BIBLIOGRAPHY

ALEJO, KEVIN F. APRIL 2011. Growth and Yield of French Beans (*Phaseolus vulgaris* spp) as Affected by Seed Size Under La Trinidad Benguet Condition. Benguet State University, La Trinidad, Benguet

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ABSTRACT

The study was conducted at the BSU Organic Farm, in Balili La Trinidad Benguet, from November 2010 to February 2011 to assess the growth and yield performance of French beans from varying seed sizes and to determine which size of French beans seeds can give the best growth and yield.

Result showed that large seed sized French beans produced the tallest seedling, , it was respectively followed by French beans from medium sized seeds and mixed seed sizes then lastly the French bean plants from small seeds (28.29 cm,26.70 cm, 26.66 cm and 26.66cm respectively), longest pod size with 12.57 cm. compared to but there were no significant difference between days from sowing to flowering and first pod setting

percentage germination, number of lateral branches produced, fresh weight of individual plant, weight of marketable yield, non-marketable yield, total yield and yield per plant and profitability.

Therefore, larger size of French bean seeds are recommended to obtain the highest benefit and further studies about this experiment is recommended.

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INTRODUCTION

French beans (*Phasoelus vulgaris spp.)* is one of the most important member of the family of leguminosae. French beans are also known by a variety of names such as flageolets and haricot beans. French beans can be harvested 12 weeks from sowing. French beans prefer a sunny condition and sheltered site because it gives protection from cold winds which helps at the seedling stage and later on during the pollination phase. French beans are sub-tropical in origin and for this reason it needs a minimum soil of 16 ^{0}C.

One of the questions that farmers always ask is does seed size have a effect on the yield and growth of plants (Mc Collum, 1975). If one sifts the seeds, the larger ones, will he harvest better crop? Much study has been focused on this problem with considerable confusion on the results. The influence of seed size upon germination, seed emergence, subsequent growth and ultimate yield of agricultural crops has been studied in a number of species of economic importance since 1893 according to Boss. Keiselbach (1924) showed that in wheat, barley and oat seed, the number of plants per unit area, that reach maturity was greater in plants originating in heavy seeds. Large seeds will have an advantage over the small seeds in the stock of nutrients in the disposal off embryo until the latter has developed a root system. Roots of large seeds have much higher penetrating potential than small seeds. This is for utmost importance for the establishment of the plant and its competitive survival potential with other plants. This advantage is most evident in deeper than usual sowing and under difficult germination and emergence condition.

In 1973, Nobel Laureate Norman Borlaug suggested that the food legumes as a group were “slow runners’’ in cropping systems of the developing countries. As a result of the green revolution, cereal production, had risen rapidly in the 1960’s and the 1970’s and many countries which were previously net importers are now self sufficient in rice and legumes. One effect of the revolution has been the displacement of food legumes onto more agricultural marginal environments.

However, Borlaug (1973) recognized the importance of food legumes in the farming systems and in human and animal nutrition. He proposed an approach to raising the production and productivity of these crops though the development of high yielding cultivars and improved systems of management.

In addition, there is an increased recognition by farmers, scientist and policy makers that legume crops are crucial components of Asian farming systems and that this crop has the potential for high yield and can be profitable by farmers.

There are several technologies generated to increase yield and income from French beans, but the work must go on to generate more information to generate production to cope up with the rapidly increasing production, with the production of new inputs which are claimed to increase the growth and yield of crops, it is the function of the research to find out the truth about the claims.

The result of the study will help anyone interested in crop production to know the facts about the sizes of seeds and its effect to the yield of the crop, in which the seed producers and the farmers must know in order to produce high quality seeds and the farmers be guided on the size of seeds that produce high pod yield.

This study was conducted with the following objectives

1. To determine the growth and yield of French beans grown from varying seed sizes.

2. To determine which size of French beans seeds can give the best growth and yield.

3. To determine the profitability of planting different seed size of French bean

This study was conducted at the BSU Organic farm in Balili, La Trinidad, Benguet from October 2010 to January 2011.

REVIEW OF LITERATURE

Description of French Beans

French beans prefer a sunny sheltered site because it gives sheltered from cold wind which helps at the seedling stage and later on during pollination phase. French beans prefer a rich soil with plenty of organic matter. French beans have deep root system, that's why digging must be to a spade and a half's depth incorporating compost or organic material the process. If possible prepare the soil a month or so in advance of sowing the seed. The requirements of French beans are simple: watering and weeding and possibly some feeding. French beans are subtropical in origin, and for this reason, it need a minimum soil temperature of 16^oC (60^oF). French beans have a germination rate of approximately 75% and for this reason, it should be sown thinly, one seed every 15 cm to be thinned out to a final spacing of one seedling for every 30 cm about 3 weeks after sowing (Anonymous, 2007).

Seed Development

Seed development starts with the production of flower primordial long before anthesis. The flower contains tissues that will ultimately be a part of the fruit and the seed. The pod walls or carpel of the fruit of legume and the pericarp of the cereal cryopsis develop from the ovary, the testa from the integuments around the ovule, thus, the seed is a mixture of embryonic and maternal tissue. The mature seed could conceivably be influenced by developmental process occurring before anthesis (Hill, 1987).

Seed development is from fertilization to mature seed; it could be divided into 3 phases according to Hill (1987):

1. Development of seed structure – includes fertilization and rapid cell division when all structures are formed.

2. Linear phase of seed development – seeds accumulates reserve materials that give it economic valve.

3. The end of seed growth-physiological maturity- begins when the accumulation of reserve materials slows down prior to stopping at physiological maturity. Visual indicators of physiological maturity have been developed for many crops and they are frequently based on seed color or seed characteristics. The general patterns of growth and development are the same to all seeds of common crop species regardless of their structure, composition size. Consequently, we can treat this seeds as a common group to investigate the role of the individual seed in the production of yield (Hill, 1987).

Mabesa (1980) defined that seed maturation as the morphological and functional that occur from the time of fertilization until the mature ovule (seed) are ready for harvest. Fertilization is the stage of sexual reproduction in which a sperm fuses with the egg resulting in the mixing of genetic information carried in the parent cells. This occurs when both male and female gametophytes are fully mature.

After the egg is fertilized, it will undergo developmental stages as illustrated by Hill (1987), the following stages are:

Growth Stage

This stage will not last for more than10 days immediately after pollination. The rate of seed growth is rapid and the stage is marked by intense cell multiplication, at this rate moisture content of the seed remains very high at a constant of 80% - 90%. Hill (1987) explained that the seed harvested during this state is not viable, but this stage is important as the period when the frame work of the future seed is being laid down.

Sage and Webster (1987) reported that the major increase in pods, seed coat, embryo, endosperm and seed weight as well as nitrogen accumulation and cotyledon initiation occur five or more days of post anthesis in most bean cultivars, during this stage, moisture content of the seed remains very high at a constant of 80% - 90%.

Food Reserve Accumulation Phase

This stage last for 10 – 14 days in which there is slow increase in dry weight, reaching maximum at the end of the phase (Hill, 1987). He further added that the amount of water in the phase change very little, but the percentage of the water falls steadily and the seed become viable early in this phase of seed development which substance translocated from other parts accumulate as the seed reserves (sugars, fats, starch and proteins) reaching physiological maturity at the end of this phase. Rate of growth is determined at the rate at which food materials are transferred from the parent plant to the developing seed, color changes are indication of approaching maturity, which gradually takes place during the latter half of this phase where in there is a reproduction in germination percentage.

Ripening Stage

This last for about a week but varies depending on the drying power of air. During this stage, the moisture falls about 40% and equilibrate (12-16% moisture content) with the atmosphere while dry weight remains relatively constant. It is at this phase that the seed has become what is normally termed "ripe" and ready for harvest.

Germination and Vigor

Some kinds of seeds are capable germination long before maturity (maximum dry weight) is reached from the time that a small percentage of seeds are capable of germination, germination percentage increases to a maximum (generally before seed maturity). Although seeds are capable of germination long before maturity is reached, seed vigor increases a maximum dry weight (maturity) is reached.

Chemical Changes During
Seed Development

Carbohydrates increase rapidly as endosperm develops. Sucrose and reducing sugars decrease rapidly as starch content increases. as development proceeds, protein nitrogen amide from of nitrogen increases slightly. Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) also increases rapidly during the early embryo and endosperm growth because of increase in cell expansion. Endosperm, amino acid increases rapidly during the first few weeks for this coincides with the period and the endosperm is RNA content directs amino acid synthesis.

French Bean's Structure (Purseglove, 1968)

1. Roots- the pronounced tap root grows rapidly to a depth of 1m. and there are extensive lateral roots mainly confined to the top 6 inches of soil nodules.

2. Stems- in twining cultivars, the stem length is 2-3 m tall with determinate growth with 11-16 or 28-30 elongated nodes, in erect cultivars stem is 20-60 cm tall

terminating in an inflorescence. Sub-erect and spreading occur, together with intermediates between poles with developed weak runners.

3. Leaves- alternate, trifoliate, petiole is long.

4. Flower- borne on axillaries, usually shorter than leaves , pedicels are short, 5-8 mm long.

5. Pollination- it is self fertilized, fertilization takes place at any time the flower opens.

6. Germination - germination which is epigeal is usually good and rapid, the seed remain viable for two years, a condition known as bald head occurs in which small or no growth takes place on the cotyledon and is caused by mechanical injury to the seed or apical meristem

Nutritive content of French beans (Anonymous, 2004)

Nutrient	Units	Value per 100 grams of edible portion
Proximate		
Water	g	10.77
Energy	kcal	343
Energy	kj	1435
Protein	g	18.81
Ash	g	4.30
Carbohydrate, by difference	g	64.11
Fiber, total dietary	g	25.2
Iron, Fe	mg	3.40
Magnesium, Mg	mg	188
Phosphorus, P	mg	304
Potassium, K	mg	1316
Sodium, Na	mg	18
Copper, Cu	mg	0.440
Manganese, Mn	mg	1.200
Selenium, Se	mcg	12.9
Vitamin C, total ascorbic acid	mg	4.6
Thiamin	mg	0.535
Riboflavin	mg	0.221

Nutrient	Units	Value per 100 grams of edible portion
Niacin	mg	2.083
Pantothenic acid	mg	0.789
Vitamin B-6	mg	0.401
Folate, total	mcg	399
Folic acid	mcg	0
Folate, food	mcg	399
Folate, DFE	mcg_DFE	399
Vitamin B-12	mcg	0.00
Proximate		
Vitamin A, IU	IU	
Vitamin A, RAE	mcg_RAE	0
Retinol	mcg	0
Lipids		
Fatty acids, total saturated	g	0.221
14:0	g	0.005
16:0	g	0.186
18:0	g	0.023
18:1 undifferentiated	g	0.135
Fatty acids, total polyunsaturated		1.207
18:2 undifferentiated	g	0.442
18:3 undifferentiated	g	0.765
Cholesterol	mg	0
Tryptophan	g	0.223
Isoleucine	g	0.831
Leucine	g	1.502
Lysine	g	1.291
Methionine	g	0.283
Cystine	g	0.205
Amino acids		
Arginine	g	1.165
Histidine	g	0.524
Alanine	g	0.789
Glycine	g	0.734
Proline	g	0.798
Serine	g	1.023
Aspartic acid	g	2.276

Economic Importance of French Beans

Phaseolus vulgaris spp.are grown for their immature pods and for the dry ripe seeds and to the lesser extent of green shelled beans. The leaves are used as a pot herb in some parts of the tropics. In Latin America and some parts of Africa they furnish a large part of the protein foods of the inhabitants, being grown mainly for the dried pulse , in Europe, the U.S. and other temperate country, they are grown mainly for the green immature pods which are eaten as a vegetable and are also canned and frozen, the whole dried beans are also cooked with tomato sauce and are canned and are usually known as baked beans (Purseglove, 1968).

Nutritional Importance of French Beans

French bean contains protein, fat, calcium, phosphorus, vitamins A, B, D and starch. French beans also contain much iron, which aid blood cells production. Vitamin French Beans - Containing protein, fat, calcium, phosphorus, vitamins A, B, D and starch. French beans also contain much iron, which aid blood cells production. B in them benefits the Qi (vital energy), the spleen and kidneys. French beans also stimulate sperm production and virility. They help to alleviate swelling stomach, bad appetite, premature ejaculation, and frequent urination. French beans are neutral in nature and can be consumed frequently. French beans make great soups and are highly nutritious. Do not eat French beans raw, as they contain red blood cell coagulant that causes food poisoning. The dark liquid that is present in all French beans dishes is actually oxidized iron and should not be discarded. French beans with tofu are an effective dish to stimulate peristalsis and intestinal absorption. Stir French beans with beef or pork is good for the eyesight (Anonymous, 2010).

Medicinal Importance of French Beans

According to the website of the elements4health (2010) these are some diseases that French beans can cure:

1. Green beans for Osteoporosis Prevention

Green beans and other green vegetables are a very good source of vitamin K, which plays an important role in bone health and the prevention of osteoporosis. Several studies have demonstrated that vitamin K deficiency is associated with low bone mineral density, and an increase in bone fractures. Vitamin K supplementation and an increase in consumption of vitamin K rich foods such as green beans have been shown to improve bone health. In one 3-year double blind placebo controlled study, 181 healthy postmenopausal women showed reduced bone loss of the femoral neck after vitamin K supplementation.

2. Green beans as a Diuretic

The pods of the green bean are a medium strength diuretic, stimulating urine flow and the flushing of toxins from the body.

3. Green beans for Eczema

Powdered beans may be dusted on areas of weeping eczema to relieve itching and help dry the skin.

4. French bean, prescribed food for diabetic patients

Beans are high in carbohydrates and fiber. They should be eaten liberally to keep diabetes under control. A decoction prepared from the beans is an excellent remedy for diabetes. This decoction is prepared by boiling 60 grams of fresh kidney bean pods, after removing their seeds, in four liters of water on a slow fire for four hours. It is then strained through fine muslin cloth and allowed to stand for eight hours. One glass of this decoction every two hours during the day is recommended. This treatment should be continued for four to eight weeks along with the prescribed diet restrictions. The decoction must made fresh every day, as it loses it medicinal value after 24 hours. The juice extracted from French beans is also valuable in controlling diabetes. It stimulates the production of insulin. This juice is generally used in combination with the juice of Brussels sprouts. The patient must, however be on a controlled diet. Dr. James Anderson of the Human Nutrition Research Center of the US Department of Agriculture insists that the same foods that lower cholesterol and fight heart disease are also excellent for diabetics, who are at high risk of heart disease. This puts foods like beans that are high in soluble fiber in “highly recommended” category. Dr. Anderson quotes confirm that high fiber foods significantly reduce blood sugar along with cholesterol.

Effect of Seed Size

The influence of seed size upon germination, field emergence, subsequent growth and ultimate yield of agricultural has been studied in the number of species of economic importance since 1893 (Boss). Keisselbatch (1924) showed that in wheat, barley and oat seed, the number of plants per unit area that reached maturity was greater in plants originating from heavy seeds than from light seeds. Waldron (1941) reported that heavier wheat seeds have higher yields.

Large seeds will have an advantage over small seeds in stock of nutrients in the disposal of embryo until the latter has develop a root system; roots of large seeds have much higher penetrating potential than roots of small seeds. This is of utmost importance of the establishment of the plant and its competitive survival potential of the plant with other plant. This advantage is most evident in deeper than usual sowing and under difficult germinating and growing condition.

Large seeds are assumed to have higher probability of successful recruitment than small seeds. This is because larger seeds give rise to larger seedlings and larger seedlings better withstand environmental hazards like deep shade and drought. Biotic and abiotic limitations to seedling growth and survival, and conversely availability of safe sites for recruitment, vary along environmental gradients and between habitat types. Thus, the value to plant species of possessing large seeds may differ between plant communities. We analyzed the relationship between seed mass and per-seed recruitment success (seedlings established per number of seeds produced) along an environmental gradient from open grassland to closed-canopy forest using data collected by Uuno Perttula in southern Finland in 1934. We found that larger seeds have greater recruitment success relative to smaller seeds in all investigated communities. However, the recruitment success of large seeds relative to small seeds strongly increased from grassland and open forest to closed-canopy forest. Of the measured environmental variables, canopy closure most strongly explained this increase. This indicates a strong direct effect of deep shade on seedling survival in natural plant communities. Additional explanatory power was associated with soil moisture. Litter cover, moss cover, and soil pH did not contribute to explaining the variation in relative recruitment success of larger seeds. Thus, the advantage of large seeds in recruitment success is pronounced in deeply shaded forest but may be insignificant in open vegetation (Bruun, 2008).

Cordazzo (1994) stated that seed size (usually measured as mass) has long been regarded as an important aspect of plant reproductive biology. Traditionally, seed mass within a plant species is considered a remarkably constant characteristic (Harper *et al*., 1970; Silvertown, 1981). However, other studies have demonstrated that seed mass within a species or even an individual plant can vary greatly (Harper *et al*., 1970; Schaal, 1980). Salisbury (1942) recognized that although seed mass varied between species, seed size was correlated with habitat and tended to increase with successional maturity of the community.

Differential seed size may have several important ecological implications. Variation in seed mass within a species may affect seed germination (Schaal, 1980; Weis, 1982) and germination rate (Weis, 1982; Zhang and Maun, 1990). Large seeds frequently have greater percent germination or emergence than small seeds (Weis, 1982; Hendrix, 1984). On the other hand, small seeds may germinate more quickly than large seeds and, thus, have a competitive advantage (Howell, 1981). Seed size also affects seedling biomass (Zimmerman and Weis, 1983): usually, the seedlings from large seeds are larger than those from small seeds, especially in the early stages of growth (Schaal, 1980; Saverimuttu and Westoby, 1996). The initial seedling size differences may persist until maturity (Schaal, 1980; Weis, 1982) or become imperceptible with time (Zimmerman and Weis, 1983) because of the differential relative growth rate among seedlings from differently sized seeds (Lewis and Garcia, 1979; Zhang and Maun, 1990). Some studies (Zimmerman and Weis, 1983) indicate that a higher relative growth rate of seedlings from small seeds exists only in the early stages of development, and/or that the RGR may be reduced in competitive conditions (Westoby *et al.*, 1996).

Mc Collum (1975) explained that if one sifts the seeds, the larger ones, will he harvest better crop? Much study has been focused on this problem with considerable confusion on the results, but it seems to resolve itself to the following: larger seeds gives earlier and more uniform maturity, mature seeds would even mature more evenly. This advantage makes it profitable in some cases to separate the seeds into three sizes, planting the two larger sizes separately but discarding the small seeds which are usually weak and improperly mature.

Factors Affecting Seed Size

By seed parents, pollen parents and their interaction.The size of legume seed maybe the result of either the genetic or environmental condition that influences the accumulation of seed reserves in the two (Black, 1957). Any environmental condition that influence of accumulation of seed reserves in seeds has the potential in influencing the seed quality and seed vigor of the following generation (Polloc and Roos, 1972). Seeds that differ in size may also differ in composition. In an experiment performed recently with sorghum seeds (Beyer, 1973), it was shown that the concentration of proteins (mg/g or dry matter) was inversely proportional to the seed size, this fact is readily explained since the smaller the seed, the greater the relative weight of the embryo. There was no difference in germination rate between small and large seeds but there was a significant difference in growth rate (for seventeen days after emergence) in favor of the large seeds.

MATERIALS AND METHODS

The materials used in the study were seeds of French beans, organic fertilizers, garden tools, identifying pegs, measuring tape, plastic drum to contain water for irrigation and record book.

The study was conducted on a 60 sq. m. area which was divided into three blocks, each of which was sub-divided into four plots measuring 1m x 5 m. The blocks represent the replications while the plots represent the treatments that were laid out following the Randomized Complete Block design (RCBD). The treatment were represented as follows:

Treatments	Seed Size	Total Weight (g)	Average Seed Weight (g)
T_1	small	27.085	0.108
T_2	medium	38.596	0.154
T_3	large	50.965	0.204
T_4	mixed sizes	42.345	0.169

Land Preparation

The area was cleaned from weeds, then the plots were dug 30 cm deep. Furrows were constructed and applied with organic fertilizers (two cans of alnus leaves and weed compost) that was mixed with the soil as base-dressed fertilizer, the plot surface were leveled ready for planting.

Planting the Seeds

The distance of planting was measured 25 cm in row and 25 cm between rows which were marked with stick. Two seeds of French beans ‘claudine’ were planted two inches deep then covered with soil. This means that in one row, there were 20 bills or 40 seeds or 80 plants per plot.

Irrigation

Immediately after planting the seeds, two cans of clean water were applied to each plot. This was done every after three days up to the last harvest of the fresh pods.

Crop Maintenance

Weeds were uprooted as they emerge on the plot to avoid competition with the crops especially during the vegetative stage. The plots were hilled up two weeks after the emergence to cover growing weeds and to fix the plots so that irrigation water would not flow to the canals between plots. During the crop was infested by insects, the eggs and larvae were crushed by hand. Other cultural practices in growing snap beans will be done to ensure optimum growth and yield.

Harvesting Fresh Pods

Pods were harvested as they reach green mature stage. Harvesting was done every two to three days thereafter up to the last picking or termination of the study.

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

A Growth

1. Percentage of germination (%). This was computed by dividing the number of seedlings that have germinated nine days after planting 80 seedlings which is the number of seeds to be planted per plot then multiplied by 100

2. Number of days to flowering. This was the number of days from planting to the appearance of flower buds.

3. Number of days to harvesting. This was the number of days counted from planting the seeds to the day that the green mature pods were harvested.

4. Plant height (cm). Ten sample plants per treatment were measured after the. Last pod harvest then summed up and divided by ten to get the average height.

5. Number of lateral branches produced. This was obtained from ten sample plants by uprooting and counting the branches produced after the last harvest. The total number of branches was divided by ten sample plants to obtain the average number of branches produced per plant.

6. Fresh weight of individual plant (g). The uprooted ten sample plants per plot were weighed and the weight was divided by ten to get the weight per plant.

B.Yield

7. Length of pods (cm). Ten sample pods were measured every harvest and after the last harvest the measurements were added and divided by the number of pods measured to get the average length of pods per treatment.

8. Marketable yield (kg). This was the weight of pods without any defect from first to the last harvest that were sold to the market.

9. Weight of non-marketable yield (kg). This was the weight of pods with defects such as malformed, very short and insect damaged that were not sold in the market from the first to the last harvest.

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

11. Yield per plant (g). The total yield per plot was divided by the number of plant per plot that produced pods.

12. Economic analysis from the different seed sizes planted in 5 sq. m.

This was obtained by subtracting the total expenses per plot from the sales of pods per plot. The expenses consisted of the cost of seeds, labor cost from land preparation to last harvesting, organic fertilizers and packing polyethylene bags.

RESULTS AND DISCUSSION

Percentage Germination

As presented in Table 1, the large seeds had higher percentage of germination followed by the mixed sizes, small and medium seeds with very slight differences. This results imply that the seed sizes in French bean do not affect the percentage of germination. However, the germination percentages recorded in this study were very low compared to the 80% acceptable in beans. The low percentage of germination might be due to the heavy rains immediately after planting in November 2010 and also because the seeds were taken from hybrid parent plants.

Number of Days from Sowing to Flowering

As presented in Table 2, the number of days from sowing to flower bud appearance did not differ significantly. These observations may suggest that the seed size does not influence the number of days to flowering. The seeds, whether small, medium of large-sized emerged simultaneously at 7 days from sowing and initiated flowering also at the same time.

Table 1. Percentage germination as affected by seed size on the percentage emergence of the French beans seedlings

SEED SIZE	MEAN (%)
Small seeds (0.11 g)	57.92[a]
Medium seeds (0.15 g)	57.08[a]
Large seeds (0.20 g)	62.08[a]
Mixed sizes (0.17 g)	58.25[a]

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

Table 2. Number of days from sowing to flower bud appearance as affected by seed size

SEED SIZE	DAYS
Small seeds (0.11 g)	43
Medium seeds (0.15 g)	43
Large seeds (0.20 g)	43
Mixed sizes (0.17 g)	43

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

Number of Days from Sowing to First Pod Harvesting

There were no significant differences observed among the different seed sizes planted on the number of days to first pod harvesting (Table 3). This means that the duration to pod harvesting is a characteristic of the frop and cannot be affected by the sizes of seeds planted.

Plant Height

The different seed sizes of French beans planted produced significantly different heights at the end of the last harvest (Table 4). The large seeds produced significantly taller plants among the seed sizes planted. This was followed by the medium and the mixed sizes which significantly surpassed the plants from the small seeds.

Large seeds according to Bruun and Brink (2008) contains more food supply during seedling emergence and higher potential for root penetration which may explain the significant differences on the plant height.

Table 3. Number of days from sowing to first pod setting as affected by seed size

SEED SIZE	DAYS
Small seeds (0.11 g)	59
Medium seeds (0.15 g)	59
Large seeds (0.20 g)	59
Mixed sizes (0.17 g)	59

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

Table 4. Plant height of French beans as affected by seed size

SEED SIZE	MEAN (cm)
Small seeds (0.11 g)	24.69[c]
Medium seeds (0.15 g)	26.70[b]
Large seeds (0.20 g)	28.29[a]
Mixed sizes (0.17 g)	26.66[b]

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

<u>Number of Lateral Branches Produced Per Plant</u>

Table 5 shows that there were no significant differences on the number of lateral branches produced per plant among the seed sizes studied. This means that whatever is the size of seeds when planted, the plants will produce similar number of lateral branches during vegetative stage of French beans.

Fresh Weight of Individual Plant (g)

Table 6 shows that there were no significant effect of seed size on the fresh weight of the individual plant. While the plant height showed significant differences among the seed sizes, the number of lateral branches did not differ which may have compensated the differences in height, thus in the fresh weight of the individual plant showed similar results.

Table 5. Number of lateral branches of French beans produced as affected by seeds size

SEED SIZE	MEAN
Small seeds (0.11 g)	5.47[a]
Medium seeds (0.15 g)	5.80[a]
Large seeds (0.20 g)	5.67[a]
Mixed sizes (0.17 g)	5.43[a]

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

Table 6. Fresh weight of individual plant as affected by seed size

SEED SIZE	MEAN (g)
Small seeds (0.11 g)	25.27[a]
Medium seeds (0.15 g)	25.87[a]
Large seeds (0.20 g)	25.97[a]
Mixed sizes (0.17 g)	25.70[a]

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

Length of Pods

Table 7 shows that French bean pods have different lengths which were significantly affected by the different seed sizes planted. This results shows that the length of pods was correspondingly related to the size of seeds of French beans when they were sorted and planted separately, wherein the large seeds produced significantly larger pods compared to ht mixed and the small seeds, but did not differ from the medium seeds.

The observed differences in the length of pods are directly related to the sizes as McCollum (1973) explained that larger seeds give earlier and more uniform maturity. This advantage, the author mentioned, makes it profitable to separate the seeds into three sizes, planting the two larger sizes separately and discarding the small seeds which are usually weak and improperly mature.

Weight of Marketable Yield (g)

Table 8 shows the marketable yield of French beans from varying seed sizes. Pods harvested from large seeds produced the heaviest weight but it did not differ significantly from the other seed sizes planted. The very low yield was due to the very low percentage of germination (Table 1) where few plants survived the heavy down pour after planting the seeds to emergence.

Table 7. Length of pods produced as affected by seed size

SEED SIZE	MEAN (cm)
Small seeds (0.11 g)	12.06[b]
Medium seeds (0.15 g)	12.36[ab]
Large seeds (0.20 g)	12.57[a]
Mixed sizes (0.17 g)	12.10[b]

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

Table 8. Weight of marketable yield of French beans as affected by seed size

SEED SIZE	MEAN (g)
Small seeds (0.11 g)	491.67[a]
Medium seeds (0.15 g)	533.33[a]
Large seeds (0.20 g)	548.67[a]
Mixed sizes (0.17 g)	547.33[a]

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

Weight of Non-Marketable Yield

Table 9 shows the marketable yield of French beans from varying seed sizes. Again, the large seeds have resulting plants producing slightly heavier non-marketable pods from the other seed sizes. This result might imply that the non-marketable pods are not affected by the size of seeds planted

Total Yield per Plot

As presented in Table 10, large seeds of French beans produced the heaviest total yield, while the plants from small seeds produced the lowest total yield but the differences were not significant. As mentioned earlier, the experiment was severely affected by the heavy rains after planting the seeds to emergence. In fact, the yield of less than one kilo from a plot measuring five meters reflect the severity of the rainfall that coincided during the germination period.

Table 9. Weight of non- marketable pods of French beans pods as affected by seed size

SEED SIZE	MEAN (g)
Small seeds (0.11 g)	44.33[a]
Medium seeds (0.15 g)	53.67[a]
Large seeds (0.20 g)	60.33[a]
Mixed sizes (0.17 g)	37.67[a]

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

Table 10. Total yield of French bean per plot as affected by seed size

SEED SIZE	MEAN (g)
Small seeds (0.11 g)	536.00[a]
Medium seeds (0.15 g)	587.00[a]
Large seeds (0.20 g)	609.00[a]
Mixed sizes (0.17 g)	585.00[a]

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

Yield per Plant

The yield per plant from the large seeds obtained the highest but it did not significantly differ from the yields of the other seed sizes (Table 11). The similar number of lateral branches and fresh weight of individual plant might have contributed to the slight differences in the yield per plant, although the length of pods was longer from the large seeds.

Economic analysis from the different seed sizes planted in 5 sq. m.

Table 12 show the profitability of planting the different seed sizes of French beans.Statistical analysis show that there were no significant differences on the profitability of French beans from varying seed sizes.

Table 11. Yield per plant as affected by seed size

SEED SIZE	MEAN (g)
Small seeds (0.11 g)	12.11[a]
Medium seeds (0.15 g)	12.95[a]
Large seeds (0.20 g)	13.54[a]
Mixed sizes (0.17 g)	13.42[a]

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

Table 12. Economic analysis from the different seed sizes planted in 5 sq. m.

PARTICULARS	SEED SIZES			
	SMALL	MEDIUM	LARGE	MIXED SIZES
Market yield (g)	1475.00	1600.00	1646.00	1642.00
Sales (peso)	150.00	160.00	170.00	
Expenses				
Compost	90.00	90.00	90.00	90.00
Seeds	13.00	18.53	24.46	20.33
Packaging cellophane	1.25	1.50	1.50	1.50
Labor				
Digging	50.00	50.00	50.00	50.00
Applying compost	45.00	45.00	45.00	45.00
Planting	25.00	25.00	25.00	25.00
Maintenance	30.00	30.00	30.00	30.00
Harvesting	50.00	50.00	50.00	50.00
Total	304.25	310.03	315.96	318.30
Net Income	-155.25	-150.3	-145.96	-143.83
ROI	-50.70%	-48.40%	-46.19%	-46.12%
RANK	4	3	2	1

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted at the BSU Organic Farm, in Balili La Trinidad Benguet, from November 2010 to February 2011 to assess the growth and yield performance of French beans from varying seed sizes and to determine which size of French beans seeds can give the best growth and yield.

The result of the study shows that French bean plants from large seeds had the tallest, produced the longest pods, it was respectively followed by French beans from medium sized seeds and mixed seed sizes then lastly the French bean plants from small seeds(28.29 cm,26.70 cm, 26.66 cm and 26.66cm respectively).

The length of pods produced by French beans from large seeds (12.57 cm) significantly differed over the shortest pods produced by the French beans grown from mixed seed sizes and small seeds (12.10 cm and 12.06 cm respectively)

In terms of days from sowing to flowering and first pod setting, there were no significant differences between the treatments (36 days and 56 respectively). The varying sizes of French beans seeds didn't show any significant difference interns of percentage germination, number of lateral branches produced, fresh weight of individual plant, weight of marketable yield, non-marketable yield, total yield and yield per plant, there were also no significant difference in terms of the profitability of the varying seed sizes.

Conclusion

Based on the results presented and discussed, large seeds of French beans have higher potential of producing taller plants with longer pods resulting to heavier yield than the medium and small seeds. However, the profitability did not show the real performance due to the damage done by the heavy rains.

Recommendation

It is therefore recommended that larger seeds must be planted in the production of French beans to obtain the highest benefit. It is strongly recommended that the study be verified using the same condition of the experiment except the rainfall.

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APPENDICES

Appendix Table 1.Percentage of emergence

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	56.25	52.50	65.00	173.75	57.92
T_2	52.50	57.50	61.25	171.25	57.08
T_3	68.75	57.50	60.00	186.25	62.08
T_4	65.00	52.25	57.50	174.75	58.25
TOTAL	242.50	219.75	243.75	706.00	235.33

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Block	2	91.26	45.63	0.49^{ns}	4.76	9.78
Treatment	3	44.42	14.81			
Error	6	181.49	30.25			
Total	11	317.17				

ns- Not significant

Coefficient of variation = 9.35%

Appendix Table 2. Number of days from sowing to flower bud appearance as affected by seed size

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
T_1	43.00	43.00	43.00	129.00	43.00
T_2	43.00	43.00	43.00	129.00	43.00
T_3	43.00	43.00	43.00	129.00	43.00
T_4	43.00	43.00	43.00	129.00	43.00
TOTAL	172.00	172.00	172.00	516.00	172.00

Appendix Table 3. Number of days from sowing to first pod setting as affected by seed size

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
T_1	59.00	59.00	59.00	177.00	59.00
T_2	59.00	59.00	59.00	177.00	59.00
T_3	59.00	59.00	59.00	177.00	59.00
T_4	59.00	59.00	59.00	177.00	59.00
TOTAL	236.00	236.00	236.00	708.00	236.00

Appendix Table 4. Plant height (cm)

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T_1	24.42	24.64	25.00	74.06	24.69
T_2	26.61	27.33	26.15	80.09	26.70
T_3	27.80	28.93	28.13	84.86	28.29
T_4	26.09	26.96	26.94	79.99	26.66
TOTAL	104.92	107.86	106.22	319.00	106.33

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Block	2	1.09	0.54	4.64**	4.76	9.78
Treatment	3	19.55	6.52			
Error	6	0.96	0.16			
Total	11	21.6				

**- highly significant Coefficient of variation = 1.51%

Appendix Table 5. Number of lateral branches produced

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T_1	5.40	5.80	5.20	16.40	5.47
T_2	6.10	5.50	5.80	17.40	5.80
T_3	5.60	5.80	5.60	17.00	5.67
T_4	5.90	5.00	5.40	16.30	5.43
TOTAL	23.00	22.10	22.00	67.10	22.37

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Block	2	0.15	0.08	0.83^{ns}	4.76	9.78
Treatment	3	0.27	0.09			
Error	6	0.65	0.11			
Total	11	1.07				

ns- Not significant

Coefficient of variation = 5.88%

Appendix Table 6. Fresh weight of individual plant (g)

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T_1	27.60	25.80	22.40	75.80	25.27
T_2	27.20	25.90	24.50	77.60	25.87
T_3	27.00	26.60	24.30	77.90	25.97
T_4	24.40	26.00	26.70	77.10	25.70
TOTAL	106.20	104.30	97.90	308.40	102.80

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Block	2	9.46	4.73	0.12^{ns}	4.76	9.78
Treatment	3	0.86	0.27			
Error	6	15.17	2.53			
Total	11	25.49				

ns- Not significant

Coefficient of variation = 6.19%

Appendix Table 7. Length of pods (cm)

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T_1	12.53	11.35	12.30	36.18	12.06
T_2	12.56	12.15	12.38	37.09	12.36
T_3	12.89	12.26	12.57	37.72	12.57
T_4	12.40	11.69	12.21	36.30	12.10
TOTAL	50.38	47.45	49.46	147.29	49.10

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Block	2	1.12	0.56	4.89^{ns}	4.76	9.78
Treatment	3	0.52	0.17			
Error	6	0.21	0.03			
Total	11	1.85				

ns- Not significant

Coefficient of variation = 1.54%

Appendix Table 8. Weight of marketable yield (g)

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T_1	551.00	484.00	440.00	1475.00	491.67
T_2	581.00	501.00	518.00	1600.00	533.33
T_3	593.00	554.00	499.00	1646.00	548.67
T_4	562.00	543.00	537.00	1642.00	547.33
TOTAL	2287.00	2082.00	1994.00	6363.00	2121.00

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Block	2	11301.2	5650.75	3.87^{ns}	4.76	9.78
Treatment	3	6387.58	2129.19			
Error	6	3301.17	550.19			
Total	11	20989.9				

ns- Not significant Coefficient of variation = 4.42%

Appendix Table 9. Weight of non marketable yield (g)

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
T_1	36.00	46.00	51.00	133.00	44.33
T_2	71.00	37.00	53.00	161.00	53.67
T_3	43.00	61.00	77.00	181.00	60.33
T_4	29.00	46.00	38.00	113.00	37.67
TOTAL	179.00	190.00	219.00	588.00	196.00

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Block	2	213.5	106.75	1.49^{ns}	4.76	9.78
Treatment	3	901.33	300.44			
Error	6	1205.17	200.86			
Total	11	2320				

ns- Not significant Coefficient of variation =28.92%

Appendix Table 10. Total yield

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T_1	587.00	530.00	491.00	1608.00	536.00
T_2	652.00	538.00	571.00	1761.00	587.00
T_3	636.00	615.00	576.00	1827.00	609.00
T_4	591.00	589.00	575.00	1755.00	585.00
TOTAL	2466.00	2272.00	2213.00	6951.00	2317.00

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Block	2	8760.50	4380.25	3.57^{ns}	4.76	9.78
Treatment	3	8546.25	2848.75			
Error	6	4789.50	798.25			
Total	11	22096.25				

ns- Not significant

Coefficient of variation = 4.88%

Appendix Table 11. Yield per plant

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T_1	13.04	12.61	10.67	36.32	12.11
T_2	15.52	11.69	11.65	38.86	12.95
T_3	14.45	13.36	12.80	40.61	13.54
T_4	13.74	14.02	12.50	40.26	13.42
TOTAL	56.75	51.68	47.62	156.05	52.02

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	Computed F	TABULAR F 0.05	0.01
Block	2	10.46	5.23	1.42^{ns}	4.76	9.78
Treatment	3	3.79	1.26			
Error	6	5.33	0.89			
Total	11	19.58				

ns- Not significant

Coefficient of variation = 7.24%