BIBLIOGRAPHY

KIAL, ALEX I. APRIL 2009. Appropriate Time in Pinching Shoot of Pole Snapbean During Juvenile Stage. Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The study was conducted at BSU, Balili, La Trinidad, Benguet from November 2008 to March 2009 to determine the effect of pinching the shoot of pole snapbean 'Black Valentine' during juvenile stage on the growth and yield, appropriate timing and profitability of the practice.

The results of the study revealed that the first harvest of green mature pods was 60 to 66 days from planting the seeds when shoot pinching is done one and two weeks after emergence. In terms of yield, no shoot pinching and pinching the shoots one week after emergence slightly differ in the marketable, non-marketable pods, total yield and computed yield per hectare but their advantages over the shoot pinching two, three and four weeks after emergence are negligible.

Similar results were recorded in pod length, pod counts, pod weight, pod diameter and number of pickings. It was observed that the number of lateral branches significantly increased from one to three weeks of weekly pinching the shoot but in plant height the opposite occurred where plant height decreased as the number of lateral branches increased.

In terms of profitability, no shoot pinching or the control treatment obtained the highest return on investment of 56.85% or PhP0.56 for every peso spent in the production followed by pinching the shoot one week after emergence (19.20%). The pinching of shoots two, three and four weeks after emergence incurred a negative or loss of -26.30, -3.86 and -23.66% respectively.

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INTRODUCTION

Pole snap bean (*Phaseolus vulgaris* Linn) belongs to the family *leguminosae*. It originated in tropical America. It is an annual crop adapted to a wide variety of soils. Moreover, it helps maintain and conserve soil fertility because of its ability to fix free nitrogen from the atmosphere through the action of nitrogen fixing bacteria present in its root (Watts, 1972).

Also known as protein source, it contains high calories and ascorbic acid (Vitamin C). This legume has industrial and agricultural importance. It is used as vegetable food, processed into various forms, and as animal feeds. Beans are used as medicine in reducing the cases of beri-beri. Leguminous crops like pole snap bean could also fix nitrogen in the soil. It is recommended for crop rotation and for green manuring thus contribute to the improvement of the physical and fertility conditioning of the soil.

The availability of water during dry season is a serious problem in pole snap bean production. Thus, it is necessary to know the stage when pole snap bean is most sensitive to moisture stress so that limited irrigation of water could be applied efficiently.

Snap bean production is one of the main sources of livelihood by farmers in the Cordillera. It is mainly grown for fresh pods which can produce 17 to 23 tons/ha from pole types depending on the cultivar. Poleg (1977) stated that the effect of pruning on the total yield of bean pods was more from the unpruned one. Reyes (1955) reported that tomatoes pruned to a single stem, staked and mulched with rice straw produced greater yield of marketable fruits as compared to unpruned and unstaked plants. Furthermore, Aquino (1962) found that topping and training delays flowering by four days in varieties of native tomato. Thus, it is also necessary to know the effect of shoot pruning in pole snap beans.

The objectives of the study was conducted to: determine the effect of removing the shoot of snap bean during juvenile stage on the growth and yield; determine the appropriate number of weeks from emergence when the shoot of snap bean can be removed to enhance growth of lateral branches and yield; and determine the profitability of removing shoot at juvenile stage.

The study was conducted at Benguet State University, Balili, La Trinidad, Benguet from November 2008 to March 2009.

REVIEW OF LITERATURE

Description of Pole Snap Beans

Pole snap beans (*Phaseolus vulgaris Linn*) belongs to the *Leguminosae* family which is adapted to a wide range of condition but are best grown in areas with temperature from 16 to 24^{o}C. Snap beans can also be grown in all kinds of soil but thrives well in a fertile and well drained soil with 5.5 to 7.0 pH (Bautista et al., 1983).

The stems are slender, twisted, angled, and almost square in cross-section often with purple. Snap beans have long and extensive root system vegetable legumes, produce nodules which are important in nitrification and in the nutritional requirements of the crops (Tindall, 1983).

The flowers of pole snap beans vary in size and color depending on the species. Calyxes are generally green and purple. The corollas are white, yellow, purple, blue and mixtures of blue, purple, pink, green and purple yellow. Pod characteristics also vary with species. The pod maybe linear, cylindrical, slightly curved, oblong or crescent shape and flat. Length and diameter range from 6.75 cm from 0.5-2 cm, respectively. An immature pod varies in color from light green to dark green, yellow and purple mottled green or purple pods are also observed among those of cowpea kidney beans and pigeon pea. The number of seed pea pod ranges from 1-22 (Knott and Deanon, 1967).

The seeds are varied in size, shape, color, maybe white, pink, red, black, brown or speckled depending on the variety grown (Perez, 1983).

Economic Importance of Pole Snap Beans

Snap bean, a major crop grown in Benguet is a leading vegetable crop due to its protein, phosphorous, calcium, iron and vitamin contents for better human nutrition. It helps in the maintenance of soil fertility level especially when the soil is continuously cropped with high nitrogen feeding plants (Tisdale and Nelson, 1970). In addition to their use as a human food, the poorer qualities of beans are feed to livestock and the plants are used for forage. They rank high as a cheap source of protein and calories (Matzke, 1973). Moreover, dried bean seeds have high carbohydrate content, which is extremely nutritious food for man and many domesticated animals (Tiedjens, 1964).

Soil and Climatic Requirement

Legume crops can be grown in any type of soil provided with available water. They perform best in soil that is granular, fertile, well-drained, and relatively free from nematodes and fusarium disease. They thrive in soil with 5.5 to 7.0 pH (Bautista, et al., 1983).

Tindall (1983) mentioned that European forms or cultivars are normally cultivated in elevations over 600 m above sea level. It is further stated that many cultivars can tolerate a wide range of soil conditioning with optimum pH of about 5.5 to 6.5. However, acid soils should be avoided since it reduces the activity of Rhizobium nitrogen fixing bacteria.

Martin and Leonard (1970) stated that bean plant is a warm season and annual crop adapted to a wide variety of soil. Its optimum temperature requirement is 65o to 75oF. High temperatures interfere with seed setting, while low temperatures are unfavorable for growth. Dry beans are produced most successfully in areas where rainfall is light during the later part of the season. This reduces weather damage to the mature beans. Under dry land conditions, the bean plant adjusts its growth, flowering and pod setting to the soil moisture supply to a marked degree. Beans require a minimum frost-free season of about 120 to 130 days in order to mature seed.

Apical Dominance

Limited bud growth has been widely explained in terms of apical dominance. It is the correlative phenomenon in which the growth and development of lateral buds is inhibited by the terminal bud. Scientists have proposed the hormone and nutrient theories. Cytokinin under hormone theory is known to initiate bud growth (Wickson and Thimann, 1958) that includes the accordance of the higher the auxin level, the higher the kinetin concentration needed to overcome the inhibition. Under nutrient theory, the reasons behind apical dominance maybe summarized into two aspects, Phillips (1968). First, the production of hormones; and second, the background balance of hormones present in the plant. Hence, modification of apical dominance and the release of lateral buds from inhibition maybe obtained by interfering with these two aspects.

Salisbury (1968) disclosed that the active substance normally produced by the apical bud is an auxin which is a hormone and that this hormone controls branching in plants.

Devlin (1977) agreed that the apical dominance is due to the presence of auxin produced at the terminal bud transported downward through the stem. Ting (1982) also agreed that the apical dominance is the regulatory control of growth that the plant apex exerts on the other potentially meristematic regions. Thus, it regulates both the extent and the angle of branching and controls the overall growth from the above ground portions of plants.

MATERIALS AND METHODS

Materials

The materials used in the study are: seeds of pole snap beans "Black Valentine", fertilizer (compost and 14-14-14), sticks, farm tools and equipment, measuring tape, pen and record book.

Methods

The experiment was laid out in a randomized complete block design (RCBD) with three replications. The treatments are the following:

T_1 – shoot pinched 1 week from emergence

T_2 – shoot pinched 2 weeks from emergence

T_3 – shoot pinched 3 weeks from emergence

T_4 – shoot pinched 4 weeks from emergence

T_5 – No shoot pinching

Land preparation. An area of 75 m2 was prepared thoroughly for the study. The area was divided into three blocks, each of which were sub-divided into five plots measuring 1 m x 5 m.

The plots was dug about 25 cm deep then applied with processed chicken manure at the rate of 3 kg per plot as fertilizer base dress. This was mixed with the soil thoroughly. Double rows of shallow canals were made on each plot to serve as guide in planting.

Planting. Two seeds of pole snap bean "Black Valentine" was planted 25 cm x 25 cm both ways. This spacing was planted 35 seeds per row or 70 seeds per treatment plot. The depth of planting the seeds was 2.54 cm.

Irrigation. After planting the seeds, all the treatment plots was watered at the rate of two watering cans (32 liters of water) per plot. Irrigation was done every three days or twice a week.

Side dressing and hilling up. Two weeks after emergence, the plants was side dressed with 14-14-14 at the rate of 90-90-90 kg N-P_20_5-K_20 per hectare or 321.43 grams per plot. After applying the side dress fertilizer equally near the base of plants, hilling-up was done immediately to cover the fertilizer, growing weeds and fix the plots.

Training. After hilling-up, trellises were fixed at the middle of the plant rows interwoven perpendicularly. The plant shoots was directed to twine the trellises.

Crop maintenance. All the cultural practices of growing snap beans was followed in all the treatment plots equally in order to insure optimum growth and yield.

Data Gathered

1. Planting to first pod picking. This was the number of days from planting to first picking/harvesting.

2. Pod length (cm). This was taken from five sample pods per treatment from first to the last harvest.

3. Pod counts. This was the total number of harvested pods from the first picking to last picking.

4. Number of pickings from first to last harvest. The number of pickings from each treatment was recorded.

5. Weight of marketable pods (kg/plot). This was the total weight of harvested pods without defects such as matured, very short, over matured or damaged by insects.

6. Weight of non-marketable pods (kg/plot). This was the total w eight of harvested pods with defects that can not be sold in the market.

7. Total yield (kg/plot). This was the weight of marketable and non-marketable pods harvested from the first to the last harvest.

8. Number of lateral branches produced. The number of lateral branches produced was counted below the shoot removed.

9. Final plant height (cm). Five plants from each treatment plot were measured after the last harvest by carefully coravelling the plants from the sticks and measuring from the base to the tip of the vines.

10. Computed yield per hectare (ton/ha). The yield per plot was converted to tons per hectare by multiplying the yield per plot by 2000 and divided by 1000. The 2000 is the number of plots per hectare based in 1 m x 5 m plot of the study and the 1000 is the weight of one ton.

11. Average pod weight. The weight of marketable pods was divided by the number of marketable pods per plot to get the average weight of individual pod.

12. Pod diameter. This was the pod diameter of five samples per treatment.

13. Insect pest infestation. This was observed on each block per treatment using the rate below.

Rating	Description
1	No infestation
2	Slight infestation (1-19%)
3	Moderate infestation (20-39%)
4	Severe infestation (40% or more)

14. Economic analysis. All expenses incurred in the study were recorded. Expenses include the cost of seeds, fertilizers, trellis depreciation, labor, etc. The return on investment (ROI) was computed using the formula:

ROI = Gross Sales – Expenses ÷ Expenses x 100

15. Documentation after pinching shoots of pole snapbean. This was done just after pinching the shoots of pole snapbean.

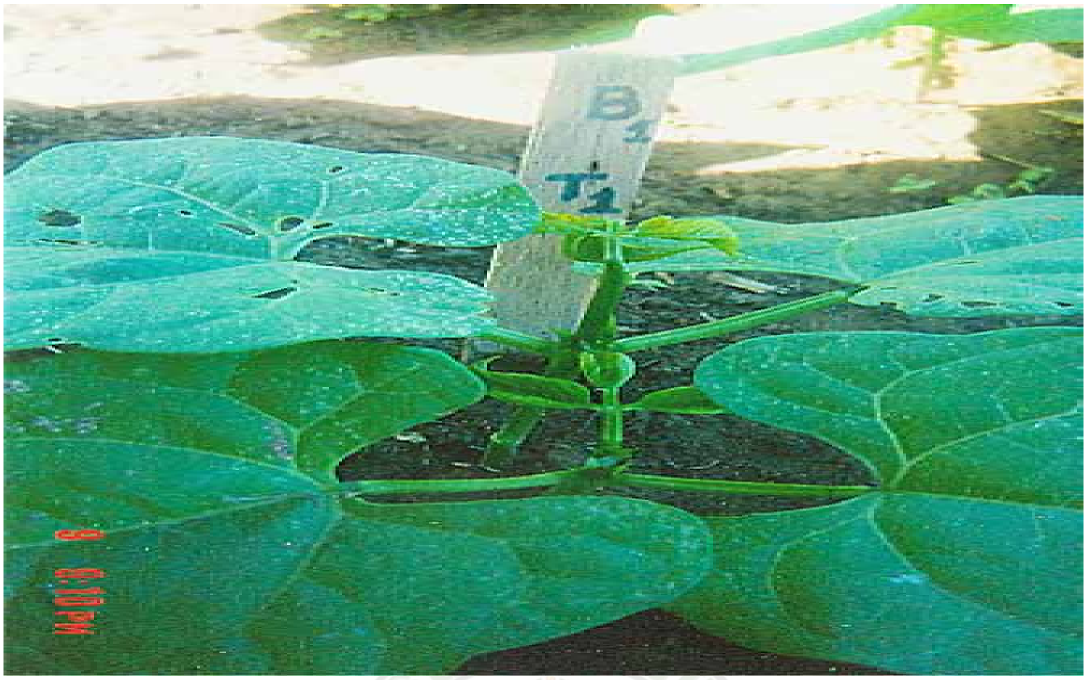

Figure 1. Shoot pinched one week from emergence

Figure 2. Shoot pinched two weeks from emergence

Figure 3. Shoot pinched three weeks from emergence

Figure 4. Shoot pinched four weeks from emergence

Figure 5. No shoot pinching

RESULTS AND DISCUSSION

Planting to First Pod Picking

Table 1 shows that pinching the shoot of 'Black Valentine' three and four weeks from emergence had similar days to first picking with the plants without shoot pinching which significantly differed from those plants with shoots pinched one and two weeks from emergence. This means that there was a delay of 6 days to harvest when the shoots were pinched one to two weeks from emergence.

According to Kudan (2008) the first harvest of green mature pods starts 60 days from planting the seeds under La Trinidad, Benguet condition. This tally in this study on no shoot pinching and those plants whose shoots were pinched three to four weeks from emergence, but early shoot pinched from one to two weeks from emergence delays the first harvest of green mature pods.

Table 1. Planting to first pod picking

TREATMENT	MEAN
Shoot pinched one week from emergence	66.0[a]
Shoot pinched two weeks from emergence	66.0[a]
Shoot pinched three weeks from emergence	60.0[b]
Shoot pinched four weeks from emergence	60.0[b]
No shoot pinching (control)	60.0[b]

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

Pod Length

As presented in Table 2, pinching the shoots of ‘Black Valentine’ one to four weeks after emergence did not affect the pod length compared to the no shoot pinching or control plants. It appears that the pod length of ‘Black Valentine’ at this time is longer than in 1960’s and 1990’s. The observed characteristic of the earlier ‘Black Valentine’ was that pod bearing is concentrated on then lower portion of the vines but the present ‘Black Valentine’ has up to the upper portion. There might be some sort of cross pollination after more than 40 years.

Pod Counts

The number of pods harvested from ‘Black Valentine’ is shown in Table 3. Shoot pinched one week, three weeks from emergence and no pinching had similar number of pods per plot but did not significantly differ from pinching the shoots four or two weeks after emergence. Obviously, there was no trend in the number of pods produced corresponding to the increasing number of lateral branches produced (Table 3). It might be that shoot pinching did not influence the number of pods produced.

Table 2. Pod length

TREATMENT	MEAN (cm)
Shoot pinched one week from emergence	16.32[a]
Shoot pinched two weeks from emergence	16.02[a]
Shoot pinched three weeks from emergence	17.29[a]
Shoot pinched four weeks from emergence	16.12[a]
No shoot pinching (control)	16.10[a]

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

Table 3. Pod counts per plot

TREATMENT	MEAN
Shoot pinched one week from emergence	1,303.00[a]
Shoot pinched two weeks from emergence	923.67[b]
Shoot pinched three weeks from emergence	1,147.67[ab]
Shoot pinched four weeks from emergence	937.00[b]
No shoot pinching (control_	1,289.67[a]

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

Table 4. Number of pickings from first to last harvest

TREATMENT	MEAN
Shoot pinched one week from emergence	6.0[b]
Shoot pinched two weeks from emergence	6.0[b]
Shoot pinched three weeks from emergence	7.0[a]
Shoot pinched four weeks from emergence	7.0[a]
No shoot pinching (control)	7.0[a]

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

Number of Pickings from First to Last Harvest

As shown in Table 4, shoot pinched one and two weeks from emergence had lesser number of picking pods compared to those shoot pinched three and four weeks from emergence. However, the number of pickings did not influence the total yield of the treatment plots as those with more pickings did not surpass those with less number of pickings (Table 5).

Weight of Marketable Pods

The weight of marketable pods produced by the different treatments was presented in Table 5. No shoot pinching and shoot pinched one week after emergence produced the heaviest marketable pods but did not differ significantly over those shoots pinched two, three or four weeks from emergence. This means that shoot pinching during the juvenile state in pole bean 'Black Valentine' did not affect the marketable pods.

Weight of Non-marketable pods

Table 5 shows the non-marketable yield from shoot pinched plants. No shoot pinching, shoot pinched one and three weeks after emergence produced the heaviest weight of non-marketable pods which slightly differ from two and four weeks pinching from emergence. The slight differences in the w eight of non-marketable pods are not an effect of the treatments but maybe due to human error in classifying the non-marketable pods.

Total Yield

Plants with no shoot pinching and those with shoot pinched one week after emergence produced similar total yield per plot which slightly differ from those plants with shoot pinched three weeks from emergence (Table 5). Shoot pinching two and four weeks after emergence have total yields similar to the plants with shoot, pinched three weeks after emergence.

As mentioned earlier, there was no trend in the yield that follow the trend of increasing number of lateral branches produced (Table 6) from one to four weeks

Table 5. Weight of marketable, non-marketable pods and total yield per plot

TREATMENT	MARKETABLE POD (kg)	NON-MARKETABLE POD (kg)	TOTAL YIELD (kg)
Shoot pinched one week from emergence	4.16[ab]	4.16[a]	8.33[ab]
Shoot pinched two weeks from emergence	2.66[b]	2.95[a]	5.60[c]
Shoot pinched three weeks from emergence	3.56[b]	3.78[ab]	7.20[bc]
Shoot pinched four weeks from emergence	2.81[b]	3.03[a]	6.02[c]
No shoot pinching	5.18[a]	4.23[a]	9.42[a]

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

pinching of shoots which means that the increase in the number of lateral branches do not necessary increase the pod yield of 'Black Valentine'.

Computed Yield per Hectare

Table 6 shows that no shoot pinching produced the highest computed yield per hectare which slightly differed from plants whose shoots were pinched one week after emergence, which in turn did not also differ from pinching the shoots three weeks after emergence. Pinching the shoots three weeks after emergence has computed yield that did not differ from either pinching two or four weeks after emergence.

This result clearly shows that the practice of some farmers in pinching the shoots of their snapbean plants has no economic advantage.

Table 6. Computed yield per hectare (t/ha)

TREATMENT	MEAN
Shoot pinched one week from emergence	16.67[ab]
Shoot pinched two weeks from emergence	11.20[c]
Shoot pinched three weeks from emergence	14.40[bc]
Shoot pinched four weeks from emergence	11.69[c]
No shoot pinching	18.69[a]

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

Number of Lateral Branches Produced

Table 7 shows that the number of shoots produced from three to four weeks after emergence slightly differ but both treatments significantly produced more lateral branches over shoot pinching one and two weeks after emergence. Moreover, shoot pinched two weeks after emergence significantly out numbered the lateral branches produced from shoot pinching one week after emergence.

The increasing number of lateral branch production is directly related to the number of nodes present above the soil surface. Shoot pinching one week after emergence has one or two nodes and this increases each week up to four weeks that the shoot pinching treatments was implemented. Meanwhile, the no shoot pinching did not produce lateral branch at all due to the effect of apical dominance wherein the presence of the main shoot prevented the production of lateral shoot.

Table 7. Number of lateral branches produced per plant and final plant height

TREATMENT	LATERAL BRANCHES	PLANT HEIGHT (cm)
Shoot pinched one week from emergence	3.0 c	318.53[b]
Shoot pinched two weeks from emergence	5.0 b	310.7 [b]
Shoot pinched three weeks from emergence	8.0 a	280.80[c]
Shoot pinched four weeks from emergence	9.0 a	287.5 [c]
No shoot pinching	0.0 d	348.0 [a]

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

Final Plant Height

Table 7 shows that no shoot pinching significantly outgrow the plants with shoots pinched at weekly interval from one to four weeks after emergence. Among the plants whose shoots were pinched, one and two weeks had significantly taller lateral branches compared to the three and four weeks pinched plants. It is apparent in this study that pinching f shoot earlier resulted to longer vines. This maybe due to one or two nodes producing lesser lateral branches, thus lesser competition in food, moisture and space for growth. The more the lateral branches, the more the competition resulting to reduced growth.

Average Pod Weight

Table 8 shows that the plants without shoot pinching and those shoots were pinched one and two weeks after emergence have similar pod weight which did not significantly differ over those shoot pinched three and four weeks after emergence. This slight difference in pod weight means that shoot pinching does not affect the individual pod weight.

Table 8. Average pod weight and pod diameter

TREATMENT	POD WEIGHT (g)	POD DIAMETER (cm)
Shoot pinched week from emergence	8.19[ab]	1.56[a]
Shoot pinched two weeks from emergence	7.84[ab]	1.47[b]
Shoot pinched three weeks from emergence	7.55[b]	1.51[ab]
Shoot pinched four weeks from emergence	7.48[b]	1.51[ab]
No shoot pinching	8.89[a]	1.55[a]

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

Pod Diameter

Table 8 shows that similar to pod weight, the pod diameter slightly differ among the shoot pinching and the plants without pinching. Again, pod diameter maybe a varietal characteristic and can not be affected by shoot pinching.

Insect Pest Infestation

Table 9 shows that no shoot pinching and shoot pinched one week from emergence had the same rating of slight infestation by pod borer. This was followed by pinching the shoot two weeks from emergence with a rating of moderate infestation of pod borer while those pinching three and four weeks after emergence had the highest rating of severe infestation by pod borer.

Table 9. Insect pest infestation (pod borer)

TREATMENT	MEAN	DESCRIPTION
Shoot pinched one week from emergence	2	Slight infestation (1-19%)
Shoot pinched two weeks from emergence	3	Moderate infestation 20-39%)
Shoot pinched three weeks from emergence	4	Severe infestation (40% or more)
Shoot pinched four weeks from emergence	4	Severe infestation (40% or more)
No shoot pinching	2	Slight infestation (1-19%)

Means with the same letter are not significantly different

Economic Analysis

Table 10 shows the profitability of the five treatments evaluated. Among the treatments, no shoot pinching obtained the highest return of investment (ROI) of 56.85% or Ph0.56 for every peso the shoots one week after emergence with 19.20% ROI. Pinching the plant shoots two, three and four weeks after emergence obtained a negative return on investment of 26.30, 3.86 and 23.66 respectively.

Table 10. Economic analysis

TREATMENTS	PINCHED AFTER ONE WEEK	PINCHED AFTER TWO WEEKS	PINCHED AFTER THREE WEEKS	PINCHED AFTER FOUR WEEKS	NOT SHOOT PINCHING
Marketable (kg)	12.00	8.00	10.70	8.43	15.56
Sales (PhP)	275.95	170.60	222.55	176.75	342.70
Expenses					
Seeds	18.90	18.90	18.90	18.90	18.90
Chicken manure (Bio-organic)	42.00	42.00	42.00	42.00	42.00
14-14-14	32.60	32.60	32.60	32.60	32.60
Labor	138.00	138.00	138.00	138.00	125.00
TOTAL EXPENSES	231.50	231.50	231.50	231.50	218.50
Net Profit	44.45	-60.90	-8.95	-54.55	124.20
ROI %	19.20	-26.30	-3.86	-23.66	56.85
RANK	2	5	3	4	1

Note: Selling price during harvest ranged from PhP15.00 to PhP30/kg.

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted at BSU Administration Area, Balili, La Trinidad, Benguet from November 2008 to March 2009 to determine the effect of pinching the shoot of pole snapbeans “Black Valentine” during juvenile stage on the growth and yield, appropriate timing and profitability of the practice.

The results of the study revealed that the first harvest of green mature pods was 60 to 66 days from planting the seeds when shoot pinching is done one and two weeks after emergence. In terms of yield, no shoot pinching and pinching the shoots one week after emergence slightly differ in the marketable, non-marketable pods, total yield and computed yield per hectare but their advantages over the shoot pinching two, three and four weeks after emergence are negligible.

Similar results were recorded in pod length, pod counts, pod weight, pod diameter and number of pickings. It was observed that the number of lateral branches significantly increased from one to three weeks of weekly pinching the shoot but in plant height the opposite occurred where plant height decreased as the number of lateral branches increased.

In terms of profitability, no shoot pinching or control obtained the highest return on investment of 56.85 or Ph0.56 for every peso spent in the production followed by pinching the shoot one week after emergence (19.20%), and the pinching of shoots two, three and four weeks after emergence incurred a negative or loss of -26.30, -3.86 and -23.66% respectively.

Conclusion

Based on the results presented and discussed, no shoot pinching on pole snapbean 'Black Valentine' had better growth and yield that obtained the highest return on investment. It is unnecessary to be pinching the shoots of snapbeans.

Recommendation

It is therefore recommended that farmers need not to pinch the shoots of snapbean 'Black Valentine' in order to obtain the highest yield and profit. It is, however, recommended that this result be verified in other growing areas.

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APPENDICES

Appendix Table 1. Days to first pod picking

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	66.0	66.0	66.0	198.0	66.00
T_2	66.0	66.0	66.0	198.0	66.00
T_3	60.0	60.0	60.0	180.0	60.00
T_4	60.0	60.0	60.0	180.0	60.00
T_5	60.0	60.0	60.00	180.0	60.00

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
Block	2	0.000	0.000			
Treatment	4	129.600	32.400	99999.99**	3.84	7.01
Error	8	0.000	0.000			
TOTAL	14	129.600				

** - Highly significant

Coefficient of variation = 0%

Appendix Table 2. Pod length (cm)

TREATMENT	REPLICATION I	REPLICATION II	REPLICATION III	TOTAL	MEAN
T_1	16.26	16.64	16.07	48.97	16.32
T_2	16.72	15.82	15.54	48.08	16.02
T_3	16.07	15.92	15.88	47.87	17.29
T_4	15.36	16.16	16.25	48.37	16.12
T_5	16.25	16.27	15.79	48.31	16.10

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Block	2	0.850	0.425			
Treatment	4	3.295	0.823	0.64^{ns}	3.84	7.01
Error	8	10.343	1.292			
TOTAL	14	14.488				

^{ns} - Not significant

Coefficient of variation = 6.94%

Appendix Table 3. Pod counts

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	1,211	1,291	1,407	3,909	1,303.00
T_2	897	921	953	2,771	923.67
T_3	1,073	1,331	979	3,443	1,147.67
T_4	1,031	893	917	2,841	937.00
T_5	1,230	1,352	1,287	3,869	1,289.67

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
Block	2	17870.800	8935.400			
Treatment	4	394478.400	98619.600	6.88*	3.84	7.01
Error	8	114691.200	14336.400			
TOTAL	14	527040.400				

* - Significant

Coefficient of variation = 10.67%

Appendix Table 4. Number of pickings from first to last harvest

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	6	6	6	18	6.00
T_2	6	6	6	18	6.00
T_3	7	7	7	21	7.00
T_4	7	7	7	21	7.00
T_5	7	7	7	21	7.00

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
Block	2	0.000	0.000			
Treatment	4	3,600	0.900	99999.99**	3.84	7.01
Error	8	0.000	0.000			
TOTAL	14	3.600				

** - Highly significant

Coefficient of variation = 0%

Appendix Table 5. Weight of marketable pods (kg/plot)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	2.90	3.80	5.80	12.50	4.16
T_2	2.35	2.75	2.90	8.00	2.66
T_3	3.40	4.15	3.15	10.70	3.56
T_4	2.95	2.63	2.85	8.43	2.81
T_5	5.28	5.81	4.47	15.56	5.18

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
Block	2	0.690	0.345			
Treatment	4	12.910	3.227	4.80*	3.84	7.01
Error	8	5.384	0.673			
TOTAL	14	18.984				

* - Significant

Coefficient of variation = 22.29%

Appendix Table 6. Weight of non-marketable pods (kg/plot)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	4.80	4.00	3.70	12.50	4.16
T_2	2.95	2.95	2.95	8.85	2.95
T_3	3.50	5.00	2.85	11.35	3.78
T_4	3.39	3.50	2.21	9.10	3.03
T_5	4.23	4.21	4.25	12.69	4.23

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Block	2	1.518	0.760			
Treatment	4	4.469	1.117	3.46^{ns}	3.84	7.01
Error	8	2.584	0.322			
TOTAL	14	8.571				

^{ns} – Not significant

Coefficient of variation = 0%

Appendix Table 7. Total yield (kg/plot)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	7.70	7.80	9.50	25.00	8.33
T_2	5.30	5.70	5.80	16.80	5.60
T_3	6.45	9.15	6.00	21.60	7.20
T_4	6.34	6.13	5.60	21.49	6.02
T_5	9.51	10.25	8.50	28.26	9.42

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
Block	2	1.806	0.904			
Treatment	4	30.272	7.568	7.55**	3.84	7.01
Error	8	8.019	1.002			
TOTAL	14	40.097				

** - Highly significant

Coefficient of variation = 13.69%

Appendix Table 8. Number of lateral branches produced

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	3	3	3	9	3.00
T_2	5	5	5	15	5.00
T_3	8	7	9	24	8.00
T_4	9	8	10	27	9.00
T_5	0	0	0	0	0

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
Block	2	1.600	0.800			
Treatment	4	162.000	40.500	135.00**	3.84	7.01
Error	8	2.400	0.300			
TOTAL	14	166.000				

** - Highly significant

Coefficient of variation = 10.96%

Appendix Table 9. Final plant height (cm)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	321.4	318.0	316.2	955.6	318.53
T_2	320.4	311.8	300.0	932.2	310.73
T_3	286.0	191.4	264.0	842.4	280.80
T_4	292.0	197.0	273.6	862.6	287.53
T_5	349.8	353.2	341.0	1,044.0	348.00

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
Block	2	774.976	387.488			
Treatment	4	8612.624	2153.156	62.50**	3.84	7.01
Error	8	275.584	34.448			
TOTAL	14	9663.184				

** - Highly significant

Coefficient of variation = 1.89%

Appendix Table 10. Computed yield per hectare (ton/ha)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	15.40	15.60	19.00	50.00	16.67
T_2	10.60	11.40	11.60	33.60	11.20
T_3	12.90	18.30	12.00	43.20	14.40
T_4	12.68	12.26	10.12	35.06	11.69
T_5	19.03	20.05	17.00	56.08	18.69

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
Block	2	74.696	37.348			
Treatment	4	123.267	30.816	7.45**	3.84	7.01
Error	8	33.088	41.360			
TOTAL	14	231.051				

** - Highly significant

Coefficient of variation = 13.99%

Appendix Table 11. Average pod weight (g)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	7.54	8.26	8.78	24.58	8.19
T_2	8.18	7.75	7.59	23.52	7.84
T_3	7.29	7.91	7.47	22.67	7.55
T_4	7.81	7.58	7.07	22.46	7.48
T_5	10.17	8.43	8.09	26.69	8.89

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
Block	2	0.396	0.199			
Treatment	4	3.981	0.996	2.25^{ns}	3.84	7.01
Error	8	3.545	0.444			
TOTAL	14	7.992				

^{ns} – Not significant

Coefficient of variation = 8.320%

Appendix Table 12. Pod diameter (cm)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	1.55	1.57	1.57	4.69	1.56
T_2	1.51	1.47	1.45	4.43	1.47
T_3	1.52	1.53	1.50	4.55	1.51
T_4	1.51	1.49	1.54	4.54	1.51
T_5	1.57	1.60	1.50	4.67	1.55

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
Block	2	0.001	0.001			
Treatment	4	0.015	0.003	3.86*	3.84	7.01
Error	8	0.007	0.000			
TOTAL	14	0.023				

* - Significant   Coefficient of variation = 2.04%