BIBLIOGRAPHY

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ABSTRACT

The sudy was conducted to identify bush snapbean variety that is most responsive to a certain kind of soil amendment; determine which soil amendment would give the highest seed yield of bush snapbean; and determine the interaction of soil amendment and different varieties of bush snapbean.

Based on the study, Red Kidney bean was the most responsive to carbonized rice hull as soil amendment in terms of pod width, marketable seed yield per plot and produced the highest CRA. The use of coconut coir dust enhanced earlier seed emergence, days to flowering, taller plants at 90 DAP, higher number of seeds per pod and higher seed yield. The interaction of Contender on coconut coir dust were significantly taller plants than the other treatments at 90 DAP, and the number of seeds observed on Landmark in combination with carbonized rice hull.

With the good performance of Red Kidney bean, it is highly recommended for seed production under La Trinidad, Benguet condition for higher return on cash expenses. Likewise, coconut coir dust as soil amendment is also recommended for taller plants,

higher marketable seed yield thus, higher CRA “Lipstikan” with coconut coir dust as soil amendment could be an alterative choice.

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INTRODUCTION

Bush snapbean (*Phaseolus vulgaris* L.) is an annual season crop that is grown in a wide range of soil condition. It is grown for its fleshy, immature pods as it reaches its maturity from 50 to 60 days depending on climate, weather and soil conditions they are exposed to (Anonymous, 2004).

Snapbean belongs to the *Leguminoseae* Family that is excellent source of protein and vitamins, and one of the most cash crop of the highland people. This can contribute to the energy and body building nutrients for human and easily grown for both fresh market and processing even though they may not require intensive management (Swiader and Ware, 2002).

The nutrient quality of bush beans partly contributes to the solution of malnutrition problem in the country. Aside from the benefit it directly provides to farmers, it is also beneficial in maintaining soil productivity due to the capacity of its roots to fix atmospheric nitrogen in symbiosis with bacteria to make the soil fertile.

The physical and chemical properties of the soil are considered major factors affecting plant growth and development. These are water holding capacity, porosity, bulk density, particle density and soil pH. A knowledge on the maintenance of these soil properties leads to improved production (Cuyahon, 1962).

Most agricultural soils that are continuously grown become acidic making them deficient in calcium. Hence, there is a need to supply lime to the soil to correct the acidity and to supply the calcium ions needed by the plants. The addition of lime increases the soil pH of the soil making it more favorable for microbial growth. It also improves the physical property of the soil such as granulation, aeration and increased water holding capacity of the soil.

Common bean is an important crop. Thus, production should be increased by some producers, practices like the use of good variety and soil amendments should be done to increase production. Successful production of this crop depends much on the adaptability of the variety used, fertility of the soil and cultural management practices employed.

At present, only few farmers are knowledgeable on the good quality and high yielding varieties of snap bean. In this case, there is a need to determine the best variety that is adapted with soil amendments.

These soil amendments include the use of dolomite, coconut coir dust compost and carbonized rice hull. Dolomite is a natural mineral composed of Ca and Mg carbonates and is widely used as a liming material and as an ingredient in mixed fertilizers. It is used to reduce or correct soil acidity, promote beneficial effects on microbial activity, supplies both Ca and Mg as plant food, transforms "dead soil" or "soil poisons" to harmless compound, increase sugar content of fruits and vegetables, protect plant from hypomagnesaemia, prevent chlorosis (yellowish coloring of leaves as a result of deficient chlorophyll production), increases crop yield per hectare thus securing highest return and profits, and eliminate the problem of infertile soil and less productive soil due to acidity (Swerdt, 2003).

Compost fertilizers are also more economical to the farmers than inorganic fertilizers because they don't need too much money to buy inorganic fertilizers fort heir plants. Instead, they make compost to save money (Marquez, 1998).

Coconut coir dust maintains excellent air porosity even when saturated and gives better crop with faster developing roots and more flowers and fruits per plant when used correctly (Evans, 2003).

Carbonized rice hull and coconut coir dust can be incorporated in the soil and it may supply some nutrients to plants, but these are applied mainly as soil conditioner.

The study was conducted to identify bush snapbean variety that is most responsive to certain kind of soil amendment; determine which soil amendment would give the highest seed yield of bush snapbean; and determine the interaction of soil amendments and different varieties of bush snapbeans.

The study was conducted at the Benguet State University Experimental Station at Balili, La Trinidad, Benguet from October 2005 to February 2006.

REVIEW OF LITERATURE

Growth and Seed Yield of Bush Bean

Snapbean is either bushy or viny leguminous plant. The bushy type is determinate in growth habit and the stem elongation ceases when the terminal flower racemes have developed (Martin and Leonard, 1979). Purseglove (1978) stated that dwarf or bush cultivars which do not require support are early maturing while the climbing or pole cultivars which require support take longer periods to mature and have a longer bearing period.

Kudan (1991) reported that the maturity of seed pods starts at 60 days from planting under La Trinidad condition. In warmer areas, it is earlier to mature while in higher elevations takes longer with cooler temperature. Harvesting is dependent on the variety used, location and temperature of the area.

Organic Matter and Soil Amendments

Parnes (1986) claimed that organic matter is the principal source of nitrogen, phosphorous, and sulfur become available as the organic matter continuous to decompose. Most of the calcium, magnesium and potassium in decaying organic residue are discarded by the soil organism during the first stages of decomposition and these nutrients are quickly available to plants. Organic matter through its effect on the conditions of the soil increases the amount of water available for plant growth. Experiment from IRRI showed that carbonated rice hull in whatever form increases nitrogen content of the soil. Soil high in organic matter allows little or no soil-borne diseases of the oxygen and ethylene cycle in the soil.

Not only does humus confer immunity to plan__pest and diseases, it also improves the quality of crops, a characteristic that has a very definite commercial value (Abadilla, 1982).

Erasquin (1981) reported that soil for vegetable production should be rich in organic matter through sustained application of decomposed saw dust and other type of plant residues that are converted to useful soil amendment. Such soil amendments that the saw dust contains about 1.69% phosphoric acid and 6.99% of potash.

When undecomposed sawdust is mixed with the soil, there is harmful effect on particles by soil. However, this nitrogen in excess or that wax provided extends beyond by first season if no more than 3 to 4 tons of dry material per acre added to the soil.

Crockett (1987) stated that organic matter opens up non-porous clays to improve soil physical and chemical properties favorable for root growth. Soil amendments are needed in very porous soils to retain moisture and proper light penetration; and in sandy soils to help in retaining moisture and nutrients. Reduces fluctuation in soil pH, improves soil aeration, facilitates the activities of microorganisms and serve as additional source of nutrients for plants (Vander Wertt, 1997).

Marcelino (1995) stated that organic fertilizer supplies some amount of the nutrient requirements of the crop and promotes favorable soil properties such as granulation, efficient aeration, easy root penetration and improved water holding capacity of the soil.

Effect of Compost

Soil for vegetable production should be rich in organic matter (Pataras, 1984). He mentioned that the best way to achieve this compost is by garden compost, manures and other farm green manures converted to useful soil amendment which when used in farm can improve soil structure making it ideal for vegetable production. Similarly, Andrew (1947) claimed that compost of plant residues is excellent source of organic matter as a soil amendment.

Compost residues are low in nitrogen but high in cellulose and pentosan but thus, they do not decompose easily (Jones, 1982). The dark brown organic matter has a high buffer capacity over a considerable range of pH values, and it serves to stabilize soil structure and improve water infiltration capacity of the soil.

Compost application replenishes soil organic matter or humus being depleted with continuous cropping organism, consequently increasing the availability of nutrient that plants feed on (Marquez, 1998).

Successive application of compost enriched the soil organic matter and improved the physical, chemical and biological properties of the soil. Compost application builds up the absorbing capacity of the soil. Soils with compost have less water evaporation than the soil without compost applied. Therefore, it is recommended that in crop production, it is highly desirable that compost should be applied to increase crop yield and to minimize water evaporation from the soil (Sangatanan, 1990).

Effect of Coconut Coir Dust

Vavriva (1992) reported that coir dust is biodegradable and has superior structural ability, water absorption ability and drainage, and cation exchange capacity compared to either sphagnum peat or sedge peat. He also explained that small amount of nitrogen draw down (N kept from availability to plants during decomposition of organic matter amendments low in nitrogen) occurred with coir dust, but typical production fertilization practices would likely compensate for the amount of nitrogen loss.

A study performed in the mid- 1990s at Iowa State University, researchers found that a mix of 80% coir and 20% perlite provides the greater height of petunia and marigold (Francois, 2003).

Savithri (1993) stated that high level of potassium present in coir dust proves more a benefit than a detriment to plant growth. The higher pH of coir dust may allow less time to add the coir dust based medium.

Effect of Dolomite

Dolomite ($CaCO_3.MgCO_3$) is a natural mineral compost of 39% Mg carbonate (equiv. to 11.5% Mg) and 5% Ca carbonate (equiv. to 24% Ca). The calcium content neutralizes the acidity of the soil as a result of prolonged used of commercial fertilizer and effective in reducing the number of empty pods while Mg content provides the essential elements for the production of chlorophyll responsible for green coloring of plant and protecting leaves from sunlight (Schwerdt, 2003).

Crops with Mg deficiency are likely observed with hypomagnesaemia or "grass tetany" which is characterized by thinning of crop leaves and occurrence of losing chlorophyll in the plant. This inevitably results to low crop yield. This deficiency can only be overcome by treating soil with liming materials that has balance formula of Ca-Mg element such as dolomite (Schwerdt, 2003).

Addition of dolomite will tremendously increase the benefit that could be demanded from the coconut coir dust as calcium and magnesium become also available for plant.

Dolomite is a natural mineral composed of Ca and Mg carbonates and is widely used to remedy soil acidity. It promotes beneficial effect on microbial activities, supplies both Ca and Mg as plant food, transform "dead soil" or soil "poisons" to harmless compound, increase sugar content of fruits and vegetables, protect plant from hypomagnesae, prevent chlorosis (yellowish coloring of leaves as a result of deficient chlorophyll production), increases crop yield per hectare thus securing highest return and profits, and eliminate the problem of soil infertility and low productivity due to acidity (Cuyahon and Marquez, 2001).

Effect of Carbonized Rice Hull (CRH)

PHILRICE (2003) in their report "Hybrid Rice Production Technology" stated that the application of 10-15 big of CRH for every $400m^2$ seedbed makes the soil loose and friable. This will facilitate pulling of seedlings and minimize root damage. Rice yield can be improved over and above yield obtained with regular use of fertilizer by addition of rice hull ash. Rice hull can also serve as a moisture retention helper or as a weed growth inhibitor in the soil. When rice hull is burned, the remaining ash serves as mix for fertilizer. Finely ground rice hulls are also used as a component in commercial mixed fertilizer. The rice hulls prevent caking of other fertilizer components.

In Japan, farmers had been using carbonized (partially burnt) rice hulls as soil conditioner (Vien, 2003).

Tadeo (2003) claimed that CRH is an excellent soil conditioner. Continuous application of CRH replenished the nutrients lost from the soil as a result of continuous use of inorganic fertilizers. When applied to the soil, CRH artificially prolongs the duration of sunlight that increases soil and water temperature. It has high air permeability since it is porous and bulky, and has the ability to replenish air in the soil. It is also a favorable habitat for beneficial microorganisms in the soil because it is sterilized and free from disease organisms.

Moreover, CRH is an excellent ingredient for bioorganic fertilizer, it can be mixed with other farm and kitchen wastes plus microbial inoculants for making bioorganic fertilizer.

Huang and Lin (2001) in their study “Growing Media for Arum Llilies” tested the effectivity of bark compost, bagasse, coconut fiber and carbonized rice hull, mixed with each other or with peat moss. The tested plants grew normally in all mixed media and were comparable to those grown in peat moss only. *Spathiphyllum petite,* vegetatively propagated pot plant showed that media mixed with carbonized rice hull produced plant with more tillers.

Effect of Soil Amendments on Soil Properties

According to Carandang (1968) as stated by Mabazza (1997), soil for vegetable production should be rich in organic matter through sustained application of decomposed saw dust and other type of plant residue that the converted useful soil amendment such as soil amendment improves soil structure is good for vegetable production. Furthermore, he found that sawdust contains about 1.69% of phosphoric acid and 6.99% of potassium.

Pontailler (1964) cited that most soil contain important quantities of soil amendments such as free lime, even if the soil is relatively poor in lime. Lime is useful, however, not only providing the crop with nutrients, in which cases supplies added by calcium fertilizers C nitrate of lime, cyanamide, copper phosphate, raw phosphates, slag, *etc.* would be sufficient. Lime also affects the physical state of soil and influences ploughing operation (Pandosen, 1980).

MATERIALS AND METHODS

An area of $400m^2$ was thoroughly prepared for planting. The area was divided into 16 plots, each measuring 1m x 8 m. Three seeds were sown manually by hill method with a distance of 30 cm between hills and rows.

The different soil amendments were applied and thoroughly mixed with the soil 10 days before planting to hasten decomposition and to enhance faster reaction with the soil. The experiment was laid out following the two factor factorial in randomized complete block design (RCBD) with three replications.

Soil samples were taken before and after the study for analyses of the initial and final pH, organic matter, nitrogen, potassium and phosphorous contents at the Bureau of Soils, Pacdal, Baguio City.

The varieties (Factor A) and the different soil amendments (Factor B) were the following:

Factor A: Variety	Factor B: Soil Amendments
V_1 - Land Mark	S_1 - Coconut coir dust (5t/ha)
V_2 - Contender	S_2- Carbonized rice hull (5t/ha)
V_3 - Red Kidney Bean	S_3 - Dolomite (2t/ha)
V_4 - “Lipstikan”	S_4 - Garden compost (6t/ha)

Data Gathered:

A. Meteorological Data. The following data were taken every week from the BSU-PAGASA Agro Station:

1. Sunshine duration (minutes)
2. Relative humidity (%)

3. Air temperature (minimum and maximum; ^{0}C)

4. Rainfall (mm)

B. Soil Chemical Properties

Soil samples taken before and after planting were brought to the Bureau of Soils at Pacdal, Baguio City for analyses.

1. Soil pH

2. Organic matter content of the soil (%)

3. N (%), P and K (ppm)

C. Growth and Yield Data

1. Days to emergence. This was done by counting the days from planting to at least 50% of plants/plot had fully emerged.

2. Days to flowering. This was done by counting the number of days from planting to the time when at least 50% of plants/plot had fully opened flowers.

3. Plant height at 90 DAP (cm). This was taken by measuring the plant height from the ground level to the tip of the youngest leaf of five sample plants using a meter stick during the last harvest of dried pods.

4. Number of seeds per pod. The number of seeds (developed or undeveloped) were counted from 10 random sample pods per treatment.

5. Length of pods (cm). The same sample pods used in data # 4 above were measured from the pedicel end to the blossom end at maximum fresh pod-fill stage or at two months after planting (2 MAP).

6. Width of pods (cm). The width of the ten random sample pods used in data #

5 was measured using a vernier caliper.

7. Weight of marketable dry beans per plot (kg). Seeds free from damages and considered marketable were weighed.

8. Weight of non-marketable dry bean yield per plot (kg). Damaged and deformed seeds and are considered non-marketable were weighed.

9. Total yield (kg). All harvested dry seeds per plot were weighed and recorded.

D. Occurrence of Pests and Diseases. Insect pests and diseases that attacked the plants during the study were identified and the extent of infestation (insect pests) and infection (diseases) were rated using the following scale:

1. Rating scale for insect (Bean fly)

Scale	Description	Remarks
1	no infestation per plot	highly resistant
2	20-30% infestation per plot	moderately resistant
3	31-40% infestation per plot	resistant
4	41-60% infestation per plot	susceptible
5	greater than 60% infestation per plot	highly resistant

2. Rating scale for disease (Bean rust)

Scale	Description	Remarks
1	no infection per plot	highly resistant
2	20-30% infection per plot	moderately resistant
3	31-40% infection per plot	resistant
4	41-60% infection per plot	susceptible
5	greater than 60% infection per plot	highly resistant

E. Return on Cash Expense. The production cost, gross sales, net return, and return on cash expense (ROCE) were determined. The ROCE was computed using the formula:

$$CRA = \frac{\text{Gross Sales - Total Expenses}}{\text{Total Expenses}} \times 100$$

Data Analyses

All the quantitative data measured in the study were statistically analyzed using randomized complete block design (RCBD) with two factor factorial. The differences among the treatment means were tested using the Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Meteorological Data

The temperature, relative humidity and rainfall amount were recorded throughout the conduct of the study are shown in Table 1.

The maximum temperature (24.14^0C) was highest during the first week of November. The minimum temperature was lowest in the first week of January. This temperature range was favorable to the growth of bush snapbean.

Total sunshine ranged from 289.94 to 508 minutes. Relative humidity ranged from 74.71 to 87% which did not favor the increase of bean fly population and bean rust inoculum to cause considerable damage to the plants. Unexpected rainfall was noted throughout the duration of the study especially during the vegetative and fruit development stages where the plants needed much water thereby providing irrigation. When rainfall was not enough to provide water requirement of the bush snapbeans, this was augmented by artificial irrigation.

The climate during the cropping period was found to be suitable for bush snapbean production. However, the unexpected rain during the latter part of the experiment was detrimental to dry bean production as this enhanced seed discoloration thereby making seeds non-marketable.

Table 1. Average weekly climatic data during the study period

PERIOD	RAINFALL (mm)	TEMPERATURE MINIMUM (^0C)	TEMPERATURE MAXIMUM (^0C)	SUNSHINE (min)	RELATIVE HUMIDITY (%)
November					
First week	0	23.87	16.57	355.71	78.14
Second week	5.17	24.14	15.97	290.57	85.59
Third week	1.34	23.20	14.56	292.28	76.00
Fourth week	0	23.37	15.24	327.43	78.86
December					
First week	3.63	23.66	15.33	282.00	74.71
Second week	0.68	21.81	15.37	189.94	83.28
Third week	0.37	22.42	14.87	269.14	80.00
Fourth week	2.37	22.41	12.81	262.28	78.14
Fifth week	3.66	22.74	13.80	294.00	82.28
January					
First week	1.34	21.83	11.44	344.57	84.14
Second week	0	22.98	12.14	580.00	81.25
Third week	2.44	22.14	13.53	340.57	82.00
Fourth week	0.96	22.31	14.66	239.14	87.00

Source: BSU PAGASA Agro Station, Balili, La Trinidad, Benguet

Soil Analyses

Soil pH. After harvest, there was an increase on the soil pH applied with coconut coir dust, dolomite and garden compost. The increase in pH using dolomite is expected since this soil amendment is generally used as liming material to check soil acidity. The similar increase in soil pH applied with coconut coir dust is due to its inherent high pH.

Organic matter content (%). There was an increase on the OM content of the soil applied with coconut coir dust and CRH while there was no change on the initial value of OM content of the soil applied with dolomite and garden compost. The increase on OM content could be attributed to the decomposition of CCD and CRH since both are plant residues while dolomite does not undergo decomposition. This property of coconut coir dust and carbonized rice hull make them more valuable in soil revitalization.

Nitrogen content (%). Among the treatments tested, the soil applied with coconut coir dust and carbonized rice hull increased soil N content by 0.025% while the soil added with dolomite and garden compost did not show similar increase in N content. The slight increase of N content due to CCD and CRH further proves their usefulness in the maintenance of soil integrity and in the overall soil management practice.

Phosphorous content ppm). In terms of phosphorous content, soils applied with dolomite and coconut coir dust had reduced phosphorous content while there was an increase on soil applied with CRH and garden compost. The result showed that application of CRH and garden compost increased the level of phosphorous in the soil.

Potassium content (ppm). There was a reduction of potassium content on soil applied with coconut coir dust, CRH and garden compost as shown by soil analysis. Application of dolomite in the soil before planting increased the potassium content of the soil.

Table 2. Initial and final soil analyses of the experimental area*

	pH	OM(%)	N(%)	P(ppm)	K(ppm)
Before planting	6.17	2.50	0.125	100.00	528.00
After planting					
Coconut coir dust	6.41	3.00	0.150	90.00	432.00
Carbonized rice hull	6.10	3.00	0.150	124.00	476.00
Dolomite	6.96	2.50	0.120	75.00	620.00
Garden compost	6.29	2.50	0.120	120.00	500.00

* Done by the Bureau of Soils, Pacdal, Baguio City

Days to Emergence

Effect of variety. Table 3 shows the number of days from planting to emergence of the four varieties of bush snapbean. It was observed that the Red Kidney bean and "Lipstikan" emerged a day later than the other two varieties which emerged four days after planting (DAP). The difference between traditional and introduced varieties could be attributed to their varietal characteristics where the traditional varieties have more water resilient skin thus they absorbed moisture necessary for germination slower than the introduced varieties.

Effect of soil amendment. It was observed that dolomite and garden compost delayed the emergence of seeds on bush snapbean by one day as compared to the other soil amendments. Statistically, however, no significant difference was revealed.

Interaction effect . Landmark and Contender with the different soil amendment emerged at the same day while Red kidney bean and "Lipstikan' also emerged at the same time but a day later than the two former varieties. Statistically, there was no interaction of bush snapbean varieties and the different soil amendments on the number of days to emergence. Further, the different soil amendments do not in any way had an effect on snapbean emergence.

Days to Flowering

Effect of variety. Among the four varieties of bush snapbeans tested, Landmark and Contender were the earliest to flower at 39 DAP. Red Kidney bean and "Lipstikan" were observed to have flowered one day later. The trend follows that of days to emergence where snapbean varieties that emerged earlier were also noted to have flowered earlier (Table 3).

Effect of soil amendment. Coconut coir dust and carbonized rice hull (CRH) enhanced the flowering of snapbean by one day. The result appeared not conclusive enough to say that the soil amendments had influenced the number of days to flowering.

Interaction effect. From the data gathered, it could be deduced that the number of days to flowering is not influenced by the different soil amendments. The slight differences on the number of days to flowering could be attributed to varietal trait.

Plant Height at Maturity

Effect of variety. The average plant height as affected by bush snapbean is also shown in Table 3. Results showed that Contender was the tallest with a mean of 35.77 followed by Red kidney bean, Landmark and "Lipstikan". Statistical analysis revealed no significant differences on the plant height of the four snapbean varieties.

Effect of soil amendment. Table 3 also shows the height of bush snapbean as affected by the different soil amendments. Statistical analysis revealed no significant differences on the height of the plants applied with the different soil amendments. Although, plants applied with coconut coir dust appear to be the tallest among the treatments.

Interaction effect. Differences on plant height of the different varieties in response to the soil amendments were found to be statistically significant. Contender which was planted on soil with coconut coir dust was the tallest. The shortest plants were noted in Landmark with dolomite as soil amendment.

Other intervening factors necessary for plant growth such as availability of nutrients, light, soil moisture, etc. might have caused the differences in plant height at maturity.

Table 3. Days from planting to emergence, days to flowering and plant height at 90 DAP as affected by variety and soil amendments

TREATMENT	DAYS TO EMERGENCE	DAYS TO FLOWERING	PLANT HEIGHT (cm)
Factor A			
Landmark	4.0	39.0	33.27
Contender	4.0	39.0	35.77
Red Kidney Bean	5.0	41.0	35.41
"Lipstikan"	5.0	41.0	32.40
Factor B			
Coconut coir dust	4.0	39.0	36.26
Carbonized rice hull	4.0	39.0	33.92
Dolomite	5.0	41.0	32.93
Garden compost	5.0	41.0	33.76
Factor A x Factor B			*
CV (%)			11.51

The shortest plants in each variety were noted on garden compost as soil amendment except on "Lipstikan" where garden compost was favorable in influencing its height. The addition of coconut coir dust in the soil favored taller plants in Landmark and Contender, both introduced varieties (Fig. 1).

Length of Pods

Effect of variety. The longest pods were gathered from Contender which was found to be highly significant over the pod length of the other three varieties. The results indicate that bush snapbean varieties have different response in terms of pod length.

Effect of soil amendment. The pod length as affected by the different soil amendments gave comparable result though numerically, longer pods were obtained using garden compost and carbonized rice hull. This indicates that pod development was better sustained by garden compost and carbonized rice hull.

Interaction effect. Based on the interaction data, it can be observed that the different bush snapbean varieties gave varied responses to the different soil amendments. "Lipstikan", a traditional variety in Apayao responded better to carbonized rice hull but gave the shortest pods when in combination with coconut coir dust. The possibility could be that coconut coir dust exudates along the process of decomposition is not favorable to "Lipstikan" thus, it suppressed pod growth in terms of length.

On the other hand, Red kidney bean with almost uniform pod length and Contender responded fairly well on the four soil amendments used while Landmark responded well on garden compost but poorly on dolomite.

Width of Pods

Effect of variety. The two traditional varieties, "Lipstikan" and Red kidney bean gave comparable pod width but were found to be statistically wider than Landmark and Contender (Table 4). In the fresh market, the preferred bean pods are long and narrow (almost pencil-size) which both characters are possessed by Landmark and Contender.

Effect of soil amendment. The width of pods as affected by the different soil amendment is shown in Table 4. Using Garden Compost as soil amendment gave the widest pods followed by plants grown with Dolomite as soil amendment. However, no significant differences were revealed between the four soil amendments to cause differences on the width of pods.

Interaction effect. There were no significant interaction effect between bush snapbean varieties and the four different soil amendments. However, it was observed that the different soil amendments favored wider pods on the two traditional varieties but shorter. And, favored longer pods but narrower on the two introduced varieties.

Number of Seeds per Pod

Effect of variety. Landmark and Contender gave statistically higher number of seeds per pod over Red Kidney bean and "Lipstikan". Since Landmark and Contender were observed to have longer pods and smaller seeds, thus, more seeds developed from each pod.

Effect of soil amendment. As shown in Table 4, there exist significant differences on the number of seeds per pod as affected by the different soil amendments. The least number of seeds was observed on using CRH as soil amendment. Landmark and Contender were found to be comparable but had higher number of seeds per pod compared with Red Kidney bean and "Lipstikan". Using carbonized rice hull as soil additive gave statistically lesser seeds per pod while the three other soil additives gave comparably higher results. With this, it is suffice to say that the use of soil additives influenced the number of seeds per pod.

Interaction effect. It was observed that there were significant interaction effect of variety and soil amendment on the number of seeds per pod. Landmark grown in soil with coconut coir dust and dolomite as soil amendment gave numerically equal number of seeds per pod while those grown with carbonized rice hull and garden soil had lesser seeds. On the other hand, Contender grown in coconut coir dust, dolomite and garden compost as soil amendment developed equal number of seeds per pod which was higher than Contender grown with carbonized rice hull. The result is true with Red Kidney bean which gave the same response to the different soil amendments though numerically lower in value. “Lipstikan” gave similar response to coconut coir dust, carbonized rice hull and garden

Table 4. Length of pods, width of pods, and number of seeds per pod as affected by variety and soil amendments

TREATMENT	LENGTH OF PODS (cm)	WIDTH OF PODS (cm)	NUMBER OF SEEDS PER POD
Factor A			
Landmark	14.53^{b}	1.37^{b}	5.78^{a}
Contender	16.53^{a}	1.41^{b}	5.92^{a}
Red Kidney bean	14.50^{b}	1.65^{a}	3.92^{b}
“Lipstikan”	14.32^{b}	1.63^{a}	4.04^{b}
Factor B			
Coconut coir dust	14.77	1.50	5.04^{a}
Carbonized rice hull	15.00	1.50	4.66^{b}
Dolomite	14.94	1.52	5.07^{a}
Garden compost	15.17	1.55	4.90^{a}
Factor A x Factor B	ns	ns	*
CV (%)	7.53	4.90	5.03

Means with a common letter are not significantly different by DMRT (P 0.05)

compost and gave lesser number of pods as a result of its interaction with dolomite (Fig.2).

<u>Marketable Seeds/Plot</u>

<u>Effect of variety</u>. Red kidney bean though found to have shorter pods that contained lesser number of seeds than Contender, produced heavier marketable seeds (Table 5). This could be attributed to seed size. Though Contender and Landmark produced more seeds, these are smaller compared to the seeds of Red kidney bean and “Lipstikan”.

Effect of soil amendment. The four soil amendments applied to the soil did not show any significant effect on the marketable seed yield. The effect of dolomite on the marketable seed yield of bush snapbean was the poorest while the use of coconut coir dust had the highest seed yield. However, the slight differences in weight was found to be comparable among the four soil amendments.

Interaction effect. The effect of garden compost on Landmark gave the heaviest seed yield while Landmark on carbonized rice hull had the least seed yield which is the opposite on the interaction of Contender on carbonized rice hull, the least yield was obtained on Contender planted with coconut coir dust. On the other hand, the response of Red kidney bean on dolomite and garden compost was the similar and found to be lower than the seeds produced by Red kidney bean with carbonized rice hull. The production of better seed yield in "Lipstikan" is favored by the use of coconut coir dust and the best for Red kidney bean is with the use of carbonized rice hull as soil amendment.

There were no significant interaction effect between variety and soil amendment observed on the marketable seed yield.

Non-Marketable Bean Seeds

The non-marketable seed yield considered in sorting the seeds were those that were too small or underdeveloped and those that showed damages and were deemed not fit for human consumption and as seed stock.

Effect of variety. Statistical analysis showed that Landmark and Contender showed significantly higher non-marketable seed yield compared with Red Kidney bean and "Lipstikan". Contender produced the heaviest non-marketable seed yield followed by Landmark, the least was obtained from "Lipstikan" (Table 5). Rainfall during the field drying of bean pods was the major contributory factor. It appeared that dry pods of the two introduced varieties had the tendency to absorb moisture easily thus causing damage to the seeds.

Effect of soil amendment. The use of soil amendments did not have an effect on the non-marketable seed yield of bush snapbean because at field drying stage of bean pods it is the above-ground environment that intervened. The four soil amendments applied did not significantly contribute to the non-marketable seed yield of bush snapbean.

Interaction effect. No significant interaction between variety and soil amendments on the weight of non-marketable seed yield was observed.

Total Seed Yield Per Plot

Effect of variety. Red Kidney bean produced numerically the heaviest dry seed yield but was found statistically similar with the other varieties. This could be that Red Kidney bean being a traditional variety is adapted to the growing conditions of the locality.

Effect of soil amendment. The result indicates that using soil amendments did not in any way influenced the production of dry seeds though it was observed that addition of coconut coir dust gave the highest seed yield.

Interaction effect. There was no significant interaction effect between the varieties and soil amendments applied on the seed yield of bush snapbean.

Reaction to Bean Fly and Bean Rust

It was observed that all the varieties grown with the different soil amendments were moderately resistant against bean fly and bean rust (Table 6). This reaction, however, may have been affected by the relatively low temperature that prevailed during the experiment. The prevalence of bean fly and bean rust is usually associated with higher temperature and humid conditions.

Table 5. Weight of marketable, non-marketable, and total seed yield/plot as affected by variety and soil amendments

TREATMENT	SEED YIELD		TOTAL SEED YIELD
	MARKETABLE ($kg/8m^2$)	NON-MARKETABLE ($kg/ 8 m^2$)	($kg/ 8 m^2$)
Factor A			
Landmark	1.14[b]	0.173[a]	1.313
Contender	1.21[b]	0.235[a]	1.443
Red Kidney Bean	1.66[a]	0.085[b]	1.758
“Lipstikan”	1.39[ab]	0.081[b]	1.472
Factor B			
Coconut coir dust	1.43	0.142	1.594
Carbonized rice hull	1.36	0.134	1.496
Dolomite	1.26	0.131	1.396
Garden compost	1.33	0.167	1.501
Factor A x Factor B	ns	ns	ns
CV (%)	28.35	73.28	29.61

Means with a common letter are not significantly different by DMRT (P 0.05)

Table 6. Reaction of four snapbean varieties to bean fly and bean rust as affected by variety and soil amendments

VARIETY	BEAN FLY	BEAN RUST
Landmark	2.0	2.0
Contender	2.0	2.0
Red Kidney Bean	2.0	2.0
“Lipstikan”	2.0	2.0

==

Cost and Return Analysis (CRA)

Varietal effect. All the four snapbean varieties evaluated for seed production were found to be profitable under La Trinidad, Benguet condition as evidenced by the computed cost and return analysis (Table 7). It was observed that Red Kidney bean gave the highest return on cash expense (251.85%). “Lipstikan” and Contender followed with 188.00% and 150.05%. The least cost and return analysis was obtained on Landmark with 136.05% but the figure is still considered high.

Effect of soil amendment. The cost and return analysis of bush snapbean plants as affected by the different soil amendments is shown in Table 7. It was observed that the plants applied with garden compost registered the highest cost and return analysis (194.66%) while plants applied with CCD and CRH had an CRA of 186.65% and 183.33%, respectively. The plants applied with dolomite had the lowest CRA with 162.62%. Bush snapbean for seed production with any of the four soil amendments applied had been proven to be profitable.

Interaction effect. The highest CRA was obtained from Red Kidney bean planted on soil added with CRH while the lowest CRA was obtained from Landmark using CRH as soil amendment (Table 7).

Table 7. Cost and return analysis of producing four bush snapbean varieties under La Trinidad, Benguet

VARIETY	SEED YIELD (kg)	GROSS SALES (PhP)	TOTAL EXPENSES (PhP)	NET INCOME (PhP)	CRA (%)
Landmark	13.68	4104.00	2197.30	2365.50	107.65
Contender	14.49	4347.00	2197.30	2608.50	118.71
Red kidney bean	20.39	5097.50	2197.30	2900.20	131.99
"Lipstikan"	16.69	4172.50	2197.30	1975.20	89.89

Total expenses include land preparation, seeds, cost of soil amendment, care and management includes weeding, watering and spraying

- Selling Price: Landmark & Contender = PhP300.00/kg
  Red Kidney bean & "Lipstikan" = PhP250.00/kg

Table 8. Cost and reteurn analysis of producing four bush snapbean varieties with soil amendment under La Trinidad, Benguet

SOIL AMEND MENTS	SEED YIELD (kg)	GROSS SALES (PhP)	TOTAL EXPENSES (PhP)	NET INCOME (PhP)	CRA (%)
Coconut coir dust	17.18	4625.50	1798.00	2827.50	157.26
Carbonized rice hull	16.32	4435.50	1728.00	2707.50	156.68
Dolomite	15.74	4305.00	1798.00	2507.00	139.43
Garden Compost	16.01	4356.00	1630.00	2726.00	167.24

Total expenses include land preparation, seeds, cost of soil amendment, care and management includes weeding, watering and spraying

- Selling Price: Landmark & Contender = PhP300.00/kg
  Red Kidney bean & "Lipstikan" = PhP250.00/kg

Table 9. Cost and return analysis of producing four bush snapbean varieties applied with different soil amendments under La Trinidad, Benguet

VARIETY	SEED YIELD (kg)	GROSS SALES (PhP)	TOTAL EXPENSES (PhP)	NET INCOME (PhP)	CRA (%)
Landmark					
Coconut coir dust	3.56	1068.00	564.40	503.60	89.23
Carbonized rice hull	2.92	876.00	564.60	329.40	60.26
Dolomite	3.40	1020.00	564.40	455.60	80.78
Garden compost	3.80	1140.00	521.90	618.10	118.43
Contender					
Coconut coir dust	3.05	915.00	564.40	760.60	62.83
Carbonized rice hull	3.19	1257.00	564.60	710.40	128.97
Dolomite	4.00	1200.00	564.40	635.60	112.66
Garden compost	3.25	975.00	521.90	453.10	86.82
Red Kidney Bean					
Coconut coir dust	5.30	1325.00	564.40	760.40	134.76
Carbonized rice hull	5.60	1400.00	564.60	853.40	156.13
Dolomite	4.74	1185.00	564.40	620.60	109.97
Garden compost	4.75	1187.50	521.90	665.60	127.53
"Lipstikan"					
Coconut coir dust	5.27	1317.50	564.40	753.10	133.43
Carbonized rice hull	3.61	902.50	564.60	355.90	65.11
Dolomite	3.60	900.00	564.40	335.90	59.46
Garden compost	4.21	1053.50	521.90	530.60	101.67

Total expenses include land preparation, seeds, cost of soil amendment, care and management includes weeding, watering and spraying

Selling Price: Landmark & Contender = PhP300.00/kg

Red Kidney bean & "Lipstikan" = PhP250.00/kg

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted at the BSU Experimental Station to identify bush snapbean variety that is most responsive to certain kind of soil amendment; determine which soil amendment would give the highest yield of bush snapbean; and determine the interaction of soil amendments and different varieties of bush snapbeans.

The longest pods were gathered from Contender. The results indicate that bush snapbean varieties have different response in terms of pod length. Also, longer pods were obtained using garden compost and carbonized rice hull. "Lipstikan", a traditional variety in Apayao responded better to carbonized rice hull treatment but gave the shortest pods on coconut coir dust. Furthermore, the two traditional varieties, "Lipstikan" and Red kidney bean had comparable pod width. Using garden compost as soil amendment gave the widest pods. The different soil amendments favored wider but shorter pods on the two traditional varieties. Landmark and Contender exhibited higher number of seeds per pod comparable to Red Kidney Bean and "Lipstikan". Using carbonized rice hull as soil additive gave lesser seeds per pod. Landmark grown in soil with coconut coir dust and dolomite as soil amendment gave numerically equal number of seeds per pod while those grown with carbonized rice hull and garden soil had lesser seeds. On the other hand, Contender grown in coconut coir dust, dolomite and garden compost as soil amendment developed equal number of seeds per pod. Compared to Landmark and Contender, "Lipstikan" and Red Kidney bean produced lower number of seeds when grown using any of the soil amendments.

Contender and Landmark produced more but smaller seeds. The effect of dolomite on the marketable seed yield of bush snapbean was the poorest while the use of coconut coir dust had the highest seed yield. Garden compost on Landmark gave the heaviest seed yield while Landmark on carbonized rice hull had the least seed yield. On the other hand, the response of Red kidney bean to dolomite and garden compost was similar and found to be lower than the seeds produced by Red Kidney bean with carbonized rice hull. The production of better seed yield in "Lipstikan" is favored by the use of coconut coir dust and the best for Red kidney bean is with the use of carbonized rice hull as soil amendment. Landmark and Contender had higher non-marketable seed yield compared with Red Kidney Bean and "Lipstikan". The four soil amendments applied appear to favor the production of marketable seeds of bush snapbean.

Red Kidney bean produced the heaviest seed yield while Contender had the lowest. Also, Red Kidney on coconut coir dust and on carbonized rice hull produced high CRA.

Conclusion

Red Kidney bean was the most responsive to carbonized rice hull as soil amendment in terms of pod width, marketable seed yield per plot thus gave the highest return on cash expenses. The use of coconut coir dust enhanced earlier seed emergence, days to flowering, taller plants at 90 DAP, higher number of seed per pod and higher seed yield.

Contender on coconut coir dust were significantly taller than the other treatments at 90 DAP. The number of seeds observed on Landmark in combination with carbonized rice hull were significantly higher. The cost and return analysis observed on Red Kidney bean in combination with carbonized rice hull was high.

Recommendation

With the good performance of Red Kidney bean, it is highly recommended for seed production under La Trinidad, Benguet condition for higher return on cash expense. Likewise, coconut coir dust as soil amendment is also recommended for taller plants, higher marketable seed yield thus, will give high CRA. “Lipstikan” with coconut coir dust as soil amendment could be an alterative choice.

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APPENDICES

APPENDIX TABLE 1. Weekly climatic data during the study period

PERIOD	RAINFALL (mm)	TEMPERATURE MINIMUM (^0C)	TEMPERATURE MAXIMUM (^0C)	SUNSHINE (min)	RELATIVE HUMIDITY (%)
Nov. 10, 2005	5.20	15.2	24.8	48	82
Nov. 17, 2005	0.00	13.6	23.2	420	83
Nov. 2, 2005	0.00	13.3	22.4	456	84
Dec. 1, 2005	0.00	14.5	23.8	354	75
Dec. 8, 2005	0.00	15.8	23.4	114	77
Dec. 15, 2005	0.00	14.8	21.9	246	89
Dec. 22, 2005	0.00	14.2	23.5	342	77
Dec. 29, 2005	0.00	15.2	23.0	18	83
Jan. 5, 2006	4.80	11.0	22.0	408	82
Jan. 12, 2006	0.00	7.5	21.0	588	76
Jan. 19, 2006	0.00	11.6	23.0	528	59
Jan. 26, 2006	1.90	14.5	21.5	174	95
Feb. 2, 2006	0.00	14.5	23.5	372	69

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APPENDIX TABLE 2. Soil pH, organic matter (OM) and NPK content of the soil before and after planting*

	pH	OM(%)	N(%)	P(ppm)	K(ppm)
Before planting	6.17	2.50	0.12	100.00	528.00
After planting					
Coconut coir dust	6.41	3.00	0.15	90.00	432.00
Carbonized rice hull	6.10	3.00	0.15	124.00	476.00
Dolomite	6.96	2.50	0.12	75.00	620.00
Garden compost	6.29	2.50	0.12	120.00	500.00

*Done by the Bureau of Soils, Pacdal, Baguio City

APPENDIX TABLE 3. Days to emergence

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
V_1S_1	4.0	4.0	4.0	12.0	4.0
S_2	4.0	4.0	4.0	12.0	4.0
S_3	4.0	4.0	4.0	12.0	4.0
S_4	4.0	4.0	4.0	12.0	4.0
V_2S_1	4.0	4.0	4.0	12.0	4.0
S_2	4.0	4.0	4.0	12.0	4.0
S_3	4.0	4.0	4.0	12.0	4.0
S_4	4.0	4.0	4.0	12.0	4.0
V_3S_1	5.0	5.0	5.0	15.0	5.0
S_2	5.0	5.0	5.0	15.0	5.0
S_3	5.0	5.0	5.0	15.0	5.0
S_4	5.0	5.0	5.0	15.0	5.0
V_4S_1	5.0	5.0	5.0	15.0	5.0
S_2	5.0	5.0	5.0	15.0	5.0
S_3	5.0	5.0	5.0	15.0	5.0
S_4	5.0	5.0	5.0	15.0	5.0
TOTAL					

APPENDIX TABLE 4. Days to flowering

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
V_1S_1	39.0	39.0	39.0	117.0	39.0
S_2	39.0	39.0	39.0	117.0	39.0
S_3	39.0	39.0	39.0	117.0	39.0
S_4	39.0	39.0	39.0	117.0	39.0
V_2S_1	39.0	39.0	39.0	117.0	39.0
S_2	39.0	39.0	39.0	117.0	39.0
S_3	39.0	39.0	39.0	117.0	39.0
S_4	39.0	39.0	39.0	117.0	39.0
V_3S_1	41.0	41.0	41.0	123.0	41.0
S_2	41.0	41.0	41.0	123.0	41.0
S_3	41.0	41.0	41.0	123.0	41.0
S_4	41.0	41.0	41.0	123.0	41.0
V_4S_1	41.0	41.0	41.0	123.0	41.0
S_2	41.0	41.0	41.0	123.0	41.0
S_3	41.0	41.0	41.0	123.0	41.0
S_4	41.0	41.0	41.0	1230	41.0
TOTAL					

APPENDIX TABLE 5. Plant height at 90 DAP (cm)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
V_1S_1	37.20	34.34	30.60	101.96	33.99
S_2	41.42	28.00	29.58	99.00	33.00
S_3	28.30	29.16	29.88	87.34	29.11
S_4	39.72	35.80	35.50	111.02	27.00
V_2S_1	39.86	40.74	44.72	125.32	41.77
S_2	35.88	39.56	34.18	109.62	36.54
S_3	39.56	30.46	34.86	104.88	35.57
S_4	35.34	29.86	24.30	89.50	29.83
V_3S_1	36.90	38.60	31.20	106.70	35.57
S_2	34.02	38.74	32.32	105.08	35.03
S_3	39.70	33.70	39.64	113.04	37.68
S_4	29.16	37.36	33.54	100.06	33.35
V_4S_1	31.66	32.78	36.70	101.14	33.71
S_2	39.64	27.80	25.90	103.34	34.45
S_3	31.46	26.56	31.76	89.78	29.92
S_4	33.46	37.28	33.84	104.58	34.86
TOTAL					

TWO-WAY TABLE

VARIETY	SOIL AMENDMENT CCD	CRH	DOLOMITE	GARDEN COMPOST	TOTAL	MEAN
LANDMARK	1021.60	990.00	873.40	1110.20	3995.20	332.93
CONTENDER	1253.20	1096.20	1048.80	895.00	4293.20	357.77
RED KIDNEY BEAN	1067.00	1050.80	1130.40	1000.60	4248.80	354.07
“LIPSTIKAN”	1011.40	933.40	897.80	1045.80	3888.40	324.03
TOTAL	4353.20	4070.40	3950.40	4051.60	16425.20	
MEAN						342.20

ANALYSIS OF VARIANCE

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	TABULAR F 0.01
Replication	2	66.250	33.125			
Factor A	3	96.258	32.086	2.0672	2.92	4.51
Factor B	3	73.801	24.600	1.5849	2.92	4.51
AB	9	314.589	34.954	2.2520	2.21	3.06
Error	30	465.652	15.522			
TOTAL	47	1016.550				

Coefficient of variation = 11.51%

APPENDIX TABLE 6. Number of seeds per pod

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
V_1S_1	6.10	5.90	6.00	18.00	6.00
S_2	6.20	5.40	5.30	16.90	5.33
S_3	5.70	6.20	6.10	18.00	6.00
S_4	5.40	6.00	5.10	16.50	5.50
V_2S_1	6.00	6.10	6.30	18.40	6.00
S_2	5.70	5.20	5.00	15.90	5.00
S_3	6.50	6.30	6.00	18.80	6.00
S_4	6.10	6.00	5.90	18.00	6.00
V_3S_1	4.10	4.00	4.00	12.10	4.00
S_2	3.80	3.10	3.90	10.80	3.60
S_3	4.10	4.00	4.00	12.10	4.00
S_4	4.10	3.90	4.10	12.10	4.00
V_4S_1	4.00	4.00	4.00	12.00	4.00
S_2	4.10	4.20	4.00	12.30	4.00
S_3	3.90	4.00	4.00	11.90	3.90
S_4	4.20	3.90	4.10	12.20	4.00
TOTAL					

TWO-WAY TABLE

VARIETY	SOIL AMENDMENT CCD	CRH	DOLOMITE	GARDEN COMPOST	TOTAL	MEAN
LANDMARK	18.00	16.90	18.00	16.50	69.40	5.78
CONTENDER	18.40	15.90	18.80	18.00	71.40	5.92
RED KIDNEY BEAN	12.10	10.80	12.10	12.10	47.10	3.92
“LIPSTIKAN”	12.00	12.34	11.90	12.20	48.44	4.04
TOTAL	60.50	55.94	60.80	58.80	236.34	
MEAN					4.92	

ANALYSIS OF VARIANCE

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	TABULAR F 0.01
Replication	2	0.167	0.084			
Factor A	3	42.308	14.103	230.0586**	2.92	4.51
Factor B	3	1.241	0.414	6.7488**	2.92	4.51
AB	9	1.480	0.164	2.6820*	2.21	3.06
Error	30	1.839	0.061			
TOTAL	47	47.035				

Coefficient of variation = 5.03%

APPENDIX TABLE 7. Length of pods (cm)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
V_1S_1	12.74	15.85	14.06	42.65	14.22
S_2	14.87	14.42	13.34	42.63	14.21
S_3	14.62	14.37	12.92	41.91	13.97
S_4	16.23	15.95	14.96	47.14	15.71
V_2S_1	15.52	17.54	18.12	51.18	17.06
S_2	16.94	13.84	17.42	48.20	16.07
S_3	15.83	17.24	17.83	50.90	16.97
S_4	16.67	16.58	14.85	48.10	16.03
V_3S_1	14.48	15.08	13.91	43.47	14.49
S_2	14.03	14.44	14.93	43.40	14.47
S_3	13.81	16.45	14.08	44.34	14.78
S_4	13.06	15.33	14.42	42.81	14.27
V_4S_1	14.53	12.89	12.52	39.94	13.31
S_2	16.43	14.94	14.41	45.78	15.26
S_3	14.61	14.03	13.55	42.19	14.06
S_4	15.22	13.47	15.24	43.93	14.64
TOTAL					

TWO-WAY TABLE

VARIETY	SOIL AMENDMENT CCD	CRH	DOLOMITE	GARDEN COMPOST	TOTAL	MEAN
LANDMARK	42.65	42.63	41.91	47.14	174.33	14.53
CONTENDER	51.18	48.20	50.90	48.10	198.38	16.53
RED KIDNEY BEAN	43.47	43.40	44.34	42.81	174.02	14.50
“LIPSTIKAN”	39.94	45.78	42.19	43.93	171.84	14.32
TOTAL	177.24	180.01	179.34	181.98	718.57	
MEAN						14.97

ANALYSIS OF VARIANCE

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	TABULAR F 0.01
Replication	2	1.074	0.537			
Factor A	3	39.317	13.106	10.3093**	2.92	4.51
Factor B	3	0.955	0.318	0.2505ns	2.92	4.51
AB	9	14.187	1.576	1.2399ns	2.21	3.06
Error	30	38.138	1.271			
TOTAL	47	93.671				

Coefficient of variation = 7.53%

APPENDIX TABLE 8. Width of pods (cm)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
V_1S_1	1.30	1.32	1.39	4.01	1.34
S_2	1.22	1.36	1.30	3.88	1.29
S_3	1.28	1.35	1.41	4.04	1.35
S_4	1.70	1.37	1.43	4.50	1.50
V_2S_1	1.40	1.31	1.46	4.17	1.39
S_2	1.50	1.40	1.37	4.27	1.42
S_3	1.41	1.43	1.43	4.27	1.42
S_4	1.46	1.35	1.41	4.22	1.41
V_3S_1	1.54	1.70	1.70	4.94	1.65
S_2	1.70	1.63	1.64	4.97	1.65
S_3	1.64	1.66	1.74	5.04	1.68
S_4	1.56	1.67	1.66	4.89	1.63
V_4S_1	1.63	1.62	1.67	4.92	1.64
S_2	1.60	1.59	1.65	4.84	1.61
S_3	1.64	1.60	1.64	4.88	1.63
S_4	1.51	1.72	1.71	4.94	1.65
TOTAL					

TWO-WAY TABLE

VARIETY	SOIL AMENDMENT CCD	CRH	DOLOMITE	GARDEN COMPOST	TOTAL	MEAN
LANDMARK	10.16	8.76	12.44	10.67	42.03	3.50
CONTENDER	11.68	12.37	12.77	12.22	49.04	4.09
RED KIDNEY BEAN	19.05	19.66	20.38	18.91	78.00	6.50
"LIPSTIKAN"	19.22	18.36	18.76	19.49	75.83	6.32
TOTAL	60.11	59.15	64.35	61.29	244.90	
MEAN						5.10

ANALYSIS OF VARIANCE

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	TABULAR F 0.01
Replication	2	0.011	0.006			
Factor A	3	0.778	0.259	46.9863**	2.92	4.51
Factor B	3	0.017	0.006	1.0389ns	2.92	4.51
AB	9	0.064	0.007	1.2934ns	2.21	3.06
Error	30	0.166	0.006			
TOTAL	47	1.037				

Coefficient of variation = 4.90%

APPENDIX TABLE 9. Weight of marketable dry seed yield (kg)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
V_1S_1	1.56	1.25	0.75	3.56	1.19
S_2	0.92	1.25	0.75	2.92	0.97
S_3	1.25	1.40	0.75	3.40	1.13
S_4	1.70	1.10	1.00	3.80	1.27
V_2S_1	1.25	1.00	0.80	3.05	1.02
S_2	1.27	1.44	1.50	4.19	1.40
S_3	1.85	0.90	1.25	4.00	1.33
S_4	1.90	0.95	0.40	3.25	1.08
V_3S_1	2.80	1.25	1.25	5.30	1.77
S_2	2.70	1.50	1.40	5.60	1.87
S_3	1.24	1.60	1.24	4.74	1.58
S_4	1.25	1.90	1.60	4.75	1.58
V_4S_1	2.27	1.50	1.50	5.27	1.76
S_2	1.10	1.25	1.26	3.61	1.20
S_3	1.35	1.25	1.00	3.60	1.20
S_4	1.30	1.27	1.64	4.21	1.40
TOTAL					

TWO-WAY TABLE

VARIETY	SOIL AMENDMENT CCD	CRH	DOLOMITE	GARDEN COMPOST	TOTAL	MEAN
LANDMARK	3.56	2.92	3.40	3.80	13.68	1.14
CONTENDER	3.05	4.21	4.00	3.25	14.51	1.21
RED KIDNEY BEAN	5.30	5.60	4.08	4.75	19.73	1.64
“LIPSTIKAN”	5.27	3.61	3.60	4.21	16.69	1.39
TOTAL	17.18	16.34	15.08	16.01	64.61	
MEAN						1.35

ANALYSIS OF VARIANCE

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	TABULAR F 0.01
Replication	2	1.864	0.932			
Factor A	3	1.825	0.608	4.1775*	2.92	4.51
Factor B	3	0.188	0.063	0.4314ns	2.92	4.51
AB	9	1.331	0.148	1.0159ns	2.21	3.06
Error	30	4.368	0.146			
TOTAL	47	9.577				

Coefficient of variation = 28.35%

APPENDIX TABLE 10. Weight of non-marketable seed yield (kg)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
V_1S_1	0.25	0.15	0.06	0.46	0.15
S_2	0.35	0.10	0.11	0.56	0.19
S_3	0.30	0.10	0.11	0.51	0.17
S_4	0.25	0.15	0.15	0.55	0.18
V_2S_1	0.25	0.15	0.20	0.60	0.20
S_2	0.20	0.19	0.11	0.50	0.17
S_3	0.25	0.15	0.25	0.65	0.22
S_4	0.80	0.20	0.06	1.06	0.35
V_3S_1	0.20	0.05	0.05	0.30	0.10
S_2	0.25	0.07	0.05	0.37	0.12
S_3	0.05	0.05	0.10	0.20	0.07
S_4	0.05	0.05	0.05	0.20	0.07
V_4S_1	0.19	0.05	0.10	0.34	0.11
S_2	0.03	0.10	0.05	0.18	0.06
S_3	0.05	0.06	0.10	0.21	0.07
S_4	0.05	0.10	0.09	0.24	0.08
TOTAL					

TWO-WAY TABLE

VARIETY	SOIL AMENDMENT CCD	CRH	DOLOMITE	GARDEN COMPOST	TOTAL	MEAN
LANDMARK	0.46	0.56	0.51	0.55	2.08	0.17
CONTENDER	0.60	0.50	0.65	1.06	2.81	0.23
RED KIDNEY BEAN	0.30	0.37	0.20	0.15	1.02	0.09
"LIPSTIKAN"	0.34	0.18	0.21	0.24	0.97	0.08
TOTAL	1.70	1.61	1.57	2.00	6.88	
MEAN						0.14

ANALYSIS OF VARIANCE

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	TABULAR F 0.01
Replication	2	0.141	0.071			
Factor A	3	0.198	0.066	5.9685**	2.92	4.51
Factor B	3	0.009	0.003	0.2856ns	2.92	4.51
AB	9	0.068	0.008	0.6839ns	2.21	3.06
Error	30	0.331	0.011			
TOTAL	47	0.747				

Coefficient of variation = 73.28%

APPENDIX TABLE 11. Total seed yield per plot (kg)

TREATMENT	REPLICATION I	REPLICATION II	REPLICATION III	TOTAL	MEAN
V_1S_1	1.81	1.40	0.81	4.02	1.34
S_2	1.27	1.35	0.86	3.46	1.15
S_3	1.55	1.50	0.86	3.96	1.35
S_4	1.95	1.25	1.15	4.35	1.45
V_2S_1	1.50	1.15	1.00	3.65	1.22
S_2	1.47	1.63	1.61	4.74	1.58
S_3	2.10	1.05	1.50	4.65	1.55
S_4	2.70	1.15	0.46	4.31	1.43
V_3S_1	3.00	1.30	1.55	5.85	1.95
S_2	2.95	1.57	1.45	5.97	1.99
S_3	1.29	1.65	1.44	4.38	1.46
S_4	1.30	1.95	1.65	4.90	1.63
V_4S_1	2.46	1.55	1.60	5.61	1.87
S_2	1.13	1.35	1.31	3.79	1.26
S_3	1.40	1.31	1.10	3.81	1.27
S_4	1.35	1.37	1.73	4.45	1.48
TOTAL					

TWO-WAY TABLE

VARIETY	SOIL AMENDMENT CCD	CRH	DOLOMITE	GARDEN COMPOST	TOTAL	MEAN
LANDMARK	4.02	3.48	3.91	4.35	15.76	1.31
CONTENDER	3.65	4.71	4.65	4.31	17.32	1.44
RED KIDNEY BEAN	5.85	5.97	4.38	4.90	21.10	1.76
“LIPSTIKAN”	5.61	3.79	3.81	4.45	17.66	1.47
TOTAL	19.13	17.95	16.75	18.01	71.84	
MEAN						1.50

ANALYSIS OF VARIANCE

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	TABULAR F 0.01
Replication	2	2.804	1.402			
Factor A	3	1.267	0.422	2.1502ns	2.92	4.51
Factor B	3	0.236	0.079	0.4012ns	2.92	4.51
AB	9	1.443	0.160	0.8165ns	2.21	3.06
Error	30	5.891	0.196			
TOTAL	47	11.641				

Coefficient of variation = 29.61%