BIBLIOGRAPHY

ABELLERA, RONNIE C. APRIL 2012. Growth and Yield of Pole Snap Bean Mixed with Pine Wood Strips During Seed Storage.Benguet State University, La Trinidad, Benguet.

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ABSTRACT

This study was conducted to evaluate the growth and yield of pole snap bean varieties mixed with pine wood strips during seed storage; determine the best amount of pine wood strips on germination, growth and yield of snap beans; determine the interaction effect of variety and pine wood strips on germination, growth and yield of pole snap bean; and determine the ROCE of growing pole snap bean mixed with pine wood strips during seed storage.

Mixing pine wood strips in a kilogram of pole snap bean seeds did not affect all the parameters measured in this study except the percent emergence of pole snap bean. Mixing the seeds with 12.5g of pine wood strips resulted in highest percent emergence and ROCE but comparable to those unmixed seeds and those with 50g of pine wood strips. All varieties evaluated did not differ in their growth and yield except for percent emergence, number of seeds per pod and pod length and width. Maroon had the highest percent emergence together with Stone Hill black and Black Valentine. Black Valentine and Stone Hill black had longer and wider pods than Burik and Maroon. Growing all the varieties resulted in positive ROCE but growing Stone Hill black mixed with 50 g of PWS per kg of seeds at storage recorded the highest ROCE (34.77%).

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INTRODUCTION

Snap bean (*Phaseolus vulgaris L.*) is a tender annual, grown for its edible immature pods. It grows either as bush or vine. The size and color of pod and seeds vary. Pods can be 3or 4inches to 6-8 inches or more long. The colors are green, yellow, purple, and speckled. Pods can be round or flat. Bush bean varieties are ready to harvest 45 to 60 day while pole beans are harvested 60 to 85 days. Bush beans grow to 2 to 3 feet tall and mature earlier than pole bean that grows to 8 feet and requires support. Pole beans produce more pods per plant than bush bean.

Pole snap bean is important food worldwide and a significant source of nutrients because of its fiber, protein and vitamin contents. It is traditionally a basic food in many developing countries and it serves as a major plant for rural and urban areas(Dursun,2007).

Bean seeds easily loose their germination ability if stored under ordinary conditions. In order to keep seeds for the next season, they must be stored properly. Close and cold storage are commonly used in storing bean seed (FAO, 2007). However, apparently, seeds at storage are easily infested with weevil. Bean weevil is a major stored product pest because of the damage it causes to bean seeds. It becomes a pest in heated granaries where it can breed continuously on dried seeds. They may consume nearly the entire bean nutrient contents (Beyond Pest Control Inc., 2009).

Seed is the most important and basic input in agriculture. It protects and sustains life. We must also consider the seed quality, which ensures desirable crop production. Maintaining seed quality is maintaining the moisture content and temperature of stored

seed.In addition, seeds play a very important role in determining the fruit yield. It requires the purity, percentage mixture and no weed seeds (Acad, 2009).

For generation, farmers struggled to improve the performance of their seeds, and protect from pest and diseases. Apparently, bean seeds are easily infested by weevil even after seed extraction. Benguet farmers use pine wood chips as seed treatment during seed storage with the belief that it controls weevil infestation (Tandang, 2011).

High seed production depends upon the viability of high quality seeds. The quality of seeds obtained from reliable sources could be beneficial by reducing seedling rate and risk of pest and disease problems(Simsim and Balaoing, 2007).

Sowing healthy seeds of high quality is a major concern to improve crop yield thus increasing food production. It has a great concern to farmers and seed producing agencies where the diseases is high and the average yields are low and where more food is needed to feed the ever-increasing population. So, it is important to test the seeds for disease causing organism before they are sown in the field and to avoid harmful organisms traveling from infected to non-infected areas within a country or across internationalboundaries.

The study was undertakento:

1. evaluate the growth and yield of pole snap bean varieties mixedwith pine wood stripsduring seed storage;

2. determine the best amount of pine wood strips on germination, growth and yield of snap bean;

3. determine the interaction effect of variety and pine wood strips on germination, growth and yield of pole snap bean; and

4. determine the return on cash expense (ROCE) of pole snap beanmixedwith pine wood strips.

The storage study wasdone from June 2011 to November 2011 andthe field experiment was on November 2011 to February 2012at IPB-BSU Highland Crops Research Station in Benguet State University, La Trinidad, Benguet.

REVIEW OF LITERATURE

Importance of Seed Storage
and Quality of Seeds

Seed treatment is the oldest practice in plant protection. In 1992, the modern introduce organo-mercury fungicide for seed treatments are widely used for several decades(Nergaad, 1997). Today, the most widely used application of seed treatment is a traditional way of protecting the germinating seedling against pest and disease (Catnas, 2009).

Seed vigor is a measure of the quality of seed. It involves seed viability, the germination percentage, germination rate and the strength of seedlings produced (Wikipedia). Good quality bean seed should be pure and clean, that is, all seed should be of the same variety and then same size. It should not include any dirt, stones, broken seed, shriveled seed, moldy seed, rotten seed, andinsect damaged seed (David, 2007).

Barton (1996) found that the seeds of high initial viability are more resistant to unfavorable storage environment condition than low viable seed. Once seed start to deteriorate it proceeds rapidly. Seeds which were injured mechanically suffered a lot and lose its viability and vigor very quickly.

Storing seeds in a cool dry environment keeps them viable for longer period. Seeds have a tendency to absorb moisture during storage. To maintain dryness, the storage containers could be filled to a quarter capacities with dry wood, ash or dry charcoal. Viability and quality of seeds will be protected from insects and pests (FAO, 2007).

Cooler temperature will extend seed life, as long as the seeds are protected from all moisture, seeds to be saved for many years should be sealed from any air circulation, because of the moisture it carries (Farmerik, 2007).

Using salt water treatment is found to be effective in separating healthy seeds from unhealthy ones. This is effective in paddy seeds (Kaufman, 2000).

Snap Bean Seed Storage Problem

Snap bean is one of the most important vegetable. Since it is an important vegetable crop, production should be amplified using good quality seeds for planting. Proper storage of seed are sometimes also neglected that result to poor growth and low yield. In this regards, it is important to know the nature of the seeds before planting (Simsim and Balaoing, 2007).

In 2004, the number of farmer engaged in growing snap bean decreased from 9,903 to 5,088 in 2009. These farmers were observed to mainly defend on traditional cultivars due to lack of improved varieties of snap bean. Alno and Burik, are commonly grown traditional varieties, which are susceptible to pest and diseases. They were also low yielding varieties (Tandang, 2007).

Acad (2009) stated many problems were encountered in bean production. Insect pests and diseaseoccur in seed storage and bean growing areas.Bruchids, or bean weevil are major pest of dry bean around the world. Two bruchids species (Zobrotessubfasciatus and Acanthoscelidesobtectus) are found in East. Z. subfesciatus prefer lower elevations and warmer temperatures, while A.obtectus is found in higher latitude environments with cooler temperature (Ampofo, 1992).

The female bean weevil deposits her eggs on bean pods in the field or on whole beans in storage. Each female lays up to 60 eggs in her lifetime and numerous whitish eggs can be seen on a single bean. Bean weevils are internal feeders so the tiny, grub-like larvae bore their way into the bean. Several larvae may feed inside each bean and a considerable portion of the bean's interior is consumed. It is the larvae that do the damage. Adults do not feed. Upon maturity, the larvae pupate near the surface of the bean and then emerge from the bean, leaving numerous holes in the bean. The entire life cycle can last from 21 days or as long as 80 days. Populations of bean weevils develop quickly in stored beans where suddenly hundreds or thousands of weevils are seen crawling or flying in infested rooms. The first indication of an infestation is often the presence of numerous flying weevils. A bag, box or storage bin of beans may be so infested that weevils are forced to leave the container in search of fresh beans on which to lay their eggs. Bean weevils "play dead" when disturbed and may take up to five minutes to resume movement (Beyond Pest Control Inc., 2009).

Beans are normally harvested when the pods are black and stems have shriveled. Because water loss is slow forming the thick fleshy pods and large seeds, a prolonged period of ripening and drying may be required before combining, particularly in cool climates. If the crop is harvested too soon, the beans in the topmost pods will be immatured. They will also be higher in moisture content than in those lower pods. Because of problems associated with prolonged ripening, late harvesting, frost damage, and prolonged drying, fababeans are frequently binned in a nonuniform state and consequently they need to be carefully monitored during storage(Demand Media, Inc., 2011).

Mechanical handling damage is a problem which becomes more severe at low temperature and moisture levels. To reduce damage, use belt conveyors or front- end loaders rather than augers to handle beans wherever possible. Avoid roping beans from excessive heights, particularly onto concrete floors (Canadian Grain Commission, 2001).

Varietal Evaluation

In 2007, Mulchino found that the six varieties of pole snap bean grown underKabayan, Benguet condition differed in their yielding potential. Violeta and Blue Lake performed significantly better than other varieties in pod cluster/plant, pod/plant and number and weight of marketable pods.

12 varieties of pole snap bean was evaluated by Tandang and her team under highlands condition in 2007. Violeta significantly recorded highest computed yield/ha followed by Burik and N2643 (Tandang*et al*, 2007).

In 2005, Cayso stated that among the varieties she evaluated, they did not show differences on percent survival, days to flowering, number of flower per cluster and percent pod set. B-21, Stonehill, Taichung, and Violeta were observed to have mild resistance to pod and bean rust. Bluelake, Maccarao and B-21, exhibited higher yield potential.

Calya-en (2009),stated that among the ten varieties of pole snap bean she evaluated in Mankayan, Benguet in 2009, CPV 69 was the earliest to flower in 40 DAS; While BVC-8521 recorded the shortest flowering duration in 21 days. B-21, CPV 60, CPV 69 and Bluelake were the earliest varieties to be harvested in 75 DAS. Pole snap bean produced four to five flowers per cluster. Magbunga, Bluelake, and Taichung had

highest pod cluster par plant while Hav 71 had the highest percentage of pod setting. Magbunga had the longest pod and Bluelake had the narrowest pod.

Importance of Pine Wood Chip

Pinewood is an excellent construction material. In the mining areas of Benguet, pine is used as mine shafts and tunnels. It is also used as piles, posts, Christmas trees, and as raw material for pulp and paper manufacturing. Wood from pine trees is a good fuel source both for cooking and heating purposes. Pine bark is a potential source of tannin for the country's leather industry, and sawmills wastes like Pine sawdust are source of tan and pitch. Oleoresin from pine trees generates income for many inhabitants in the pine region. Upon distillation, oleoresin yields turpentine and residue called resin. Resin is a hydrocarbonsecretion. Turpentine is used as a solvent and thinner in paints (Balague, 1990).

The properties of pine are antimicrobial, antineuralgic, antirheumatic, antiseptic, antiviral, bactericidal, balsamic, cholagogue, deodorant, diuretic, expectorant, hypertensive, insecticidal, restorative, rubefacient, adrenal cortex stimulant as well as stimulant to the circulation and nervous system(Esoteric Oils CC and Sallamander Concepts (Pty) Ltd, 2011).

Pine woodstrips locally known as "Saleng" is traditionally used as a seed treatment in many provinces of Cordillera for next season planting materials. *Pinuskesiya*, is one of the most distributed pines in Asia. Its range extends south and east from the Khasi hills in the Northeast Indian state of Meghalaya from where it got its name to northern Thailand, Burma, Laos, Southern China, Vietnam and the Philippines (Wikipedia, 2008).

MATERIALS AND METHODS

A. Laboratory Experiment

Seeds of four varieties of pole snap bean harvested last April 2011, weighing 1500 grams each and a trunk of more than 50 years old pine treeobtained from Wangal, La Trinidad, Benguet was chopped into small pieces were used in the storage study. The seedswere divided into twelve sets weighing 125 grams each. The seedswere mixed with different amounts of pine wood strips(PWS) during storagesuch as 12.5g/kg of seeds, 25g/kg of seeds, 50g/kg of seeds and without any treatment. The experiment was set-up following the 4 x 4 factor factorial in Randomized Complete Block Design (RCBD) with three replications. This was done at IPB-BSU Highland Crop Research Station, for a period of six months from May 2011 to October 2011.

B. Field Experiment

A total area of 240$m^2$was prepared for the experiment. This was divided into three blocks, consisting of 16 plots each with a dimension of 1m x 5m. Two seeds were sown per hill at a distance of 25cm between hills and between rows. The experiment was laid out using 4 x 4 factor factorial in Randomized Complete Block Design (RCBD) with three replications. The seed mixed with different amounts of pine wood strips during storage wasconsidered as factor A and the four varieties of pole snap bean were considered as factor Bas follows:

FACTOR A –AMOUNT OF PINE WOOD STRIPS

Code	Amount of PWS (g/kg of seeds)
S_1	O (Control)
S_2	12.5
S_3	25.0
S_4	50.0

FACTOR B – VARIETY

Code	Variety
V_1	Black Valentine
V_2	Stone Hill Block
V_3	Burik
V_4	Maroon

Data Gathered

A. At Storage

1. Weevil infestation during storage. This was observed every two weeksafter storing the seeds using the following scale:

Scale	PercentInfestation	Description
1	No infestation	Highly resistant
2	1-25% infestation/plot	Moderately resistant
3	26-50% infestation/plot	Resistant
4	51 - 75% infestation/plot	Susceptible
5	76-100% infestation/plot	Very susceptible

2. Final weight of stored seeds. This was monitored using the digital weighing scale every two weeks after seed storage.

3. Weight loss. This was monitored by weighing the seeds using the digital weighing scale every two weeks throughout the duration of seed storage under ordinary room condition.

Experimental Field

1. Percent of emergence. This was obtained by using the following formula:

$$\%\text{emergence} = \frac{\text{Number of Seeds Germinated}}{\text{Number of Seeds Sown}} \times 100\%$$

2. Days from sowing to emergence. This was recorded by counting the days fromsowing to the time when at least 50% of the plant emerged.

3. Days from emergence to flowering. This was recorded by counting the number of days from emergence to the day whenat least 50% of the plants have fully opened flowers.

4. Days from flowering to pod setting. This was recorded by counting the number of days starting from flowering to the day when pod set.

5. Days from emergence to pod setting.This was recorded by counting the number of days starting from emergence to the day when pod set.

6. Days from emergence to first harvesting. This was recorded by counting the number of days from emergence to first harvesting

7. Days from emergence to last harvesting. This was recorded by counting the number of days from emergence to last harvesting.

8. Number of flowers per cluster. The number of flowers per cluster was counted from ten samples per plot during peak of flowering stage.

9. Number of pods per cluster. The number of pod per cluster was counted from ten random sample plants per plot.

10. Percentage pod set per cluster. This was computed using the data gathered in Nos.8 and 9 using the following formula:

$$\% \text{ Pod Setting per cluster} = \frac{\text{Total No. of Pods per Cluster}}{\text{Total No. of Flower per Cluster}} \times 100\ \%$$

11. Number of seeds per pod. The number of seeds per pod was countedfrom ten sample pods per plot.

12. Length of marketable pods (cm). Ten samplepods werepicked at random from each plot and their lengthwere measured from pedicel end to blossom end using the foot rule.

13. Width of marketable pods (cm). This was measured from ten random sample pods per plot using the vernier caliper.

14. Weight of marketable pods (kg). The marketable pods were harvested and weight every harvesting period. Marketable pods were pods that are free from damage caused by insect pest and diseases and not deformed.

15. Weight of non-marketable pods (kg). The non-marketable pods werethose affected by insect pest and diseases, and deformed pods. They were weight every harvesting period.

16. Total yield per plot (kg). This was the total weight of all harvested fresh pods per plot.

17. Reaction to pod borer. This was taken by assessing the degree of infestation by pod borer using the following scale used at BSU-IPB Highland Crop Research Station, by Tandang, *et al*. in 2008:

Scale	PercentInfestation	Description
1	No infestation	Highly resistant
2	1-25% infestation/plot	Moderately resistant
3	26-50% infestation/plot	Resistant
4	51 - 75% infestation/plot	Susceptible
5	76-100% infestation/plot	Very susceptible

18. Reaction to bean rust. This was taken by assessing the degree of infection causedby bean rust that infested the crop using the following scale used at BSU-IPB, Highland Crop Research Station by Tandang, *et al*. in 2008.

Scale	Percent Infection	Description
1	No infection	High resistance
2	1-25% infection/plot	Moderate resistance
3	26-50% infection/plot	Mild resistance
4	51 - 75% infection/plot	Susceptible
5	76-100% infection/plot	Very susceptible

19. Return on Cash Expenses. This was computed using the following formula:

$$ROCE = \frac{\text{Gross sales- Total Expenses}}{\text{Total Expenses}} \times 100\%$$

Analysis of Data

All quantitative datawerestatistically analyzed using analysis of variance (ANOVA) for 4 x4 factor factorial inRandomized Complete Block Design (RCBD) with three replications. The significance of differences among the treatment means were tested using F test and the Duncan's Multiple Range Test (DMRT).

RESULTSAND DISCUSSION

A. At Storage

Weevil Infestation

All seeds of four varieties of pole snap bean mixed with different amountsof pine wood strips during seed storage were highly resistant to weevil infestation throughout five months of storage after harvest in a biscuit tin can at ordinary room condition(Appendix Table 1).

Final Weight and Weight Lossof Seeds

No significant differences were noted in the final weight and weight lossof stored seeds of different varieties of pole snap bean mixed with different amounts ofpine wood strips (PWS)after five months of storage in a biscuit tin can under ordinary room condition (Table 1). All four varieties of pole snap beans mixed with different amounts of PWShad statistically similarfinal weight and weight lossafter five months of storage. Probably seeds were properly dried that after five months of storage, they were not yet infested with weevil.

No significant interaction effect of variety and PWS on the weight and weight loss of stored seeds of pole snap beans were observed (Table 1).

B. Experimental Field

Percent Emergence

Significant differences were noted on the percent emergence of pole snap bean mixed with different amounts of pine wood strips during seeds storage. Pole snap beans

Table 1. Final weight and weight loss of seeds of four varieties of pole snap bean mixed with differentamountsof pine wood strips (PWS) after five months of storage

TREATMENT	WEIGHT OF STORED SEEDS (g)	WEIGHT LOSS OF STORED SEEDS (g)
PWS (g/kg of seeds)		
0 (Control)	123.77	1.24
12.5	123.72	1.40
25.0	123.58	1.35
50.0	123.57	1.34
Variety (V)		
Black Valentine	123.73	1.01
Stone Hill black	123.61	1.46
Burik	123.61	1.46
Maroon	123.67	1.40
A x B	ns	ns
CV(%)	0.57	20.33

mixedwith 12.5g of pine wood strips had the highest percent emergence but comparable to those of 50g of pine wood strips and no pine wood strips (Table 2). Seed mixed with 25g of pine wood strips had the lowest percent of emergence.

Maroon had the highest percent emergence but comparable to those of Stone Hill black and Black Valentine which had statistically similar percent emergence with Burik. The differences observed could be due to varietal characteristics.

Table 2. Percent emergence of four varieties of pole snap beans mixed with different amounts of pine wood strips (PWS) during storage

TREATMENT	EMERGENCE (%)
PWS (g/kg of seeds)	
0 (Control)	93.25[a]
12.5	94.08[a]
25.0	89.41[b]
50.0	93.16[a]
Variety (V)	
Black Valentine	92.08[ab]
Stone Hill black	93.66[a]
Burik	89.66[b]
Maroon	94.58[a]
A x B	ns
CV %	4.04

*Means of the same letter not significantlydifferent from each other at 5% level of significance using DMRT.

No significant interaction effect of variety and the pine wood strips were noted on the percent emergence of pole snap beans (Table 2).

Number of Days from Sowing to Emergence, to Flowering, from Emergence to Pod Setting, and from Flowering to Pod Setting

The seeds of four pole snap bean varieties that were mixed with different amounts of PWS emerged within six days after sowing. They all took 42-43 days from emergence

to flowering, 48 days to set pod and five to six days from flowering to set pod (Appendix Table 5-7).

The number of days from sowing to emergence, from emergence to flowering, from emergence to pod setting, and from flowering to pod setting were similar in different varieties (Appendix Table 5-7). All the varieties emerged within six days after sowing. Stone Hill black, Burik and Maroon flowered 42 days after emergence while Black Valentine flowered one day later. Similar observation was noted on the days from emergence to pod setting. Stone Hill black, Burik and Maroon produced pods within 47 days after sowing while Black Valentine produced pods two days later. The same result was observed on the flowering to pod setting. Stone Hill black, Burik and Maroon produced pods 5 days after flowering while Black valentine produced pods one day later. Differences might be due to varietal characteristics of the pole snap bean varieties.

Days from Emergence to FirstHarvest
andfrom Emergence to LastHarvest

All the varieties of pole snap bean and the seeds treated with different amount of BPWC during storage were first harvested at 56 DAE and last harvesting of pole snap bean was done at 78 DAE.

Number of Flower per Cluster, Pods
per Cluster, and Percent Pod Set

No significant differences were noted on the number of flowers, pods per cluster and percent pod set of the different varieties of pole snap bean mixed with pine wood strips during seed storage. There were eight flowers per cluster, six pods per cluster and 71% pod setting (Table 3).

The number of flower per cluster, pod per cluster, and percent pod set of different varieties of pole snap beans testedwere not significantly different (Table 3). There were eight flowers per cluster, six pods per cluster and 71% pod setting in the four varieties of pole snap bean.

There was no interaction effect of variety and pine wood strips observed on the number of flower per cluster, pod per cluster and percent pod set of pole snap bean (Table 3).

Table 3.Number of flower per cluster, pods per cluster, and percent pod set of four varieties of pole snap bean mixed with different amounts of pine wood strips (PWS)during storage

TREATMENT	NUMBER OF: FLOWER PER CLUSTER	POD PER CLUSTER	PERCENT POD SET (%)
PWS (g/kg of seeds)			
0 (Control)	8	6	71
12.5	8	6	71
25.0	8	6	71
50.0	8	6	71
Variety (V)			
Black Valentine	8	6	71
Stone Hill black	8	6	71
Burik	8	6	71
Maroon	8	6	71
A x B	ns	ns	ns
CV %	1.75	2.94	1.92

Number of Seeds per Pod

No significant differences were noted on the number of seeds per pod of the four varieties of pole snap bean seeds mixed with different amounts of pine wood strips (Table 4). There were eight seeds per pod that developed regardless of the amount of pine wood strips.

Stone Hill black and Black Valentine had statistically high number of seeds per pod (9) than Burik and Maroon. The differences might due to varietal characteristics.

Table 4.Number of seeds per podof four varieties of pole snap bean mixed withdifferentamountsof pine wood strips (PWS) during storage

TREATMENT	NUMBER OF SEED PER POD
PWS (g/kg of seeds)	
0 (Control)	8
12.5	8
25.0	8
50.0	8
Variety (V)	
Black Valentine	9[a]
Stone Hill black	9[a]
Burik	8[b]
Maroon	8[b]
A x B	ns
CV %	4.22

*Means of the same letter not significantlydifferent from each other at 5% level of significance using DMRT.

No significant interaction between the variety and pine wood strips was noted on the number of seeds per pod of pole snap bean (Table 4).

Length and Width of Marketable Fresh Pods

No significant differences on the pod length and width of four varieties of pole snap bean produced from seeds mixed with different amounts ofpine wood strips. The length ranged from 17.99 to 18.23cm and the width ranged from 0.76 to 0.77cm (Table 5).

Stone Hill black and Black Valentine significantly had the longer pod than those of Burik and Maroon (Table 5). Similar observation was noted in pod width. Stone Hill black and Black Valentine had significantly wider pod than those of Burik and Maroon (Table 5). The difference observed could be due to varietal characteristic.

No significant interaction effect of variety and pine wood strips on pod length and width of marketable fresh pods of pole snap bean was noted (Table 5).

Weight of Marketable and Non-marketable
Fresh Pods and Total Yield per Plot

No significant differences were noted on the weight of marketable, non-marketable and total yield of fresh pod per plot of the different varieties of pole snap beans mixed with different amounts of pine wood strips during seeds storage. Treatment of PWS did not significantly increase the yield of pole snap bean varieties.

No significant differences were also noted on the weight of the marketable, non-marketable and the total yield of fresh pods per plot among different varieties of pole snap beans evaluated (Table 6). All snap bean varieties studied produced around 9 kg fresh pods/5m^2 plots.

Table 5.Length and width of marketable fresh podsof four varieties of pole snap bean mixed with different amountsof pine wood strips (PWS) during storage

TREATMENT	MARKETABLE FRESH POD	
	LENGTH (cm)	WIDTH (cm)
PWS (g/kg of seeds)		
0 (Control)	18.23	0.77
12.5	18.07	0.77
25.0	18.21	0.76
50.0	17.99	0.77
Variety (V)		
Black Valentine	19.45[a]	0.79[a]
Stone Hill black	19.89[a]	0.79[a]
Burik	17.00[b]	0.75[b]
Maroon	16.15[b]	0.73[b]
AxB	ns	ns
CV%	2.87	2.03

No significant interaction effect of variety and pine wood strips was noted on the weight of marketable, non-marketable and the total yield per plot of pole snap beans (Table 6).

Reaction to Pod BorerInfestation and Bean Rust Infection

No significant differences were noted on the reaction to pod borer and bean rust of pole snap bean mixed with different amounts of pine wood strips (Table 7).

Similarly,all PWS treatments resulted in moderate resistance to pod borer and bean rust in pole snap bean (Table 7).

Highly significant differences on the reaction to pod borer were noted among the four varieties of pole snap bean (Table 7). Stone Hill and Maroonwere observed to be moderately resistant to pod borer while Black Valentine and Burik were mildly resistant. All the varieties of pole snap bean evaluated exhibited was moderate resistance to bean rust.

Table 6.Weight of marketable and non-marketable fresh pods and total yield per plot (kg/m^2) of four varieties of pole snap bean mixed with different amounts of pine wood strips (PWS) during storage

TREATMENT	FRESH POD YIELD ($kg/5m^2$) MARKETABLE	NON-MARKETABLE	TOTAL
PWS (g/kg of seeds)			
0 (Control)	9.00	0.37	9.37
12.5	9.14	0.40	9.54
25.0	8.29	0.36	8.65
50.0	9.11	0.37	9.48
Variety (V)			
Black Valentine	8.54	0.36	8.90
Stone Hill black	9.27	0.40	9.67
Burik	8.86	0.35	9.21
Maroon	8.87	0.39	9.26
A x B	ns	ns	ns
CV %	14.24	28.08	13.84

No significant interaction effect of the variety and pine wood strips was noted on the reaction of pole snap bean to pod borer and bean rust (Table 7).

Return on Cash Expense

Seeds mixed with 12.5g pine wood strips and withoutPWS recorded the highest ROCE. It was followed by those mixed with 50g of PWS. Seeds mixed with 3.12g of PWS had the lowest ROCE (Table 8).

The return on cash expenses of four pole snap bean varieties is also shown in Table 8. Stone Hill black registered the highest ROCE (30.10%) followed by Maroon (24.49%) and Burik (24.21%). The lowest ROCE was obtained in producing Black Valentine (19.86%). These results indicated the feasibility of growing four varieties of pole snap bean mixed with different amounts of PWS during seed storage. All treatment combination appeared to be profitable but mixing 12.5g of pine wood strips per kg of pole snap bean resulted in highest ROCE because it produced high marketable fresh pods.

Table 7.Reaction to pod borer infestation and bean rust infectionof four varieties of pole snap bean mixed with different amountsof pine wood strips (PWS) during storage

TREATMENT	POD BORER	BEAN RUST
PWS (g/kg of seeds)		
0 (Control)	Moderately resistant	Moderate resistance
12.5	Moderately resistant	Moderate resistance
25.0	Moderately resistant	Moderate resistance
50.0	Moderately resistant	Moderate resistance
Variety (V)		
Black Valentine	Moderately resisant	Moderate resistance
Stone Hill black	Mildly resistant	Moderate resistance
Burik	Mildly resistant	Moderate resistance
Maroon	Moderately resisant	Moderate resistance
A x B	ns	
CV %	8.43	

Table 8.Return on Cash Expenses (ROCE) of pole snap bean varieties mixed with different amount of pine wood strips (PWS)during storage

TREATMENT	YIELD ($kg/5m^2$)	VARIABLE COST	GROSS INCOME	NET INCOME	ROCE (%)
PWS (g/kg of seeds)					
0 (Control)	9.00	178.12	225.00	46.88	26.31
12.5	9.13	180.12	228.25	48.13	26.72
25.0	8.28	182.12	207.00	24.88	13.66
50.0	9.11	185.12	227.75	42.63	23.02
Variety (V)					
Black Valentine	8.54	178.12	213.50	35.38	19.86
Stone Hill black	9.27	178.12	231.75	53.63	30.10
Burik	8.85	178.12	221.25	43.13	24.21
Maroon	8.87	178.12	221.75	43,63	24.49

*Variable cost includes seeds, fertilizer, pesticides, gasoline and labor
*Sales was based on average of 25 pesos per kilo

Table 9. Return on Cash Expenses(ROCE) of pole snap bean varieties mixed with different amountsofpine wood strips(PWS) of during storage

TREATMENT	YIELD ($kg/5m^2$)	VARIABLE COST	GROSS INCOME	NET INCOME	ROCE (%)
S_1V_1	9.45	178.12	236.25	58.13	32.63
V_2	9.11	178.12	227.75	49.63	27.86
V_3	6.61	178.12	215.25	37.13	20.84
V_4	8.85	178.12	221.25	43.13	24.21
Mean					20.13
S_2V_1	8.85	180.12	221.25	41.13	22.83
V_2	9.21	180.12	230.25	50.13	27.83
V_3	9.23	180.12	230.75	50.63	28.10
V_4	9.26	180.12	231.50	51.38	28.52
Mean					26.82
S_3V_1	7.36	182.12	184.00	1.88	1.03
V_2	8.80	182.12	220.00	37.88	20.79
V_3	8.81	182.12	220.25	38.13	20.93
V_4	8.18	182.12	204.50	22.38	12.28
Mean					13.75
S_4V_1	8.50	185.12	212.50	27.38	14.79
V_2	9.98	185.12	249.50	64.38	34.77
V_3	8.78	185.12	219.50	34.38	18.57
V_4	9.20	185.12	230.50	45.38	24.51
Mean					23.16

*Variable cost includes seeds, fertilizer, pesticides, gasoline and labor
*Sales was based on average of 25 pesos per kilo
Legend:
V_1- Black valentine V_3- BurikS_1- 0 (Control) S3–25g
V_2- Stone hill black V_4- Maroon S_2 – 12.5gS_4 – 50g

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The pole snap bean seedsmixed with different amounts of pine wood strips were apparentlyrated highly resistant to weevil infestation throughout five months of storage after harvest. No significant differences were noted in the final weight and weight loss of stored seeds of pole snap bean.

Mixing pine wood strips in a kg of pole snap bean seeds did not significantly affectall the parameters measured except on the percent emergence. Pole snap beans mixed with 12.5g of pine wood strips per kg of seeds had the highest percent emergence but comparable to those of the control and 50gpine wood strips. Seed mixed with 25g of pine wood strips had the lowest percent of emergence.The seeds of four pole snap bean varieties that were mixed with different amounts of pine wood strips emerged within six days after sowing. They all took 42 days to flower after emergence, 48 days to set pod and five days from flowering to set pod. First harvesting of all the varieties studied was done at 56 DAE and the last harvesting was also done on the same day, at 78 DAE.

The four varieties emerged at 6 DAE. Maroon andStone Hill black had significantly higher percentemergence than Burik which was comparable with those of Black Valentine. Stone Hill black, Burik and Maroon flowered in 42 DAE and set pods at 47 DAE. First harvesting of the four varieties of pole snap bean was done at 56 DAE while last harvesting was done at the same time, at 78 DAE.The four varieties of pole snap beans studied did not significantly differ in other characters measured except on the number of seeds per pod and pod length and width. Black Valentine and Stone Hill black had significantly higher seeds per pod (9) than Burik and Maroon which had eight seeds

per pod. They also had longer and wider pods than Burik and Maroon. Stone Hill black and Maroon showed moderate resistance to pod borer whileBlack Valentine and Burik exhibited mild resistance to pod borer. All varieties showed moderate resistance to bean rust. Stone Hill black recorded the highest return in cash expenses (ROCE).

No significant interaction effect of varieties of pole snap bean and the different amounts of pine wood strips used during seeds storagewas observed in all the parameters measured. However, mixingStone Hill black with 50g pine wood stripsper kg of pole snap bean resultedin highest ROCE (34.74%) although all treatment combinations resulted in positive ROCE.

Conclusion

In this study, mixing pine wood strips to a kg of pole snap beandidnot affect the growth and yield of pole snap bean except its percent emergence. Even without mixing PWS on the pole snap bean seeds at five months of storage, comparable emergence of seeds with 12.5g and 50g of PWS per kg of seeds resulted. Using 12.5g of PWS per kg of pole snap bean seeds gave higher ROCE than other treatments.

The four varieties of pole snap beans evaluated differed in terms of percent emergence, number of seeds per pod and pod length and width. Maroon and Stone Hill black had significantly higher emergence than Burik and was comparable to Black Valentine. Black Valentine and Stone Hill black had significantly higher number of seeds per pod and longer and wider pods than Burik and Maroon. All the varieties gave positive returns. Stone Hill black production resulted in highest ROCE (30.10%)

The PWS and variety of pole snap bean did not have a significant interaction effect on germination, growth and yield of pole snap bean. However, positive ROCE

were recorded in all treatment combinations. Among them, Stone Hill black seeds stored with 50g of PWS per kg of pole snap bean seed resulted in the highest ROCE (34.77%).

Recommendation

Based on the result of the study, it is recommended that a similar study with longer duration of seed storage in more than five months be conducted in the future to observe the effect of PWS in controlling weevil infestation in pole snap bean seeds considering the amount of moisture loss in the seeds during storage. Although no significant effect of PWS were observed in this study, mixing of 12.5g of PWS/kg of pole snap bean seed would give higher ROCE. Any of the four varieties of pole snap bean tested could be planted by the farmers in La Trinidad, Benguet but growing Stone Hill black mixed with 50g of PWS per kg of seed would give the highest ROCE.

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APPENDICES

Appendix Table 1. Weevil infestation during seed storageof four varieties of pole snap bean mixed with different amounts of pine wood strips (PWS)

	REPLICATION				
TREATMENT	I	II	III	TOTAL	MEAN
S_1V_1	1	1	1	3	1
S_1V_2	1	1	1	3	1
S_1V_3	1	1	1	3	1
S_1V_4	1	1	1	3	1
S_2V_1	1	1	1	3	1
S_2V_2	1	1	1	3	1
S_2V_3	1	1	1	3	1
S_2V_4	1	1	1	3	1
S_3V_1	1	1	1	3	1
S_3V_2	1	1	1	3	1
S_3V_3	1	1	1	3	1
S_3V_4	1	1	1	3	1
S_4V_1	1	1	1	3	1
S_4V_2	1	1	1	3	1
S_4V_3	1	1	1	3	1
S_4V_4	1	1	1	3	1
TOTAL	16	16	16	48	16
MEAN	1	1	1	3	1

Appendix Table 2.Final weight (g) of the stored seedof four varieties of pole snap bean after 5 monthsmixed with different amounts of pine wood strips (PWS) during storage

	REPLICATION				
TREATMENT	I	II	III	TOTAL	MEAN
S_1V_1	123.75	123.87	124.75	372.37	124.12
S_1V_2	122.87	122.75	123.81	369.43	123.14
S_1V_3	122.75	124.75	124.75	372.25	124.08
S_1V_4	123.50	123.75	123.75	371.00	123.66
S_2V_1	123.75	124.75	123.25	371.75	123.91
S_2V_2	124.25	124.75	122.81	371.81	123.93
S_2V_3	123.87	122.81	122.93	369.61	123.20
$_2V_4$	123.87	122.81	123.87	371.55	123.85
S_3V_1	124.87	122.81	123.75	369.31	123.10
S_3V_2	122.75	122.75	123.75	370.25	123.41
S_3V_3	123.75	123.75	122.75	371.25	123.75
S_3V_4	*124.75*	*123.75*	*123.75*	*372.25*	*124.08*
S_4V_1	124.75	123.75	123.75	371.37	123.79
S_4V_2	123.87	123.75	124.37	371.87	123.95
S_4V_3	123.75	123.75	122.81	370.31	123.43
S_4V_4	123.75	122.81	122.75	369.31	123.10
TOTAL	1980.85	1977.36	1977.60	5935.81	1978.60
MEAN	123.80	123.48	123.60	370.98	123.66

TWO WAY TABLE

VARIETY	PWS				TOTAL	MEAN
	S_1	S_2	S_3	S_4		
V_1	124.12	123.91	123.1	123.79	494.92	123.73
V_2	123.14	123.93	123.41	123.95	494.43	123.61
V_3	124.08	123.2	123.75	123.43	494.46	123.62
V_4	123.66	123.85	124.08	123.1	494.69	123.67
TOTAL	495	494.89	494.34	494.27	1978.5	
MEAN	123.75	123.723	123.585	123.568		123.66

ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIANCE	DEEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	F VALUE	TABULAR F 0.05	0.01
Replication	2	0.442	0.221			
FACTOR A	3	0.315	O.105	0.21^{ns}	3.04	4.06
FACTOR B	3	0.115	0.038	0.07^{ns}	3.04	4.06
AB	9	5.778	0.642	1.28^{ns}	3.35	4.45
ERROR	30	14.975	O.99			
TOTAL	47	21.624				

ns = not significant CV = 0.57%

Appendix Table 3. Final weight (g) lost of stored seed of four varieties of pole snap beanmixed with different amounts of pine wood strips (PWS) during storage

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
S_1V_1	1.25	1.13	0.25	2.63	0.87
S_1V_2	2.13	2.25	1.19	5.57	1.85
S_1V_3	2.25	0.25	0.25	2.75	0.91
S_1V_4	1.50	1.25	1.25	4.00	1.33
S_2V_1	1.25	0.25	1.75	3.25	1.08
S_2V_2	0.75	0.25	2.19	3.10	1.06
S_2V_3	1.13	2.19	2.07	5.39	1.79
S_2V_4	1.13	2.19	1.13	4.45	1.48
S_3V_1	0.13	2.19	1.25	3.57	1.19
S_3V_2	2.25	2.25	1.25	5.75	1.91
S_3V_3	1.25	1.25	2.25	4.75	1.58
S_3V_4	0.25	1.25	1.25	2.75	0.91
S_4V_1	0.25	1.25	1.25	2.75	0.91
S_4V_2	1.13	1.25	0.63	3.01	1.00
S_4V_3	1.25	1.25	2.19	4.69	1.56
S_4V_4	1.25	2.19	2.25	5.69	1.89
TOTAL	19.15	22.64	22.40	64.19	21.39
MEAN	1.21	1.41	1.40	4.02	1.33

TWO WAY TABLE

VARIETY	PWS				TOTAL	MEAN
	S_1	S_2	S_3	S_4		
V_1	0.87	1.08	1.19	0.91	4.05	1.01
V_2	1.85	1.06	1.91	1	5.82	1.46
V_3	0.91	1.79	1.58	1.56	5.84	1.46
V_4	1.33	1.48	0.91	1.89	5.61	1.40
TOTAL	4.96	5.41	5.59	5.36	21.32	
MEAN	1.24	1.35	1.40	1.34		1.33

ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIANCE	DEEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	F VALUE	TABULAR F 0.05	0.01
Replication	2	0.475				
FACTOR A	3	0.155	0.052	0.11^{ns}	3.04	4.06
FACTOR B	3	1.669	0.556	1.16^{ns}	3.04	4.06
AB	9	5.010	0.557	1.16^{ns}	3.35	4.45
ERROR	30	14.350	0.478			
TOTAL	47	21.660				

ns = not significant CV = 20%

Appendix Table 4. Percent of emergence of four varieties of pole snap beanmixed with different amounts of pine wood strips (PWS) during storage

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
S_1V_1	93	91	98	282.00	94.00
S_1V_2	90	96	96	282.00	94.00
S_1V_3	88	86	98	272.00	90.66
S_1V_4	96	93	96	285.00	95.00
S_2V_1	90	94	94	278.00	92.66
S_2V_2	98	89	99	286.00	95.33
S_2V_3	97	89	97	283.00	94.33
S_2V_4	95	93	94	282.00	94.00
S_3V_1	80	93	97	270.00	90.0
S_3V_2	94	91	86	271.00	90.33
S_3V_3	85	80	85	250.00	83.33
S_3V_4	90	95	98	283.00	94.33
S_4V_1	90	88	97	275.00	91.66
S_4V_2	95	92	98	285.00	95.00
S_4V_3	92	87	92	271.00	90.33
S_4V_4	98	94	96	288.00	96.00
TOTAL	1471	1451	1521	4443	1481
MEAN	91.93	90.68	95.06	277.67	92.56

TWO WAY TABLE

VARIETY	PWS				TOTAL	MEAN
	S_1	S_2	S_3	S_4		
V_1	94	92.66	90	91.66	368.32	92.08
V_2	94	95.33	90.33	95	374.66	93.67
V_3	90.66	94.33	83.33	90.33	358.65	89.66
V_4	95	94	94.33	96	379.33	94.83
TOTAL	373.66	376.32	357.99	372.99	1480.96	
MEAN	93.415	94.08	89.4975	93.2475		92.56

ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIANCE	DEEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	F VALUE	TABULAR F 0.05	0.01
Replication	2	162.500	81.250			
FACTOR A	3	154.729	81.576	3.68*	3.04	4.06
FACTOR B	3	179.896	59.965	4.28**	3.04	4.06
AB	9	115.188	12.799	0.91ns	3.04	4.06
ERROR	30	419.500	13.983			
TOTAL	47	1031.813				

* = significant
** = highly significant
ns = significant

CV = 4.04%

Appendix Table 5.Days from sowing to emergence of pole snap bean mixed with different amounts of pine wood strips (PWS) during storage

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
S_1V_1	6	6	6	18	6.00
S_1V_2	6	6	6	18	6.00
S_1V_3	6	6	6	18	6.00
S_1V_4	6	6	6	18	6.00
S_2V_1	6	6	6	18	6.00
S_2V_2	6	6	6	18	6.00
S_2V_3	6	6	6	18	6.00
S_2V_4	6	6	6	18	6.00
S_3V_1	7	6	6	19	6.33
S_3V_2	6	7	6	19	6.33
S_3V_3	6	7	6	20	6.33
S_3V_4	6	6	6	18	6.00
S_4V_1	6	6	6	18	6.00
S_4V_2	6	6	6	18	6.00
S_4V_3	6	6	6	18	6.00
S_4V_4	6	6	6	18	6.00
TOTAL	98	98	96	292	97.33
MEAN	6.12	6.12	6.00	18.25	6.08

Appendix Table 6.Days from emergence to floweringof pole snap bean mixed with different amounts of pine wood strips (PWS) during storage

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
S_1V_1	43	43	43	129	43
S_1V_2	42	42	42	126	42
S_1V_3	42	42	42	126	42
S_1V_4	42	42	42	126	42
S_2V_1	43	43	43	129	43
S_2V_2	42	42	42	126	42
S_2V_3	42	42	42	126	42
S_2V_4	42	42	42	126	42
S_3V_1	43	43	43	129	43
S_3V_2	42	42	42	126	42
S_3V_3	42	42	42	126	42
S_3V_4	42	42	42	126	42
S_4V_1	43	43	43	129	43
S_4V_2	42	42	42	126	42
S_4V_3	42	42	42	126	42
S_4V_4	42	42	42	126	42
TOTAL	676	676	676	2028	676
MEAN	42.25	42.25	42.25	126.75	42.25

Appendix Table 7.Days from flowering to pod settingof pole snap bean mixed with different amounts of pine wood strips (PWS) during storage

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
S_1V_1	6	6	6	18	6
S_1V_2	5	5	5	15	5
S_1V_3	5	5	5	15	5
S_1V_4	5	5	5	15	5
S_2V_1	6	6	6	18	6
S_2V_2	5	5	5	15	5
S_2V_3	5	5	5	15	5
S_2V_4	5	5	5	15	5
S_3V_1	6	6	6	18	6
S_3V_2	5	5	5	15	5
S_3V_3	5	5	5	15	5
S_3V_4	5	5	5	15	5
S_4V_1	6	6	6	18	6
S_4V_2	5	5	5	15	5
S_4V_3	5	5	5	15	5
S_4V_4	5	5	5	15	5
TOTAL	83	83	83	249	83
MEAN	5.18	5.18	5.18	15.54	5.18

Appendix Table 8. Days from emergence to pod settingof pole snap bean mixed with different amounts of pine wood strips (PWS) during storage

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
S_1V_1	49	49	49	147	49
S_1V_2	47	47	47	141	47
S_1V_3	47	47	47	141	47
S_1V_4	47	47	47	141	47
S_2V_1	49	49	49	147	49
S_2V_2	47	47	47	141	47
S_2V_3	47	47	47	141	47
S_2V_4	47	47	47	141	47
S_3V_1	49	49	49	147	49
S_3V_2	47	47	47	141	47
S_3V_3	47	47	47	141	47
S_3V_4	47	47	47	141	47
S_4V_1	49	49	49	147	49
S_4V_2	47	47	47	141	47
S_4V_3	47	47	47	141	47
S_4V_4	47	47	47	141	47
TOTAL	757	757	757	2271	757
MEAN	47.31	47.31	47.31	141.93	757

Appendix Table 9.Days from emergence to first harvestingof pole snap bean mixed with different amounts of pine wood strips (PWS) during storage

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
S_1V_1	56	56	56	168	56
S_1V_2	56	56	56	168	56
S_1V_3	56	56	56	168	56
S_1V_4	56	56	56	168	56
S_2V_1	56	56	56	168	56
S_2V_2	56	56	56	168	56
S_2V_3	56	56	56	168	56
S_2V_4	56	56	56	168	56
S_3V_1	56	56	56	168	56
S_3V_2	56	56	56	168	56
S_3V_3	56	56	56	168	56
S_3V_4	56	56	56	168	56
S_4V_1	56	56	56	168	56
S_4V_2	56	56	56	168	56
S_4V_3	56	56	56	168	56
S_4V_4	56	56	56	168	56
TOTAL	896	896	896	2688	896
MEAN	56	56	56	158	56

Appendix Table 10.Days from emergence to last harvestingof pole snap bean mixed with different amounts of pine wood strips (PWS) during storage

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
S_1V_1	78	78	78	234	78
S_1V_2	78	78	78	234	78
S_1V_3	78	78	78	234	78
S_1V_4	78	78	78	234	78
S_2V_1	78	78	78	234	78
S_2V_2	78	78	78	234	78
S_2V_3	78	78	78	234	78
S_2V_4	78	78	78	234	78
S_3V_1	78	78	78	234	78
S_3V_2	78	78	78	234	78
S_3V_3	78	78	78	234	78
S_3V_4	78	78	78	234	78
S_4V_1	78	78	78	234	78
S_4V_2	78	78	78	234	78
S_4V_3	78	78	78	234	78
S_4V_4	78	78	78	234	78
TOTAL	1248	1248	1248	3744	1248
MEAN	78	78	78	234	78

Appendix Table 11.Number of flower per cluster of pole snap bean mixed with different amounts of pine wood strips (PWS) during storage

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
S_1V_1	7.9	8.4	8.3	24.60	8.2
S_1V_2	8.0	8.2	8.1	24.30	8.1
S_1V_3	8.0	8.3	8.5	24.80	8.2
S_1V_4	8.3	8.2	8.1	24.60	8.2
S_2V_1	8.3	8.3	8.3	24.90	8.3
S_2V_2	7.9	8.1	8.1	24.10	8.0
S_2V_3	8.4	8.1	8.2	24.70	8.2
S_2V_4	8.3	8.5	8.2	25.00	8.3
S_3V_1	8.0	8.5	8.3	24.80	8.2
S_3V_2	8.4	8.2	8.0	24.60	8.2
S_3V_3	8.3	8.3	8.3	24.90	8.3
S_3V_4	8.1	8.4	8.3	24.80	8.2
S_4V_1	8.3	8.3	8.3	24.90	8.3
S_4V_2	8.2	8.2	8.3	24.70	8.2
S_4V_3	8.3	8.2	8.3	24.80	8.2
S_4V_4	8.2	8.4	8.4	25.00	8.3
TOTAL	139.1	132.6	132.0	403.7	134.5
MEAN	8.6	8.2	8.2	25.0	8.20

TWO WAY TABLE

VARIETY	PWS				TOTAL	MEAN
	S_1	S_2	S_3	S_4		
V_1	8.20	8.30	8.20	8.30	33.00	8.25
V_2	8.10	8.00	8.20	8.20	32.50	8.13
V_3	8.20	8.20	8.30	8.20	32.90	8.23
V_4	8.20	8.30	8.20	8.30	33.00	8.25
TOTAL	32.70	32.80	32.90	33.00	131.40	
MEAN	8.18	8.20	8.22	8.25		8.20

ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIANCE	DEEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	F VALUE	TABULAR F 0.05	0.01
Replication	2	0.093	0.046			
FACTOR A	3	0.057	0.019	0.91^{ns}	3.04	4.06
FACTOR B	3	0.156	0.052	2.48^{ns}	3.04	4.06
AB	9	0.082	0.009	0.43^{ns}	3.35	4.45
ERROR	30	0.627	0.021			
TOTAL	47	1.015				

ns = not significant CV = 1.75%

Appendix Table 12.Number of pods per clusterof pole snap bean mixed with different amounts of pine wood strips (PWS) during storage

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
S_1V_1	5.5	6.1	5.9	17.50	5.83
S_1V_2	5.9	6.0	5.9	17.80	5.93
S_1V_3	5.5	6.0	6.1	17.60	5.86
S_1V_4	5.9	5.6	5.8	17.30	5.76
S_2V_1	6.0	5.8	5.9	17.70	5.90
S_2V_2	5.8	5.8	5.7	17.30	5.76
S_2V_3	5.9	5.8	5.8	17.50	5.83
S_2V_4	6.1	6.1	5.9	18.10	6.03
S_3V_1	5.8	6.0	6.0	17.80	5.93
S_3V_2	6.1	5.7	5.6	17.40	5.80
S_3V_3	5.9	5.9	5.8	17.60	5.86
S_3V_4	6.0	6.2	5.9	18.10	6.03
S_4V_1	6.0	5.8	6.1	17.90	5.96
S_4V_2	6.0	5.7	6.0	17.70	5.90
S_4V_3	6.1	5.8	5.8	17.70	5.90
S_4V_4	5.8	5.9	5.9	17.60	5.86
TOTAL	94.3	94.2	941	282.6	94.2
MEAN	5.8	5.8	5.8	17.5	5.88

TWO WAY TABLE

VARIETY	PWS				TOTAL	MEAN
	S_1	S_2	S_3	S_4		
V_1	5.83	5.90	5.93	5.96	23.62	5.91
V_2	5.93	5.76	5.80	5.90	23.39	5.85
V_3	5.86	5.83	5.86	5.90	23.45	5.86
V_4	5.76	6.03	6.03	5.86	23.68	5.92
TOTAL	23.38	23.52	23.62	23.62	94.14	
MEAN	5.85	5.88	5.91	5.91		5.88

ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIANCE	DEEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	F VALUE	TABULAR F 0.05	0.01
Replication	2	0.001	0.001			
FACTOR A	3	0.027	0.009	0.30^{ns}	3.04	4.06
FACTOR B	3	0.044	0.015	0.49^{ns}	3.04	4.06
AB	9	0.221	0.025	0.82^{ns}	3.35	4.45
ERROR	30	0.899	0.030			
TOTAL	47	1.192				

ns = not significant CV = 2.94%

Appendix Table 13.Percentage pod set per clusterof pole snap beanmixed with different amounts of pine wood strips (PWS) during storage

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
S_1V_1	69.62	72.61	71.08	213.31	71.10
S_1V_2	73.75	73.17	72.83	219.75	73.25
S_1V_3	68.75	72.28	71.76	212.79	70.93
S_1V_4	71.08	68.29	71.60	210.97	70.32
S_2V_1	72.28	69.87	71.08	213.23	71.07
S_2V_2	73.41	71.60	70.37	215.38	71.79
S_2V_3	70.23	71.60	70.73	212.56	70.85
S_2V_4	73.49	71.76	71.95	217.20	72.40
S_3V_1	72.50	70.58	72.28	215.36	71.78
S_3V_2	72.61	69.51	70.00	212.12	70.70
S_3V_3	71.08	71.08	72.28	214.44	71.48
S_3V_4	74.07	73.80	71.08	218.95	72.98
S_4V_1	72.28	69.87	73.49	215.64	71.88
S_4V_2	73.17	69.51	72.28	214.96	71.65
S_4V_3	73.49	70.23	69.87	213.59	71.19
S_4V_4	70.73	70.23	70.23	211.19	70.39
TOTAL	1152.54	1135.99	1142.41	3431.44	1143.81
MEAN	72.03	70.99	71.43	214.45	71.49

TWO WAY TABLE

VARIETY	PWS				TOTAL	MEAN
	S_1	S_2	S_3	S_4		
V_1	71.1	71.07	71.78	71.88	285.83	71.46
V_2	73.25	71.79	70.7	71.65	287.39	71.85
V_3	70.93	70.85	71.48	71.19	284.45	71.11
V_4	70.32	72.4	72.98	70.39	286.09	71.52
TOTAL	285.60	286.11	286.94	285.11	1143.76	
MEAN	71.40	71.53	71.74	71.28		71.49

ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIANCE	DEEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	F VALUE	TABULAR F 0.05	0.01
Replication	2	8.636	4.318			
FACTOR A	3	1.379	0.460	0.24	3.04	4.06
FACTOR B	3	3.275	1.092	0.57	3.04	4.06
AB	9	27.776	3.086	1.63	3.35	4.45
ERROR	30	56.603	1.888			
TOTAL	47	97.669				

ns = not significant CV = 1.92%

Appendix Table 14. Total number of seeds per podof pole snap bean mixed with different amounts of pine wood strips (PWS) during storage

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
S_1V_1	8.7	8.6	8.5	25.80	8.60
S_1V_2	9.2	9.3	8.5	27.00	9.00
S_1V_3	8.6	7.7	8.2	24.50	8.16
S_1V_4	7.7	8.3	7.9	23.90	7.96
S_2V_1	8.9	8.8	9.2	26.90	8.96
S_2V_2	9.4	8.7	8.4	26.50	8.33
S_2V_3	8.5	8.3	8.1	24.90	8.30
S_2V_4	8.4	7.9	7.7	24.00	8.00
S_3V_1	8.8	9.1	8.5	26.40	8.80
S_3V_2	8.9	9.5	8.5	26.90	8.96
S_3V_3	7.9	7.7	8.3	23.90	7.96
S_3V_4	7.8	7.7	8.1	23.60	7.86
S_4V_1	9.2	8.7	8.4	26.30	8.76
S_4V_2	8.9	9.3	8.2	26.40	8.80
S_4V_3	7.6	7.7	8.2	23.50	7.83
S_4V_4	7.7	8.3	7.6	23.60	7.86
TOTAL	136.2	135.6	132.3	404.1	134.7
MEAN	8.5	8.4	8.2	25.1	8.38

TWO WAY TABLE

VARIETY	PWS				TOTAL	MEAN
	S_1	S_2	S_3	S_4		
V_1	8.6	8.96	8.8	8.76	35.12	8.78
V_2	9	8.33	8.96	8.8	35.09	8.77
V_3	8.16	8.3	7.96	7.83	32.25	8.06
V_4	7.96	8	7.86	7.86	31.68	7.92
TOTAL	33.72	33.59	33.58	33.25	134.14	
MEAN	8.43	8.40	8.40	8.31		8.38

ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIANCE	DEEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	F VALUE	TABULAR F 0.05	0.01
Replication	2	0.551	0.276			
FACTOR A	3	0.267	0.089	0.70^{ns}	3.04	4.06
FACTOR B	3	8.787	2.929	23.15^{**}	3.04	4.06
AB	9	0.452	0.050	0.40^{ns}	3.35	4.45
ERROR	30	3.795	0.127			
TOTAL	47	13.853				

ns = not significant CV = 4.22%
** = highly significant

Appendix Table 15. Length (cm) of marketable pods of pole snap bean mixed with different amounts of pine wood strips (PWS) during storage

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
S_1V_1	19.75	19.22	19.84	58.81	19.60
S_1V_2	20.32	19.84	20.72	60.88	20.29
S_1V_3	17.33	16.73	16.88	50.94	16.98
S_1V_4	16.11	16.28	15.75	48.14	16.04
S_2V_1	19.84	19.62	19.24	58.70	19.56
S_2V_2	19.36	19.18	20.40	58.94	19.64
S_2V_3	16.81	17.35	16.99	51.15	17.05
S_2V_4	16.24	16.07	15.80	48.11	16.03
S_3V_1	18.64	19.47	20.71	58.82	19.60
S_3V_2	19.72	19.02	20.61	59.35	19.78
S_3V_3	17.16	17.11	17.13	51.40	17.13
S_3V_4	16.65	16.39	15.95	48.99	16.33
S_4V_1	19.77	19.70	19.65	57.12	19.04
S_4V_2	20.17	19.46	19.97	59.60	19.86
S_4V_3	16.80	17.06	16.76	50.62	16.87
S_4V_4	16.17	16.26	16.13	48.56	16.18
TOTAL	291.04	288.76	292.56	87236	290.78
MEAN	18.19	18.04	18.28	54.51	18.12

TWO WAY TABLE

VARIETY	PWS				TOTAL	MEAN
	S_1	S_2	S_3	S_4		
V_1	19.6	19.56	19.6	19.04	77.80	19.45
V_2	20.29	19.64	19.78	19.86	79.57	19.89
V_3	16.98	17.05	17.13	16.87	68.03	17.01
V_4	16.04	16.03	16.33	16.18	64.58	16.15
TOTAL	72.91	72.28	72.84	71.95	289.98	
MEAN	18.23	18.07	18.21	17.99		18.12

ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIANCE	DEEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	F VALUE	TABULAR F 0.05	0.01
Replication	2	0.580	0.290			
FACTOR A	3	0.471	0.157	0.58^{ns}	3.04	4.06
FACTOR B	3	120.649	40.216	148.61^{**}	3.04	4.06
AB	9	1.200	0.133	0.49^{ns}	3.35	4.45
ERROR	30	8.118	0.271			
TOTAL	47	131.019				

ns = not significant CV = 2.87%
** = highly significant

Appendix Table 16. Width (cm) of marketable pods of pole snap bean mixed with different amounts of pine wood strips (PWS) during storage

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
S_1V_1	0.77	0.78	0.78	2.33	0.77
S_1V_2	0.83	0.83	0.78	2.44	0.81
S_1V_3	0.77	0.77	0.72	2.26	0.75
S_1V_4	0.75	0.71	0.75	2.21	0.73
S_2V_1	0.82	0.82	0.76	2.40	0.80
S_2V_2	0.79	0.79	0.78	2.36	0.78
S_2V_3	0.80	0.75	0.74	2.29	0.76
S_2V_4	0.74	0.74	0.73	2.21	0.73
S_3V_1	0.81	0.80	0.76	2.37	0.79
S_3V_2	0.78	0.78	0.76	2.32	0.77
S_3V_3	0.75	0.75	0.72	2.22	0.74
S_3V_4	0.76	0.74	0.72	2.22	0.74
S_4V_1	0.80	0.81	0.79	2.40	0.80
S_4V_2	0.81	0.83	0.78	2.42	0.80
S_4V_3	0.75	0.76	0.73	2.24	0.74
S_4V_4	0.77	0.74	0.72	2.23	0.74
TOTAL	12.50	12.40	12.02	36.92	12.30
MEAN	0.78	0.77	0.75	2.3	0.77

TWO WAY TABLE

VARIETY	PWS				TOTAL	MEAN
	S_1	S_2	S_3	S_4		
V_1	0.77	0.8	0.79	0.8	3.16	0.79
V_2	0.81	0.78	0.77	0.8	3.16	0.79
V_3	0.75	0.76	0.74	0.74	2.99	0.75
V_4	0.73	0.73	0.74	0.74	2.94	0.74
TOTAL	3.06	3.07	3.04	3.08	12.25	
MEAN	0.77	0.77	0.76	0.77		0.77

ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIANCE	DEEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	F VALUE	TABULAR F 0.05	0.01
Replication	2	0.008	0.004			
FACTOR A	3	0.001	0.000	1.66^{ns}	3.04	4.06
FACTOR B	3	0.029	0.010	39.52^{**}	3.04	4.06
AB	9	0.004	0.000	1.78^{ns}	3.35	4.06
ERROR	30	0.007	0.000			
TOTAL	47	0.049				

ns = not significant CV = 2.03%

** = highly significant

Appendix Table 17. Weight of marketable pods (kg/5m^2 plot)of pole snap beanmixed with different amounts of pine wood strips (PWS) during storage

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
S_1V_1	11.60	8.60	8.15	28.35	9.45
S_1V_2	10.20	7.35	9.80	27.35	9.11
S_1V_3	10.30	8.05	7.50	25.85	8.61
S_1V_4	10.15	7.60	8.80	26.55	8.85
S_2V_1	9.80	9.60	7.15	26.55	8.85
S_2V_2	8.00	9.60	10.05	27.65	9.21
S_2V_3	9.85	7.25	10.60	27.70	9.23
S_2V_4	10.10	10.05	7.65	27.80	9.26
S_3V_1	5.85	7.25	9.00	22.10	7.36
S_3V_2	9.45	9.20	7.75	26.40	8.80
S_3V_3	8.80	10.10	7.55	26.45	8.81
S_3V_4	9.05	7.00	8.50	24.55	8.18
S_4V_1	8.60	7.45	9.45	25.50	8.50
S_4V_2	11.25	9.65	9.05	29.95	9.98
S_4V_3	8.95	9.45	7.95	26.35	8.78
S_4V_4	10.15	7.75	9.70	27.60	9.20
TOTAL	152.10	135.95	138.65	426.70	142.23
MEAN	9,50	8.49	8.66	26.65	8.89

TWO WAY TABLE

VARIETY	PWS				TOTAL	MEAN
	S_1	S_2	S_3	S_4		
V_1	9.45	8.85	7.36	8.5	34.16	8.54
V_2	9.11	9.21	8.8	9.98	37.10	9.28
V_3	8.61	9.23	8.81	8.78	35.43	8.86
V_4	8.85	9.26	8.18	9.2	35.49	8.87
TOTAL	36.02	36.55	33.15	36.46	142.18	
MEAN	9.01	9.14	8.29	9.12		8.89

ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIANCE	DEEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	F VALUE	TABULAR F 0.05	0.01
Replication	2	9.354	4.677			
FACTOR A	3	5.841	1.947	1.21^{ns}	3.04	4.06
FACTOR B	3	3.285	1.095	0.68^{ns}	3.04	4.06
AB	9	6.167	0.685	0.43^{ns}	3.35	4.45
ERROR	30	48.072	1.602			
TOTAL	47	72.720				

ns = not significant CV = 14.24%

Appendix Table 18. Weight of non-marketable pods (kg/5m^2 plot) of pole snap bean mixed with different amounts of pine wood strips (PWS) during storage

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
S_1V_1	0.25	0.55	0.25	1.05	0.35
S_1V_2	0.55	0.35	0.35	1.25	0.41
S_1V_3	0.35	0.45	0.35	1.15	0.38
S_1V_4	0.30	0.35	0.35	1.00	0.33
S_2V_1	0.30	0.60	0.40	1.30	0.43
S_2V_2	0.40	0.45	0.45	1.30	0.43
S_2V_3	0.60	0.35	0.35	1.30	0.43
S_2V_4	0.45	0.25	0.30	1.00	0.33
S_3V_1	0.15	0.40	0.30	0.85	0.28
S_3V_2	0.45	0.50	0.15	1.10	0.36
S_3V_3	0.15	0.30	0.40	0.85	0.28
S_3V_4	0.50	0.60	0.45	1.55	0.51
S_4V_1	0.35	0.50	0.35	1.20	0.40
S_4V_2	0.40	0.35	0.45	1.20	0.40
S_4V_3	0.25	0.35	0.30	0.90	0.30
S_4V_4	0.30	0.50	0.40	1.20	0.40
TOTAL	5.75	6.85	5.60	18.20	6.06
MEAN	0.35	0.42	0.35	1.12	0.38

TWO WAY TABLE

VARIETY	PWS				TOTAL	MEAN
	S_1	S_2	S_3	S_4		
V_1	0.35	0.43	0.28	0.4	1.46	0.37
V_2	0.41	0.43	0.36	0.4	1.60	0.40
V_3	0.38	0.43	0.28	0.3	1.39	0.35
V_4	0.33	0.33	0.51	0.4	1.57	0.39
TOTAL	1.47	1.62	1.43	1.50	6.02	
MEAN	0.37	0.41	0.36	0.38		0.38

ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIANCE	DEEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	F VALUE	TABULAR F 0.05	0.01
Replication	2	0.058	0.029			
FACTOR A	3	0.015	0.005	0.43^{ns}	3.04	4.06
FACTOR B	3	0.023	0.008	0.67^{ns}	3.04	4.06
AB	9	0.143	0.16	1.40^{ns}	3.35	4.45
ERROR	30	0.340	0.011			
TOTAL	47	0.579				

ns = not significant CV = 28.08%

Appendix Table 19. Total yield (kg/5m^{2}plot)of pole snap bean mixed with different amounts of pine wood strips (PWS) during storage

	REPLICATION				
TREATMENT	I	II	III	TOTAL	MEAN
S_1V_1	11.85	9.15	8.40	29.40	9.80
S_1V_2	10.75	7.70	10.15	28.60	9.53
S_1V_3	10.65	8.50	7.85	27.00	9.00
S_1V_4	10.55	7.95	9.15	27.65	9.21
S_2V_1	10.10	10.20	7.55	27.85	9.28
S_2V_2	8.40	10.05	10.50	28.95	9.65
S_2V_3	10.45	7.40	10.95	28.80	9.60
S_2V_4	10.55	10.30	7.95	28.80	9.60
S_3V_1	6.00	7.65	9.30	22.95	7.65
S_3V_2	9.90	9.70	7.90	27.50	9.16
S_3V_3	8.95	10.10	7.95	27.00	9.00
S_3V_4	9.55	7.60	8.95	26.10	8.70
S_4V_1	8.95	7.95	9.80	26.70	8.90
S_4V_2	11.65	10.00	9.50	31.15	10.38
S_4V_3	9.20	9.80	8.25	27.25	9.08
S_4V_4	10.45	8.25	10.10	28.80	9.60
TOTAL	157.95	142.30	144.25	444.50	148.16
MEAN	9.87	8.89	9.01	27.77	9.26

TWO WAY TABLE

VARIETY	PWS				TOTAL	MEAN
	S_1	S_2	S_3	S_4		
V_1	9.80	9.28	7.65	8.90	35.63	8.91
V_2	9.53	9.65	9.16	10.38	38.72	9.68
V_3	9.00	9.60	9.00	9.08	36.68	9.17
V_4	9.21	9.60	8.70	9.6	37.11	9.28
TOTAL	37.54	38.13	34.51	37.96	148.14	
MEAN	9.39	9.53	8.63	9.49		9.26

ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIANCE	DEEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	F VALUE	TABULAR F 0.05	0.01
Replication	2	9.092	4.546			
FACTOR A	3	6.511	2.170	1.32^{ns}	3.04	4.06
FACTOR B	3	3.734	1.245	0.76^{ns}	3.04	4.06
AB	9	5.774	0.642	0.39^{ns}	3.35	4.45
ERROR	30	49.298	1.643			
TOTAL	47	74.410				

ns = not significant CV = 13.84%

Appendix Table 20.Reaction to pod borerof pole snap beanmixed with different amounts of pine wood strips (PWS) during storage

	REPLICATION				
TREATMENT	I	II	III	TOTAL	MEAN
S_1V_1	3	3	3	9.00	3.00
S_1V_2	2	2	2	6.00	2.00
S_1V_3	3	3	3	9.00	3.00
S_1V_4	2	2	2	6.00	2.00
S_2V_1	3	3	3	9.00	3.00
S_2V_2	2	2	2	6.00	2.00
S_2V_3	4	3	3	10.00	3.33
S_2V_4	2	2	2	6.00	2.00
S_3V_1	3	3	3	9.00	3.00
S_3V_2	2	2	2	6.00	2.00
S_3V_3	3	3	3	9.00	3.00
S_3V_4	2	2	2	6.00	2.00
S_4V_1	3	3	3	9.00	3.00
S_4V_2	2	2	2	6.00	2.00
S_4V_3	2	3	3	8.00	2.66
S_4V_4	2	2	2	6.00	2.00
TOTAL	41.00	40.00	40.00	121.00	40.33
MEAN	2.56	2.50	2.50	7.56	2.52

TWO WAY TABLE

VARIETY	PWS				TOTAL	MEAN
	S_1	S_2	S_3	S_4		
V_1	3.00	3.00	3.00	3.00	12.00	3.00
V_2	2.00	2.00	2.00	2.oo	8.00	2.00
V_3	3.00	3.33	3.00	2.66	11.99	3.00
V_4	2.00	2.00	2.00	2.00	8.00	2.00
TOTAL	10.00	10.33	10.00	9.66	39.99	
MEAN	2.50	2.58	2.50	2.42		2.50

ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIANCE	DEEGREES OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	F VALUE	TABULAR F 0.05	0.01
Replication	2	0.00	0.00			
FACTOR A	3	0.167	0.05	1.25	3.04	4.06
FACTOR B	3	12.00	4.00	90.00	3.04	4.06
AB	9	0.50	0.05	1.25	3.35	4.45
ERROR	30	1.33	0.044			
TOTAL	47	14.00				

ns = not significant CV = 8.43%
** = highly significant

Appendix Table 21.Reaction to bean rustof pole snap bean mixed with different amounts of pine wood strips (PWS) during storage

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
S_1V_1	2	2	2	6	2
S_1V_2	1	1	1	3	1
S_1V_3	2	2	2	6	2
S_1V_4	1	1	1	3	1
S_2V_1	2	2	2	6	2
S_2V_2	1	1	1	3	1
S_2V_3	2	2	2	6	2
S_2V_4	1	1	1	3	1
S_3V_1	2	2	2	6	2
S_3V_2	1	1	1	3	1
S_3V_3	2	2	2	6	2
S_3V_4	1	1	1	3	1
S_4V_1	1	2	2	6	2
S_4V_2	1	1	1	3	1
S_4V_3	2	2	2	6	2
S_4V_4	1	1	1	3	1
TOTAL	24	24	24	72	24
MEAN	1.5	1.5	1.5	4.5	1.5