMRT) at 5% level of significance.

RESULT AND DISCUSSION

Rainfall, Relative Humidity, and Temperature

Temperature ranged from 13°C to 24°C, relatively humidity is from 75% to 89% while rainfall amount was recorded at average of 4.13mm. Total sunshine duration ranged from 267 to 393 kj from October to April.

Sorghum grows best in areas with a mean temperature of about 37°C (Martin, *et al*., 1976). The average temperature of 15°C during the conduct of the study may affect stalk and grain yield of the entries.

Table 1. Rainfall, relative humidity, and temperature from October 2008 to April 2009 at La Trinidad, Benguet. Pag-asa (2008-2009)

MONTHS	RAINFALL AMOUNT	RELATIVE HUMIDITY	TEMPERATURE		SUNSHINE DURATION
	(MM)	(%)	MAX	MIN	(KJ)
October	7.7	85	24.4	21.4	319.6
November	3.10	75.2	25.2	16.2	304.6
December	0.1	82	24.4	13.6	369.8
January	0.03	85	24.6	13.1	349.0
February	3.5	85	24.8	13.6	393.0
March	1.6	86	25.1	14.8	266.9
April	12.9	89	24.4	16.0	278.6
MEAN	4.13	83.88	24.74	15.53	325.93

Plant Survival

Cropping system. No significant differences were noted on the percentage survival of sorghum plants (Table 2). Monocropping of sorghum had higher plant survival.

Sorghum entries. Highly significant differences were noted on the percentage survival of the sorghum entries. Entries ICSU 700 and ICSU 93046 had the highest plant

Table 2. Plant survival of different sorghum entries intercropped with bush beans (%)

TREATMENTS	SURVIVAL (%)
Cropping System (CS)	
Sorghum only	97.46
Sorghum + bush bean	96.01
Sorghum Entries (SE)	
SPV 422	98.50[b]
M552	98.55[b]
ICSU 700	100.00[a]
ICSU 93046	100.00[a]
ICBR 93034	90.22[d]
Bakakew	93.12[c]
CS x SE	ns
(CS)	2.83
(SE)	4.06

Means of different letters are significantly different from each other using 5% level of significance by DMRT

survival while ICBR 93034 had the lowest plant survival of 90.22%. These results signify that the differences on percentage of survival may be attributed to the different genetic characteristics of the entries. Moreover, temperature and light intensity during the conduct of the study may have been favorable for plant survival of some entries.

Interaction effect. No significant effect was noted on the interaction of cropping system and sorghum entries on plant survival.

Plants Vigor

Cropping system. An increasing vigor is observed on both cropping systems at 45 to 90 days after planting. Significant differences were also noted on the plant vigor of sorghum at 45 days after planting (Table 3). Monocropping of sorghum was moderately vigorous with robust stem and leaves while sorghum plants intercropped with bush beans were vigorous. This may be due to the shading afforded by the bush bean plants on the sorghum seedlings at 45 DAP.

Sorghum entries. Highly significant differences were noted on the plant vigor of the different entries of sorghum at 45 and 60 days. Majority of the sorghum entries were moderately vigorous except for Bakakew which was vigorous at 45 days. Similarly majority of the sorghum entries were highly vigorous except for M552 and Bakakew which were moderately vigorous at 60 days. These differences may be due to the slight to moderate resistance of the entries to pest.

Interaction effect. Significant interaction was noted between cropping system and sorghum entries on plant vigor taken at 45 days after sowing (Fig. 1). Intercropping of

Bakakew with bush beans resulted in vigorous plants. At 45 DAP, the sorghum plants were shaded by the bush beans.

No significant interaction was noted on the plant vigor at 60 to 90 days after planting.

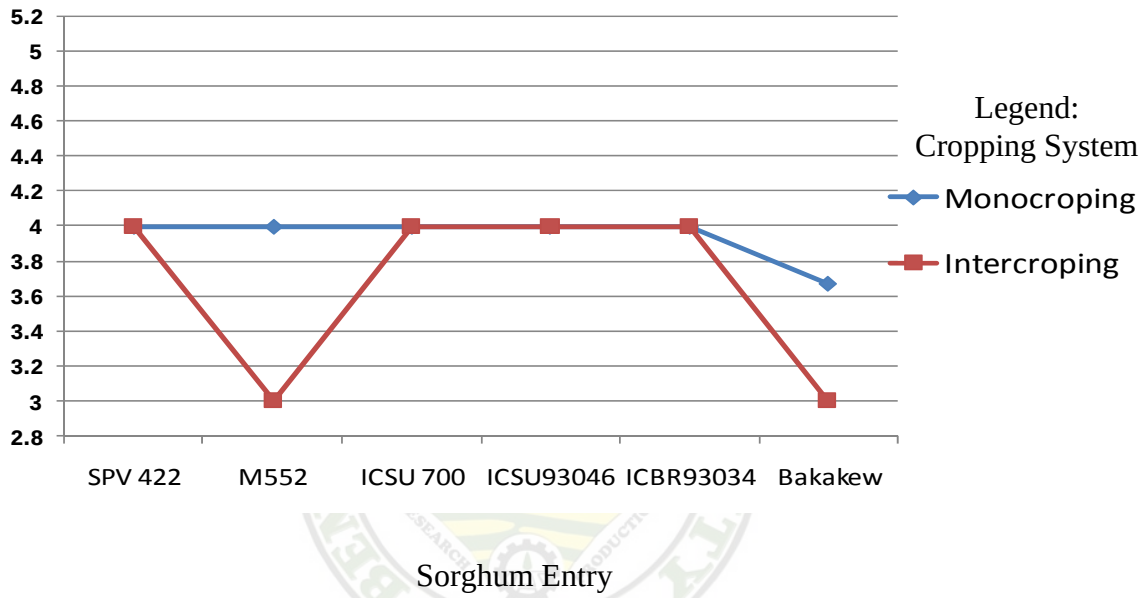


Figure 1. Interaction of sorghum entry and cropping system on plant vigor at 45 DAP.

Table 3. Plant vigor of different sorghum entries intercropped with bush bean

TREATMENTS	PLANT VIGOR			
	45 DAP	60 DAP	75 DAP	90 DAP
Cropping System (CS)				
Sorghum only	4[a]	4	5	5
Sorghum + bush bean	3[b]	4	5	5
Sorghum Entries (SE)				
SPV 422	4[a]	5[a]	5[a]	5[a]
M552	4[a]	4[b]	5[a]	5[a]
ICSU 700	4[a]	5[a]	5[a]	5[a]
ICSU 93046	4[a]	5[a]	5[a]	5[a]
ICBR 93034	4[a]	5[a]	5[a]	5[a]
Bakakew	3[b]	4[b]	4[b]	4[b]
CS x SE	**	ns	ns	ns
(CS)	4.38	3.55	0.00	0.00
(SE)	4.38	3.55	0.00	0.00

Means of different letters are significantly different from each other using 5% level of significance by DMRT

(Rating scale: 1= Poor vigor, 2 = Less vigorous, 3 = Vigorous, 4 = moderately vigorous 5 = highly vigorous.)

Number of Days from Sowing to Emergence,
Tillering, Heading, Ripening and Harvesting

Cropping system. As shown in Table 4, no significant differences were noted on the number of days from sowing to emergence, tillering, heading, ripening and harvesting of monocropped and intercropped sorghum. Monocropped sorghum produced tillers earlier than sorghum intercropped with bush bean.

Sorghum entries. As shown in Table 3, no significant differences were noted on the number of days from sowing to emergence, tillering, ripening and harvesting of the different entries. The number of days from sowing to emergence of the different entries ranged from 8-10 days, with Bakakew as the latest to emerge. The entries produced tillers up to 76 days except ICSU 930346 which did not produce any tillers. The heads of the different sorghum entries ripened and were harvested after 155 and 162 days.

Highly significant differences were observed in the number of days from sowing to heading of the different entries of sorghum. Entry M552 was the earliest to produce heads which may be due to the early production of tillers.

Interaction effect. No significant interaction between cropping system and sorghum entries was observed in the number of days from sowing to emergence, tillering, heading, ripening and harvesting.

Number of Tillers

Cropping system. No significant differences were noted on the number of tillers produced by monocropped and intercropped sorghum (Table 4).

Table 4. Number of days from sowing to emergence, tillering, heading, ripening, harvesting, and number of tillers of different sorghum entries intercropped with bush bean

TREATMENTS	NUMBER OF DAYS FROM SOWING TO					NUMBER OF TILLERS
	EMER-GENCE	TILLERING	HEADING	RIPENING	HARVESTING	
Cropping System (CS)						
Sorghum only	9	52	104	140	159	3
Sorghum + bush Bean	9	69	104	140	159	3
Sorghum Entries (SE)						
SPV 422	9	74	102[c]	141	155	3[c]
M552	8	68	94[a]	129	155	5[a]
ICSU 700	8	76	107[d]	144	162	3[c]
ICSU93046	8	0	113[e]	148	162	1[d]
ICBR93034	9	76	108[d]	141	155	3[c]
Bakakew	10	68	99[b]	136	162	4[b]
CS x SE	ns	ns	ns	ns	ns	ns
(CS)	0.00	0.00	0.80	0.00	0.00	15.99
(SE)	0.00	0.00	1.10	0.00	0.00	11.88

Means of different letters are significantly different from each other using 5% level of significance by DMRT

Sorghum entries. Highly significant differences were noted on the number of tillers produced by the different entries of sorghum. Entry M552 produced the most tillers which may indicate production of more heads resulting to higher grain yield,

stalk yield, and sugar yield. Entry ICSU 930346 did not produce tillers but produced a secondary panicle

Interaction effect. There was no significant interaction between cropping system and sorghum entry on the number of tillers

Final Plant Height

Cropping system. Table 5 shows highly significant differences on the final height of monocropped and intercropped sorghum. Monocropped sorghum plants were taller than sorghum intercropped with bush bean. This result may be due to the competition of sorghum and bush bean plants for light and space. Furthermore, the result contradicts the findings made by PCARRD that sorghum intercropped with legumes was taller than monocropped sorghum.

Sorghum entries. Highly significant differences were noted on the final plant height of the different entries of sorghum. ICSU 700 was the tallest entry which may indicate high stalk yield and stem sugar content.

Interaction effect. There was a significant interaction between the different entries and cropping system (Fig. 2). Monocropping of entry ICSU 700 produced the tallest plants. This result indicates that both sorghum entry and cropping system are important considerations in selecting for tall plants.

Stem Diameter

Cropping system. Significant differences were noted on the stem diameter of sorghum affected by different cropping systems. Monocropped sorghum plants had wider stems,

whereas sorghum intercropped with bush beans had narrower stems. Eswara Prasada Rao *et al.* (2009) stated that sweet sorghum intercropped with short-stalked plant had long stalk and narrow stems. This was due to the shading of the intercrop during the growing stage of sorghum plants.

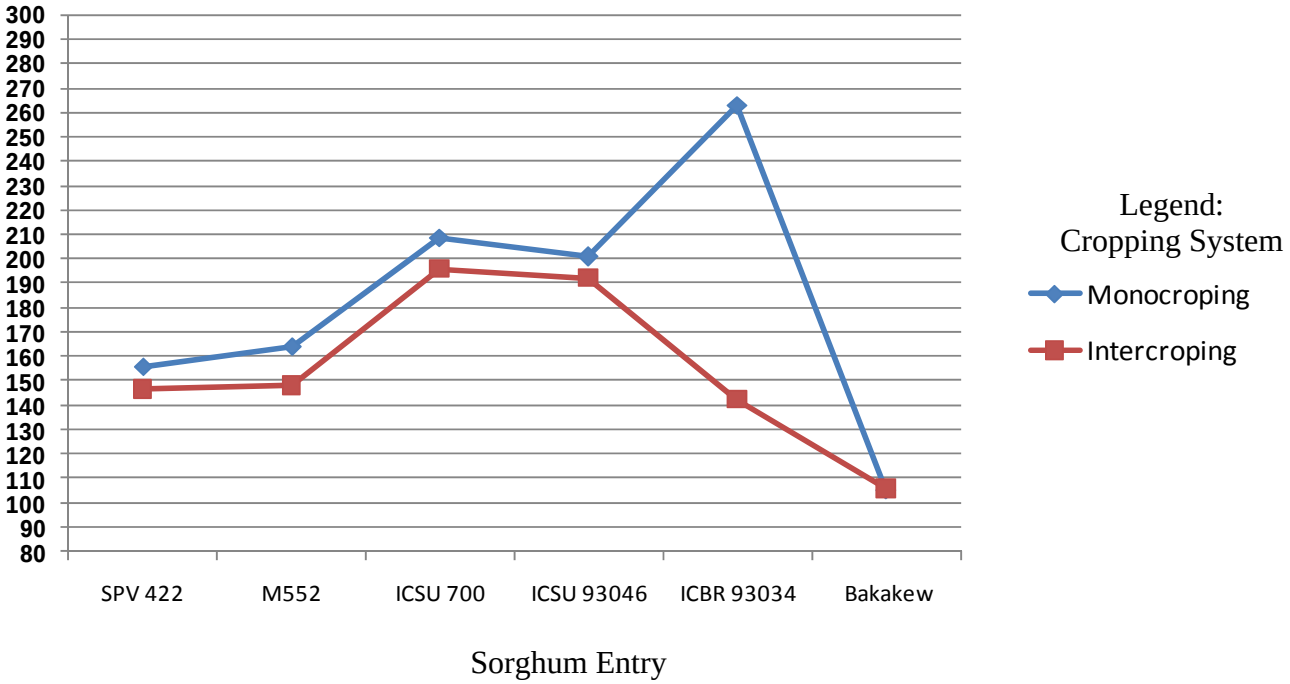


Figure 2. Interaction of sorghum entry and cropping system on final plant Height.

Sorghum entries. Highly significant differences were noted in the stem diameter of the different entries of sorghum. Entry SPV 422 had the widest stem while Bakakew had the narrowest stem (1.02cm and 0.71cm respectively). The wide stems of some entries maybe due to good germination of seeds (PCARRD, 2001.) leading to strong stalk and high biomass yield (Li Guiying *et al*, 2006).

Interaction effect. There was no significant interaction between cropping system and entries of sorghum on stem diameter.

Table 5. Final plant height and stem diameter of different sorghum entries intercropped with bush bean

TREATMENT	FINAL HEIGHT (CM)	STEM DIAMETER (CM)
Cropping System (CS)		
Sorghum only	166.38[a]	0.94[a]
Sorghum + bush bean	155.11[b]	0.83[b]
Sorghum Entries (SE)		
SPV 422	151.20[c]	1.02[a]
M552	155.98[c]	0.88[c]
ICSU 700	202.35[a]	0.82[c]
ICSU93046	196.48[b]	0.92[b]
ICBR93034	152.83[c]	0.97[b]
Bakakew	105.62[d]	0.71[d]
CS x SE	*	ns
(CS)	1.04	6.91
(SE)	3.09	10.33

Means of different letters are significantly different from each other using 5% level of significance by DMRT

Corn Borer Infestation

Cropping system. High significance was noted on the insect infestation of monocropped and intercropped sorghum at 45 to 90 days after planting. Monocropped sorghum was moderately infested with corn borer. In contrast, sorghum intercropped with

Table 6. Corn borer infestation of different sorghum entries intercropped with bush bean

TREATMENTS	CORN BORER INFESTATION AT			
	45 DAP	60 DAP	75 DAP	90 DAP
Cropping System (CS)				
Sorghum only	5[a]	5[a]	5[a]	5[a]
Sorghum + bush bean	3[b]	3[b]	3[b]	3[b]
Sorghum Entries (SE)				
SPV 422	5	3[b]	3[b]	5[a]
M552	5	3[b]	3[b]	5[a]
ICSU 700	5	5[a]	5[a]	3[b]
ICSU 93046	5	5[a]	3[b]	3[b]
ICBR 93034	5	5[a]	5[a]	5[a]
Bakakew	5	5[a]	3[b]	5[a]
CS x SE	ns	ns	ns	ns
(CS)	7.32	43.49	51.39	53.53
(SE)	18.51	18.74	26.43	22.35

Means of different letters are significantly different from each other using 5% level of significance by DMRT

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(Rating scale: 1 = sound, 3 = slight, 5 = moderate, 7 = severe and 9 = skeletonized)

bush bean was slightly damaged by corn borer. The lesser damage in intercropped sorghum may be due to the bush bean plants serving as alternative host to corn borer (ICRISAT, 1981).

Sorghum entries. Most of the entries had moderate infestation at 45 DAP, slight infestation at 65 to 75 DAP, and moderate infestation at 90 DAP. This irregular trend in corn borer infestation may indicate the rejuvenation of the vigor of the plants. Entries ICSU 93046 and ICSU 700 remained slightly infested with corn borer until 90 DAP.

Interaction effect. No significant interaction was noted between cropping system and the different entries on corn borer infestation.

Kernel Smut Infection

Cropping system. No significant differences were noted on the kernel smut infection of sorghum as affected by the cropping systems. Monocropped sorghum and sorghum intercropped with bush bean were moderately resistant to kernel smut. This may imply that intercropping sorghum with bush bean does not prohibit disease infection.

Sorghum entries. Highly significant differences were noted on the resistance of the different sorghum entries to kernel smut. Entries ICSU 700 and ICSU 93046 were resistant to kernel smut which may result in good quality grains, higher yield, and high profit.

Interaction effect. Significant interaction was noted between cropping system and sorghum entries on kernel smut infection (Fig.3). Selecting entries ICSU 700 and ICSU 93046 as either monocrop or intercrop is important in lessening disease infection.

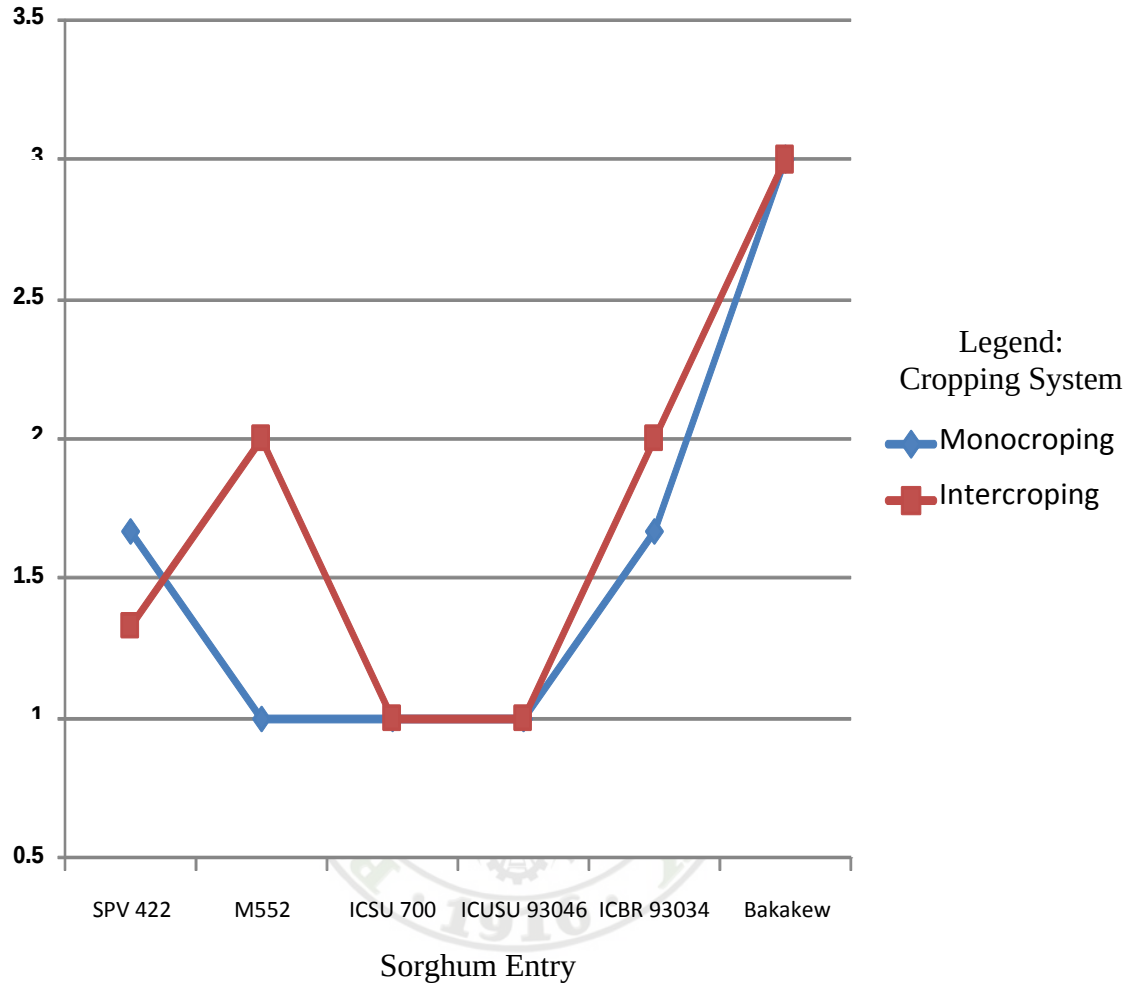

Figure 3. Interaction of sorghum entry and cropping system on kernel smut infection.

Table 7. Kernel smut infection of different sorghum entries intercropped with bush bean

TREATMENTS	KERNEL SMUT INFECTION (160 DAP)
Cropping System (CS)	
Sorghum only	2
Sorghum + bush bean	2
Sorghum Entries (SE)	
SPV 422	2[b]
M552	2[b]
ICSU 700	1[c]
ICSU 93046	1[c]
ICBR 93034	2[b]
Bakakew	3[a]
CS x SE	*
(CS)	17.61
(SE)	18.19

Means of different letters are significantly different from each other using 5% levelof significance by DMRT

(Rating scale: 1 = resistant, 2 = moderately resistant, 3 = weak.)

Length of the Panicle

Cropping system. Table 8 shows that sorghum entries intercropped with bush bean had longer panicle. This result corroborates with the claim by PCARRD (1983) that using legumes as intercrops can increase plant height, panicle length and yield.

Table 8. Length of the panicle of different sorghum entries intercropped with bush bean

TREATMENTS	PANICLE LENGTH (cm)
Cropping System (CS)	
Sorghum only	27.67
Sorghum + bush bean	29.08
Sorghum Entries (SE)	
SPV 422	29.60[c]
M552	33.53[b]
ICSU 700	21.33[d]
ICSU 93046	20.42[d]
ICBR 93034	28.92[c]
Bakakew	36.45[a]
CS x SE	ns
(CS)	3.56
(SE)	5.06

Means of different letters are significantly different from each other using 5% level of significance by DMRT

Sorghum entries. Highly significant differences were noted on the length of panicle of the sorghum entries. Bakakew had the longest panicle of 36.45 cm while entries ICSU 700 and ICSU 93046 had the shortest panicle. It was observed that entries with longer panicles had the highest kernel smut infection.

Interaction effect. There was no significant interaction between cropping system and the different entries on panicle length.

Stalk Yield

Cropping system. Monocropped sorghum had higher stalk yield than intercropped sorghum which may be due to the long and wide stems of the plants. (Table 9).

Sorghum entries. Highly significant differences on the stalk yield of the different entries of sorghum are observed. Entry ICSU 93046 had the highest stalk yield of 14.75 kgs which may be due to the relatively wide stems of the plants. Reddy *et al,* (2009) stated that high stalk yield of sweet sorghum indicates high sucrose and biomass yield.

Interaction effect. There was no significant interaction between cropping system and the different entries on stalk yield.

Weight of 100 grains

Cropping system. Table 9 shows that the weight of 100 grains for monocropped and intercropped sorghum was not significantly different.

Sorghum entries. Highly significant differences were noted on the weight of 100 grains of the different entries. Entry M552 had the highest weight of 100 grains which

could be attributed to the relatively long panicles of the entry and moderate resistance to kernel smut.

Interaction effect. No significant interaction was observed between cropping system and the different entries on the weight of 100 grains.

Table 9. Stalk yield, weight of 100 grains, and yield per plot of the different sorghum entries intercropped with bush bean

TREATMENTS	STALKYIELD PER PLOT (kg)	WEIGHT OF 100 GRAIN(g)	GRAIN YIELD PERPLOT (kg/10m^2)
Cropping System (CS)			
Sorghum only	8.73[a]	3.43	1.77
Sorghum + bush bean	7.17[b]	3.40	1.79
Sorghum Entries (SE)			
SPV 422	6.42[c]	3.62[b]	2.10[a]
M552	4.48[d]	3.88[a]	1.84[c]
ICSU 700	12.13[b]	3.13[d]	1.97[b]
ICSU 93046	14.75[a]	3.45[c]	1.92[b]
ICBR 93034	5.78[c]	3.07[d]	1.83[c]
Bakakew	3.96[e]	3.33[c]	1.03[d]
CS x SE	ns	ns	ns
(CS)	4.74	9.73	14.87
(SE)	10.34	10.75	12.19

Means of different letters are significantly different from each other using 5% level of significance by DMRT

Grain Yield per Plot

Cropping ystem. There was no significant difference on the total yield per plot of monocropped sorghum and sorghum intercropped with bush beans (Table 9).

Sorghum entries. Highly significant differences were noted on the total yield per plot of the different sorghum entries (Table 8). Entry SPV 422 had the highest total yield per plot of 2.10 kg while Bakakew only had a yield of 1.03 kg. The high yield of entry SPV 422 may be attributed to its high plant survival, high vigor, and slight damage by birds.

Interaction effect. There were no significant interaction between the cropping system and the different entries on total yield/ plot.

Sugar Content

Cropping system. No significant differences were noted on the sugar content of stalk from base to tip of monocropped and intercropped sorghum. (Table 10). These findings signify that there is no significant effect of cropping system on the sugar content of sorghum stalk.

It was also observed that the middle part of the stalk contained the highest sugar content. The higher sugar on the middle part of the stalk may be due to wider diameter and maturity of the plant (PCARRD, 200I).

Sorghum entries. Highly significant differences were observed on the sugar content of the stalk of the different sorghum entries. ICSU 700 had the highest sugar content on the base, middle and tip part of the stalk. Also, it was observed that ICSU 93046 had the highest sugar content on the tip part of the stalk. PCARRD (2001) stated

that high sugar content of sweet sorghum indicates that the plant had reached physiological maturity and is ready for harvest. Thus, entry ICSU 700 may be early maturing as indicated by its high sugar content.

Date of harvesting may therefore be considered for production of higher sugar content. Delaying harvest to a later date was found to produce higher sugar content in

Table 10. Sugar content on the base, middle and tip of stalk of different sorghum entries intercropped with bush bean

TREATMENTS	STEM SUGAR CONTENT (^{o}Brix) BASE	MIDDLE	TIP
Cropping System (CS)			
Sorghum only	11.51	11.99	9.56
Sorghum + bush bean	10.98	11.64	9.70
Sorghum Entries (SE)			
SPV 422	10.15^{c}	10.47^{c}	6.17^{b}
M552	8.67^{d}	5.98^{d}	5.88^{b}
ICSU 700	15.75^{a}	17.42^{a}	15.85^{a}
ICSU 93046	14.18^{b}	16.82^{b}	16.03^{a}
ICBR 93034	11.90^{c}	12.20^{c}	7.17^{b}
Bakakew	6.80^{e}	7.00^{d}	6.67^{b}
CS x SE	ns	*	ns
(CS)	13.17	10.73	13.48
(SE)	21.49	13.02	15.68

Means of different letters are significantly different from each other using 5% level of significance by DMRT

sorghum stems (Rao et al, 2009). In addition, entries with 16-23% Brix sugar had great potential for jiggery syrup and most importantly fuel alcohol production (Reddy *et al,* 2009).

Interaction effect. No significant interaction between cropping system and sorghum entry was noted on the sugar content of base and tip parts of the stalk. However, a significant interaction was observed on the sugar content of the middle part of sorghum stalk (Fig. 4). Monocropping of ICSU 700 produce the highest sugar content. This result may be due to the higher stalk yield of monocopped sorghum.

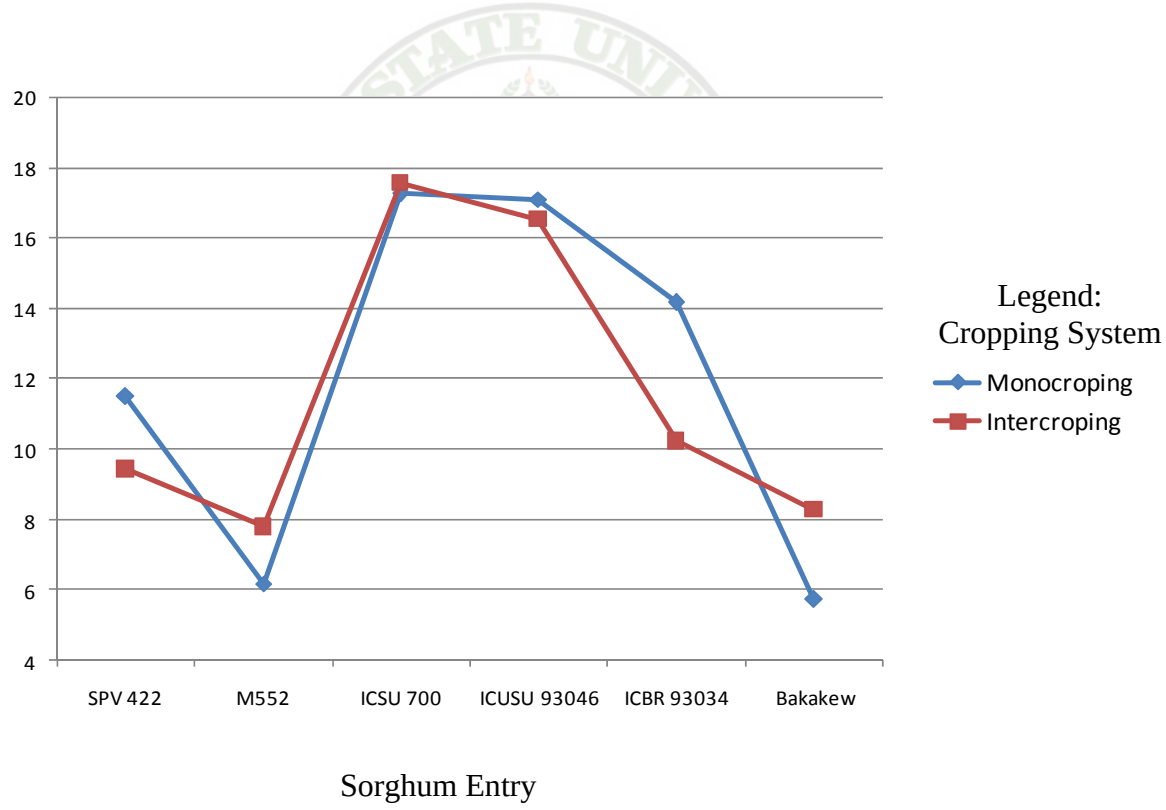

Figure 4. Interaction of sorghum entry and cropping system on stalk sugar content.

Grain Moisture Content

Cropping system. The moisture content of sorghum as affected by cropping system was not significantly different from each other. This result signifies that there is no significant effect of cropping system on the grain moisture content of sorghum.

Table 11. Grain moisture content of different sorghum entries intercropped with bush bean (%)

TREATMENTS	GRAIN MOISTURE CONTENT (%)
Cropping System (CS)	
Sorghum only	8.88
Sorghum + bush bean	8.89
Sorghum Entries (SE)	
SPV 422	8.90
M552	8.97
ICSU 700	8.92
ICSU 93046	8.90
ICBR 93034	8.72
Bakakew	8.90
CS x SE	ns
(CS)	2.65
(SE)	2.39

Means of different letters are significantly different from each other using 5% level of significance of DMRT

Sorghum entries. The moisture content of the different entries of sorghum was not significantly different from each other. The moisture content of the entries ranged from 8.72 to 8.97%.

Interaction effect. No significant interaction was noted on the moisture content of sorghum entries affected by the different cropping systems.

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The studies was conducted to identify the most suitable cropping system for sorghum; determine the best sorghum entry based on yield and resistance to disease; and determine the interaction between cropping system and sorghum entries.

Results show that cropping system did not significantly affect plant survival, plant vigor at 60 to 90 DAP, days from sowing to emergence, tillering, heading, ripening and harvesting , number of tillers, insect infestation at 60 to 90 DAP, kernel smut infection, length of the panicle, weight of 100 grains, total yield per plot, sugar content, and grain moisture content.

Significant differences among monocropped and intercropped sorghum was observed on the plant vigor at 45 DAP, stem diameter, final plant height, insect infestation at 45 DAP, and stalk yield per plot.

In terms of sorghum entries, highly significant differences were observed on plant survival, insect infestation at 45 to 60 DAP, number of tillers, number of days from sowing to heading, stem diameter, final plant height, resistance to kernel smut, length of the panicle, stalk yield, weight of 100 grain, yield per plot, and sugar content. Entries ICSU 700 and ICSU 93046 were observed to be the most resistant to kernel smut, had the highest plant vigor, sugar content, and stalk yield. Entry SPV 422 had the highest yield per plot and stem diameter.

Significant interaction between cropping system and sorghum entries were noted on final plant height, resistance to kernel smut, and sugar content of the middle stalk.

Conclusion

Based on the results, monocropping of sorghum is best for wider stems and high stalk yield. Intercropping of sorghum numerically produced the highest yield and resistance to corn borer. Bush bean might therefore be a good intercrop of sorghum.

Among the sorghum entries, SPV422 produced the highest grain yield while ICSU 93046 produced the highest stalk yield. Both ICSU 700 and ICSU 93046 were the most resistant to kernel smut and corn borer. Entry ICSU 700 produced the highest sugar on all stems parts.

In terms of treatment combinations, intercropping of either ICSU 700 or ICSU 93046 with bush beans is best in decreasing corn borer infestation. In addition, monocopping of SPV 422 AND ICSU 93046 is best for high grain yield and stalk yield, respectively.

Recommendation

Intercropping of sorghum with bush beans is recommended for resistance to corn borer. Monocropping of sorghum is recommended for high grain and stalk yield.

Among the entries, SPV 422 is recommended for high grain yield while ICSU 93046 is recommended for high stalk yield. Both ICSU 700 and ICSU 93046 are recommended for resistance to corn borer.

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APPENDICES

Appendix 1. Plant survival

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CSI					
SPV 422	97.83	97.83	97.83	293.49	97.83
M552	100	100	100	300	100
ICSU 700	100	100	100	300	100
ICSU 93046	100	100	100	300	100
ICBR93034	93.48	97.83	89.13	280.43	93.48
Bakakew	100	91.30	89.13	280.43	93.48
SUB TOTAL	591.31	586.96	576.09	1,754.35	584.79
CS2					
SPV 422	100	100	97.83	297.83	99.28
M552	97.83	97.83	95.65	291.31	97.10
ICSU 700	100	100	100	300	100
ICSU 93046	100	100	100	300	100
ICBR93034	80.43	95.65	84.78	280.86	86.95
Bakakew	100	95.65	82.61	278.26	92.75
SUB TOTAL	578.26	589.13	560.87	1748.26	576.08
TOTAL	1,169.57	1,176.09	1,136.96	3,502.61	1,160.87

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	97.83	99.28	197.11	98.55
E_2	100.00	97.10	197.10	98.55
E_3	100.00	100.00	200.00	100.00
E_4	100.00	100.00	200.00	100.00
E_5	93.48	86.95	180.43	90.22
E_6	93.48	92.75	186.23	93.12
Total	584.79	576.09	1160.87	
Mean	97.46	96.01		96.74

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	73.252	36.626	4.89^{ns}	19.00	99.00
Main plot (A)	1	18.922	18.922	2.53^{ns}	18.51	98.50
Error (a)	2	14.966	7.483			
Sub-plot (B)	5	501.120	100.224	6.49^{**}	2.71	4.10
AxB	5	61.484	12.297	0.80^{ns}	2.71	4.10
Error (b)	20	308.821	15.441			
Total	35	978.565				

** - highly significant
ns –not significant

CV (a) = 2.83
CV (b) = 4

Appendix 2. Plant vigor at 45 days

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	4	4	4	12	4
M552	4	4	4	12	4
ICSU 700	4	4	4	12	4
ICSU 93046	4	4	4	12	4
ICBR93034	4	4	4	12	4
Bakakew	4	4	3	11	3.67
SUB TOTAL	24	24	24	71	23.67
CS2					
SPV 422	4	4	4	12	4
M552	3	3	3	9	3
ICSU 700	4	4	4	12	4
ICSU 93046	4	4	4	12	4
ICBR93034	4	4	4	12	4
Bakakew	3	3	3	9	3
SUB TOTAL	22	22	22	66	22
TOTAL	46	46	46	137	45.67

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	4.00	4.00	8.00	4
E_2	4.00	3.00	7.00	4
E_3	4.00	4.00	8.00	4
E_4	4.00	4.00	8.00	4
E_5	4.00	4.00	8.00	4
E_6	3.67	3.00	6.67	3
Total	23.67	22.00	45.67	
Mean	4	3		4

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	0.056	0.028	1.00^{ns}	19.00	99.00
Main plot (A)	1	0.694	0.694	25.00^{*}	18.51	98.50
Error (a)	2	0.056	0.028			
Sub-plot (B)	5	2.806	0.561	20.20^{**}	2.71	4.10
AxB	5	1.472	0.294	10.60^{**}	2.71	4.10
Error (b)	20	0.556	0.028			
Total	35	5.639				

** - highly significant
*-significant
ns-not significant

CV (a) = 4.38
CV (b) = 4.38

Appendix 3. Plant vigor at 60 days

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	5	5	5	15	5
M552	5	4	4	13	4.33
ICSU 700	5	5	5	15	5
ICSU 93046	5	5	5	15	5
ICBR93034	5	5	5	15	5
Bakakew	4	4	4	12	4
SUB TOTAL	29	28	28	85	28.33
CS2					
SPV 422	5	5	5	15	5
M552	4	4	4	12	4
ICSU 700	5	5	5	15	5
ICSU 93046	5	5	5	15	5
ICBR93034	5	5	5	15	5
Bakakew	4	4	4	12	4
SUB TOTAL	28	28	28	84	28
TOTAL	57	56	56	169	56.33

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	5.00	5.00	10.00	5
E_2	4.33	4.00	8.33	4
E_3	5.00	5.00	10.00	5
E_4	5.00	5.00	10.00	5
E_5	5.00	5.00	10.00	5
E_6	4.00	4.00	8.00	4
Total	28.33	28.00	56.33	
Mean	5	5		5

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	0.056	0.028	1.00^{ns}	19.00	99.00
Main plot (A)	1	0.028	0.028	1.00^{ns}	18.51	98.50
Error (a)	2	0.056	0.028			
Sub-plot (B)	5	6.806	1.361	49.00^{**}	2.71	4.10
AxB	5	0.139	0.028	1.00^{ns}	2.71	4.10
Error (b)	20	0.556	0.028			
Total	35	7.639				

** - highly significant
ns-not significant

CV (a) = 3.55
CV (b) = 3.55

Appendix 4. Plant vigor at 75 days

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	5	5	5	15	5
M552	5	5	5	15	5
ICSU 700	5	5	5	15	5
ICSU 93046	5	5	5	15	5
ICBR93034	5	5	5	15	5
Bakakew	4	4	4	12	4
SUB TOTAL	29	29	29	87	29
CS2					
SPV 422	5	5	5	15	5
M552	5	5	5	15	5
ICSU 700	5	5	5	15	5
ICSU 93046	5	5	5	15	5
ICBR93034	5	5	5	15	5
Bakakew	4	4	4	12	4
SUB TOTAL	29	29	29	87	29
TOTAL	58	58	58	176	58

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	5.00	5.00	10.00	5
E_2	5.00	5.00	10.00	5
E_3	5.00	5.00	10.00	5
E_4	5.00	5.00	10.00	5
E_5	5.00	5.00	10.00	5
E_6	4.00	4.00	8.00	4
Total	29.00	29.00	58.00	
Mean	5	5		5

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	0.000	0.000	0.00^{ns}	19.00	99.00
Main plot (A)	1	0.000	0.000	0.00^{ns}	18.51	98.50
Error (a)	2	0.000	0.000			
Sub-plot (B)	5	5.000	1.000	0.00^{ns}	2.71	4.10
AxB	5	0.000	0.000	0.00^{ns}	2.71	4.10
Error (b)	20	0.000	0.000			
Total	35	5.000				

ns-not significant CV (a) = 0.00 CV (b) = 0.00

Appendix 5. Plant vigor at 90 days

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	5	5	5	15	5
M552	5	5	5	15	5
ICSU 700	5	5	5	15	5
ICSU 93046	5	5	5	15	5
ICBR93034	5	5	5	15	5
Bakakew	4	4	4	12	4
SUB TOTAL	29	29	29	87	29
CS2					
SPV 422	5	5	5	15	5
M552	5	5	5	15	5
ICSU 700	5	5	5	15	5
ICSU 93046	5	5	5	15	5
ICBR93034	5	5	5	15	5
Bakakew	4	4	4	12	4
SUB TOTAL	29	29	29	87	29
TOTAL	58	58	58	174	58

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	5.00	5.00	10.00	5
E_2	5.00	5.00	10.00	5
E_3	5.00	5.00	10.00	5
E_4	5.00	5.00	10.00	5
E_5	5.00	5.00	10.00	5
E_6	4.00	4.00	8.00	4
Total	29.00	29.00	58.00	
Mean	5	5		5

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	0.000	0.000	0.00^{ns}	19.00	99.00
Main plot (A)	1	0.000	0.000	0.00^{ns}	18.51	98.50
Error (a)	2	0.000	0.000			
Sub-plot (B)	5	5.000	1.000	0.00^{ns}	2.71	4.10
AxB	5	0.000	0.000	0.00^{ns}	2.71	4.10
Error (b)	20	0.000	0.000			
Total	35	5.000				

ns-not significant

CV (a) = 0.00

CV (b) = 0.00

Appendix 6. Number of days from sowing to emergence

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	9	9	9	27	9
M552	8	8	8	24	8
ICSU 700	8	8	8	24	8
ICSU 93046	8	8	8	24	8
ICBR93034	9	9	9	27	9
Bakakew	10	10	10	30	10
SUB TOTAL	52	52	52	156	52
CS2					
SPV 422	9	9	9	27	9
M552	8	8	8	24	8
ICSU 700	8	8	8	24	8
ICSU 93046	8	8	8	24	8
ICBR93034	9	9	9	27	9
Bakakew	10	10	10	30	10
SUB TOTAL	52	52	52	156	52
TOTAL	104	104	104	312	104

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	9.00	9.00	18.00	9.00
E_2	8.00	8.00	16.00	8.00
E_3	8.00	8.00	16.00	8.00
E_4	8.00	8.00	16.00	8.00
E_5	9.00	9.00	18.00	9.00
E_6	10.00	10.00	20.00	10.00
Total	52.00	52.00	10.4	
Mean	8.67	8.67		8.67

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	0.000	0.000	0.00^{ns}	19.00	99.00
Main plot (A)	1	0.000	0.000	0.00^{ns}	18.51	98.50
Error (a)	2	0.000	0.000			
Sub-plot (B)	5	20.000	4.000	0.00^{ns}	2.71	4.10
AxB	5	0.000	0.000	0.00^{ns}	2.71	4.10
Error (b)	20	0.000	0.000			
Total	35	20.000				

ns-not significant

CV (a) = 0.00

CV (b) = 0.00

Appendix 7. Number of days from sowing to tillering

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	60	60	60	180	60
M552	60	60	60	180	60
ICSU 700	67	67	67	201	67
ICSU 93046					
ICBR93034	67	67	67	201	67
Bakakew	60	60	60	180	60
SUB TOTAL	314	314	314	942	314
CS2					
SPV 422	88	88	88	264	88
M552	76	76	76	228	76
ICSU 700	88	88	88	264	88
ICSU 93046					
ICBR93034	88	88	88	264	88
Bakakew	76	76	76	228	76
SUB TOTAL	416	416	416	1,148	416
TOTAL	730	730	730	2,090	730

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	60.00	88.00	148.00	74
E_2	60.00	76.00	136.00	68
E_3	67.00	88.00	155.00	78
E_4	0.00	0.00	0.00	0.00
E_5	67.00	88.00	155.00	78
E_6	60.00	76.00	136.00	68
Total	314.00	416.00	730.00	
Mean	52	69		61

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	0.000	0.000	0.00^{ns}	19.00	99.00
Main plot (A)	1	2601.000	2601.000	0.00^{ns}	18.51	98.50
Error (a)	2	0.000	0.000			
Sub-plot (B)	5	27194.000	5438.800	0.00^{ns}	2.71	4.10
AxB	5	666.000	133.200	0.00^{ns}	2.71	4.10
Error (b)	20	0.000	0.000			
Total	35	30461.000				

ns-not significant

CV (a) = 0.00

CV (b) = 0.00

Appendix 8. Number of tillers

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CSI					
SPV 422	3.6	3.2	2.4	9.2	3.07
M552	5.7	4.7	3.7	14.1	4.7
ICSU 700	3.8	3.1	2.6	9.5	3.17
ICSU 93046	1.0	1.0	1.0	3.0	1.0
ICBR93034	2.8	3.2	2.7	8.7	2.9
Bakakew	4	4.3	4.3	12.6	4.2
SUB TOTAL	20.9	19.5	16.7	57.1	19.04
CS2					
SPV 422	3.4	3.2	3.3	9.9	3.3
M552	5	5.1	4.7	14.8	4.93
ICSU 700	3	2.4	2.6	8	2.67
ICSU 93046	1.0	1.0	1.0	3.0	1.0
ICBR93034	3.8	3	3.1	9.9	3.3
Bakakew	4.1	4	4.2	12.3	4.1
SUB TOTAL	20.3	18.7	18.9	57.9	19.3
TOTAL	41.2	38.2	35.6	115	38.34

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	3.07	3.30	6.37	3
E_2	4.70	4.93	9.63	5
E_3	3.17	2.67	5.83	5
E_4	1.00	1.00	3.00	1
E_5	2.90	6.20	6.20	3
E_6	4.20	8.30	8.30	4
Total	19.03	19.30	38.33	
Mean	3	3		4

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	1.309	0.654	2.79^{ns}	19.00	99.00
Main plot (A)	1	0.018	0.018	0.08^{ns}	18.51	98.50
Error (a)	2	0.469	0.234			
Sub-plot (B)	5	82.012	16.402	126.71^{**}	2.71	4.10
AxB	5	0.776	0.155	1.20^{ns}	2.71	4.10
Error (b)	20	2.589	0.129			
Total	35	87.172				

** - highly significant
ns-not significant

CV (a) = 15.99
CV (b) = 11.88

Appendix 9. Number of days from sowing to heading

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CSI					
SPV 422	102	102	102	306	102
M552	94	94	94	282	94
ICSU 700	106	106	110	322	107.33
ICSU 93046	113	113	113	339	113
ICBR93034	108	108	110	326	108.67
Bakakew	99	99	99	297	99
SUB TOTAL	622	622	628	1872	624
CS2					
SPV 422	102	102	99	303	101
M552	94	94	94	282	94
ICSU 700	106	106	110	322	107.33
ICSU 93046	113	113	113	339	113
ICBR93034	108	108	108	324	108
Bakakew	99	99	99	297	99
SUB TOTAL	622	622	623	1,867	622.33
TOTAL	1,244	1,244	1,251	3,739	1,246.33

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	102.00	101.00	203.00	101.50
E_2	94.00	94	188.00	94.00
E_3	107.33	107.33	214.67	107.33
E_4	113.00	113.00	226.00	113.00
E_5	108.67	108.00	216.67	108.33
E_6	99.00	99.00	198.00	99.00
Total	624.00	622.33	1246.33	
Mean	104.00	103.72		103.86

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	2.722	1.361	1.96^{ns}	19.00	99.00
Main plot (A)	1	0.694	0.694	1.00^{ns}	18.51	98.50
Error (a)	2	1.389	0.694			
Sub-plot (B)	5	1452.139	290.428	224.36^{**}	2.71	4.10
AxB	5	1.472	0.294	0.23^{ns}	2.71	4.10
Error (b)	20	25.889	1.294			
Total	35	1484.306				

** - highly significant
ns-not significant

CV (a) = 0.080
CV (b) = 1.10

Appendix 10. Number of days from sowing to ripening

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CSI					
SPV 422	141	141	141	423	141
M552	129	129	129	387	129
ICSU 700	144	144	144	432	144
ICSU 93046	148	148	148	444	148
ICBR93034	141	141	141	423	141
Bakakew	136	136	136	408	136
SUB TOTAL	839	839	839	2,517	839
CS2					
SPV 422	141	141	141	423	141
M552	129	129	129	387	129
ICSU 700	144	144	144	432	144
ICSU 93046	148	148	148	444	148
ICBR93034	141	141	141	423	141
Bakakew	136	136	136	408	136
SUB TOTAL	839	839	839	2,517	839
TOTAL	1,678	1,678	1,678	5,034	1,678

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	141.00	141.00	282.00	141
E_2	129.00	129.00	258.00	129
E_3	144.00	144.00	288.00	144
E_4	148.00	148.00	296.00	148
E_5	141.00	141.00	282.00	141
E_6	136.00	136.00	272.00	136
Total	839.00	839.00	1678.00	
Mean	140	140		140

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	0.000	0.000	0.00^{ns}	19.00	99.00
Main plot (A)	1	0.000	0.000	0.00^{ns}	18.51	98.50
Error (a)	2	0.000	0.000			
Sub-plot (B)	5	1313.000	262.600	0.00^{ns}	2.71	4.10
AxB	5	0.000	0.000	0.00^{ns}	2.71	4.10
Error (b)	20	0.000	0.000			
Total	35	1313.000				

ns-not significant CV (a) = 0.00 CV (b) = 0.00

Appendix 11. Number of days from sowing to harvesting

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	155	155	155	465	155
M552	155	155	155	465	155
ICSU 700	162	162	162	486	162
ICSU 93046	162	162	162	486	162
ICBR93034	155	155	155	465	155
Bakakew	162	162	162	486	162
SUB TOTAL	951	951	951	2,853	951
CS2					
SPV 422	155	155	155	465	155
M552	155	155	155	465	155
ICSU 700	162	162	162	486	162
ICSU 93046	162	162	162	486	162
ICBR93034	162	162	162	465	162
Bakakew	162	162	162	486	162
SUB TOTAL	951	951	951	2,853	951
TOTAL	1,902	1,902	1,902	5,706	1,902

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	155.00	155.00	310.00	155
E_2	155.00	155.00	310.00	155
E_3	162.00	162.00	324.00	162
E_4	162.00	162.00	324.00	162
E_5	155.00	155.00	310.00	155
E_6	162.00	162.00	324.00	162
Total	951.00	951.00	1902	
Mean	159	159		159

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	0.000	0.000	0.00^{ns}	19.00	99.00
Main plot (A)	1	0.000	0.000	0.00^{ns}	18.51	98.50
Error (a)	2	0.000	0.000			
Sub-plot (B)	5	441.000	88.200	0.00^{ns}	2.71	4.10
AxB	5	0.000	0.000	0.00^{ns}	2.71	4.10
Error (b)	20	0.000	0.000			
Total	35	441.000				

ns-not significant

CV (a) = 0.00

CV (b) = 0.00

Appendix 12. Stem diameter

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	1.06	1.07	1.09	3.22	1.07
M552	0.97	0.99	0.95	2.91	0.97
ICSU 700	1	0.69	0.81	2.5	0.83
ICSU 93046	0.95	0.93	0.98	2.86	0.95
ICBR93034	0.99	1.09	1.03	3.11	1.04
Bakakew	0.93	0.76	0.67	2.36	0.79
SUB TOTAL	5.9	5.53	5.53	16.96	5.65
CS2					
SPV 422	0.92	0.96	0.99	2.87	0.96
M552	0.83	0.84	0.71	2.38	0.79
ICSU 700	0.81	0.87	0.72	2.4	0.8
ICSU 93046	0.95	0.77	0.96	2.68	0.89
ICBR93034	1.02	0.94	0.75	2.71	0.90
Bakakew	0.8	0.63	0.49	1.92	0.64
SUB TOTAL	5.33	5.01	4.62	14.96	4.98
TOTAL	11.23	10.54	10.15	31.92	10.63

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	1.07	0.96	2.03	1.02
E_2	0.97	0.79	1.76	0.88
E_3	0.83	0.80	1.63	0.82
E_4	0.95	0.89	1.85	0.82
E_5	1.04	0.90	1.94	0.97
E_6	0.79	0.64	1.43	0.71
Total	5.65	4.99	10.64	
Mean	0.94	0.83		0.89

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	0.050	0.025	6.64^{ns}	19.00	99.00
Main plot (A)	1	0.111	0.111	29.61^{*}	18.51	98.50
Error (a)	2	0.008	0.004			
Sub-plot (B)	5	0.358	0.072	8.54^{**}	2.71	4.10
AxB	5	0.022	0.004	0.53^{ns}	2.71	4.10
Error (b)	20	0.168	0.008			
Total	35	0.717				

** - highly significant
*-significant
ns-not significant

CV (a) = 6.91
CV (b) = 10.33

Appendix 13. Final plant height

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	159.4	150.7	157.9	468	156
M552	166.9	164.6	16.7	492.2	164.07
ICSU 700	202.1	216.4	207.5	626	208.67
ICSU 93046	200.5	210.8	191.0	602.3	200.77
ICBR93034	163.8	163.1	162.8	489.7	263.23
Bakakew	107.5	101.1	107.1	316.7	105.57
SUB TOTAL	1000.2	1006.7	988	2,994.9	998.31
CS2					
SPV 422	146.9	148.1	144.2	439.2	146.4
M552	151.8	151.2	140.7	443.7	147.9
ICSU 700	197.3	197.3	193.5	588.1	196.03
ICSU 93046	191.1	195.1	190.4	576.6	192.2
ICBR93034	147.1	144	136.2	427.3	142.43
Bakakew	104.1	103.4	109.5	317	105.67
SUB TOTAL	938.3	939.1	914.5	2,719.9	930.63
TOTAL	1,938.5	1,945.1	1,902.5	5,786.8	1,928.94

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	156.00	146.40	302.40	151.20
E_2	164.07	147.90	311.97	155.98
E_3	208.67	196.03	404.70	202.35
E_4	200.77	192.20	392.97	202.35
E_5	163.23	142.43	305.67	196.48
E_6	105.57	105.67	211.23	152.83
Total	998.30	930.63	1928.93	
Mean	166.38	155.11		160.74

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	89.561	44.780	15.97*	19.00	99.00
Main plot (A)	1	1144.694	1144.694	408.29**	18.51	98.50
Error (a)	2	5.607	2.804			
Sub-plot (B)	5	37342.276	7468.455	303.25**	2.71	4.10
AxB	5	384.046	76.809	3.12*	2.71	4.10
Error (b)	20	492.566	24.628			
Total	35	39458.749				

** - highly significant *-significant CV (a) = 1.04 CV (b) = 3.09

Appendix 14. Corn borer infestation at 45 days

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	5	5	5	15	5
M552	7	5	5	17	5.67
ICSU 700	5	5	7	17	5.67
ICSU 93046	5	5	7	17	5.67
ICBR93034	5	5	5	15	5
Bakakew	5	5	5	15	5
SUB TOTAL	32	30	34	96	32.01
CS2					
SPV 422	5	5	5	15	5
M552	3	3	3	9	3
ICSU 700	3	3	3	9	3.67
ICSU 93046	3	3	3	9	3.67
ICBR93034	5	5	5	15	4.33
Bakakew	3	3	3	9	3
SUB TOTAL	22	22	24	68	22.67
TOTAL	52	52	58	164	54.68

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	5.00	5.00	10.00	5
E_2	5.67	3.00	8.67	5
E_3	5.67	3.67	9.33	5
E_4	5.67	3.67	9.33	5
E_5	5.00	4.33	9.33	5
E_6	5.00	3.00	8.00	5
Total	32.00	22.67	54.67	
Mean	5	3		4.56

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	1.556	0.778	7.00^{ns}	19.00	99.00
Main plot (A)	1	21.778	21.778	196.00^{**}	18.51	98.50
Error (a)	2	0.222	0.111			
Sub-plot (B)	5	3.556	0.711	1.00^{ns}	2.71	4.10
AxB	5	7.556	1.511	2.12^{ns}	2.71	4.10
Error (b)	20	14.222	0.711			
Total	35	48.889				

** - highly significant ns-not significant CV (a) = 7.32 CV (b) = 18.51

Appendix 15. Corn borer infestation at 60 days

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	3	5	5	13	4.33
M552	5	5	5	15	5
ICSU 700	3	5	7	15	5
ICSU 93046	5	5	7	17	5.67
ICBR93034	5	5	5	15	5
Bakakew	5	5	5	15	5
SUB TOTAL	26	30	34	90	30
CS2					
SPV 422	3	3	3	9	3
M552	3	3	1	7	2.33
ICSU 700	3	3	3	9	3
ICSU 93046	3	3	3	9	3
ICBR93034	5	3	3	13	4.33
Bakakew	3	3	3	9	3
SUB TOTAL	20	20	16	56	18.66
TOTAL	46	50	50	146	48.66

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	4.33	3.00	7.33	3
E_2	5.00	2.33	7.33	3
E_3	5.00	3.00	8.00	5
E_4	5.67	3.00	8.67	5
E_5	5.00	4.33	9.33	5
E_6	5.00	3.00	8.00	5
Total	30.00	18.67	48.67	
Mean	5	3		4

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	0.889	0.444	0.14^{ns}	19.00	99.00
Main plot (A)	1	32.111	32.111	10.32^{ns}	18.51	98.50
Error (a)	2	6.222	3.111			
Sub-plot (B)	5	4.556	0.911	1.58^{ns}	2.71	4.10
AxB	5	4.556	0.911	1.58^{ns}	2.71	4.10
Error (b)	20	11.556	0.578			
Total	35	59.889				

ns - not significant CV (a) = 43.49 CV (b) = 18.74

Appendix 16. Corn borer infestation at 75 days

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	3	3	3	9	3
M552	3	3	3	9	3
ICSU 700	5	5	7	17	5.67
ICSU 93046	3	3	5	11	3.67
ICBR93034	5	5	3	13	4.33
Bakakew	3	5	5	13	4.33
SUB TOTAL	22	24	26	72	24
CS2					
SPV 422	5	5	3	13	4.33
M552	3	3	3	9	3
ICSU 700	3	3	3	9	3
ICSU 93046	3	3	3	9	3
ICBR93034	5	5	1	11	3.67
Bakakew	3	3	1	7	2.33
SUB TOTAL	22	22	14	58	19.3
TOTAL	44	46	40	130	43.3

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	3.00	4.33	7.33	3
E_2	3.00	3.00	6.00	3
E_3	5.67	3.00	8.67	5
E_4	3.67	3.00	6.67	3
E_5	4.33	3.67	8.00	5
E_6	4.33	2.33	6.67	3
Total	24.00	19.33	43.33	
Mean	5	3		3

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	1.556	0.778	0.23^{ns}	19.00	99.00
Main plot (A)	1	5.444	5.444	1.58^{ns}	18.51	98.50
Error (a)	2	6.889	3.444			
Sub-plot (B)	5	7.222	1.444	1.59^{ns}	2.71	4.10
AxB	5	15.222	3.044	2.34^{ns}	2.71	4.10
Error (b)	20	18.222	0.911			
Total	35	54.556				

ns-not significant CV (a) =51.39 CV (b) =26.43

Appendix 17. Corn borer infestation at 90 days

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	3	3	5	11	3.67
M552	5	3	5	13	4.33
ICSU 700	3	3	5	11	3.67
ICSU 93046	3	3	5	11	3.67
ICBR93034	5	5	5	15	5
Bakakew	5	5	5	15	5
SUB TOTAL	24	22	30	76	25.34
CS2					
SPV 422	5	5	3	13	4.33
M552	5	5	3	13	4.33
ICSU 700	3	3	3	9	3
ICSU 93046	1	3	3	7	2.33
ICBR93034	3	5	3	11	3.67
Bakakew	5	3	3	11	3.67
SUB TOTAL	22	24	18	64	21.33
TOTAL	46	46	48	140	46.67

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	3.67	4.33	8.00	5
E_2	4.33	4.33	8.67	5
E_3	3.67	3.00	6.67	3
E_4	3.67	2.33	6.00	3
E_5	5.00	3.67	8.67	5
E_6	5.00	3.67	8.67	5
Total	25.33	21.33	46.67	
Mean	5	3		3

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	0.222	0.111	0.03^{ns}	19.00	99.00
Main plot (A)	1	4.000	4.000	0.92^{ns}	18.51	98.50
Error (a)	2	8.667	4.333			
Sub-plot (B)	5	10.222	2.044	2.71^{*}	2.71	4.10
AxB	5	5.333	1.067	1.41^{ns}	2.71	4.10
Error (b)	20	15.111	0.756			
Total	35	43.556				

* - significant ns-not significant CV (a) =53.53 CV (b) =22.35

Appendix 18. Kernel smut infection

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	2	1	2	5	1.67
M552	1	1	1	3	1
ICSU 700	1	1	1	3	1
ICSU 93046	1	1	1	3	1
ICBR93034	1	2	2	5	1.67
Bakakew	3	3	3	9	3
SUB TOTAL	9	9	10	28	9.34
CS2					
SPV 422	1	2	1	4	1.33
M552	2	2	2	6	2
ICSU 700	1	1	1	3	1
ICSU 93046	1	1	1	3	1
ICBR93034	2	2	2	6	2
Bakakew	3	3	3	9	3
SUB TOTAL	10	11	10	31	10.33
TOTAL	19	20	20	59	19.67

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	2	1	3.00	2
E_2	1	2	3.00	2
E_3	1	1	2.00	1
E_4	1	1	2.00	1
E_5	2	2	3.67	2
E_6	3	3	6.00	3
Total	9.33	10.33	19.67	
Mean	2	2		2

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	0.056	0.028	0.33^{ns}	19.00	99.00
Main plot (A)	1	0.250	0.250	3.00^{ns}	18.51	98.50
Error (a)	2	0.167	0.083			
Sub-plot (B)	5	16.472	3.294	37.06^{**}	2.71	4.10
AxB	5	1.583	0.317	3.56^{*}	2.71	4.10
Error (b)	20	1.778	0.089			
Total	35	20.306				

** - highly significant
*-significant ns-not significant
CV (a) = 17.61
CV (b) = 18.19

Appendix 19. Length of panicle (cm)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	28.7	28.7	29.6	85	28.37
M552	30.3	33.7	33.5	97.5	32.5
ICSU 700	22.1	19.7	22.5	64.3	21.43
ICSU 93046	20.9	20.5	20	61.4	20.47
ICBR93034	27.3	26.2	29.1	82.6	27.54
Bakakew	33.6	32.6	39.1	105.3	35.1
SUB TOTAL	162.9	161.4	173.8	496.1	165.36
CS2					
SPV 422	30.6	29.2	30.8	90.6	30.2
M552	34.4	35.5	33.8	103.7	34.57
ICSU 700	21	21.8	20.9	63.7	21.23
ICSU 93046	20.7	19.9	20.5	61.1	20.37
ICBR93034	29.1	29.5	32.3	90.9	30.3
Bakakew	37.8	35.7	39.9	113.4	37.8
SUB TOTAL	173.6	171.6	178.2	523.4	174.47
TOTAL	336.5	333	352	1,019.5	339.83

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	29.00	30.20	59.20	29.60
E_2	32.50	34.57	67.07	33.53
E_3	21.43	21.23	42.67	21.33
E_4	20.47	20.37	40.83	20.42
E_5	27.53	30.30	57.83	28.92
E_6	35.10	37.80	72.90	36.45
Total	166.03	174.47	340.50	
Mean	27.67	29.08		28.38

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	17.042	8.521	8.34^{ns}	19.00	99.00
Main plot (A)	1	17.780	17.780	17.40^{ns}	18.51	98.50
Error (a)	2	2.044	1.022			
Sub-plot (B)	5	1239.169	247.834	120.15^{**}	2.71	4.10
AxB	5	13.278	2.656	1.29^{ns}	2.71	4.10
Error (b)	20	41.254	2.063			
Total	35	1330.568				

** - highly significant ns-not significant CV (a) = 3.56 CV (b) = 5.06

Appendix 20. Stalk yield

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	7.6	6.9	7	21.5	7.17
M552	5.8	6.6	3.4	15.8	5.27
ICSU 700	13.5	11.75	12.75	38	12.67
ICSU 93046	17.75	16.25	15.25	49.25	16.42
ICBR93034	6.8	7.5	5.6	19.9	6.63
Bakakew	4.75	3.75	4.25	12.75	4.25
SUB TOTAL	56.2	52.75	48.25	157.2	52.41
CS2					
SPV 422	6	6.6	4.4	17	5.67
M552	4.9	4	3.4	12.3	4.1
ICSU 700	12.25	11.25	11.25	34.75	11.58
ICSU 93046	14.5	11.75	13	39.25	13.08
ICBR93034	5.8	5.4	3.6	14.8	4.93
Bakakew	4.75	4.25	2	11	3.67
SUB TOTAL	48.2	43.25	37.65	129.1	43.03
TOTAL	104.4	96	85.9	286.3	95.44

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	7.17	5.67	12.83	6.42
E_2	5.27	4.10	9.37	4.68
E_3	12.67	11.58	24.25	12.13
E_4	16.42	13.08	29.50	14.75
E_5	6.63	4.93	11.57	5.78
E_6	4.25	3.67	7.92	3.96
Total	52.40	43.03	95.43	
Mean	8.73	7.17		7.95

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	14.301	7.150	50.37*	19.00	99.00
Main plot (A)	1	21.934	21.934	154.52**	18.51	98.50
Error (a)	2	0.284	0.142			
Sub-plot (B)	5	583.924	116.785	172.67**	2.71	4.10
AxB	5	6.756	1.351	2.00ns	2.71	4.10
Error (b)	20	13.527	0.676			
Total	35	640.725				

** - highly significant
*-significant
ns-not significant
CV (a) = 4.74
CV (b) = 10.34

Appendix 21. Weight of 100 grains (g)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	3.7	4	3.3	11	3.67
M552	4.4	3.9	3.6	11.9	3.97
ICSU 700	3.2	3	3.2	9.4	3.13
ICSU 93046	3.6	3.4	3.5	10.5	3.5
ICBR93034	2.2	3	3.8	9	3
Bakakew	3.5	3.1	3.3	9.9	3.3
SUB TOTAL	20.6	20.4	20.7	61.7	20.57
CS2					
SPV 422	3.9	3.2	3.6	10.7	3.57
M552	4	3.1	4.3	11.4	3.8
ICSU 700	3.2	3.2	3	9.4	3.13
ICSU 93046	3.6	3.3	3.3	10.2	3.4
ICBR93034	3.4	3	3	9.4	3.13
Bakakew	3.5	3.3	3.3	10.1	3.37
SUB TOTAL	21.6	19.1	20.5	61.2	20.14
TOTAL	42.2	39.5	41.2	122.9	40.71

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	3.67	3.57	7.23	3.62
E_2	3.97	3.80	7.77	3.88
E_3	3.13	3.13	6.27	3.013
E_4	3.50	3.40	6.90	3.45
E_5	3.00	3.13	6.13	3.07
E_6	3.30	3.37	6.67	3.33
Total	20.57	20.40	40.97	
Mean	3.43	3.40		3.41

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	0.311	0.155	1.41^{ns}	19.00	99.00
Main plot (A)	1	0.007	0.007	0.06^{ns}	18.51	98.50
Error (a)	2	0.221	0.110			
Sub-plot (B)	5	2.811	0.562	4.17^{**}	2.71	4.10
AxB	5	0.098	0.020	0.15^{ns}	2.71	4.10
Error (b)	20	2.696	0.135			
Total	35	6.143				

** - highly significant
ns-not significant

CV (a) = 9.73
CV (b) = 10.75

Appendix 22. Total yield of sorghum per plot

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	2.2	1.9	2.1	6.2	2.06
M552	1.8	2.1	1.25	5.15	1.71
ICSU 700	2.2	1.7	2	5.9	1.96
ICSU 93046	2	1.9	2	5.9	1.96
ICBR93034	2.1	1.7	1.5	5.3	1.76
Bakakew	1.5	0.9	1	3.4	1.13
SUB TOTAL	11.8	10.2	9.85	31.85	10.58
CS2					
SPV 422	2.2	2.2	2	6.4	2.13
M552	1.9	2	2	5.9	1.96
ICSU 700	1.9	2	2	5.9	1.96
ICSU 93046	1.9	1.9	1.9	5.6	1.86
ICBR93034	1.8	1.9	1	5.7	1.9
Bakakew	1.3	1	2	2.8	0.93
SUB TOTAL	10.9	11	10.4	32.3	10.74
TOTAL	22.7	21.2	20.25	64.15	21.32

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	2.07	2.13	4.20	2.10
E_2	1.72	1.97	3.68	1.84
E_3	1.97	1.97	3.93	1.97
E_4	1.97	1.87	3.83	1.92
E_5	1.77	1.90	3.67	1.83
E_6	1.13	0.93	2.07	1.03
Total	10.62	10.77	21.38	
Mean	1.77	1.79		1.78

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	0.254	0.127	1.81^{ns}	19.00	99.00
Main plot (A)	1	0.006	0.006	0.08^{ns}	18.51	98.50
Error (a)	2	0.140	0.070			
Sub-plot (B)	5	4.320	0.864	18.31^{**}	2.71	4.10
AxB	5	0.196	0.039	0.83^{ns}	2.71	4.10
Error (b)	20	0.944	0.047			
Total	35	5.861				

** - highly significant ns-not significant CV (a) = 14.87 CV (b) = 12.19

Appendix 23. Stalk sugar content (Base)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	11.5	9.6	10.1	31.2	10.4
M552	13.8	10	4.5	28.3	9.43
ICSU 700	15.6	15.6	16	47.2	15.73
ICSU 93046	15.5	14.8	15.5	44.8	14.93
ICBR93034	13.8	12.2	9.9	35.9	11.97
Bakakew	4.9	5.6	9.2	19.7	6.57
SUB TOTAL	75.1	67.8	64.2	207.1	69.03
CS2					
SPV 422	9.9	9.6	10.2	29.7	9.9
M552	5.7	13	5	23.7	7.9
ICSU 700	16.5	16.13	14.5	47.3	15.77
ICSU 93046	15.7	9.9	14.7	40.3	13.43
ICBR93034	12.1	12.5	10.9	35.5	11.83
Bakakew	7.5	8.9	4.7	21.1	7.03
SUB TOTAL	67.4	70.2	60	197.6	65.86
TOTAL	142.5	138	124.2	404.7	134.89

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	10.40	9.90	20.30	10.15
E_2	9.43	7.90	17.33	8.67
E_3	15.73	15.77	31.50	15.75
E_4	14.93	13.43	28.37	14.18
E_5	11.97	11.83	23.80	11.90
E_6	6.57	7.03	13.60	6.80
Total	69.03	65.87	134.90	
Mean	11.51	10.98		11.24

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	15.155	7.578	3.46^{ns}	19.00	99.00
Main plot (A)	1	2.507	2.507	1.14^{ns}	18.51	98.50
Error (a)	2	4.384	2.192			
Sub-plot (B)	5	341.776	68.355	11.71^{**}	2.71	4.10
AxB	5	5.125	1.025	0.18^{ns}	2.71	4.10
Error (b)	20	116.721	5.836			
Total	35	485.668				

** - highly significant ns-not significant CV (a) = 13.17 CV (b) = 21.49

Appendix 24. Stalk sugar content (Middle)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	13.7	10.2	10.6	34.5	11.5
M552	8.5	5.2	4.8	18.5	6.17
ICSU 700	17	17.8	17	51.8	17.27
ICSU 93046	16.9	16.5	17.9	51.3	17.1
ICBR93034	13.7	16.4	12.4	42.5	14.17
Bakakew	5.2	5.2	6.8	17.2	5.73
SUB TOTAL	75	71.3	69.5	215.8	71.93
CS2					
SPV 422	9.9	9	9.4	28.3	9.43
M552	8.2	10.2	5	23.4	7.8
ICSU 700	17.7	19.1	15.9	52.7	17.57
ICSU 93046	17.2	15.5	16.9	49.6	16.53
ICBR93034	10.7	9.7	10.3	30.7	10.23
Bakakew	9.9	9.7	5.2	24.8	8.27
SUB TOTAL	73.6	73.2	62.7	209.5	69.83
TOTAL	148.6	144.5	132.2	425.3	141.76

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	11.50	9.43	20.93	10.47
E_2	6.17	7.80	13.97	6.98
E_3	17.27	17.57	34.83	17.42
E_4	17.10	16.53	33.63	16.82
E_5	14.17	10.23	24.40	12.20
E_6	5.73	8.27	14.00	7.00
Total	71.93	69.83	141.77	
Mean	11.99	11.64		11.81

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB} 0.05	F_{TAB} 0.01
Replication	2	12.141	6.070	3.78^{ns}	19.00	99.00
Main plot (A)	1	1.103	1.103	0.69^{ns}	18.51	98.50
Error (a)	2	3.215	1.607			
Sub-plot (B)	5	629.345	125.869	53.19^{**}	2.71	4.10
AxB	5	42.756	8.551	3.61^{*}	2.71	4.10
Error (b)	20	47.324	2.366			
Total	35	735.883				

** - highly significant
*-significant
ns-not significant
CV (a) = 10.73
CV (b) = 13.02

Appendix 25. Stalk sugar content (Tip)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	7.7	7.1	4.4	19.2	6.4
M552	4.1	5.3	4.4	13.8	4.6
ICSU 700	16.5	13.6	15.3	48.4	16.13
ICSU 93046	15.5	17.5	16.8	49.8	16.6
ICBR93034	11.1	6.9	5.7	23.7	7.9
Bakakew	4.8	5	7.3	17.1	5.7
SUB TOTAL	59.7	58.4	53.9	172	57.33
CS2					
SPV 422	5.2	7.2	5.4	17.8	5.93
M552	8.6	7.6	5.3	21.5	7.17
ICSU 700	16	16.8	13.9	46.7	15.57
ICSU 93046	15.7	15.7	15	46.4	15.47
ICBR93034	9.3	4.8	5.2	19.3	6.43
Bakakew	8.8	9.3	4.8	22.9	7.63
SUB TOTAL	63.6	61.4	49.6	174.6	58.2
TOTAL	123.3	119.8	103.5	346.6	115.53

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	6.40	5.93	12.33	6.17
E_2	4.60	7.17	11.77	5.88
E_3	16.13	15.57	31.70	15.85
E_4	16.60	15.47	32.07	16.03
E_5	7.90	6.43	14.33	7.17
E_6	5.70	7.63	13.33	6.67
Total	57.33	58.20	115.53	
Mean	9.56	9.70		9.63

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	18.611	9.305	5.52^{ns}	19.00	99.00
Main plot (A)	1	0.188	0.188	0.11^{ns}	18.51	98.50
Error (a)	2	3.371	1.685			
Sub-plot (B)	5	723.436	144.687	63.51^{**}	2.71	4.10
AxB	5	21.262	4.252	1.87^{ns}	2.71	4.10
Error (b)	20	45.566	2.278			
Total	35	812.432				

** - highly significant
ns-not significant

CV (a) = 13.48
CV (b) = 15.68

Appendix 26. Grain moisture content

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422	8.8	8.8	8.7	26.3	8.77
M552	9.0	9.1	9.2	27.3	9.1
ICSU 700	9.0	8.9	9	26.9	8.97
ICSU 93046	9.0	8.9	9	26.9	8.97
ICBR93034	7.9	9	8.8	25.7	8.57
Bakakew	8.8	8.9	9	26.7	8.9
SUB TOTAL	52.5	53.6	53.7	149.8	49.93
CS2					
SPV 422	9.1	8.9	9.1	27.1	9.03
M552	8.8	9	8.7	26.5	8.83
ICSU 700	8.9	8.7	9	26.6	8.87
ICSU 93046	9	8.6	8.9	26.5	8.83
ICBR93034	8.7	9.1	8.8	26.6	8.87
Bakakew	9	8.8	8.9	26.7	8.9
SUB TOTAL	53.5	53.1	53.4	160	53.33
TOTAL	106	106.7	107.1	309.8	103.26

TWO-WAY TABLE

Treatment	CS1	CS2	Total	Mean
E_1	8.77	9.03	17.80	8.90
E_2	9.10	8.83	17.93	8.97
E_3	8.97	8.87	17.83	8.92
E_4	8.97	8.83	17.80	8.90
E_5	8.57	8.87	17.43	8.72
E_6	8.90	8.90	17.80	8.90
Total	53.27	53.33	106.60	
Mean	8.88	8.88		8.88

ANALYSIS OF VARIENCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F_{COMP}	F_{TAB}	
					0.05	0.01
Replication	2	0.052	0.026	0.47^{ns}	19.00	99.00
Main plot (A)	1	0.001	0.001	0.02^{ns}	18.51	98.50
Error (a)	2	0.111	0.055			
Sub-plot (B)	5	0.220	0.044	0.98^{ns}	2.71	4.10
AxB	5	0.389	0.078	1.73^{ns}	2.71	4.10
Error (b)	20	0.898	0.045			
Total	35	1.670				

ns – not significant

CV (a) = 2.65

CV (b) = 2.39

Appendix 27. Total weight of marketable pods (kg) of bush bean

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422					
M552					
ICSU 700					
ICSU 93046					
ICBR93034					
Bakakew					
SUB TOTAL					
CS2					
SPV 422	3.5	2.1	2.75	8.35	2.78
M552	3	2.6	2.7	8.3	2.77
ICSU 700	3.45	2	2.6	8.05	2.68
ICSU 93046	2.9	3	1.95	7.85	2.62
ICBR93034	3.35	1.9	2.85	8.1	2.7
Bakakew	3.5	2.45	4.5	10.45	3.48
SUB TOTAL	19.7	12.05	17.35	51.1	17.03

Source of Variation	Sum of Squares	df	Mean Square	F_{comp}	F_{tab} 0.05	F_{tab} 0.01
Treatment	1.549	5	.310	$.621^{ns}$	3.11	5.06
Error	5.988	12	.499			
Total	7.538	17				

Ns- not significant

Appendix 28. Total weight of non-marketable pods (kg) bush bean

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
CS1					
SPV 422					
M552					
ICSU 700					
ICSU 93046					
ICBR93034					
Bakakew					
SUB TOTAL					
CS2					
SPV 422	1.3	1.04	1.28	3.62	1.21
M552	1.3	0.78	1.53	3.61	1.2
ICSU 700	0.55	0.55	1.27	2.37	0.79
ICSU 93046	1.29	0.78	1.52	3.59	1.2
ICBR93034	1.27	0.53	1.8	3.6	1.2
Bakakew	1.53	0.78	1.52	3.83	1.28
SUB TOTAL	7.24	4.46	8.92	20.62	7.88

ANALYSIS OF VARIANCE

Source of Variation	Sum of Squares	df	Mean Square	F_{comp}	F_{tab} 0.05	0.01
Treatment	.469	5	.094	$.522^{ns}$	3.11	5.06
Error	2.153	12	.179			
Total	2.622	17				

ns – not significant