BIBLIOGRAPHY

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Adviser: Leoncia L. Tandang, Ph. D.

ABSTRACT

Highly significant differences were observed on plant height at 35 DAP, diameter of the stem, pod length, width, and diameter, number of pods per plant, pod height, number of seed per pod, pod beak length, weight of marketable and non-marketable pods, number of marketable and non-marketable pods, total yield per plot and per hectare among the eight bush snap bean collection evaluated.

Significant differences among the eight bush snap bean evaluated were noted on days from emergence to last flowering. Greencrop, BBL 274, Landmark and Contender were the best entries in terms of pod length, stem diameter, number of branches and marketable fresh pod yield.

Highly significant positive correlation coefficients were noted between pod length and pod width; number of pods per plant and number of marketable pods; and weight of marketable fresh pods and the total yield per plot and per hectare.

Significant positive correlation coefficients were found between plant height at 35 DAP and the weight of marketable pods, and total yield per plot and per hectare.

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INTRODUCTION

Snap bean is one of the most important legumes for human consumption in the world. It is an important source of proteins, minerals and vitamins. It is the source of dietary protein in many Latin American countries (Somasegaran and Hoben, 1994). Because of nutritional importance, production of vegetable legumes must be increased by using good a variety to meet the demand of the increasing population.

Snap beans are either climbing or bush type. It is marketed as processed or fresh. For the processing market, varieties with white seeds are used to avoid discoloration of the processed product. Snap beans thrive in warm, frost-free areas, but excessive heat can limit growth. Pest problems for snap beans are similar to pest of dry beans. However, pest pressure may be less extensive in snap beans when the crop is harvested earlier (USDA, 1995).

Snap bean is a commonly cultivated crop in the Philippines where subsistence farmers are abundant. It has been declared as high priority crop by the Philippine government in the 1980's. It is cultivated in traditional farming systems in contrast to the intensive cultivation including semi-mechanized harvesting in North America and Europe. The principal cropping systems adopted by the farmers of the snap bean production are either monoculture in small landholdings or complex multi-cropping systems common to most of the developing tropical countries (Padua, 1997).

Furthermore, snap bean is the most important species of the genus *Phaseolus* in terms of number of varieties available and area devoted to its cultivation worldwide. It becomes an important food crop not only in parts of Africa and Asia but also in Europe, America and the Pacific islands.

The choice of an appropriate variety is one of the important factors in the successful production of beans because planting the variety that is not adapted to the environment condition will only result to a waste of resources such as money, time and labor so the necessity of selecting adaptable varieties is important.

Considering strong competition in local and worldwide market, selection of quality produce is an important step in the farm planning process. Selection of varieties is crucial for the level of success in crop production since the major objective in plant breeding is high yield. Yield is a complex entity and its ultimate expression depends upon the interplay of several characters. This includes land race, genetic variation that exists between individuals. It includes also of having risen from a homozygous parent in a previous generation selection within this mixture of pure line is effective.

Many snap bean growers have gained valuable knowledge and experiences about proper management in growing snap beans. However, the production is still far from sufficient. The farmer's knowledge on morphological traits associated with quality yield can help him in selecting high yielding varieties to plant. In addition, the identification of important yield components influencing yield and selection of superior genotypes are necessary in starting an effective breeding program (Consolacion, *et al.*, 2002).

This study was done to:

1. evaluate the agro-morphological characteristics of bush snap bean germplasm collection in Benguet;

2. determine the best accession of bush snap bean under La Trinidad condition; and

3. determine the relationship of the different agro-morphological characteristics of bush snap bean in La Trinidad Benguet.

This was conducted at Benguet State University-Institute of Plant Breeding Highland Crops Research Station in BSU La Trinidad, Benguet from November 2009 to February 2010.

REVIEW OF LITERATURE

Genetic Resources

Germplasms are the sources of resistance to several biotic and abiotic stresses. Several research inputs have been directed toward bean germplasm. These were collected from their centers of origin and evaluated to meet the demands of the plant breeders. Germplasm are evaluated by germplasm botanist or breeders for the selection of genotypes for the sources of resistance and other desirable agronomic traits (Maiti, 1997).

Parker in 2000 stated that plant breeder, geneticists, and biotechnologies are concerned about preserving and cataloguing invaluable resource for the future. Genes to incorporate traits like disease resistance and salt tolerance into tomorrow's crop plants will come from this vast germplasm pool. Some plants will be selected from this germplasm pool for cropping in the future for new uses or products, and to meet the need for crops that are adopted to adverse environments. Plants and plant products for tomorrow will come from the untapped germplasm pool that exists today only if its importance is recognized and preserved. In agriculture the main emphasis is still on increased food production with breeding programs to develop high-yielding strains especially those yielding more protein.

Characterization

Morphological characterization is done to identify morphotypes. A morphotype is a group of plants showing morphological similarities apparently of the same phenotype, but not necessarily of the same genetic constitution. Thus, molecular characterization can follow to identify genotypes. At this stage, a curator has an efficient collection with a

minimum duplicates consequently; the collection is smaller than the original one. Studies on genetic diversity and evaluation such as agronomic characters, nutrition and reaction to biotic and abiotic factors can be carried out on this kind of material. Once that this has been achieved a core collection that is basic sample of germplasm collection representing the wide range of diversity in terms of morphology, geographical coverage and genes can be established (Fontanetti, *et al.*, 2002 as cited by Atam, 2009).

Usually high heritable morphological characters are employed for the purpose of characterization. It includes a sufficient number of traits that are useful in eliminating duplicates. It is important in establishing the identity of a variety and assessing its agronomic utilization potential. It is also important in the field of agriculture for breeders, researchers and producers to further evaluate the characteristics of the existing varieties, species and progenies adapted to cold and warm condition.

Furthermore, Consolacion, *et al.*, (2002) stated that farmers' knowledge on morphological trait associated with quality yield can help him in selecting high yielding varieties to plant. Moreover, the identification of important yield components influencing yield and selection of superior genotypes are necessary in starting an effective breeding program.

Varietal Evaluation

The importance of having a varietal evaluation is to observe performance character such as yield, earliness in maturity, vigor and it's resistant to pest and diseases, because different varieties have wide range of different in plant size, and yield performance (Work and Carew, 1995). Some variety produce exceptionally well under one set of condition and become worthless under other conditions. The researchers

further said that the maturity period of the different varieties tested under highland condition was longer in days or months compared to maturity period of crops planted in warm places.

Success in evaluation is ultimately measured in terms of acceptability of the variety that passed the evaluation process to users of the variety. A farmer may initially accept a new variety because it suits his farming practice and he finds it to be better yielding than his traditional variety, but how many stop growing if he finds that traders are not willing to buy it (Rasco and Amante, 1994). Verification trials are essential to determine whether a technology is suitable to the agro-climatic conditions and socio-economic needs of particular production area and weather a technology needs further research for is ready for application or adoption.

Remoquillo (2003) cited that further evaluation of those desirable traits into one type requires information on genetic variability, genetic correlations between traits and their heritabilities. The combined inputs of breeders and physiologist in obtaining needed information and in continued selection of these traits should enhance the breeding processes for increasing yield.

The number of branches is an important factor contributing to yield in snap bean. Theoretically, the more the branches, the greater the yield. The position or orientation of branches is also an important morphological characteristic. The upright or vertical position is considered ideal because it enables branches to intercept more solar radiation or sunlight necessary in photosynthesis (PCARRD, 1989).

In evaluating the same number of varieties but different types, Dagson (2000) found varying performances. Stringless Valentine produced the highest initial and final

plant height, while Hab 63, Torrent, and Stringless Valentine produced the highest marketable pods per plot. Hab 63, Stringless Valintine, Torrent, and BBL-274 produced the highest total fresh pod yield per plot. All varieties studied however, were found resistant to pod borer and bean rust except Hab 323.

Annogue (1997) also found out that among the eleven lines of garden peas evaluated, CGP 18 produced the highest yield per plant and per hectare. It was also the earliest to mature and produced the number of pods per plant.

Paganas (2005) reported the result of her study in the evaluation of commercially grown garden pea varieties. Among the five varieties, CGP 39 and Kalantao had the highest number of pods per plant. In Addition, Chinese White, CGP 39 and 89-001 produced more seeds than the other varieties. She also found out that Kalantao had the highest yield per plot and per hectare followed by CGP 39.

Bay-an (2000) also evaluated six varieties of garden pea namely 89-011, CDG, CGP 18-A,Chinese, Taichung, and Trinidad in Atok, Benguet. Among the six varieties evaluated, CGP 18-A was the earliest to produce flower and early to mature. However, Trinidad produced the highest yield per plot and per hectare.

Correlation Analysis

Phenotypic and genotypic correlation and heritability are required to select potential parents carrying desired traits. This is frequently suggested for incorporation of physiological and morphological traits into new cultivars. Parental selection and normal agronomic evaluation approach incorporate the desired traits into one variety. This is depending also upon the heritability of the trait and its genetic correlation with yield (Hayward et al., 1993).

Golmirzhai and Serquen (1992) cited that correlation between seedlings and vegetative progeny have much good breeding materials if selection were exerted at the seedling stage rather than on the vegetative progeny. Many seedlings have to be evaluated to select the desirable genotypes. This problem increases the need for field space, manual labor and facilities. For some characters, like resistance to some diseases, the initial evaluations are done at the seedling stage. When undesirable genotypes are discarded, thus requires the planting of fewer genotypes in the field.

In addition, breeders could use descriptors as references for exploiting new traits that are desirable and related to yield of the crop. Characters and traits should be identified to be correlated with yield and later, improvement could be done (Tad-awan, and Ballas, 2007).

Jose (2004) found out significant differences among the varieties of bush snap bean characterized and evaluated in terms of almost all the parameters measured. There was significant correlation among the characters measured in bush sanp bean varieties such as days from emergence to harvesting, internodes length, number of branches to pod width indicates that they can be used a selection index for associated character and yield.

Morphological Traits Associated with
Yield in Other Crops

Among the correlation coefficients worked out by Annogue in 1997 in garden pea, total yield was found to be significantly correlated to the number of pods. The number of nodes at first flowering and last harvesting were significantly correlated to final height, maturity and flowering. In addition, plant height was significantly correlated

to flowering and first harvesting and flowering was significantly correlated to number of days to first harvesting.

Positive correlation has been reported between lodging resistance and yield while the numbers of pods per plant and seeds per pod were only phenotypically correlated by Sumarno in 1986 as cited by Consolacion (2001) using international yield testing data of 20 soybean cultivars planted at 73 locations. He also found some positive and negative correlations between yield and days to flowering, days to maturity, plant height, lodging resistance, number of plants, pod length, and seed weight. The type (positive or negative) of correalation was depended on the location.

Based on the study conducted by Lomadeo in 2005 in corn, he found out that there was positive and significant correlation coefficient of yield to other characters like leaf length, leaf width and leaf area. These characters could be used as selection indices when selecting for high yielding varieties of corn.

MATERIALS AND METHODS

An experimental area of 190 m^2 was thoroughly prepared and divided into three blocks; each block consisted of 30 plots measuring 1m x 5m including border plots. The experiment was laid out using Randomized Complete Block Design (RCBD) with three replications.

The following germplasm collection entries that were obtained from BSU-IPB Highland Crops Research Station (BSU-IPB HCRS) at BSU served as treatments:

TREATMENT	ENTRIES
V_1	Hab 63
V_2	BBL 274
V_3	Torrent
V_4	Landmark
V_5	Hab 323
V_6	Green Crop
V_7	Contender
V_8	Hab 19

Snap bean seeds were sown at two seeds per hill in a double row plot at a distance of 20 cm between hills and 25 cm between rows. All the necessary cultural management practices for production of snap beans such as fertilization, irrigation, weeding, and hilling-up and pest control were employed.

Data Gathered

1. Number of days from sowing to emergence. This was obtained by counting the number of days from sowing to emergence.

2. Number of days from emergence to first flowering. This was obtained by counting the number of days from emergence to first flowering.

3. Number of days from emergence to last flowering. This was obtained by counting the number of days from emergence to last flowering.

4. Number of days from flowering to pod setting. This was obtained by counting the number of days from flowering until the pods will be fully developed.

5. Number of days from emergence to first harvesting. This was obtained by counting the number of days from emergence to first harvesting.

6. Number of days from emergence to last harvesting. This was obtained by counting the number of days from emergence to last harvesting.

7. Number of leaves per plant. This was obtained by counting the number of leaves of 10 sample plants per replication.

8. Plant height at 35 DAP (cm). This was measured from the base of the plant at ground level to the tip of the youngest shoot using meter stick at 35 days after planting (DAP).

9. Diameter of the stem (cm). This was measured at the midportion of the stem using vernier caliper at 35 DAP.

10. Number of branches. This was obtained by counting the branches of the plants one week before harvesting.

11. Final plant height (cm). This was measured from the base of the plant to the tip of the plant using meter stick during last harvesting.

12. Pod length (cm). This was obtained by measuring the base to the tip of the pod of 10 random sample pods per entry per replication.

13. Pod width (cm). This was obtained by measuring the broadest part of the pod of 10 random sample pods per entry per treatment.

14. Pod Diameter. This was obtained by measuring the middle portion of the pod of 10 random sample pods per entry per treatment using vernier caliper.

15. Number of pod per plant. This was obtained by getting the number of pods per plant.

16. Pod height within the canopy. This was obtained by measuring the height of the pod within the canopy.

17. Location of pods in the plant. This was obtained by observing the location of the pod in the plant if they are either above the canopy, within the canopy or below the canopy.

18. Number of seed per pod. This was obtained by counting the number of seeds per pod from five (5) sample pods per treatment.

19. Weight and number of marketable fresh pods per plot (kg/m^2). This was obtained by counting and weighing the marketable pods per plot. Marketable pods are smooth, straight and no infestation of pod borer and no infection of insects.

20. Weight and number of non- marketable fresh pods per plot (kg/m^2). This was obtained by counting and weighing the non-marketable pods per plot. Non-marketable

pods are rough, curled, infested with pod borer, infected with rust, small sizes and damaged pods.

21. Total yield per plot (kg/5m^2). This was obtained by getting the total number and weight of marketable and non-marketable pods per plot.

22. Computed yield per hectare. This was computed based on the total yield per plot as follows:

Total Yield (ton/ha) = Yield/Plot (kg/5m^2) x 2

Where: 2 is a factor that will be used to convert yield per plot (kg/5m^2) to yield per hectare in (ton/ha) assuming 1 ha effective area.

23. Reaction to Pest and Diseases

a. Reaction to pod borer. This was obtained using the following rating scale used by Tandang *et al* (2008):

Scale	Description	Rating
1	no infestations/plot	highly resistant
2	1-25% of the total plant/plot are infested	mildly resistant
3	25-50% of the total plant/plot are infested	moderately resistant
4	51-75% of the total plant/plot are infested	susceptible
5	76-100% of the total plant/plot are infested	very susceptible

b. Reaction to bean rust. This was obtained using the following rating scale used by Tandang *et al* (2008):

Scale	Description	Rating
1	no infestations/plot	highly resistant
2	1-25% of the total plant/plot are infected	moderately resistant

3	25-50% of the total plant/plot are infected	resistant
4	51-75% of the total plant/plot are infected	susceptible
5	76-100% of the total plant/plot are infected	very susceptible

24. Qualitative characters

a. Leaf color. This was recorded when plants are at their maximum vegetative growth about 35 DAP using the Royal Horticultural Society Color Chart (RHSCC).

b. Flower color. This was recorded by visually looking at the flowers when they were fully opened using the RHSCC.

c. Pod color. This was recorded as green, light green, yellow, dark green and other when the pods were fully developed.

d. Pod shape. This was recorded as flat or round.

e. Pod straightness. This was recorded whether they are straight or curve.

f. Pod stringiness. This was recorded during harvest and recorded when the green pods were stringy or stringless; pods are stringy if there is pod suture string when snapped and stringless when there are no pod sutures.

g. Pod waxiness. This was recorded by observing the presence or absence of wax in the pods.

h. Pod beak length (cm). This was obtained by measuring the beak of the pod of 10 random sample pods per entry per treatment.

i. Pod beak position. This was obtained by observing the position of the beak either marginal or non-marginal.

j. Pod beak orientation. This was obtained by observing the orientation of the pod beak either upward, straight or downward.

Analysis of Data

All quantitative data were analyzed using the Analysis of variance (ANOVA) for Randomized Complete Block Design (RCBD) with three replications. The significance of differences among treatment means was tested using the Duncan's Multiple Range Test (DMRT).

Correlation Coefficient Analysis was determined among quantitative characters using correlation coefficient analysis. Correlation coefficient analysis was done between any of the characters measured and between characters and yield. The coefficient of correlation (r) was estimated using the following formula:

$$r = \frac{Spxy}{\sqrt{(SSx)\,(SSy)}}$$

Where: y and x are the 2 variables (characters)

Spxy- the sum of cross products of x and y

SSx- the sum of square of variable x

SSy- the sum of square variable y

RESULTS AND DISCUSSION

Maturity

Majority of the entries emerged within 7 days after sowing (DAS). Greencrop and Hab 19 emerged one day later while Contender was the latest to emerge within 9 DAS (Table 1). Majority of the entries evaluated produced the first flower within 28 days after emergence (DAE). BBL 274 was the latest to flower at 31 DAE. Contender was the earliest to produce flowers at 60 DAE. All other varieties took two to four days later to last flowering.

Bush snap bean entries took eight to ten days from flowering to pod setting (Table 1).

Contender was the earliest to reach first harvesting at 56 DAE. Greencrop and Hab 19 were harvested one day later while the other entries were harvested three to four days later.Contender was also the earliest to reach last harvesting at 73 DAE. Greencrop and Hab 19 followed one day later. All the other entries took 77 DAE to last harvesting.

Table 1. Days from sowing to emergence, from emergence to first flowering, to last flowering, to first and to last harvesting, and flowering to pod setting

ENTRY	DAYS FROM SOWING TO EMERGENCE	DAYS FROM EMERGENCE TO				DAYS FROM FLOWERING TO POD SETTING
		FIRST FLOWERING	LAST FLOWERING	FIRST HARVESTING	LAST HARVESTING	
Hab 63	7	28	64 [b]	60	77	8
BBL 274	7	31	63 [b]	60	77	10
Torrent	7	30	64 [b]	60	77	9
Landmark	7	30	63 [b]	60	77	9
Hab 323	7	28	63 [b]	60	77	9
Greencrop	8	28	62 [ab]	57	74	9
Contender	9	28	60 [a]	56	73	9
Hab 19	8	30	62 [ab]	57	74	9
CV%			2.12			

*Means with the same letter are not significant different at 5% level by DMRT

Color and Number of Leaves

Landmark and Contender had light green leaves while the other entries had green leaves.The number of leaves per plant among the eight varieties of bush snap bean evaluated were statistically similar. Number of leaves ranged from 11 to 14 leaves per plant at 77 days after sowing.

Plant Height

Highly significant differences in plant height at 35 DAP were observed among the eight varieties of bush snap bean evaluated (Table 2). Torrent and Greencrop were the tallest at 26.63 cm and 26.10 cm respectively. On the other hand, Hab 19 was the shortest with a height of 16.03 cm. It was observed that entries with tallest plant height have also the highest pod height from the ground.

The plant height at 84 DAP was observed to be statistically similar among the eight varieties of bush snap bean (Table 2). It ranged from 34.22 to 40.57 cm.

Diameter of the Stem

Table 2 also shows highly significant differences in stem diameter among the entries of bush snap bean evaluated. Torrent, Landmark, and Greencrop had the widest stems while Hab 63 had the narrowest stems. The observed differences in stem diameter among the entries of bush snap indicated their differential adaptability to local condition.

Table 2. Plant height and stem diameter of eight bush snap bean entries

ENTRY	PLANT HEIGHT (cm)		STEM DIAMETER (cm)
	35 DAP	84 DAP	
Hab 63	23.48[ab]	40.57	0.42[d]
BBL 274	18.27[cd]	36.95	0.49[ab]
Torrent	26.63[a]	38.75	0.52[a]
Landmark	17.15[d]	38.15	0.52[a]
Hab 323	21.00[bc]	38.67	0.43[d]
Greencrop	26.10[a]	38.28	0.51[a]
Contender	21.60[bc]	37.78	0.48[abc]
Hab 19	16.03[d]	34.22	0.45[bcd]
CV %	9.16	11.43	4.70

*Means of the same letter are not significantly different at 5% level of DMRT

Number of Branches

All bush snap bean entries studied had five branches per plant except for Torrent which had four branches per plant.

Pod Length, Width, and Diameter

The eight bush snap bean entries evaluated had round and green pods except for Greencrop which had flat and light green pods. All of them had slightly curved and stringless pods and were not waxy.

Highly significant differences were noted on pod length among the eight entries tested. Greencrop had the longest pod of about 20 cm (Table 3). Torrent had about 17 cm

pod which was comparable with the pod length of BBL 274 and Contender. Hab 19 registered the shortest pod of about 14 cm.

Similarly, Greencrop had the widest pods. It was followed by the pods of Contender and Torrent with about 10 cm. Hab 19 and Hab 63 developed the narrowest pods (Table 3). This implies that entries with widest pod may have high weight of marketable pods.

In terms of pod diameter, Greencrop had the smallest diameter among the eight bush snap bean evaluated while Torrent had the biggest diameter (Table 3). The differences in pod diameter were attributed to genetic make-up of the varieties.

Pod Height and Number of Pods per Plant

The pods of all entries evaluated were located within the canopy. The pod height from the ground of the different entries differed significantly (Table 4). Entries Greencrop and Torrent had the highest pod height together with the pods of Hab 63. On the other hand, the pods of Hab 19 were located at the lowest part within the plant from the ground level. This implies that entries which had the highest pod height may have long pods.

The number of pods per plant differed significantly among the eight bush snap bean enties studied. Hab 323 and BBL274 had the highest number of pods per plant. They were comparable with the number of pods per plant of Hab 63, Greencrop and Landmark. Hab 19 also recorded the least number of pods per plant. It was observed that entries with the highest number of pods per plant also have the highest number of marketable pods.

Table 3. Pod Length, width and diameter of bush snap bean varieties.

ENTRY	POD		
	LENGTH (cm)	WIDTH (mm)	DIAMETER (cm)
Hab 63	14.78^{cd}	7.77^{c}	0.65^{ab}
BBL 274	16.14^{bc}	8.30^{c}	0.62^{b}
Torrent	16.94^{b}	9.50^{b}	0.72^{a}
Landmark	15.21^{cd}	8.10^{c}	0.68^{ab}
Hab 323	14.18^{d}	7.70^{c}	0.63^{b}
Greencrop	19.73^{a}	11.50^{a}	0.51^{c}
Contender	16.04^{bc}	9.90^{b}	0.65^{ab}
Hab 19	13.83^{d}	7.60^{c}	0.65^{ab}
CV %	5.19	5.72	6.87

*Means with the same letter are not significantly different at 5% level of DMRT

Table 4. Pod height and number of pods per plant

ENTRY	POD HEIGHT FROM THE GROUND (cm)	NUMBER OF PODS PER PLANT
Hab 63	32.68^{ab}	16.57^{ab}
BBL 274	29.78^{bc}	16.69^{a}
Torrent	35.30^{a}	13.75^{bc}
Landmark	30.23^{bc}	15.02^{abc}
Hab 323	31.77^{a}	17.08^{a}
Greencrop	35.60^{a}	15.66^{abc}
Contender	30.62^{bc}	13.07^{c}
Hab 19	28.12^{c}	9.39^{cd}
CV %	6.19	10.53

*Means with the same letter are not significant different at 5% level by DMRT

Pod Beak Orientation and Length and Number of Seeds per Pod

The pods of all the eight bush snap bean entries had marginal beak which were mostly oriented upward. Only Hab 63, Hab 323 and Hab 19 had pods with downward beak orientation.

Pod beak length differed significantly among the entries grown. The longest beak was recorded from the pods of Contender, Torrent and Greencrop (Table 5). The other entries had comparatively shorter pod beak that ranged from 7.63 to 9.47 mm.

The number of seeds per pod significantly differed among the eight varieties evaluated (Table 5). Hab 19 had the highest number of seeds per pod which was comparable with the number of seeds of Hab 63, Grencrop and Hab 323 with more than six seeds per pod. The pods of Torrent and Contender had the fewest seeds per pod. It was observed that small seeded varieties have high number of seeds per pod.

Table 5. Pod beak orientation and length and number of seeds per pod of eight bush snap bean entries

ENTRY	POD BEAK ORIENTATION	POD BEAK LENGTH (cm)	NUMBER OF SEEDS PER POD
Hab 63	Downward	8.23[b]	6.60[ab]
BBL 274	Upward	9.27[b]	5.93[bc]
Torrent	Upward	12.27[a]	5.40[c]
Landmark	Upward	9.47[b]	5.93[bc]
Hab 323	Downward	7.77[b]	6.33[ab]
Greencrop	Upward	11.77[a]	6.40[ab]
Contender	Upward	12.47[a]	5.27[c]
Hab 19	Downward	7.63[b]	6.67[a]
CV %		13.78	6.34

*Means with same letter are not significantly different at 5% level by DMRT

Reaction to Pod Borer and Bean Rust

All the bush snap bean entries exhibited mild resistance to pod borer under natural field condition except for Torrent which showed moderate resistance to the insect.

The entries of bush snap bean studied showed high resistance to bean rust except for Torrent, Greencrop and Hab 19 which exhibited mild resistance to bean rust (Table 6).

Table 6. Reaction to pod borer and bean rust

ENTRY	REACTION TO	
	POD BORER	BEAN RUST
Hab 63	Mild resistance	Highly resistance
BBL 274	Mild resistance	Highly resistance
Torrent	Moderately resistance	Mild resistance
Landmark	Mild resistance	Highly resistance
Hab 323	Mild resistance	Highly resistance
Greencrop	Mild resistance	Mild resistance
Contender	Mild resistance	Highly resistance
Hab 19	Mild resistance	Mild resistance

Fresh Pod Yield

BBL 274 significantly produced the highest number of marketable pods per plot. It was comparable with the number of pods per plot of the majority of the entries tested.

The number of non-marketable pods per plot also differed significantly among the entries evaluated. Hab 323 had the highest number at 215 while Torrent had 51 non-marketable pods per plot.

Highly significant differences were observed on the weight of marketable pods per $5m^2$ plots. Greencrop had significantly the highest weight of marketable pods per plot at 10.38 kg yield per $5m^2$ while Hab 19 produced the lowest weight of marketable fresh pods at 4.51 kg per $5m^2$ plot (Table 7).

Both Greencrop and Hab 323 registered the highest non-marketable yield per plot while Contender had the least non-marketable yield of 0.56 kg/$5m^2$. The results show that entries with the highest number of pods per plant, long and wide pod will contribute to higher yields.

Highly significant differences were observed on the total yield per plot and per hectare of the eight entries of bush snap bean tested (Table 7). Greencrop significantly had the highest yield per plot and per hectare. Hab 19 had the lowest total yield of 5.45 kg/$5m^2$ and 10.89 ton/ha. All other entries studied had comparable total fresh pod yield that ranged from 16-18 ton/ha. The results show that bush snap bean can produced 5 to 20 tons per hectare as reported by HARRDEC in 1989.

Table 7. Number and weight of marketable and non-marketable pods.

ENTRY	NUMBER OF		WEIGHT OF (kg/5m^2)	
	MARKETABLE	NON-MARKETABLE	MARKETABLE	NON-MARKETABLE
Hab 63	1495^{ab}	162^{b}	6.73^{b}	1.03^{ab}
BBL 274	1567^{a}	102^{cd}	8.07^{b}	1.00^{ab}
Torrent	1323^{ab}	51^{d}	7.98^{b}	0.63^{bc}
Landmark	1415^{ab}	87^{cd}	8.25^{b}	0.86^{bc}
Hab 323	1493^{ab}	215^{a}	7.22^{b}	1.33^{a}
Greencrop	1448^{ab}	118^{bc}	10.38^{a}	1.33^{a}
Contender	1242^{b}	65^{cd}	8.23^{b}	0.56^{c}
Hab 19	845^{c}	95^{cd}	4.51^{c}	0.93^{abc}
CV %	11.96	27.09	12.89	22.20

*Means with the same letter are not significantly different at 5% level by DMRT

Table 8. Total yield per plot and per hectare of the eight bush snap bean varieties.

ENTRY	YIELD	
	PER PLOT (kg/5m^2)	PER HECTARE (ton/ha)
Hab 63	7.77^{b}	15.53^{b}
BBL 274	9.09^{b}	18.17^{b}
Torrent	8.62^{b}	17.23^{b}
Landmark	9.11^{b}	18.23^{b}
Hab 323	8.55^{b}	17.11^{b}
Greencrop	11.72^{a}	23.43^{a}
Contender	8.80^{b}	17.60^{b}
Hab 19	5.45^{c}	10.89^{c}
CV %	11.79	11.79

*Means with the same letter are not significantly different at 5% level by DMRT

Correlation Coefficient among Characters
Measured in Bush Snap Bean

Plant height at 35 DAP was significantly and positively correlated to the weight of marketable pods (WMP) total yield per plot (TYP) and per hectare (TYH).This indicates that highest plant height have more yield.

Stem diameter was positively correlated to pod diameter and weight of non-marketable pods. This indicates that entries with bigger stem diameter will have bigger pod diameter and higher non-marketable pods.

As indicated in Table 9, pod length was highly significant and positively correlated with pod width. This indicates that a variety of bush snap bean with longer pods will also have wider pods.

Highly significant and positive correlation coefficient was noted on the number of pods per plant (PN) and the number of marketable pods (NMP). This indicates that entries with highest number of pods per plant would have high number of marketable pods.

Highly significant and positive correlation coefficient was noted in the weight of marketable fresh pods and total yield per plot and per hectare (Table 9). This means that varieties with high weight of marketable pods would have a high total yield per plot and per hectare.

Table 9. Correlation Coefficient analysis between other characters measured in eight snap bean varieties

	PH35	SD	NB	PHLH	PL	PW	PD	PN	PH	NS	PBL	WMP	WNP	NMP	NNP	TY	TYH
PH35	1.00																
SD	0.366	1.00															
NB	0.245	0.731	1.00														
PHLH	0.488	0.044	0.084	1.00													
PL	0.282	0.138	0.211	0.286	1.00												
PW	0.459	0.231	0.237	0.451	**0.721****	1.00											
PD	0.225	**0.628***	0.111	0.458	0.425	0.639	1.00										
PN	0.171	0.024	0.031	0.036	0.153	0.170	0.043	1.00									
PH	0.420	0.062	0.226	0.019	0.518	0.497	0.231	0.166	1.00								
NS	0.065	0.178	0.085	0.286	0.189	0.065	0.099	0.098	0.569	1.00							
PBL	0.303	0.265	0.012	0.379	0.101	0.069	0.005	0.167	0.406	0.302	1.00						
WMP	**0.597***	0.252	0.017	0.323	0.277	0.477	0.463	0.520	0.326	0.294	0.062	1.00					
WNP	**0.561***	**0.568***	**0.568***	0.013	0.127	0.083	0.062	0.195	0.271	0.237	0.127	0.034	1.00				
NMP	0.168	0.165	0.016	0.003	0.118	0.156	0.039	**0.983****	0.218	0.151	0.157	0.524	0.231	1.00			
NNP	0.028	0.310	0.241	0.201	0.145	0.135	0.011	0.158	0.322	0.306	0.011	0.151	0.185	0.339	1.00		
TY	**0.697***	0.310	0.112	0.311	0.242	0.480	0.437	0.546	0.374	0.236	0.086	**0.978****	0.243	0.555	0.185	1.00	
TYH	**0.697***	0.310	0.112	0.311	0.242	0.480	0.437	0.546	0.374	0.236	0.086	**0.978****	0.243	0.555	0.185	1.00	1.00

*-significant
**- highly significant

Legend:

PH35	plant height at 35 DAP
SD	Stem diameter
NB	Number of branches
PHLH	Plant height during last harvest
PL	Pod length
PD	Pod diameter
PW	Pod width
PN	Number of pods per plant
NS	Number of seed per pod
PBL	Pod beak length
WMP	Weight of marketable pods
WNP	Weight of non-marketable pods
NMP	Number of marketable pods
NNP	Number of non-marketable pods
TY	Total yield per plot
TYH	Total yield per hectare

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

Among the varieties of bush snap bean studied, highly significant differences were observed on plant height at 35 DAP, diameter of the stem, pod length, pod width, pod diameter, number of pods per plant, pod height, number of seeds per pod, pod beak length, weight of marketable pods and non-marketable pods, number of marketable and non-marketable pods, total yield per plot and computed yield per hectare.

Significant differences were noted on days from emergence to last flowering. Number of leaves per plant, number of branches per plant, plant height during the last harvest, reaction to pod borer and bean rust were not significantly different. Greencrop produced the highest weight of marketable and total yield per plot and per hectare. BBL 274 had the highest number of marketable pods per plot.

BBL 274 also had the highest number of leaves. Torrent was the tallest entry at 35 DAP with four branches. Torrent and Landmark had the widest stems. Hab 63 was the tallest entry at 84 DAP. Bush snap bean had light green to green pods. Greencrop had the longest and widest pod, and had the tallest pod height. Torrent had the highest pod diameter. Hab 323 had the highest number of pods per plant. Contender had the longest pod beak and Hab 19 had the highest number of seeds per pod.

Highly significant and positive correlations were noted between pod length and pod width and weight of marketable pods per plot and total yield per plot and per hectare.

Significant positive correlations were found between plant height at 35 DAP and the weight of marketable pods per plot and total yield per plot and per hectare; stem diameter and pod diameter and weight of non-marketable pods; and number of branches

and weight of non-marketable pods. All other correlation coefficient computed among the parameters measured was not significant.

Conclusion

Among the eight varieties studied, Greencrop, BBL 274, Landmark, and Contender are the best performing entries based on pod length, stem diameter, number of branches, weight and number of marketable pods and total yield per plot and per hectare.

The highly significant correlation coefficient among the characters measured such as pod width and pod length, number of pods per plant and number of marketable pods; weight of marketable pods to the total yield per plot and per hectare; plant height at 35 DAP and weight of marketable pods and total yield per plot per hectare; stem diameter and pod diameter and weight of non-marketable pods; number of pods per plant and number of non-marketable pods; and number of branches and weight of non-marketable pods indicated that they can be used as selection indices for associated characters and yield.

Recommendation

BBL 274, Greencrop, Contender, Torrent, and Hab 323 are the entries highly recommended for production in La Trinidad Benguet. They performed well in terms of marketable and total fresh pod yield, pod length, number of branches, plant height at 35 DAP and pod height.

Among the characters considered in this study, plant height at 35 DAP, number and weight of marketable pods per plot could be used as selection indices for selecting high yielding entries of bush snap bean.

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APPENDICES

Appendix Table 1. Number of days from sowing to emergence

ENTRIES	REPLICATION			TOTAL	MEAN
	I	II	III		
Hab 63	7	7	7	21	7
BBL 274	7	7	7	21	7
Torrent	7	7	7	21	7
Landmark	7	7	7	21	7
Hab 323	7	7	7	21	7
Greencrop	8	8	8	24	8
Contender	9	9	9	27	9
Hab 19	8	8	8	24	8
TOTAL	60	60	60	180	60

Appendix Table 2. Number of days from emergence to first flowering

ENTRIES	REPLICATION I	II	III	TOTAL	MEAN
Hab 63	28	28	28	84	28
BBL 274	31	31	31	93	31
Torrent	30	30	30	90	30
Landmark	30	30	30	90	30
Hab 323	28	28	28	84	28
Greencrop	28	28	28	84	28
Contender	28	28	28	84	28
Hab 19	30	30	30	90	30
TOTAL	233	233	233	699	233

Appendix Table 3. Number of days from emergence to last flowering

ENTRIES	REPLICATION I	II	III	TOTAL	MEAN
Hab 63	62	65	65	192	64.00
BBL 274	62	62	65	189	63.00
Torrent	62	65	65	192	64.00
Landmark	62	65	62	189	63.00
Hab 323	62	62	65	189	63.00
Greencrop	61	61	64	186	62.00
Contender	59	60	60	179	59.67
Hab 19	61	64	61	186	62.00
TOTAL	491	504	507	1502	500.67

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Replication	2	18.083	9.042			
Treatment	7	41.167	5.881	3.35*	2.77	4.29
Error	14	24.583	1.756			
TOTAL	23	83.833	16.679			

*-Significant Coefficient of Variation = 2.12%

Appendix Table 4. Number of days from flowering to pod setting

ENTRIES	REPLICATION			TOTAL	MEAN
	I	II	III		
Hab 63	8	8	8	24	8
BBL 274	10	10	10	30	10
Torrent	9	9	9	27	9
Landmark	9	9	9	27	9
Hab 323	9	9	9	27	9
Greencrop	9	9	9	27	9
Contender	9	9	9	27	9
Hab 19	9	9	9	27	9
TOTAL	72	72	72	216	72

Appendix Table 5. Number of days from emergence to first harvesting

ENTRIES	REPLICATION			TOTAL	MEAN
	I	II	III		
Hab 63	60	60	60	180	60
BBL 274	60	60	60	180	60
Torrent	60	60	60	180	60
Landmark	60	60	60	180	60
Hab 323	60	60	60	180	60
Greencrop	57	57	57	171	57
Contender	56	56	56	168	56
Hab 19	57	57	57	171	57
TOTAL	470	470	470	1410	470

Appendix Table 6. Number of days from emergence to last harvesting

ENTRIES	REPLICATION			TOTAL	MEAN
	I	II	III		
Hab 63	77	77	77	231	77
BBL 274	77	77	77	231	77
Torrent	77	77	77	231	77
Landmark	77	77	77	231	77
Hab 323	77	77	77	231	77
Greencrop	74	74	74	222	74
Contender	73	73	73	219	73
Hab 19	74	74	74	222	74
TOTAL	606	606	606	1818	606

Appendix Table 7. Number of leaves per plant.

ENTRIES	REPLICATION			TOTAL	MEAN
	I	II	III		
Hab 63	12	11	14	37	12.33
BBL 274	13	15	13	41	13.67
Torrent	10	11	12	33	11.00
Landmark	11	12	14	37	12.33
Hab 323	11	13	13	37	12.33
Greencrop	9	12	13	34	11.33
Contender	11	13	15	39	13.00
Hab 19	11	15	14	40	13.33
TOTAL	88	102	108	298	99.32

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	2	26.333	13.167			
Treatment	7	17.833	2.548	2.28^{ns}	2.77	4.29
Error	14	15.667	1.119			
TOTAL	23	59.833	16.834			

^{ns} – Not Significant

Coefficient of Variation = 8.52%

Appendix Table 8. Plant Height at 35 DAP (cm)

ENTRIES	REPLICATION I	II	III	TOTAL	MEAN
Hab 63	25.75	23	21.70	70.45	23.48
BBL 274	17.75	21	16.05	54.80	18.27
Torrent	23.45	30	26.45	79.90	26.63
Landmark	17.95	15.90	17.60	51.45	17.15
Hab 323	21.35	21.35	20.30	63	21
Greencrop	24.05	28.20	26.05	78.30	26.10
Contender	20.25	21.45	23.10	64.80	21.60
Hab 19	17.05	17	14.05	48.10	16.03
TOTAL	167.60	177.90	165.30	510.80	170.26

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Replication	2	11.256	5.628			
Treatment	7	331.772	47.396	12.47**	2.77	4.29
Error	14	53.201	3.800			
TOTAL	23	396.228	56.824			

** – Highly Significant Coefficient of Variation = 9.16%

Appendix Table 9. Diameter of the Stem (cm)

ENTRIES	REPLICATION I	II	III	TOTAL	MEAN
Hab 63	0.42	0.43	0.40	1.25	0.42
BBL 274	0.52	0.50	0.46	1.48	0.49
Torrent	0.49	0.54	0.52	1.55	0.52
Landmark	0.52	0.54	0.50	1.56	0.52
Hab 323	0.42	0.42	0.44	1.28	0.43
Greencrop	0.49	0.52	0.52	1.53	0.51
Contender	0.46	0.48	0.50	1.44	0.48
Hab 19	0.42	0.50	0.44	1.36	0.45
TOTAL	3.74	3.93	3.78	11.45	3.82

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	2	0.003	0.001			
Treatment	7	0.035	0.005	9.84**	2.77	4.29
Error	14	0.007	0.001			
TOTAL	23	0.044	0.007			

** – Highly Significant Coefficient of Variation = 4.70%

Appendix Table 10. Number of Branches per plant

ENTRIES	REPLICATION I	II	III	TOTAL	MEAN
Hab 63	5	5	5	15	5.00
BBL 274	5	5	5	15	5.00
Torrent	4	5	4	13	4.33
Landmark	5	4	5	14	4.67
Hab 323	5	5	5	15	5.00
Greencrop	5	5	5	15	5.00
Contender	6	5	5	16	5.33
Hab 19	5	5	5	15	5.00
TOTAL	40	39	39	118	39.33

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	2	0.083	0.042			
Treatment	7	1.833	0.262	1.91^{ns}	2.77	4.29
Error	14	1.917	0.137			
TOTAL	23	3.833	0.441			

^{ns} – Not Significant

Coefficient of Variation = 7.53%

Appendix Table 11. Plant height during the last harvest (cm)

ENTRIES	REPLICATION I	II	III	TOTAL	MEAN
Hab 63	37.20	36.75	47.75	121.70	40.57
BBL 274	35.20	36.85	38.8	110.85	36.95
Torrent	39.25	37.65	39.35	116.25	38.75
Landmark	35.25	42.85	36.35	114.45	38.15
Hab 323	33.40	36.60	46.00	116.00	38.67
Greencrop	40.90	37.75	36.20	114.85	38.28
Contender	36.10	44.10	33.15	113.35	37.78
Hab 19	32.70	37.45	32.50	102.65	34.22
TOTAL	290.00	310.00	310.10	910.10	303.37

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Replication	2	33.501	16.750			
Treatment	7	69.331	9.904	0.52^{ns}	2.77	4.29
Error	14	263.217	18.801			
TOTAL	23	366.050	45.455			

^{ns} – Not Significant

Coefficient of Variation = 7.53%

Appendix Table 12. Pod Length (cm)

ENTRIES	REPLICATION I	II	III	TOTAL	MEAN
Hab 63	15.27	14.80	14.28	44.35	14.78
BBL 274	14.94	17.48	15.99	48.41	16.14
Torrent	16.50	17.20	17.11	50.81	16.94
Landmark	15.29	14.44	15.90	45.63	15.21
Hab 323	14.66	13.96	13.91	42.53	14.18
Greencrop	20.90	18.53	19.77	59.20	19.73
Contender	16.55	15.22	16.34	48.11	16.04
Hab 19	13.32	14.14	14.04	41.50	13.83
TOTAL	127.43	125.77	127.34	380.54	126.85

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Replication	2	0.218	0.109			
Treatment	7	74.377	10.625	15.69**	2.77	4.29
Error	14	9.481	0.677			
TOTAL	23	84.076	11.411			

** – Highly Significant Coefficient of Variation = 5.19%

Appendix Table 13. Pod width (cm)

ENTRIES	REPLICATION			TOTAL	MEAN
	I	II	III		
Hab 63	8.3	8.1	6.9	23.3	7.77
BBL 274	8.0	8.7	8.2	24.9	8.3
Torrent	9.3	10.0	9.3	28.6	9.5
Landmark	9.0	7.3	8.0	24.3	8.1
Hab 323	8.1	7.7	7.3	23.1	7.7
Greencrop	12.2	11.0	11.4	34.6	11.5
Contender	9.8	9.9	10.1	29.8	9.9
Hab 19	7.5	7.8	7.4	22.7	7.6
TOTAL	72.2	70.5	68.6	211.3	70.4

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	2	0.810	0.405			
Treatment	7	41.453	5.922	23.31**	2.77	4.29
Error	14	3.556	0.254			
TOTAL	23	45.819	6.581			

** – Highly Significant Coefficient of Variation = 5.72%

Appendix Table 14. Pod diameter (cm)

ENTRIES	REPLICATION I	II	III	TOTAL	MEAN
Hab 63	0.69	0.66	0.61	1.96	0.65
BBL 274	0.55	0.64	0.68	1.87	0.62
Torrent	0.76	0.70	0.69	2.15	0.72
Landmark	0.71	0.61	0.71	2.03	0.68
Hab 323	0.67	0.60	0.62	1.89	0.63
Greencrop	0.51	0.50	0.53	1.54	0.51
Contender	0.61	0.64	0.70	1.95	0.65
Hab 19	0.64	0.63	0.69	1.96	0.65
TOTAL	5.14	4.98	5.23	15.35	5.11

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	2	0.004	0.002			
Treatment	7	0.072	0.010	5.36**	2.77	4.29
Error	14	0.027	0.002			
TOTAL	23	0.103	0.014			

** – Highly Significant Coefficient of Variation = 6.87%

Appendix Table 15. Number of pods per plant

ENTRIES	REPLICATION I	II	III	TOTAL	MEAN
Hab 63	17.76	17.28	14.68	49.72	16.57
BBL 274	18.82	16.41	14.84	50.07	16.69
Torrent	14.51	14.61	12.12	41.24	13.75
Landmark	15.48	15.26	14.31	45.05	15.02
Hab 323	15.81	18.84	16.58	51.23	17.08
Greencrop	15.76	16.86	14.36	46.98	15.66
Contender	10.89	14.19	14.13	39.21	13.07
Hab 19	7.76	13.08	7.34	28.18	9.39
TOTAL	116.79	126.53	108.36	351	117.23

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	2	20.670	10.335			
Treatment	7	137.547	19.650	8.26**	2.77	4.29
Error	14	33.314	2.380			
TOTAL	23	191.531	32.365			

** – Highly Significant Coefficient of Variation = 10.53%

Appendix Table 16. Pod height (cm)

ENTRIES	REPLICATION I	II	III	TOTAL	MEAN
Hab 63	33.70	32.75	31.60	98.05	32.68
BBL 274	29.65	34.60	25.10	89.35	29.78
Torrent	34.75	35.50	35.65	105.90	35.30
Landmark	32.15	27.90	30.65	90.70	30.23
Hab 323	29.55	34.25	31.50	95.30	31.77
Greencrop	36.80	35.75	34.25	106.80	35.60
Contender	29.00	32.85	30.00	91.85	30.62
Hab 19	28.30	30.25	25.80	84.35	28.12
TOTAL	253.90	263.85	244.55	762.30	254.10

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	2	28.496	14.248			
Treatment	7	141.896	20.271	5.22**	2.77	4.29
Error	14	54.327	3.880			
TOTAL	23	224.720	38.399			

** – Highly Significant Coefficient of Variation = 6.19%

Appendix Table 17. Number of seed per pod

ENTRIES	REPLICATION I	II	III	TOTAL	MEAN
Hab 63	6.6	6.2	7.0	19.8	6.60
BBL 274	5.6	6.4	5.8	17.8	5.93
Torrent	5.6	4.6	6.0	16.2	5.40
Landmark	6.2	5.8	5.8	17.8	5.93
Hab 323	6.0	6.4	6.6	19.0	6.33
Greencrop	6.4	6.4	6.4	19.2	6.40
Contender	5.4	5.0	5.4	15.8	5.27
Hab 19	6.4	7.0	6.6	20.0	6.67
TOTAL	48.2	47.8	49.6	145.6	48.53

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Replication	2	0.223	0.112			
Treatment	7	5.840	0.834	5.64**	2.77	4.29
Error	14	2.070	0.148			
TOTAL	23	8.133	1.094			

** – Highly Significant Coefficient of Variation = 6.34%

Appendix Table 18. Pod beak length (mm)

ENTRIES	REPLICATION I	II	III	TOTAL	MEAN
Hab 63	6.7	8.9	9.1	24.7	8.23
BBL 274	9.6	10.7	7.5	27.8	9.27
Torrent	13.5	12.1	11.2	36.8	12.27
Landmark	10.4	8.9	9.1	28.4	9.47
Hab 323	7.3	8.4	7.6	23.3	7.77
Greencrop	14.3	12.3	8.7	35.3	11.77
Contender	11.5	13.8	12.1	37.4	12.47
Hab 19	7.1	8.2	7.6	22.9	7.63
TOTAL	80.4	83.3	72.9	236.4	78.88

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Replication	2	7.201	3.600			
Treatment	7	86.145	12.306	6.66**	2.77	4.29
Error	14	25.853	1.847			
TOTAL	23	119.198	17.753			

** – Highly Significant

Coefficient of Variation = 13.78%

Appendix Table 19. Weight of marketable fresh pods per plot (kg/5m^2)

ENTRIES	REPLICATION I	II	III	TOTAL	MEAN
Hab 63	7.91	6.61	5.68	20.20	6.73
BBL 274	8.13	8.74	7.39	24.26	8.07
Torrent	7.70	9.28	6.97	23.95	7.98
Landmark	7.66	7.48	9.60	24.74	8.25
Hab 323	7.70	7.42	6.54	21.66	7.22
Greencrop	10.09	10.62	10.44	31.15	10.38
Contender	6.55	9.30	8.85	24.70	8.23
Hab 19	4.11	5.68	3.75	13.54	4.51
TOTAL	59.85	65.13	59.22	184.20	61.37

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	2	2.728	1.364			
Treatment	7	58.069	8.296	8.46**	2.77	4.29
Error	14	13.721	0.980			
TOTAL	23	74.518	10.640			

** – Highly Significant Coefficient of Variation = 12.89%

Appendix Table 20. Weight of Non-marketable fresh pods per plot (kg/5m^2)

ENTRIES	REPLICATION I	II	III	TOTAL	MEAN
Hab 63	1.1	0.8	1.2	3.1	1.03
BBL 274	0.9	1.0	1.1	3.0	1.00
Torrent	0.4	0.8	0.7	1.9	0.63
Landmark	1.1	0.6	0.9	2.6	0.86
Hab 323	1.0	1.3	1.7	4.0	1.33
Greencrop	1.0	1.6	1.4	4.0	1.33
Contender	0.6	0.4	0.7	1.7	0.56
Hab 19	0.9	1.0	0.9	2.8	0.93
TOTAL	7.0	7.5	8.6	23.1	92.81

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	2	0.167	0.084			
Treatment	7	1.670	0.239	5.22**	2.77	4.29
Error	14	0.639	0.046			
TOTAL	23	2.476	0.369			

** – Highly Significant Coefficient of Variation = 22.20%

Appendix Table 21. Number of marketable fresh pods per plot (kg/5m^2)

ENTRIES	REPLICATION I	II	III	TOTAL	MEAN
Hab 63	1654	1509	1323	4486	1495
BBL 274	1757	1562	1381	4700	1567
Torrent	1406	1420	1144	3970	1323
Landmark	1447	1450	1347	4244	1415
Hab 323	1318	1725	1435	4478	1493
Greencrop	1455	1560	1328	4343	1448
Contender	1021	1366	1338	3725	1242
Hab 19	654	1226	654	2534	845
TOTAL	10702	11818	9950	32480	10828

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	2	220554.333	110277.167			
Treatment	7	1109582.000	158511.714	6.05**	2.77	4.29
Error	14	366799.000	26199.929			
TOTAL	23	1696935.333	294988.810			

** – Highly Significant Coefficient of Variation = 11.96%

Appendix Table 22. Number of Non-marketable fresh pods per plot (kg/5m^2)

ENTRIES	REPLICATION I	II	III	TOTAL	MEAN
Hab 63	122	219	145	486	162
BBL 274	125	79	103	307	102
Torrent	45	41	68	154	51
Landmark	101	76	84	261	87
Hab 323	263	159	223	645	215
Greencrop	121	126	108	355	118
Contender	68	53	75	196	65
Hab 19	122	82	80	284	95
TOTAL	967	835	886	2688	895

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	2	1107.750	553.875			
Treatment	7	60078.667	8582.667	9.32**	2.77	4.29
Error	14	12891.583	920.827			
TOTAL	23	74078.000	10057.369			

** – Highly Significant Coefficient of Variation = 27.09%

Appendix Table 23. Total yield per plot (kg/5m^2)

ENTRIES	REPLICATION I	II	III	TOTAL	MEAN
Hab 63	9.01	7.41	6.88	23.30	7.77
BBL 274	9.03	9.74	8.49	27.26	9.09
Torrent	8.10	10.08	7.67	25.85	8.62
Landmark	8.76	8.08	10.50	27.34	9.11
Hab 323	8.70	8.72	8.24	25.66	8.55
Greencrop	11.09	12.22	11.84	35.15	11.72
Contender	7.15	9.70	9.55	26.40	8.80
Hab 19	5.01	6.68	4.65	16.34	5.45
TOTAL	66.85	72.63	67.82	207.30	69.11

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	2	2.395	1.198			
Treatment	7	62.649	8.950	8.63**	2.77	4.29
Error	14	14.520	1.037			
TOTAL	23	79.565	11.185			

** – Highly Significant Coefficient of Variation = 11.79%

Appendix Table 24. Computed yield per hectare (t/ha)

ENTRIES	REPLICATION			TOTAL	MEAN
	I	II	III		
Hab 63	18.02	14.82	13.76	46.60	15.53
BBL 274	18.06	19.48	16.98	54.52	18.17
Torrent	16.20	20.16	15.34	51.70	17.23
Landmark	17.52	16.16	21.00	54.68	18.23
Hab 323	17.40	17.44	16.48	51.32	17.11
Greencrop	22.18	24.44	23.68	70.30	23.43
Contender	14.30	19.40	19.10	52.80	17.60
Hab 19	10.02	13.36	9.30	32.68	10.89
TOTAL	133.70	145.26	135.64	414.60	138.19

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	2	2.395	1.198			
Treatment	7	62.649	8.950	8.63**	2.77	4.29
Error	14	14.520	1.037			
TOTAL	23	79.565	11.185			

** – Highly Significant Coefficient of Variation = 11.79%

Appendix Table 25. Reaction to pod borer

ENTRIES	REPLICATION I	II	III	TOTAL	MEAN
Hab 63	2	2	2	6	2.00
BBL 274	2	2	2	6	2.00
Torrent	3	3	2	8	2.67
Landmark	2	2	2	6	2.00
Hab 323	2	2	2	6	2.00
Greencrop	2	2	2	6	2.00
Contender	2	3	2	7	2.33
Hab 19	2	2	2	6	2.00
TOTAL	17	18	16	51	17.00

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	2	0.250	0.125			
Treatment	7	1.292	0.185	2.38 ^{ns}	2.77	4.29
Error	14	1.083	0.077			
TOTAL	23	2.625	0.387			

^{ns} –Not Significant Coefficient of Variation = 13.09%

Appendix Table 26. Reaction to bean rust

ENTRIES	REPLICATION I	II	III	TOTAL	MEAN
Hab 63	1	2	1	4	1.33
BBL 274	1	1	1	3	1.00
Torrent	2	1	2	5	1.67
Landmark	1	1	2	4	1.33
Hab 323	1	1	1	3	1.00
Greencrop	1	3	1	5	1.67
Contender	1	1	2	4	1.33
Hab 19	2	2	2	6	2.00
TOTAL	10	12	12	34	11.33

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	2	0.333	0.167			
Treatment	7	2.500	0.357	1.0^{ns}	2.77	4.29
Error	14	5.000	0.357			
TOTAL	23	7.833	0.881			

^{ns} –Not Significant Coefficient of Variation = 16.07%