BIBLIOGRAPHY

BALDAZAN, JAYSON G. APRIL 2009. Growth and Yield of Bush Bean 'China 804' as Affected by Organic Fertilizer Materials Supplemented with Liquid Bio-fertilizer. Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The study was conducted from November 2008 to January 2009 at the experiment area of Benguet State University to determine the growth, yield, and profitability of bush bean 'China 804' as affected by different organic fertilizers supplemented with liquid bio-fertilizer.

Results showed that plants applied with Nbem supplemented with liquid bio-fertilizer significantly were the tallest, produced the longest pods, had the highest total, marketable, and computed yield at 10.91 t/ha, and had the highest return on investment of 124.09%. High marketable yield and profit could also be obtained from the application of Siglat supplemented with liquid bio-fertilizer.

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INTRODUCTION

The trend of crop production lately is toward organic to curb the problems now plaguing the vegetable industry such as soil acidity, pest and diseases, soil degradation including health hazard and other environment problems.

The cost of production is so high that vegetable growers could hardly obtain profit from their crops. This is because the cost of fertilizers together with the other inputs is continuously increasing.

Vegetable growers in Benguet are usually applying chicken manure before planting side dressing complete fertilizers (14-14-14 or 16-16-16) mixed with urea during hilling-up (2-4 weeks after transplanting) then spraying foliar fertilizers while the crop is growing. This was being done without the benefits of soil analysis and the fertilizer requirements of the crop being grown.

With the latest innovations in liquid fertilizers wherein the macro-nutrients and micro-nutrients including groups of beneficial microorganisms included in the formulation, it might be enough to apply organic fertilizers as base dress then supplemented with liquid fertilizer. If this would be enough to produce satisfactory yield, then the use of complete, urea and other dry fertilizer materials will be minimized or avoided which will not only prevent soil degradation but most especially reduce the cost of production.

As mentioned already, this study is to explore the possibility of minimizing production expenses, soil degradation and environment pollution due to the heavy use of synthetic fertilizers. If there are advantages to be obtained in this study, it will be used as guide in conducting more experiments along this line. Results of this study will be used to answer the questions asked by farmers on fertilizer application which is important to extension workers.

This study was conducted at Benguet State University, Balili, La Trinidad, Benguet from November to January 2009 to determine the effect of different organic materials on the vegetative growth of bush snap bean 'China 804',asses the yield of 'China 804' applied with the different organic fertilizer materials supplemented with liquid bio-fertilizer without the use of other fertilizers, determine the profitability of bush bean 'China 804' applied with the different organic fertilizer materials supplemented only with liquid bio-fertilizer.

REVIEW OF LITERATURE

Description of Bush Bean

According to Choung, et al. (2003), the common bean is highly variable species. Bush varieties form erect bushes 20 – 60 cm tall, while pole or running varieties form vines 2 – 3 m long. All varieties bear alternate, green or purple leaves, divided into three oval, smooth-edged leaflets, each 6 – 15 cm long and 3 – 11 cm wide. The white, pink, or purple flowers are about 1 cm long, and give way to pods 8 – 20 cm long, 1 – 1.5 cm. It is annual, glabrous, dwarf plant. The leaflets are ovate usually composed of three pointed leaflets with smooth borders. The flowers are flat-ended to sub cylindrical, upright or curved. They maybe white, yellow, or bluish purple. The inflorescence usually develops a long period of time. The seeds are varied in size and shape. The color maybe white, puff, pink, black. They have long and extensive rot system which produces nodules that are important in nitrification and in the nutritional value of the crop. Pod characteristics vary with species. The pod maybe linear, cylindrical, slightly curved, oblong, or crescent-shaped and flat. Length and diameter ranges from 6-75 cm and from 0.5-2cm, respectively. An immature pod varies in color from light green to dark green, yellow and purple, moltied neither green nor is purple pods observed among those of cow pea, kidney beans and pigeon pea. The number of seed per pod ranges from 1-22. Seeds maybe black, white or cream, red, purple gray or a combination of various shades of colors (Knott and Deanon, 1967).

Importance of Bean

Legume vegetable like snap bean is one of the promising vegetable crops produced in the Philippines. It is recognized as an important source of protein, vitamins, and minerals such as calcium and phosphorus which is consumed mainly in the green pod stage or as fresh vegetable. The crop is important from human, being nutrition and as source of enzymes for the farmers as stated by Seb-aten 1997. In the survey reports by Knott and Deanon, legumes are ranked 4th in area planted and 8th in total peso value among the 11 leading vegetable produced in the country. Aside from benefits it provides to man and animals, it is also beneficial to the soil, for they are replenishing the soil nitrogen. Legumes generally help maintain and conserve soil fertility. In addition, soils that are continuously cultivated rarely contain enough nitrogen for maximum plant growth (Thompson, 1978).

Soil and Climatic Requirement

Legume can be grown in any types of soil provided water is available. They perform best in soil that is granular, fertile, well drained and relatively free from nematodes and fusarium disease, clay loam soil is probably moderately acidic soil with a pH range of 5.0-6.0 (PCARRD, 1998).

Bush bean may either be bushy or viny. The bushy type is determined by its growth habit with an elongated steam and leases to grow when terminal racemes have developed. The pole or viny type is characterized by recemes being developed in the leaf axis while stem continuous reduction to elongate (Martin and Leonard, 1970).

Organic Fertilizer Application

Cabilatazan (1980) found that bean plants applied with ½ of the fertilizer rate at planting the remaining half 30 days after were the fullest and had the highest percentage of pod set. The plants applied with fertilizer at planting and hilling up (2 application and those that were applied at planting were the latest to flower, similar number of seeds per pod).

On the other hand Erasquin (1981) reported that soil for vegetable production should be rich in organic matter through sustained application of decomposed sawdust and other type plant residues that are converted to useful soil amendments. Such soil amendments improve soil structure, which is good for vegetable production. The same author found that the sawdust contains about 1.6 % of phosphoric acid and 6.19 % of potash. When undecomposed sawdust is mixed with the soil, there is a harmful effect on crop like manifestation or yellowing of plant indicating from the decomposition of wood practices by bacteria and fungi which requires nitrogen deficiency effect or sawdust seldom extends beyond the first season of not more than 3 to 4 tons of dry materials are added to the soil.

Effect of Organic Fertilizer on Plant

When the organic residues are in the process of becoming soil, they supply some of essential nutrients to plants serve as the principle source of nitrates, organic phosphate, organic sulfate, borate, molybdates and chloride that increase the cation exchange capacity; and make phosphorus and micronutrients more readily available nutrients faster by microbial decomposition when their cation of organic carbon to total nitrogen is now wider than above 20:1 (Follet, 1981).

Koshiro (1990) found that nutrient elements from organic fertilizer are released slowly which is particularly important in avoiding salt injury, ensuring a continuous supply nutrient during the growing season, and producing products of better quality. In 1980, Pandosen reported that as the level of organic fertilizer is raised, the tubers formation and the yield increased. This is because more were also absorption of nutrients by plants leads to the development of heavier tubers considering that the other factors were favorable.

Nutrition affect the rate of growth and state of readiness of plants to defend themselves against pathogenic attack abundance of certain nutrients like nitrogen results in the production of young succulent growth and may prolong the vegetative growth, delay maturity of the plant make of more susceptible to pathogens that prefer to attack such tissues for longer period (Follet, 1981).

In addition, Villace (1997) stated in his study that bush bean applied with chicken manure before planting followed by urea and muriate of potash at hilling up gave the highest percentage of pod set, weight of marketable pods per plot, computed yield per hectare and return on investments (ROI). It had also highest average number of pods, but did not differed significantly from the application of chicken manure before planting followed by 14-14-14.

According to Sanchez 1980, organic matter improved the physical properties of cultivated soils. It improved aggregate stability, bulk density and available water range. Movement organic matter increased the porosity of heavy soil which in turn increased water absorption and lessened water run-off leaching and erosion.

Foliar Fertilizer has been found effective to plants because of they vary small quantity of the chemical that has to be absorbed (Knott and Deanon, 1967). They added, however, that the foliage of the vegetable is unable to absorb sufficient amount of the three primary nutrients.

Effect of Liquid bio-fertilizer

Tocdangan (2007) stated that the application 1.5 ml liquid bio-fertilizer per 16 liters of water significantly increased the lettuce yield than the farmer's practice.

Likewise, Aglasi (2007) has reported that applying the liquid bio-fertilizer, 2.5 ml per 2 liter of water increased the marketable yield of carrot.

Cultural Practice for Beans

Soil tillage. The method preparing the land for beans is influenced by the season of planting generally, the land is dug by grub hoe and bed on plot raised high in process, after digging, the soil is pulverized and plots were raised 15 to 20 cm. At this point, the plant maybe prepared into hours (HARRDEC, 1989). Weeding or removing of unwanted plants is also important to beans so that it will not compete in the growing and absorption of fertilizers to be applied. Irrigation also important depends on the moisture content of the soil. It is important also during dry season most especially during the early stage growth of snap beans.

MATERIALS AND METHODS

Materials

The materials used in the study were organic fertilizer materials (Siglat, Nbem, Yama and Sagana 100), liquid bio-fertilizer (xtekh), garden tools, weighing scale, measuring tape, identifying pegs, record book, etc.

Methods

The study was laid out in a randomized complete block design (RCBD) with three replications. The treatments were represented as follows:

Treatment Code	Organic Fertilizers	Rate of Application
T_1	N2.17%-P3.19%-K2.27% (Siglat)	2.0 Kg per 5 sq m plot
T_2	N2.8%-P3.95%-K3.66% (Nbem)	2.0 Kg per 5 sq m plot
T_3	N2.25%-P3.47%-K%2.28 (Yama (PCM)	2.0 Kg per 5 sq m plot
T_4	N5.9%-P6.22%-K8.1% (Sagana 100)	2.0 Kg per 5 sq m plot
T_5	Farmer,s Practice	½ can chicken dung as base-dress plus 357.14 g 14-14-14 per 5 sq m plot
T_6	Control	No Fertilizer Application

Land Preparation

An area of 90 m^2 was prepared for the study. The plots was dug 1m x 5m.There were 18 plots which was grouped into three to represent the three blocks or replications. Each block had six plots to represent the treatments.

Planting the Seeds

Two seeds of (bush bean) ‘china 804’ were planted per hill at a distance of 25 cm in row and 25 cm between rows. There were 20 hills per row or 40 hills per plot which was planted with 80 seeds.

Fertilizer Application

All the four recommended rate of organic fertilizers as described in the treatments were applied as base dress and mixed thoroughly to the soil before planting, except in the farmers practice wherein ½ kerosene can of chicken dung was applied as base dress before planting. And the 354.14g of T_{14} was applied as side dress at hilling up three weeks after emergence. Liquid bio-fertilizer was sprayed 15 days after emergence at the rate of 3 tbsp per 16 liters of water or 2.0 ml per liter of water except in control 6, wherein no fertilizer application.

Irrigation

After planting the seeds the plots was irrigated with 64 liters of water each and this was done every three days or twice a week.

Hilling-up

Hilling –up was done in all plots three weeks after emergence to cover growing weeds.

Data Gathered

The gathered, tabulated, computed and means subjected to separation test using the Duncan's Multiple Range Test (DMRT) were the following:

1. Plant height (cm).Ten sample plants per plot were measured from the soil line to the tip of the plant.

2. Number of pods per plant. Every harvest time, the pods were counted and recorded and the total number of pods per plot was divided by the number of plants per plot to get the number of pods per plant.

3. Length of pods (cm). Ten pods per plot were measured from the peduncle to the stellar end and the summation was divided by 10 to get the average length of pods.

4. Weight of pods per plant (g). The total yield per plot was divided by the number of plants per plot to get the weight of pods per plant.

5. Yield per plot (kg). This was the total weight of pods from the first harvest to the last harvest of marketable and non-marketable pods.

6. Weight of marketable pods (kg). This was the weight of pods from first to the last harvest without defect, which was sold to the market.

7. Weight of non-marketable pods (kg). This was the weight of pods from first to last harvest with defects such as abnormally formed, very short, insect damaged or curved.

8. Computed yield per hectare (tons). The yield per plot was converted to tons per hectare by multiplying the yield per plot with 2000 then dividing by 1000. The 2000 is the number of plots per hectare and the 1000 is the weight in kilogram per ton.

9. Economic analysis. All the expenses incurred in the study was recorded such as the value of seeds, fertilizers, labor, gasoline for watering, pesticides and others, these expenses was deducted from the gross sales per plot and the net income will be computed and the return on investment will be computed by using the formula:

$$ROI = \frac{\text{Gross Sales per Plot} - \text{Expenses per Plot}}{\text{Expenses per Plot}} \times 100$$

RESULTS AND DISCUSSION

Plant Height

Table shows the plant height of bush snap bean as affected by application of organic materials supplemented with liquid bio-fertilizer. Plants applied with Nbem supplemented with liquid bio-fertilizer had the tallest plant of 32.13 cm but their height did not differ significantly from the plants applied with 1/2 kerosene can of chicken dung + 357.14 g T14 with 31.70 cm and plants applied with Siglat supplemented with liquid bio-fertilizer with mean of 31.53cm.

Table 1. Plant height

TREATMENT	MEAN (cm)
Siglat + liquid bio-fertilizer	31.53^{abc}
Nbem + liquid bio-fertilizer	32.13^{a}
Yama + liquid bio -fertilizer	26.30^{d}
Sagana + liquid bio-fertilizer	31.07^{c}
Chicken dung + 14-14-14 (Farmer’s practice)	31.70^{ab}
No fertilizer application	19.53^{e}

Means with a common letter are not significantly different at 5% level of DMRT

Results show that height of plants applied with different organic materials supplemented with liquid bio-fertilizer differ significantly from the height of plants without fertilizers.

Number of Pods per Plant

Significant differences were observed on the number of pods per plant as affected by organic application supplemented with liquid bio-fertilizer (Table 2). Highest number of 19.88 pods per plant was obtained in plants applied with Siglat supplemented with liquid bio-fertilizer but their number of pods did not differ significantly from the plants applied with Nbem supplemented with liquid bio-fertilizer with 19.85 pods per plant.

Table 2. Number of pods per plant

TREATMENT	MEAN
Siglat + liquid bio-fertilizer	19.88^{a}
Nbem + liquid bio-fertilizer	19.85^{a}
Yama + liquid bio-fertilizer	18.11^{b}
Sagana 100 + liquid bio-fertilizer	18.80^{c}
Chicken dung + 14-14-14 (Farmer's practice)	14.90^{d}
No fertilizer application	10.26^{e}

Means with a common letter are not significantly different at 5% level of DMRT

However, the aforementioned numbers of pods per plant differed significantly from the number of pods in other plants applied with different organic fertilizers and that of plants applied with ½ kerosene can chicken dung + 357.14 g T_{14}.

Results of this study showed that application of different organic materials supplemented with liquid bio-fertilizer significantly increased the number of pods per plant.

Length of Pods

Table 3 shows the length of pods as affected by organic application supplemented with liquid bio-fertilizer. Results show that application of different organic materials supplemented with liquid bio-fertilizer significantly increased the length of pods.

Table 3. Length of pods

TREATMENT	MEAN (cm)
Siglat + liquid bio-fertilizer	16.30^{c}
Nbem + liquid bio-fertilizer	17.50^{a}
Yama + liquid bio-fertilizer	15.67^{d}
Sagana 100 + liquid bio-fertilizer	16.37^{c}
Chicken dung + 14-14-14 (Farmer's practice)	17.20^{b}
No fertilizer Application	15.17^{d}

Means with a common letter are not significantly different at 5% level of DMRT

Plants applied with Nbem supplemented with liquid bio-fertilizer obtained the longest pod of 17.50 cm and differ significantly from the pod length of plants applied with ½ kerosene can chicken dung + 357.14 g T14 with 17.20 cm. On the other hand no significant differences were observed on the pod length between plants applied with Sagana 100 supplemented with liquid bio- fertilizer and plants applied with Siglat supplemented with liquid bio-fertilizer. It was also observed that the length of pods of plants applied with different organic materials supplemented with liquid bio-fertilizer differed significantly from pod length of plants without fertilizer.

Weight of Pods per Plant

Statistical analysis showed significant differences on the weight of pods per plant as affected by organic application supplemented with liquid bio-fertilizer (Table 4). Plants applied with Siglat and Nbem supplemented with liquid bio-fertilizer obtained the same weight of 0.14 kg per plant. But their pod weight did not differ significantly from the pod weight of plants applied either with Yama and Sagana 100 supplemented with liquid bio- fertilizer with a common pod weight of 0.13 kg. Likewise, pod weight of plants applied with ½ kerosene can chicken dung + 357.14 g T14 did not differ significantly from the pod weight of other plants applied with different organic fertilizers supplemented with liquid bio-fertilizer.

Results of the study show that organic fertilization can significantly increase the weight of pods.

Table 4. Weight of pods per plant

TREATMENT	MEAN (kg)
Siglat + liquid bio-fertilizer	0.14^{a}
Nbem + liquid bio-fertilizer	0.14^{a}
Yama + liquid bio-fertilizer	0.13^{ab}
Sagana 100 + liquid bio-fertilizer	0.13^{ab}
Chicken dung + 14-14-14 (Farmer's practice)	0.12^{b}
No fertilizer application	0.06^{c}

Means with a common letter are not significantly different at 5% level of DMRT

Yield per Plot

Table 5 shows the yield per plot as affected by organic application supplemented with liquid bio-fertilizer. Plants applied with Nbem supplemented with liquid bio-fertilizer obtained the highest yield of 5.45 kg per plot but their yield per plot did not differ significantly from the yield per plot obtained in plants applied with siglat and yama supplemented with liquid bio-fertilizer with means of 5.28 and 5.00 kg respectively. All the plants applied with different organic fertilizer supplemented with liquid bio-fertilizer did not differ significantly in their yield per plot but significantly differences were noted when their yield per plot were compared in plants without fertilizer.

Results of the study showed that fertilization of different organic materials can significantly increase the yield of bush snap bean 'china 804'.

Table 5. Yield per plot

TREATMENT	MEAN (kg)
Siglat + liquid bio-fertilizer	5.28[abc]
Nbem + liquid bio-fertilizer	5.45[a]
Yama + liquid bio- fertilizer	5.00[abc]
Sagana 100 + liquid bio-fertilizer	4.86[bc]
Chicken dung + 14-14-14 (Farmer's practice)	4.75[c]
No fertilizer application	2.34[f]

Means with a common letter are not significantly different at 5% level of DMRT

Weight of Marketable Pods

Statistical analysis show significant differences on the weight of marketable pods as affected by organic application supplemented with liquid bio-fertilizer (Table 6). Highest marketable pods per plant was obtained in plants applied with Nbem supplemented with liquid bio-fertilizer but their weight of marketable pods did not differ significantly in the weight of marketable pods obtained in plants applied with the different organic fertilizers supplemented with liquid with bio-fertilizer and that of plants fertilized with ½ kerosene can chicken dung + 357.14 g T_{14}.

Results show that the weight of marketable pods can be increased significantly different by an application of the different organic fertilizers supplemented with liquid bio-fertilizer.

Table 6. Weight of marketable pods

TREATMENT	MEAN (kg)
Sigla + liquid bio-fertilizer	4.50[abcd]
Nbem + liquid bio-fertilizer	4.53[a]
Yama + liquid bio-fertilizer	4.13[b]
Sagana 100 +liquid bio-fertilizer	4.02[bc]
Chicken dung + 14-14-14 (Farmer's practice)	3.86[bcd]
No fertilizer application	1.79[e]

Means with a common letter are not significantly different at 5% level of DMRT

Weight of Non-marketable Pods

Table 7 shows the weight of non marketable pods as affected by organic application supplemented with liquid bio fertilizer. Statistical analysis revealed significant differences on the weight of non marketable pods. Plants applied with Nbem supplemented with liquid bio-fertilizer obtained the highest non-marketable pods of 0.92 kg and differed significantly on the weight of non-marketable pods of plants applied with yama, sagana 100, siglat with supplemented with liquid bio- fertilizer with respective means of 0.87, 0.84, and 0.78 kg. All these means differed significantly from the weight of non-marketable pods in plants applied with ½ kerosene can chicken dung + 357.14 g T_{14} and that of plants without fertilizer with 0.55 kg of non-marketable pods.

Table 7. Weight of non-marketable pods

TREATMENT	MEAN (kg)
Siglat + liquid bio-fertilizer	0.78[e]
Nbem + liquid bio-fertilizer	0.92[a]
Yama + liquid bio-fertilizer	0.87[c]
Sagana + liquid bio-fertilizer	0.84[d]
Chicken dung + 14-14-14 (Farmer's practice)	0.89[b]
No fertilizer application	0.55[f]

Means with a common letter are not significantly different at 5% level of DMRT

Computed Yield per Hectare

Computed yield as affected by organic application supplemented with liquid bio-fertilizer is shown in Table 8. Computed yield per ha of plants applied with different organic materials supplemented with liquid bio-fertilizer did not differ significantly from the computed yield per ha of plants applied with ½ kerosene can chicken dung + 357.14 g T14 but significantly differed from the computed yield/ha of plants without fertilizer.

Results showed that application of any kind of organic fertilizers supplemented with liquid bio-fertilizer significantly increased the yield per hectare and their yield was comparable with that of plants fertilized with ½ kerosene can chicken dung + 357.14 g T14.

Table 8. Computed yield per hectare

TREATMENT	MEAN (tons)
Siglat + liquid bio-fertilizer	10.57[ab]
Nbem + liquid bio-fertilizer	10.91[a]
Yama + liquid bio-fertilizer	10.00[b]
Sagana 100 + liquid bio-fertilizer	9.71[bc]
Chicken dung + 14-14-14 (Farmer's practice)	9.50[bcd]
No fertilizer application	4.69[e]

Means with a common letter are not significantly different at 5% level of DMRT

Cost and Return Analysis

Table 9 show the cost and return analysis as affected by organic application supplemented with liquid bio-fertilizer. Results show significant differences among the treatments. Plants applied with Nbem supplemented with liquid bio-fertilizer obtained highest ROI of 124.09 and did not differ significantly on the ROI of plants applied with Siglat, and Yama, supplemented with liquid bio-fertilizer with respective means of 122.60, 104.32 ROI/plot. However, ROI of 98.55 plants applied with Sagana 100 supplemented with liquid bio-fertilizer did not differ significantly on the ROI in plants applied with ½ kerosene can chicken dung + 357.14 g T14 with ROI of 90.97. All the aforementioned ROI differed significantly from the ROI of 52.27 plants without fertilizer.

Table 9. Cost and Return Analysis

	T1	T2	T3	T4	T5	T6
Sales	310.73	312.8	284.97	277.15	266.57	123.74
Land Preparation	50	50	50	50	50	50
Seeds	31.26	31.26	31.26	31.26	31.26	31.26
Fertilizers	58.83	58.83	58.83	58.83	58.83	-
Total Expenses	139.59	139.59	139.59	39.59	139.59	81.26
ROI	122.60[ab]	124.09[a]	104.32[ab]	98.55[c]	90.97[cd]	52.25[e]

Selling Price= Php 23.00

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted at Benguet State University Experiment area, Balili La Trinidad, Benguet from November 2008 to January 2009 to determine the effect of different organic fertilizer on the growth and yield of bush snap bean ‘china 804’, and to asses the economics of applying the said fertilizers.

Results showed that application of different organic fertilizers supplemented with liquid bio-fertilizer effected significant differences in plant height, length of pods, yield, and ROI. Plants applied with Nbem supplemented with liquid bio fertilizer were the tallest, had the longest and heaviest weight of marketable pods, highest computed yield at 10.91 t/ha and ROI of 124.09%. Application of Siglat plus liquid bio-fertilizer also promoted growth, yield, and profitability.

Conclusion

Based on the result presented, the application of Nbem and Siglat supplemented with liquid bio-fertilizer enhances the growth and yield of bush bean ‘China 804’ and effected high return on investment.

Recommendation

It is therefore recommended to apply Nbem or Siglat as base dress at 2 kg / $5m^2$ before planting bush bean 'china 804' and supplemented with liquid bio-fertilizer (x-tekh) at 2 ml / l sprayed 15 days after emergence to enhance growth, yield, and obtained higher profit.

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APPENDICES

Appendix Table 1. Plant height (cm)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	31.7	31.6	31.3	96.6	31.53
T_2	31.6	32.7	32.1	96.4	32.13
T_3	25.3	26	27.6	78.9	26.30
T_4	30.7	31.1	31.4	93.2	31.07
T_5	31.9	31.1	32.1	95.1	31.70
T_6	18.7	20.0	19.1	58.6	19.53

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARE	COMPUTED F	P-VALUE	F CRITICAL
Treatment	5	372.611	74.522	205.547	0.000	3.326
Block	2	1.701	0.851	2.346	0.346	4.103
Error	10	3.626	0.363			
Total	17	377.938				

* = Significant Coefficient of Variation = 2.097%

Appendix Table 2. Number of pods per plant

TREATMENT	REPLICATION I	REPLICATION II	REPLICATION III	TOTAL	MEAN
T_1	19.38	20.82	19.44	56.64	19.88
T_2	22.08	19.83	17.63	59.54	19.85
T_3	20.45	17.31	16.58	54.34	18.11
T_4	19.53	18.2	18.67	56.4	18.80
T_5	14.08	14.61	16.03	44.72	14.91
T_6	8.98	10.9	10.91	30.79	10.26

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARE	COMPUTED F	P-VALUE	F CRITICAL
Treatment	5	211.908	42.382	18.584	0.000	3.326
Block	2	2.293	1.147	0.503	0.619	4.103
Error	10	22.806	2.281			
Total	17	237.007				

s= Significant Coefficient of Variation = 8.90%

Appendix Table 3. Length of pods (cm)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	16.1	16.3	16.5	48.9	16.30
T_2	17.2	18.5	16.8	52.5	17.50
T_3	15.6	16.2	15.2	47.0	15.67
T_4	15.7	17.0	16.4	49.1	16.37
T_5	17.1	17.5	17.0	51.6	17.20
T_6	15.5	15.2	14.8	45.5	15.17

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	P-VALUE	F CRITICAL
Treatment	5	11.740	2.348	12.925	0.000	3.326
Block	2	1.583	0.792	4.358	0.044	4.103
Error	10	1.817	0.182			
Total	17	15.140				

* = Significant   Coefficient of Variation = 2.604%

Appendix Table 4. Weight of pods per plant (kg)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	0.15	0.13	0.13	0.41	0.14
T_2	0.17	0.13	0.13	0.43	0.14
T_3	0.14	0.12	0.13	0.39	0.13
T_4	0.13	0.14	0.12	0.39	0.13
T_5	0.12	0.11	0.14	0.37	0.12
T_6	0.07	0.07	0.05	0.19	0.06

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	P-VALUE	F CRITICAL
Treatment	5	0.013	0.003	14.481	0.000	3.326
Block	2	0.001	0.000	2.025	0.183	4.103
Error	10	0.002	0.000			
Total	17	0.015				

* = Significant   Coefficient of Variation = 10.94%

Appendix Table 5. Yield per plot (kg)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	6.03	5.13	4.69	15.85	5.28
T_2	6.4	4.96	5	16.36	5.45
T_3	5.48	4.84	4.68	15	5.00
T_4	5.2	4.95	4.42	14.57	4.86
T_5	4.56	4.29	5.4	14.25	4.75
T_6	2.75	2.5	1.78	7.03	2.34

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARE	COMPUTED F	P-VALUE	F CRITICAL
Treatment	5	19.604	3.921	17.641	0.000	3.326
Block	2	1.909	0.954	4.294	0.045	4.103
Error	10	2.223	0.222			
Total	17	23.736				

* = Significant   Coefficient of Variation = 10.217%

Appendix Table 6. Weight of marketable pods (kg)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	5.48	4.18	3.85	13.51	4.50
T_2	5.50	4.45	3.65	13.6	4.53
T_3	4.38	3.99	4.02	12.39	4.13
T_4	4.50	4.00	3.55	12.05	4.02
T_5	3.80	3.64	4.15	11.59	3.86
T_6	2.00	2.00	1.38	5.38	1.79

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARE	COMPUTED F	P-VALUE	F CRITICAL
Treatment	5	15.656	3.131	16.246	0.000	3.326
Block	2	2.218	1.109	5.753	0.022	4.103
Error	10	1.927	0.193			
Total	17	19.801				

* = Significant Coefficient of Variation = 11.53%

Appendix Table 7. Weight of non-marketable pods (kg)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	0.55	0.95	0.84	2.34	0.78
T_2	0.9	0.51	1.35	2.76	0.92
T_3	1.1	0.85	0.66	2.61	0.87
T_4	0.7	0.95	0.87	2.52	0.84
T_5	0.76	0.65	1.25	2.66	0.89
T_6	0.75	0.5	0.4	1.65	0.55

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	P-VALUE	F CRITICAL
Treatment	5	0.273	0.055	0.719	0.624	3.326
Block	2	0.079	0.039	0.518	0.611	4.103
Error	10	0.759	0.076			
Total	17	1.111				

^{ns} = Not significant

Coefficient of Variation = 34.11%

Appendix Table 8. Computed yield per hectare (tons)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	12.06	10.26	9.38	31.70	10.57
T_2	12.80	9.92	10.00	32.72	10.91
T_3	10.96	9.68	9.36	30.00	10.00
T_4	10.40	9.90	8.84	29.14	9.71
T_5	9.12	8.58	10.8	28.50	9.50
T_6	5.50	5.00	3.56	14.06	4.69

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	P-VALUE	F CRITICAL
Treatment	5	78.418	15.684	17.641	0.000	3.326
Block	2	7.634	3.817	4.294	0.045	4.103
Error	10	8.891	0.889			
Total	17	94.943				

* = Significant Coefficient of Variation = 10.217%

Appendix Table 9. ROI per plot

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	170.88	106.62	90.31	367.81	122.60
T_2	171.87	119.97	80.42	372.26	124.09
T_3	116.51	97.73	98.71	312.95	104.32
T_4	122.44	97.72	75.49	295.65	98.55
T_5	87.84	79.93	105.14	272.91	90.97
T_6	69.80	69.80	17.17	156.77	52.27

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	P-VALUE	F CRITICAL
Treatment	5	38272.543	7654.509	16.261	0.000	3.326
Block	2	5414.123	2707.062	5.751	0.022	4.103
Error	10	4707.241	470.724			
Total	17	48393.907				

* = Significant   Coefficient of Variation = 26.60%