BIBLIOGRAPHY

PANG-OT, LEONYL V. MARCH 2010. Seed Development of French bean (*Phaseolus vulgaris spp.)* and seed yield as affected by rates of Plantmate Organic Fertilizer. Benguet State University, La Trinidad, Benguet.

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ABSTRACT

This study was conducted to: study the seed development in French beans; evaluate the growth of French beans as affected by Plantmate organic fertilizer and determine the seed yield of French beans as affected by Plantmate organic fertilizer.

Results of the study showed that French bean seeds both applied and not applied with Plantmate organic fertilizer have high moisture content during the early stage of growth. The moisture content then slowly decreased as the seeds developed and matured. In contrast, the dry seed weight gradually increased until it leveled off to indicate the physiological maturity, which was 41 days after pod set for the plots applied with organic fertilizer and 44 days for those not applied with organic fertilizer. Pods at this stage are already yellowing and starting to shrivel. This was supported by the germination test wherein the seeds started to be viable 26 days from pod set and attained 100% germination 41 days from pod set for both seeds applied and not applied with organic fertilizer. At 41 to 44 days from pod set, the seedlings were mostly normal showing that physiological maturity was attained.

In the effect of rates of Plantmate organic fertilizer in the seed yield of French bean, no significant effect was observed on the days from emergence to flower bud appearance, days from planting to first pod yellowing, number of pods per plant, 100 seed weight, weight per seed,

number of lateral branches produced per plant, weight of clean seed per plant and per plot, in comparison with the control (unfertilized) plants.

TABLE OF CONTENTS

INTRODUCTION

Crop legume production in many developing countries has been stagnant or declining during the past two decades. These crops, in general, continue to justify the title of “Slow Runners” conferred on them by Borlaug in 1973. We believe that this situation will be changed only if an appropriate research methodology can be developed that can effectively address the major limitations to productivity in particular farming systems and to adoption to a range of production environments.

One among these legume crops which suffer decline in its production is French beans (*Phaseolus vulgaris spp.)*, an unknown crop for the Benguet farmers. French bean is one of the important members of the legume family. It is a perennial plant, but grown in other part of the world as half-hardy annual. French beans are also known by a variety of names such as flageolets and haricot beans. In normal circumstances they can be harvested between early July to mid October. French Beans can be harvested 12 weeks from sowing.

However, the production of French beans is still limited due to some factors, one of which is the exorbitant prices of fertilizers. One means of obtaining a better yield of this crop is proper and more efficient methods and kinds of fertilizers. The application of fertilizers in the soil is currently the most common practice among farmers. Although, as King (1926) remind us,’ the first condition of farming is to maintain fertility,’ organic fertilizer application is seldom considered despite its merits claimed by early investors. The organic farmer will also need to be aware that an increase in the quantity of organic food brought will come about only if the price is competitive.

Although many studies are made to shorten the development of seeds in French Beans, one problem in the production is the time of planting to harvest which may span to 12 weeks. Breaking the normal time course of seed development by denying water has been used to reduce the normal association between seed development and duration from flowering (Sinnah, 1998). In this way it was shown that both soluble sugars and heat-stable proteins were equally likely (or unlikely) to be involved in the development of seed.

We can observe today that poor yield of legumes is due to the unfortunate state of farmlands in the province. The soil is over fed with inorganic chemicals, fertilizers, and hormones which remains in the soil and absorbed by plants. This is very detrimental to the health of the consumers. Looking at this condition, remedy must be done to save the productiveness of the soil for the coming generation. One way of which is shifting to Organic Agriculture, in this way, organic matters will be brought back to the soil improving its quality and fertility. Depriving farmers from using too much inorganic chemicals and fertilizers will be a lot of help for the environment.

It has been observed that farmers do not give proper attention to fertilization although it is considered one of the major factors in the production of legume crops. Farmers sometimes apply either too high or too low amount of fertilizer needed by the plant. Thus improper fertilizer application leads to low production and profit. Fertilizer must be applied at proper time or stage of plant growth for maximum utilization by the crops. Proper timing of fertilizer application provides an efficient and continuous supply of essential plant nutrients and promotes good growth and the development of harvested pods.

Organic fertilizers are considered to be more environmental friendly than the conventional fertilizer. Organic fertilizers contains fewer amounts of the major plant nutrients like nitrogen, phosphorous, potassium; however, it contains generally humus that favor good physical, biological conditions in the soil for plant growth.

In 1973, Nobel Laureate Norman Borlaug suggested that the food legumes as a group were the “slow runners” in the cropping systems of the developing countries. As a result of the ‘Green Revolution’, cereal production, had risen rapidly in the 1960’s and 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 the food legumes onto more marginal agricultural environments.

Borlaug recognized the importance of food legume crops in farming systems, and in human and animal nutrition. He proposed an approach to raising the production and productivity of these crops through the development of high yielding cultivars and improved systems of management.

In addition, there is an increased recognition by farmers, scientists, and policymakers that legume crops are crucial components of Asian farming systems, and that these crops have the potential for high yields and can be profitable to farmers.

There are several technologies generated to increase seed yield and income from French Beans, but the work should go on to generate more information to improve production to cope up with the rapidly increasing population. With the production of new inputs which are claimed to enhance growth and yield of crops, it is the function of research to fin out the truth about the claims.

The result of the study will help anyone interested in seed production. If the product readily enhance growth and seed yield that will result to higher return on investment, the farmer should know. But if the result does not indicate any advantage, then the farmer should be informed not to spend their thousand on the product will just waste their money.

Additional importance of the study is to show that plants have the ability to grow without fully dependent on inorganic materials.

This study was conducted to:

1. study the seed development in French beans,

2. evaluate the growth of French bean as affected by the organic fertilizer, and

3. determine the seed yield of French beans as affected by Plantmate organic fertilizer.

This study was conducted at the Balili Experiment Station of the Benguet State University from November 2009 to March 2010.

REVIEW OF LITERATURE

Description of French Bean

French bean prefers a sunny, sheltered site because it gives protection from cold wind which helps at the seedling stage and later on during the pollination phase. French Beans prefer a rich soil which has plenty of organic material in it. They have a deep root system, so digging should be to a spade and a half's depth, incorporating compost or other organic material during the process. If possible, prepare the soil a month or so in advance of sowing the seeds. The requirements of French beans are simple - water and weeding, possibly some feeding. All three can be greatly helped by a mulch of organic material spread round the plants. This will help retain moisture, keep the weeds down and gently feed the plants. If the soil has been prepared as described previously the only other attention is hand watering in very dry conditions, especially as the flower buds begin to develop. French Beans are sub-tropical in origin, and for this reason need a minimum soil temperature of 16°C (60°F). If unprotected, French Beans are in all cases damaged by even one degree of frost (Anonymous, 2007).

French Beans have a germination rate of approximately 75% and for this reason should be sown thinly, one seed every 15cm (6 in), to be thinned out to a final spacing of one seedling every 30cm (1ft) about 3 weeks after sowing. To be doubly sure, sow several seeds at the end of the row for filling in any spaces where the seed has failed to come up in the row. After sowing, water the bed well if conditions are at all dry. Dwarf French Beans may not require support in good conditions. However, the weight of the pods does tend to drag them to the ground, attracting slugs and other pests. It is best to tie them into a short bamboo pole or let them scramble through twigs inserted into the ground next to them. This will also give some protection to the plants if the weather conditions turn windy. The climbing varieties of French Beans grow to about 1.8m (6 foot) high and they definitely need support. The idea is to provide a structure which their tendrils can grow round and pull the plant up (Anonymous, 2007).

Seed Development

Seed development begins with the production of the flower primordial long before anthesis. The developing flower contains tissues that will ultimately be part of the fruit and the seed. The pod walls (carpels) of the legume fruit and the pericarp of the cereal caryopsis develop from the ovary. The testa forms from the integuments around the ovule. Thus, the seed that represents economic yield is a mixture of embryonic and maternal tissues. The mature seed could conceivably be influenced by developmental processes occurring before anthesis (Hill, 1987).

Seed development according to Hill (1987), from fertilization to mature seed, can be divided into three phases. These are:

Development of seed structure. Includes fertilization and the rapid cell division when all seed structures are formed.

Linear phase of seed development. Seeds accumulates reserve materials that give it economic value.

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 changes in seed color or seed characteristics.

The general patterns of growth and development are the same for seeds of all common crop species, regardless of their structure, composition or size. Consequently, we can treat these seeds as a common group to investigate the role of the individual seed in the production of yield (Hill, 1987).

The developing seed, a mixture of maternal and embryonic tissues, is dependent upon the mother plant for the nutrients that sustains its growth. However, the seed does not passively accumulate the nutrients supplied by the plant. Instead the seed synthesizes its storage reserves from sucrose and amino acids arriving in the phloem. Photosynthesis in vegetative plant parts is the primary production process behind the supply of nutrients to the seed, but it is only part of the yield production process in grain crops. The synthesis and accumulation of storage reserves in the seed are equally important and the seed plays a central role in this part of yield production (Hill, 1987).

Seed development is concerned with the various processes and stages occurring during the period from fertilization until the seed is fully formed ready for harvesting. Hill (1987) made the explanation between the difference of mature and ripe seeds to describe the end-point of seed development. In addition, he said that a seed is mature when it has attained maximum dry weight while a seed is ripe when its moisture content is in equilibrium with the surrounding atmosphere. Mabesa (1980) defined seed maturation as the morphological and functional changes 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 male reproductive cell, or sperm, fuses with the female reproductive cell, or egg, resulting in the mixing of the genetic information carried in the parent cells. This occurs when both male and female gametophytes are fully mature.

Once the egg is fertilized it will undergo development stages as illustrated by Hill (1987). These are:

Growth stage. This last for about 10 days immediately after pollination. The rate of seed growth is rapid and the stage is marked by intense cell multiplication. During this stage, moisture content of the seed remains very high at a constant of 80%-90%. Hill (1987) explained that seed harvested during this stage is not viable, but this stage is important as the period when the framework of the future seed is being laid down.

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

Food reserve accumulation phase. This stage last for 10-14 days during which there is a low 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 seed become viable early in this phase of seed development during which substance translocated from other parts accumulate as seed reserves (sugars, fats, starch, and protein) reaching physiological maturity at 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 an indication of approaching maturity, which gradually takes place during the later half of this phase wherein there is a reduction 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%

MC) with the atmosphere while dry weight remains relatively constant. It is at this phase that the seed has become what is normally term 'ripe' and ready for harvest.

Mabesa (1980), also enumerated the changes during seed maturity which are the following:

Seed dry weight. After sexual fusion, seed development begins and increase in weight as a result of nutrient and water intake associated with rapidly accelerating cell division and elongation. As seed mature, individual dry weight increases until maximum is reached. The point of maximum dry weight indicate the point when the translocation of soluble substances into the seed stops or the point when translocation is exactly balanced by respiration. The point of maximum dry weight is usually considered as the point of physiological maturity.

Moisture content. The moisture content of the ovary or unfertilized ovule is some what about 80%. After fertilization, moisture content usually increases for a few days then begins to decrease with further seed development until equilibrium with the field environment at 14-20% moisture content. The initial slight increase in moisture content after fertilization is due to the translocation of water to the as it begins to enlarge and develop. In dicot, there is a translocation in food materials that must occur while in grasses it is already in the endosperm; hence, dicot takes longer time to lose moisture compared with monocots.

Seed size. Seed size increases from the time of fertilization until maturity is reached at rather high moisture content of 40%. After maximum size is reached, seed size decreases some what as the seeds dry.

Germination and vigor. Some kinds of seeds are capable of 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 reaches a maximum at the same time maximum dry weight (maturity) is reached.

Chemical changes during seed development. Carbohydrate content increases rapidly as endosperm develops. Sucrose and reducing sugars decrease rapidly as starch content increases. As development proceeds, protein nitrogen amide form 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 content increases rapidly during the first few weeks for this coincides with the period when endosperm is RNA content directs amino acid synthesis.

Hill (1987), reported that maturity or lack of it can influence various quality attributes in the seed. There are three important aspects of seed quality which are greatly affected by the stage of development.

Viability. This is expressed by the ability or capacity of seeds to germinate when placed in conditions of moisture, temperature and aeration that would allow germination to occur. Many seeds harvested only ten days after pollination are viable, and more than 90% of the seeds harvested at 15 days from pollination are capable of germinating. Germination can thus take place very soon after the embryonic tissues have been formed, and well before maturity is attained. These very immature seeds would have much small food reserves that successful establishments of the seedling would be in doubt, and the seeds themselves would be so small that they should be removed during machine cleaning procedures.

Seedling vigor, strength, or "energy". There is not simple way to express this concept, but some assessments may be gained from the speed of germination, the size of seedling, the rate of seedling growth, and the depth of covering soil trough which seedling can successfully emerge. On this measure, seedling vigor was higher as the seed was nearer to maturity.

The weight of seedlings was directly proportional to the initial dry weight of the seed, and even six-week growth in a glass house, seedlings from seeds harvested at 12 and 14 days after pollination were still about half the size of seedlings grown from mature seeds. This small initial seed size is no great handicap to the plant once it ha established, establishment under normal field conditions may well be difficult for small seedlings when competition is intense that immature seed may not have sufficient food reserves to survive from sprouting through emergence and until the formation of the first true photosynthesizing leaves.

Storage life. Immature seeds deteriorate more rapidly in storage. Legume seeds of known age were stored after harvest for one month in the severe conditions of 37^{o}C temperature and 70% relative humidity. Although viability was lost in the seed of each age, the results show that the rate of loss was progressively greater with immaturity. Seed maturity is thereof an important factor in commercial seed quality, and has a number of implications for production of high quality seed crops.

Seed Moisture Content and Seed Development

In sweetcorn cv. 'Reliance', Kudan (1987) found that the moisture content of seed started from very high level then slowly decreased to a very low level. In contrast to this, the dry weight slowly increases which means that the accumulation of stored food from the leaves is slowly taking place of moisture content. The same observation was made by Sikhondze (1987) in his study in tickbean (*Vicia faba*), Sattar (1987) in his study on sweet corn line NK-195, and Vida (1987) in her study on Viola.

Klein and Harmond (1987) reported that the only property that correlated well with the time of obtaining maximum yield of pure seed was moisture is high in the immature crop, usually about '60', and then drops about 10% as the crop matures. The rate of seed moisture change varies with climatic conditions but average about 3% per day. They suggest that seed moisture was discovered to be a practical index to best cutting time for many crops and a method of quick determining moisture in the field was desired.

According to Mabesa (1980), the importance of seed maturation is to avoid unnecessary delay in harvesting seeds after they attain physiological maturity which contributes considerably to deterioration. He explained that delaying harvest after maturation is the same as "storing" seeds in the field under the usual unfavorable levels of humidity and temperature. Field deterioration of seeds can be exemplified by the behavior of certain seed subjected to adverse climatic conditions while in the plant, e.g. cotton seed sprout in the ball, radical growth of some grasses starts, and legume seeds show water damage. Mabesa (1980) concluded also that in general seeds reach their peak germination percentage and vigor at the same time of maturation in the field and once this peak is reached the seeds can only decrease in quality.

A seed is ready for harvest when all the necessary seed components have occurred or the seed has reached physiological maturity (maximum dry weight) as reported by Hampton (1987). He said, however, that maximum ‘harvest ripeness’ is not reached until seed moisture content reached equilibrium with its surrounding atmosphere. This point normally occurs when the seed moisture content has fallen to a level of approximately 14%. The art of correct harvest timing, therefore, involves correctly estimating when the seed can be removed from the plant without damage but before major loss of seed number due to shattering or loss of seed quality due to weathering has occurred.

Effect of Organic Fertilizer

Knott (1976) mentioned that the application of organic fertilizer in soil prior to planting or sowing time results high yield. Manure does not only provide nutrients but also humus, which improves physical condition of the soil. The author also said that well decomposed manure should be applied at the role of 10-20 tons/ha after the first plowing. This amount will slowly provide during vegetative growth of the crop. However, full benefits of such practice would be realized over a period of 2 years.

As explained by Tisdale and Nelson (1975), organic fertilization releases the nutrient element slowly especially nitrogen for efficient utilization of plants. Once available nutrients are translocated to plant parts, growth and yield tend to increase. Chicken manure was found to contain about 1% nitrogen, 0.8% phosphorus, 0.40% potassium (Brady and Buckham, 1960)

Crops fertilized with organic materials have greater resistance to pest and disease. The writer explained that the humid acid and growth substance are absorbed into the plant tissue through the roots and they favor the formation of protein by influencing the synthesis of enzymes increasing the vigor and insect resistance of the plant. Soils high in organic materials allow little or no soil borne disease because of the oxygen ethylene cycle in the soil. It was also mentioned that the sap of the plants fertilized with organic material is more bactericidal than plant not fertilized with organic material. Non only does humus confer immunity to plant pest and disease. It also improves the quality of crop characteristics that has very definite commercial value (Abadilla, 1982).

Effect of Organic Fertilizers
on Seed Production

Bandonil (1983) reported that organic fertilization in peas enhance the production of heavier seed, greater number of pods, high dry matter yield and higher germination percentage. Similarly, Gonzalez (1983) stated that green manure an organic fertilizer improve quality of seed produced when combined with organic fertilizer.

Hill (1987) reported the important aspects of seed quality which are greatly affected by the stage of seed development which includes viability and germination percentage, seedling vigor, strength or energy.

A study conducted by Dayag (1980) showed that the seed produced form plots applied with chicken dung at the rate of 8 tons/ha had the highest 1000 seed weight.

In legumes, De La Cruz (1963) found that the advantage of a big seeds over the smaller seed for planting was evident as shown by the increased in number in weight of pods and in dry seed yield per plot. The increase in yield maybe attributed to an increase in pod development from plant grown from big and longer seed. As explained by Hampton (1987) seed quality can be influenced at any stage of growing , fertilizer application, processing, and distribution of the crop.

Kudan (1989) reported that in terms of pods maturity, seeds for planting purposes can be harvested when the pods turn yellowish and started to soften or 44 days from pod set which coincide with physiological maturity. Harvesting earlier than the yellowish pod stage may produce inferior seed which could result to low crop performance. Harvesting beyond the stage could lead to seed deterioration especially under adverse environmental condition and exposure to weevil infestation.

Hartman and Kestler (1975) explained that the superior quality of seed is essential in successful production; additional characteristics by seed viability include prompt germination, vigorous seedling growth and normal appearance of the same seedling.

Effect of Organic Fertilizers
On Plant Growth

In 1997, Cadiz and Deanon mentioned that compost is the best organic fertilizer, since it contains reasonable levels of N, P, K, and silica as well as enough carbon of fibrous material to improve the physical, chemical and biological properties of soil. They noted that composting helps control pollution. Much of the industrial and agricultural are either burned polluting the air and or left scattered in the field clogging the way. In 1980, Pandosen as cited by Olangey (2000) reported that as the level of the organic fertilizer is raised, the tuber formation and the yield were also increased. This is because more adsorption of nutrient by plants leads to the development of heavier tubers considering that other factors were favorable.

Nutrition affects the rate of the growth and stated of the readiness of the plant to defend them against pathogen 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 making it more susceptible to pathogens that prefer to attract such tissues for longer period (Agrios, 1978).

Cid (2000) said that chicken dung contains 11% nitrogen which is the highest among organic fertilizer, but lower in phosphorus and potassium. Also, in English daisy, the application of 2 tons/ha of chicken dung enhance the production of signicant taller plants with more suckers which flowered earlier producing more flowers per plant (Mang-osan, 1996).

Donahue (1972) reported that the fertilizer should be applied as close as possible to the roots without hindrance to germination at early vegetative stage and at flowering on fruiting time, for rainfall there is still moisture in the soil. For area with equal distribution of rainfall required fertilizer dosage can be applied at planting and the other half is between planting of the crop, the fertilizer can be applied at planting on the surface of the soil between rows with shallow incorporation. Organic matter supplies nutrients by the growing plants as well as hormones and anti-biotic. These nutrients are released in harmony with the seeds of the plots with the environmental condition favors a rapid release of nutrients from organic matter.

Plantmate

Plantmate organic fertilizer product is the result of an accelerated decomposition of biodegradable materials, both plants and animal origin, through an advance biofermentation process involving more than twenty natural occurring beneficial microorganism to enhance its efficacy as a functional compound.

Plantmate consistof chemical properties such as the total Nitrogen 2.44% (4.14 % on dry basis), total phosphorous 3.74% (6.34 % on dry basis), total potassium 3.61 % (6.13 % on dry basis), total calcium 4.46% (7.5 % on dry basis), total magnesium 0.19 % (0.32 % on dry basis). It is also a chelated micronutrient and amino acid that is adequate and well balanced. Growth and promotants are also adequate.

Physical appearance of plantmate is loose, friable and very stable organic matter with high humus content, dark brown to black in color. It does not have any burning effect on plants, safe and no pathogen. The pH is 7.5, which is lightly basic.

MATERIALS AND METHODS

The study consisted of two sets. The first was on the seed development and the other was on the effect of rates of Plantmate organic fertilizer on the seed yield of French beans.

Seed Development

An area of 60 sq m comprising of six plots of 1 m x 10 m was prepared thoroughly for planting. Three plots were applied with 18 kg plantmate as fertilizer base dress before planting the seeds, and the remaining three plots were not applied to compare the seed development to when it is applied with the organic fertilizer. Other cultural practices such as regular watering and pest control to insure optimum growth and seed yield were employed.

The procedures in taking the data in determining seed development were the following:

1. Seed moisture content (%). Immediately after every harvest of samples, seeds were extracted and weighed with the use of analytical balance then dried under the sun for 15 days. When all the seeds were dried, they were re-weighed and the moisture content was calculated using the formula:

$$MC = \frac{FW - DW}{FW} \times 100$$

Where FW is the fresh weight and DW isthe dry weight.

2. Dry weight of 1000 seeds (g). Two hundred seeds were weighed in an analytical balance every sampling date and the weight per seed was calculated. The

calculated weight of each seed was used to calculate the one thousand seed weight. This was done to the fresh and dry seeds.

3. Germination test. Seed samples from each sampling were sown in sand to determine the viability of seeds. After nine days from sowing, normal, abnormal and rotten seedlings were counted as percentages. The germination percentage was calculated using the formula:

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

Seed Yield Response to Rates of Plantmate Organic Fertilizer

An area of 75 sq m was prepared for the study. The area was divided into three blocks to represent the replications and each block was subdivided into five raised plots with a dimension of 1m x 5m to represent the treatments. The experiment used the Randomized Complete Block Design (RCBD) and the rates of the organic fertilizer were the following:

Treatment Code	Rates of Organic Fertilizer per Plot
T_1	control (no organic fertilizer)
T_2	2.0 kg
T_3	2.5 kg (recommended rate)
T_4	3.0 kg
T_5	3.5 kg

After digging the plots, Plantmate organic fertilizer was broadcasted and thoroughly incorporated with the soil following the rates of organic fertilizer above. This served as the fertilizer base dress. Two seeds per hill were planted at a distance of 25 cm and at a depth of 5 cm. One month after seedling emergence, hilling up was employed to cover exposed roots, to anchor the plants and to cover the weeds. Irrigation and other cultural requirements for optimum growth and yield were employed up to the termination of the study.

The following data were gathered, tabulated, computed and means subjected to mean separation by Duncan's Multiple Range Test (DMRT):

1. Soil analysis. Soil samples from the Experiment area was taken before planting for the analysis of N, P, K content, soil pH, and organic matter content.

2. Days from emergence to first flower bud appearance. This was determined by counting the number of days from the date of emergence to the time first flower buds appear.

3. Days from planting to first pod yellowing. These were the number of days from planting the seeds to the day the first pod becomes yellowish.

4. Percentage of pod set (%). Five samples of flower bunch were tagged and the number of flowers per bunch and the pods formed were counted and the pod set computed using the formula:

$$\text{\% pod set} = \frac{\text{Number of Pods Formed}}{\text{Number of Flowers}} \times 100$$

5. Number of pods per plant. This was obtained from ten sample plants randomly marked in each treatment plot before flowering where all the pods with seeds from the ten plants were counted and divided by ten.

6. Number of seeds per pod. Ten sample pods from each plot were harvested and the seeds were counted and the total divided by ten.

7. 100 seed weight (g). The dry seed weight per plot was divided by the number of plants per plot to get the seed yield per plant.

8. Weight of individual seed (g). One hundred dry seeds from each plot were picked at random and weighed then divided by 100 to obtain the weight of individual seed.

9. Final plant height (cm). Ten sample plants were measured from the first node at the base near the roots to the tip of the vine after the harvest of the ripe pods. The sum of all the measurements was divided by ten to get the average height of plants.

10. Number of lateral branches produced. Ten sample plants were uprooted after harvesting all the ripe pods and the lateral branches produced were counted and the average was obtained by dividing by ten.

11. Weight of clean seed per plant (g). Computed weight of clean seeds per plot was divided by the total number of plants per plot to get the weight of seed per plant.

12. Weight of clean seed per plot (kg). All ripe pods were harvested, seeds were extracted and cleaned and were weighed to determine the weight of seed per plot.

13. Documentation of the study through pictures. This was done during land preparation and data gathering to record some observation that cannot be measured.

RESULTS AND DISCUSSION

Sequence of Seed Development

Seed moisture content. Figure 1 presents the seed moisture content from the seed development study of French bean applied and not applied with plantmate organic fertilizer. Seed moisture content from the seed samples obtained from 17 days from pod set show high moisture content at 84% for the plants applied with Plantmate organic fertilizer and 85% for the plants not applied and slowly decreased as the seeds developed. The trend follows the report of Sage and Webster (1987) that during the growth stage, moisture content of seed remain very high at 80% to 90%. This was similar with the study of Kudan (1989) in snap bean that the growth stage of seeds has a constant moisture content of 84% for 20 days.

Figure 2 shows that at early stage of development, the seeds were dark green and with the presence of liquid contents. As the seeds advance in development, the color changes from green, light green and then white. The moisture content of the seeds slowly decreased as the embryo develops and accumulates food reserve decreasing the liquid content. The moisture content of seed from plants not applied with organic fertilizer was 12% while the plants applied with organic fertilizer was 22% when the seeds attained their physiological maturity, then down to 7 % and 14 %, respectively, when the pods started to dry up. The attainment of physiological maturity in French bean is almost the same with the finding of Bacdayan (1996) in her study of pechay seed which attained their physiological maturity at 39 % moisture content.

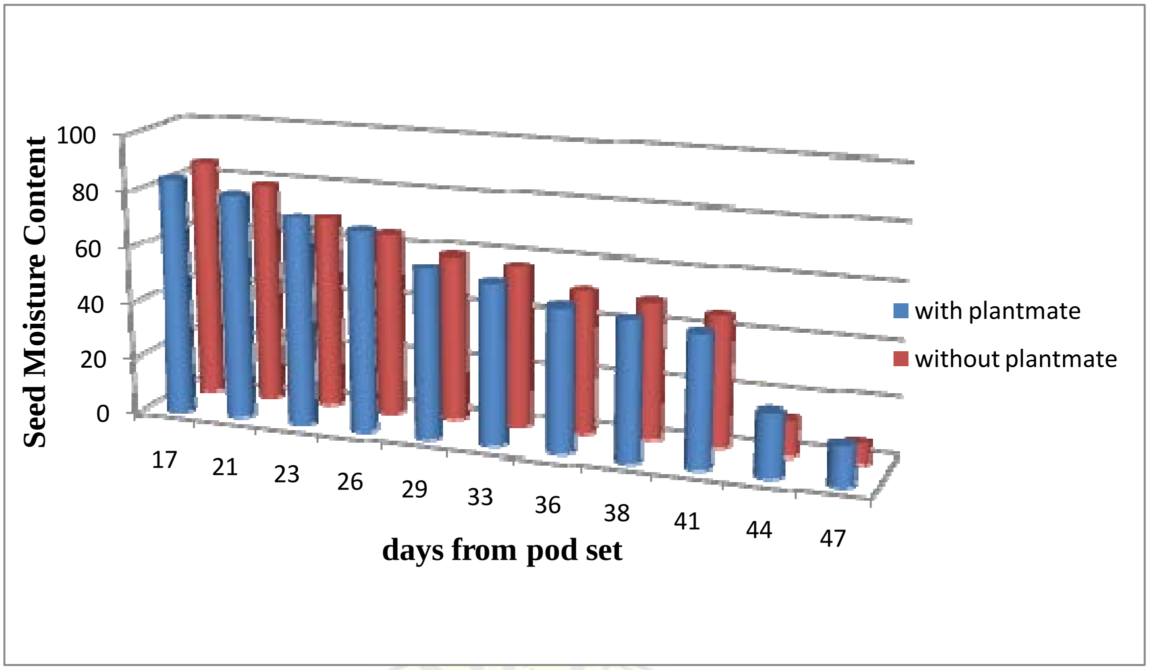


Figure 1. Seed moisture content (%) during the seed development of French bean applied and not applied with Plantmate organic fertilizer

Figure 2. The size and color changes in French bean seed during development

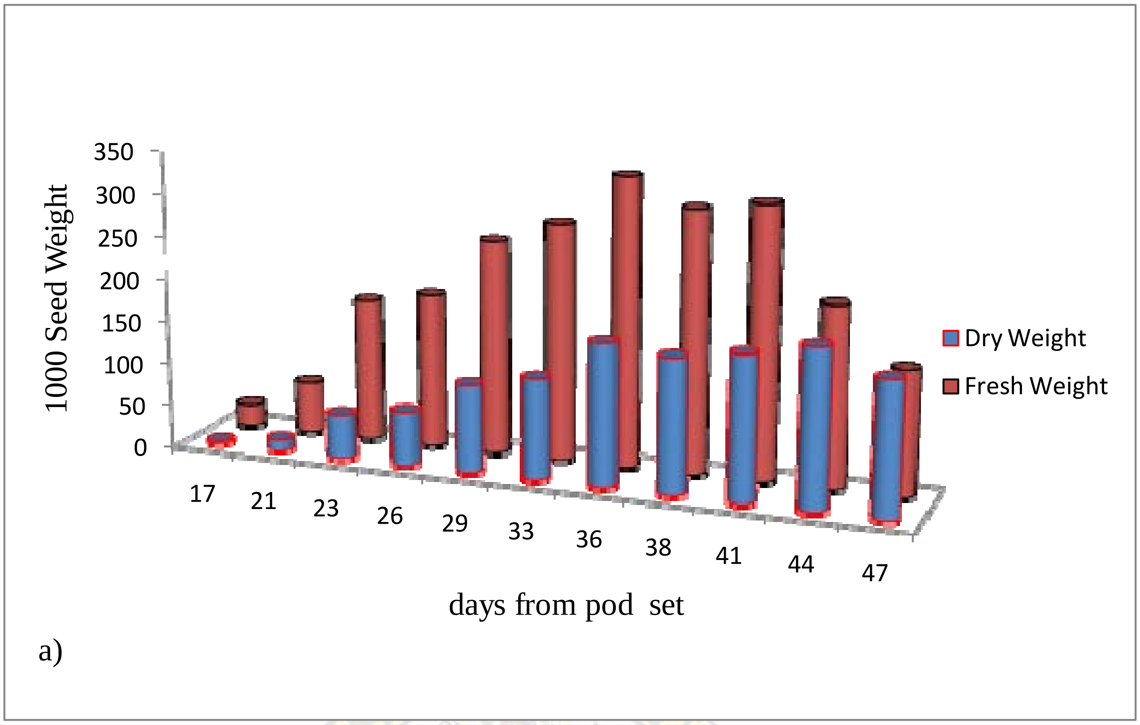
Weight of 1000 seeds. The fresh weight and dry weight of 1000 seeds from plants applied and not applied with Plantmate organic fertilizer increased from 17 days from pod set and then reached the peak 44 days of development (Fig. 3a and Fig. 4a). This means that food reserve accumulation phase was completed already. These results tally with the study of Kudan (1989) in pole snap bean which attained physiological maturity 44 days after pod set.

In contrast to the trend of moisture content which is decreasing (Fig. 1), the dry weight slowly increased, which means that the accumulation of stored food (dry matter) from the leaves is slowly replacing the moisture content of the seed. The trend in seed weight obtained from plants applied and not applied with plantmate organic fertilizer is similar but slightly differ in the maximum dry weight (Fig. 3a and Fig. 4a) due to the absence of seed laboratory equipments to be used.

Germination test. The seed germination test is shown in Figures 3b and 4b. French bean is observed to be viable 26 days after pod set (Figure 5) and attained 100 % germination 41 days from pod set.

Although French bean seeds started to be viable 26 days from pod set (for both plants applied and not applied with Plantmate organic fertilizer), the seedlings are all abnormal which means that the embryo is not developed yet. This observation agree with the statement of Mabesa (1980) that although seeds are capable of germination long before maturity is reached, seed vigor reaches a maximum when the maximum dry weight (maturity) is attained.

The percentage of abnormal seedlings started at 100% 26 days from pod set but abruptly went down in 6 days and attained 0% after another 9 days or 41 days from pod



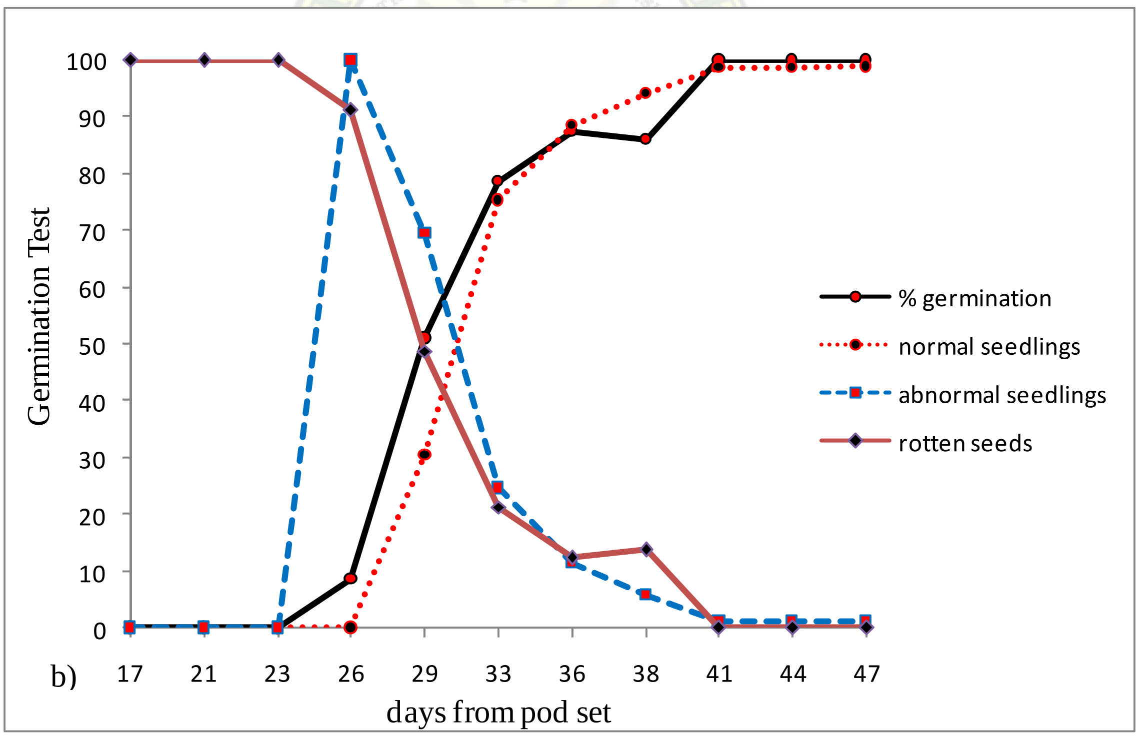


Figure 3. (a) Fresh and dry weight of 1000 seed weight (g) and (b) germination percentage during the seed development of French bean applied with Plantmate organic fertilizer

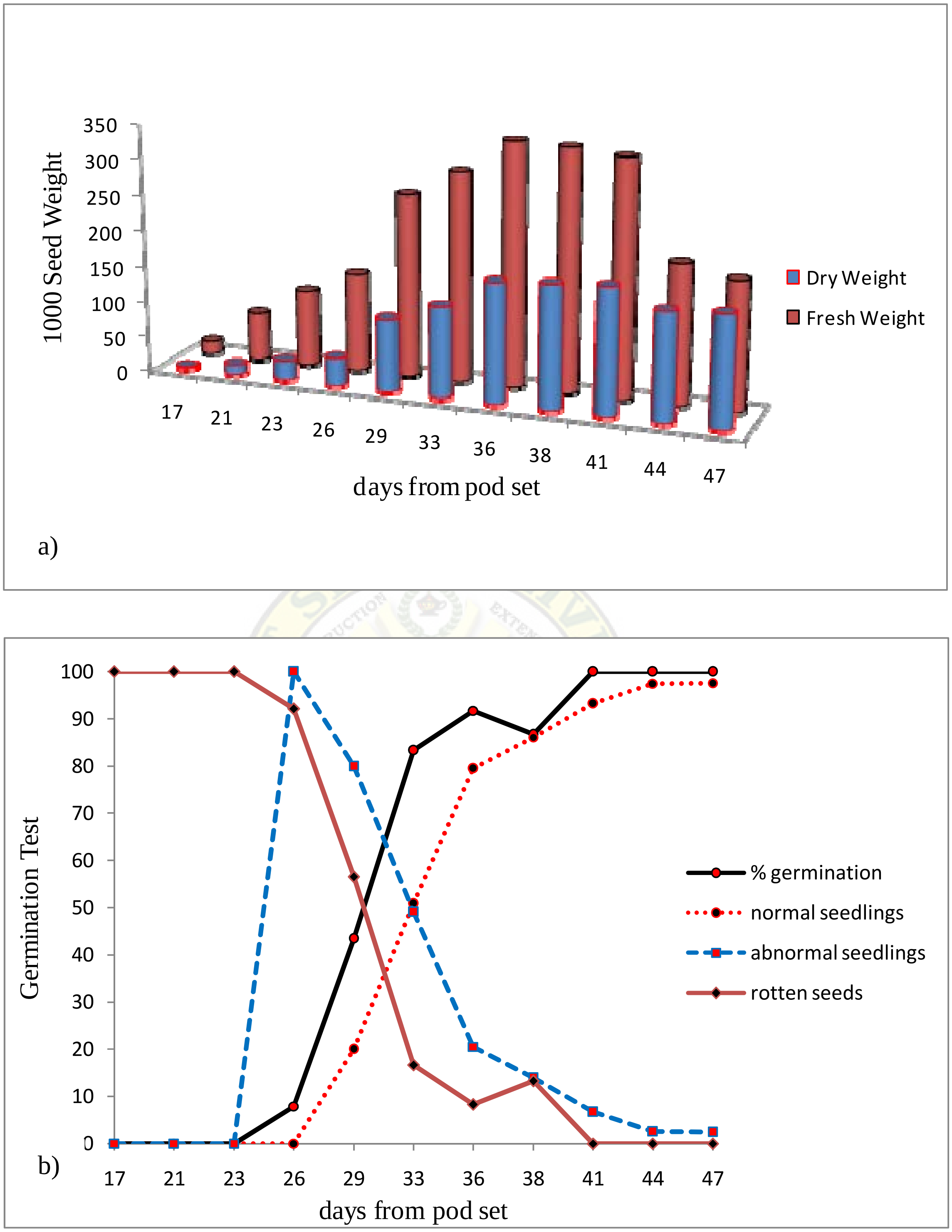


Figure 4. (a) Fresh and dry weight of 1000 seed weight (g) and (b) germination percentage during the seed development of French bean not applied with Plantmate organic fertilizer

Figure 5. Germination test on French bean which were viable 26 days from pod set with the normal and abnormal seedlings

set from plants applied with plantmate while 44 days in plants not applied with plantmate organic fertilizer. In contrast, the abnormal seedlings started at 100% then abruptly decreased 41 days from plants applied with plantmate and 44 days from plants without plantmate which coincide to the attainment of maximum dry weight of seeds on both observations (plants with and without application of plantmate organic fertilizer). This observation is similar to the result of pole snap bean studied by Kudan (1989).

Figure 6 shows the over all sequence of seed development from flower bud to seed maturity where pods can be harvested 41 to 44 days from pod set.

Effect of Rates of Plantmate Organic Fertilizer on the Seed Yield of French Bean

Days from Emergence to First Flower Bud Appearance

Table 1 shows the number of days from emergence to first flower bud appearance. Statistical analysis shows that the number of days from emergence to first flower bud appearance did not differ. This means that the different rates of applying Plantmate organic fertilizer did not affect the duration to flower bud appearance.

This observation contradicts with the findings of Simsim (2007) that application of organic fertilizer significantly enhance the emergence to flowering of pole snap beans.

Days from Planting to First Pod Yellowing

There were no significant differences among the varying rates of applying Plantmate organic fertilizer on the days from planting to first pod yellowing (Table 2).

Figure 6. The sequence of seed development in French beans from flower bud to seed maturity, seed samples were taken from 17 to 47 days from pod set

Again, these suggest that the rates of applying organic fertilizer did not influence the pod yellowing.

Table 1. Number of days from emergence to first flower bud appearance as affected by rates of Plantmate organic fertilizer

TREATMENT	DAYS TO FIRST FLOWER BUD APPEARANCE
Control	34.00[a]
2.0 kg	33.00[a]
2.5 kg	33.67[a]
3.0 kg	33.00[a]
3.5 kg	33.00[a]

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

Table 2. Number of days from planting to first pod yellowing as affected by rates of Plantmate organic fertilizer

TREATMENT	DAYS TO FIRST POD YELLOWING
Control	83.00[a]
2.0 kg	83.33[a]
2.5 kg	83.67[a]
3.0 kg	82.00[a]
3.5 kg	82.33[a]

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

Percentage Pod Set

As presented in Table 3, French bean applied with 2.5 to 3.5 kg of Plantmate organic fertilizer had significantly higher percentage of pod set compared to those applied with 2.0 kg and those without Plantmate application.

The results show that application of higher amount of Plantmate organic fertilizer enhanced the percentage of pod set in French bean. This corroborates with the findings of Simsim (2007) that organic fertilization of pole snap beans enhanced the production of heavier seeds, greater number of pods and percent germination. Moreover, Hill (1987) reported that application of organic fertilizers affect the seed development which includes viability and germination percentage, seedling vigor, strength or energy.

Number of Pods per Plant

There were no significant differences among the treatments on the number of pods produced per plant as shown in Table 4. The slight differences in the number of

Table 3. Percentage pod set of French bean as affected by rates of Plantmate organic fertilizer

TREATMENT	PERCENTAGE POD SET
Control	76.23[b]
2.0 kg	76.73[b]
2.5 kg	94.60[a]
3.0 kg	96.27[a]
3.5 kg	96.37[a]

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

Table 4. Number of pods per plant as affected by rates of Plantmate organic fertilizer

TREATMENT	NUMBER OF PODS PER PLANT
Control	125.33[a]
2.0 kg	128.00[a]
2.5 kg	126.00[a]
3.0 kg	129.67[a]
3.5 kg	133.33[a]

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

pods per plant is supported by the similar number of lateral branches produced per plant (Table 9) where the pods were produced.

This observation also agree with the report of Bandonil (1983) that organic fertilization in peas enhance the production of heavier seed, greater number of pods, high dry matter and higher germination percentage.

Number of Seeds per Pod

Table 5 shows the number of seeds per pod where the application of 2.5 to 3.5 kg of Plantmate have similar seed counts while 2.0 kg and 2.5 kg plantmate and those plants without Plantmate application have similar seed counts per pod.

Table 5. Number of seeds per pod as affected by rates of Plantmate organic fertilizer

TREATMENT	NUMBER OF SEEDS PER POD
Control	5.87[c]
2.0 kg	5.90[bc]
2.5 kg	6.13[abc]
3.0 kg	6.20[ab]
3.5 kg	6.43[a]

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

<u>100 Seed Weight</u>

There is no significant difference noticed in the 100 seed weight of French bean as affected by application of plantmate organic fertilizer (Table 6). The slight difference in the 100 seed weight may be due to the high phosphorous and potassium content of the experiment area as shown in the soil sample analysis before planting as shown presented in Table 7.

<u>Weight of Individual Seed</u>

Table 8 shows the weight of individual seed in French bean applied with varying rates of plantmate organic fertilizer. The slight difference in the number of seeds produced per pod has similar result in the weight of individual seed where the increasing rates of plantmate did not influence the weight of seed.

Table 6. Weight of 100 seeds of French bean as affected by rates of Plantmate organic fertilizer

TREATMENT	100 SEED WEIGHT (g)
Control	14.78[a]
2.0 kg	15.86[a]
2.5 kg	15.05[a]
3.0 kg	14.82[a]
3.5 kg	15.50[a]

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

Table 7. Soil chemical properties of the experimental area before planting

pH	OM (%)	N (%)	P (ppm)	K (ppm)
6.6	2	1	126	366

Note: Soil sample was analyzed at the Bureau of Soils laboratory of the Department of Agriculture, Pacdal, Baguio City.

Final Plant Height

Plants applied with 3.5 kg per plot significantly outgrew the rest of the plants as shown in Table 9. Except the 3.5 kg per plot, the rest of the treatments have similar plant heights. Although Lumioan (2006) reported that higher rates of fertilizer promoted growth of spinach and early harvesting, it was not a trend in this study. In fact, this significantly taller plants from 3.5 kg did not have any advantage in the other parameter measured.

Table 8. Weight of individual seed as affected by rates of Plantmate organic fertilizer

TREATMENT	WEIGHT OF INDIVIDUAL SEED (g)
Control	0.15[a]
2.0 kg	0.16[a]
2.5 kg	0.15[a]
3.0 kg	0.15[a]
3.5 kg	0.16[a]

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

Table 9. Final plant height as affected by rates of Plantmate organic fertilizer

TREATMENT	FINAL PLANT HEIGHT (cm)
Control	14.73[b]
2.0 kg	15.12[b]
2.5 kg	15.37[b]
3.0 kg	15.60[b]
3.5 kg	17.58[a]

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

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

The application of increasing rates of plantmate organic fertilizer had no significant effect on the production of lateral branches in French bean (Table 10). This means that the varying rates of plantmate organic fertilizer had the same effect on the

Table 10. Number of lateral branches produced per plant as affected by rates of Plantmate organic fertilizer

TREATMENT	LATERAL BRANCHES PRODUCED PER PLANT
Control	5.07[a]
2.0 kg	5.07[a]
2.5 kg	5.17[a]
3.0 kg	4.77[a]
3.5 kg	5.33[a]

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

number of lateral branches in French bean. As mentioned earlier, the significantly taller plants from the application of 3.5 kg per plot had comparable number of lateral branches.

Total Weight of Cleaned Seed per Plant

Total weight of clean French bean seed per plant is shown in Table 11. There are no significant differences among the treatments in terms of seeds produced per plant.

This means that the amount of phosphorous and potassium in the spoil before planting is already enough to support the seed growth and development, thus the increasing rates of plantmate organic fertilizer had no marked influence in the seed yield.

Total Weight of Cleaned Seed per Plot

The weight of seed produced per plot did not show significant differences among the varying rates of plantmate organic fertilizer (Table 12). This means that the different rates of applying the organic fertilizer in the soil of 6.6 pH, 2% organic matter, 126 ppm phosphorous and 366 ppm potassium has no significant effect on the production of French bean seeds.

Table 11. Total weight of clean seed per plant (g) as affected by rates of Plantmate organic fertilizer

TREATMENT	WEIGHT OF CLEANED SEED PER PLANT (g)
Control	6.42[a]
2.0 kg	7.25[a]
2.5 kg	7.05[a]
3.0 kg	6.21[a]
3.5 kg	8.12[a]

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

Table 12. Total weight of clean seed per plot (kg) as affected by rates of Plantmate organic fertilizer

TREATMENT	WEIGHT OF CLEANED SEED PER PLOT (kg)
Control	0.30[a]
2.0 kg	0.35[a]
2.5 kg	0.32[a]
3.0 kg	0.30[a]
3.5 kg	0.41[a]

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

SUMMARY, CONCLUSIONS AND RECOMMENDATION

Summary

Sequence of seed development. Seed moisture content of French bean was high (84%- 85%) at the early stages of development then slowly decreased as the growth continued until it reach 7% to 14% when the pods were starting to yellow, shrivel and dry up. Inversely, the weight of seeds increased from 17 days to reach the maximum weight 44 days after pod set, whether applied or not with Plantmate organic fertilizer.

Seeds of French bean started to be viable 26 days from pod set but 100% abnormal seedlings when germinated. However, the development of seeds was fast that in nine days there was an abrupt increase in the percentage of normal seedlings then attained the highest 44 days from pod set which coincide with the attainment of maximum dry weight of seeds. These clearly show that seed development was completed 44 days from pod set and can be harvested from the plant.

Rates of plantmate organic fertilizer. The different rates of plantmate organic fertilizer from control, 2.0, 2.5, 3.0 and 3.5 kg per 1m x 5m plot did not show significant differences on the days from emergence to flower bud appearance, days from planting to first pod yellowing, number of pods per plant, 100 seed weight, weight per seed, number of lateral branches produced per plant, weight of cleaned seed per plant and per plot.

The percentage of pod set was significantly higher from plants applied with 2.5 to 3.5 kg plantmate compared to those plants applied with 2.0 kg and those that were not applied. The same result was obtained in the number of seeds per pod where the application of 2.5 to 3.5 kg slightly surpassed the 2.0 kg and the control. Meanwhile, the application of 3.5 kg plantmate significantly outgrew the rest of the treatments.

Conclusions

In the light of the results presented and discussed, it is inferred that French bean pods can be harvested 44 days from pod set or when the pods turn yellow and dry up as the seed attained physiological maturity.

As to the rates of applying plantmate organic fertilizer, application of 2.0 to 3.5 kg per plot did not differed from plants not applied with the organic fertilizer on the seed yield of French bean in area with soil pH of 6.6, 2% organic matter content, 126 ppm phosphorous and 366 ppm potassium content.

Recommendation

It is therefore recommended that French bean pods should be harvested 44 days from pod set or when the pods start to dry up for seed production. In areas under soil fertility condition having a soil pH of 6.6, 126 ppm phosphorous and 366 ppm potassium it is recommended that no fertilization is needed to produce quality seeds of French bean.

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APPENDICES

Appendix Table 1. Number of days from emergence to first flower bud appearance

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T1	35	34	33	102	34.00
T2	33	33	33	99	33.00
T3	33	34	34	101	33.67
T4	33	33	33	99	33.00
T5	33	33	33	99	33.00
TOTAL	167	167	166	500	166.67

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SS	MS	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Block	2	0.13	0.07			
Treatment	4	2.67	0.67	2.11^{ns}	3.84	7.01
Error	8	2.53	0.32			
TOTAL	14	5.33				

ns -not significant

Coefficient of variation = 1.69%

Appendix Table 2. Number of days from planting to first pod yellowing

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T1	83	84	82	249	83.00
T2	84	82	84	250	83.33
T3	83	82	86	251	83.67
T4	82	82	82	246	82.00
T5	81	83	83	247	82.33
TOTAL	413	413	417	1243	414.33

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SS	MS	COMPUTED F	TABULAR F 0.05	0.01
Block	2	2.13	1.07			
Treatment	4	5.73	1.43	0.83^{ns}	3.84	7.01
Error	8	13.87	1.73			
TOTAL	14	21.73				

ns -not significant

Coefficient of variation = 1.59%

Appendix Table 3. Percentage of pod set (%)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T1	72.20	77.70	78.50	228.40	76.13
T2	77.70	73.60	78.90	230.20	76.73
T3	100.00	94.40	89.40	283.80	94.60
T4	94.40	94.40	100.00	288.80	96.27
T5	94.40	94.70	100.00	289.10	96.37
TOTAL	438.70	434.80	446.80	1320.30	440.10

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SS	MS	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Block	2	14.83	7.42			
Treatment	4	1341.85	335.46	22.58**	3.84	7.01
Error	8	118.84	14.85			
TOTAL	14	1475.52				

** - highly significant

Coefficient of variation= 4.38%

Appendix Table 4. Total number of pods per plant

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T1	126	126	124	376	125.33
T2	126	128	130	384	128.00
T3	120	132	126	378	126.00
T4	121	131	137	389	129.67
T5	130	134	136	400	133.33
TOTAL	623	651	653	1927	642.33

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SS	MS	COMPUTED F	TABULAR F 0.05	0.01
Block	2	112.53	56.27			
Treatment	4	123.73	30.93	2.07^{ns}	3.84	7.01
Error	8	119.47	14.93			
TOTAL	14	355.73				

ns -not significant   Coefficient of variation = 3.01%

Appendix Table 5. Number of seeds per pod

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T1	5.70	6.00	5.90	17.60	5.87
T2	5.90	6.00	5.80	17.70	5.87
T3	6.30	6.00	6.10	18.40	6.13
T4	6.20	6.10	6.30	18.60	6.20
T5	6.60	6.20	6.50	19.30	6.43
TOTAL	30.70	30.30	30.60	56.30	30.53

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SS	MS	COMPUTED F	TABULAR F 0.05	0.01
Block	2	0.02	0.01			
Treatment	4	0.65	0.16	6.41*	3.84	7.01
Error	8	0.20	0.03			
TOTAL	14	0.87				

* - significant Coefficient of variation = 2.61%

Appendix Table 6. 100 seed weight (g)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T1	13.47	14.26	16.62	44.35	14.78
T2	14.75	15.80	17.02	47.58	15.86
T3	14.53	14.53	16.09	45.16	15.05
T4	14.25	14.31	15.88	44.45	14.81
T5	14.98	15.47	16.05	46.51	15.50
TOTAL	72.00	74.39	81.66	228.04	76.01

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SS	MS	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Block	2	10.14	5.07			
Treatment	4	2.61	0.65	3.09^{ns}	3.84	7.01
Error	8	1.69	0.21			
TOTAL	14	14.44				

ns -not significant

Coefficient of variation = 3.02%

Appendix Table 7. Weight of individual seed (g)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T1	0.13	0.14	0.17	0.44	0.15
T2	0.15	0.16	0.17	0.48	0.16
T3	0.15	0.15	0.16	0.45	0.15
T4	0.14	0.14	0.16	0.44	0.15
T5	0.15	0.15	0.16	0.47	0.16
TOTAL	0.72	0.74	0.82	1.81	0.76

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SS	MS	COMPUTED F	TABULAR F 0.05	0.01
Block	2	0.001	0.001			
Treatment	4	0.000	0.000	3.09^{ns}	3.84	7.01
Error	8	0.000	0.000			
TOTAL	14	0.001				

ns -not significant

Coefficient of variation = 3.03%

Appendix Table 8. Final plant height (cm)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T1	13.80	13.80	16.60	44.20	14.73
T2	14.85	15.00	15.50	45.35	15.12
T3	15.25	15.25	15.60	46.10	15.37
T4	13.90	15.95	16.95	46.80	15.60
T5	17.05	17.60	18.10	52.75	17.58
TOTAL	74.85	77.60	82.75	235.20	74.40

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SS	MS	COMPUTED F	TABULAR F 0.05	0.01
Block	2	6.43	3.22			
Treatment	4	14.82	3.71	6.60*	3.84	7.01
Error	8	4.50	0.56			
TOTAL	14	25.75				

* - highly significant

Coefficient of variation = 4.78%

Appendix Table 9. Number of lateral branches produced

TREATMENT	REPLICATION I	REPLICATION II	REPLICATION III	TOTAL	MEAN
T1	5.10	4.90	5.20	15.20	5.07
T2	5.00	5.20	5.00	15.20	5.07
T3	4.90	5.30	5.30	15.50	5.17
T4	4.10	5.20	5.00	14.30	4.77
T5	5.20	5.30	5.50	16.00	5.33
TOTAL	24.30	25.90	26.00	60.20	25.31

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SS	MS	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Block	2	0.36	0.18			
Treatment	4	0.51	0.13	1.86^{ns}	3.84	7.01
Error	8	0.55	0.07			
TOTAL	14	1.42				

ns -not significant

Coefficient of variation = 5.16%

Appendix Table 10. Weight of clean seed per plant (g)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T1	6.27	7.22	5.77	19.26	6.42
T2	8.17	6.53	7.05	21.75	7.25
T3	8.10	5.40	6.65	21.15	7.05
T4	4.83	6.22	7.59	18.64	6.21
T5	7.61	9.16	7.59	24.36	8.12
TOTAL	34.98	34.53	35.65	105.16	35.05

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SS	MS	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Block	2	0.13	0.06			
Treatment	4	6.82	1.71	1.14^{ns}	3.84	7.01
Error	8	11.98	1.50			
TOTAL	14	18.93				

ns -not significant

Coefficient of variation = 17.45%

Appendix Table 11. Weight of clean seed per plot (kg)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T1	0.27	0.35	0.28	0.91	0.30
T2	0.38	0.29	0.36	1.04	0.35
T3	0.30	0.32	0.33	0.95	0.32
T4	0.18	0.36	0.36	0.89	0.30
T5	0.32	0.50	0.41	1.23	0.41
TOTAL	1.45	1.82	1.72	5.02	1.68

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SS	MS	COMPUTED F	TABULAR F 0.05	0.01
Block	2	0.015	0.007			
Treatment	4	0.025	0.006	1.66^{ns}	3.84	7.01
Error	8	0.030	0.004			
TOTAL	14	0.070				

ns -not significant

Coefficient of variation = 18.47%