FYP FIAT

Mass Selection for Improvement of Pod Length and Yield of Snake Bean (*Vigna unguiculata* subsp. *sesquipedalis* (L.) Verdc.) in the Fifth Generation

Noor Atika Binti Ali

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A report submitted in fulfillment of the requirement for the degree of Bachelor of Applied Science (Agrotechnology) with Honours

Faculty of Agro Based Industry
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DECLARATION

I hereby declare that the work embodied in this report is the result of the original research and has not been submitted for a higher degree to any universities or Institutions.

____

Student
Name: Noor Atika binti Ali
Date:

I certify that the report of this final year project entitled "Mass Selection for Improvement of Pod Length and Yield of Snake Bean (*Vigna unguiculata* subsp. *sesquipedalis* (L.) verd. in the Fifth Generation" by Noor Atika binti Ali, matric number F15A0106 has been examined and all the correction recommended by examiners have been done for the degree of Bachelor of Applied Science (Agriculture Technology) with Honours, Faculty of Agro-Based Industry, Universiti Malaysia Kelantan.

Approved by:

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Supervisor
Name: Dr. Dwi Susanto
Date:

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LIST OF ABBREVIATION AND SYMBOLS

cm Centimetre

cm^2 Centimetre square

g Gram

Ha Hectare

H Broad sense heritability

h^2 Narrow sense heritability

Kg Kilogram

M Metre

R A measurement how much the mean changed in one generation

S Different between the mean of selected parents and the mean of population

To Mean of offspring

Ts Mean of selected parents

µ Mean of population

Mass Selection for Improvement of Pod Length and Yield of Snake Bean(*Vigna unguiculata* subsp. *sesquipedalis* (L.) verd. in the Fifth Generation

ABSTRACT

Snake bean (*Vigna unguiculata* ssp *sesquipedalis* L.) is including one of important vegetables in this world especially in tropical and subtropical region. The production of snake bean in Malaysia cannot achieve the market demand. So, to fulfill the market demanding in Malaysia it is needed to increase the yield of the snake bean. This research was discussed about the method used to increase the yield of the snake bean. Therefore, the objective of this research was to improve the yield of snake bean by improving the pod length through mass selection. Two hundred and forty seeds of snake bean selected from fourth generation were grown in nine plots. The pods length greater than 75 cm were selected and dried and the seed from those pod will be used for the next generation. From this research, the mean of pod length of population increased compared to previous generation (fourth generation) from 54.31cm to 56.49 cm.

Keywords: Snake bean, mass selection, pod length, generation.

Seleksi Pukal untuk Peningkatan Panjang dan Hasil Kacang Panjang (*Vigna unguiculata* subsp. *sesquipedalis* (L.) verd. dalam Generasi Kelima

ABSTRAK

Kacang panjang (*Vigna unguiculata* ssp *sesquipedalis* L.) adalah salah satu sayuran yang penting terutamanya di rantau tropika dan subtropika. Pengeluaran kacang panjang di Malaysia tidak dapat mencapai permintaan di pasaran. Oleh itu, untuk memenuhi permintaan pasaran di Malaysia adalah perlu meningkatkan hasil kacang panjang di Malaysia dengan meningkatkan biji benih kacang panjang dengan cara melakukan seleksi pukal. Kajian ini membincangkan mengenai kaedah yang digunakan untuk meningkatkan hasil kacang panjang. Oleh itu, objektif kajian ini adalah untuk meningkatkan hasil kacang panjang dengan meningkatkan panjang biji benih kacang panjang melalui seleksi pukal. Dua ratus empat puluh biji benih kacang panjang dipilih dari generasi keempat dan ditanam di sembilan batas. Biji benih yang besar daripada 75 cm dikeringkan dan dipilih dan biji benih akan digunkan untuk generasi akan datang. Dari kajian ini, purata panjang biji benih meningkat berbanding generasi keempat. Terdapat peningkatan panjang biji benih kacang panjang dari generasi sebelumnya hingga generasi kelima dan ini dapat dibuktikan dengan peningkatan nilai min, iaitu generasi keempat adalah 54.31cm manakala generasi kelima adalah 56.49 cm.

Kata kunci: Kacang panjang, seleksi pukal, panjang biji benih, generasi.

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Snake bean known also as yard long bean or cowpea, shows its thin and wide length pod appearance (Poffley and Owens, 2006). In Malaysia, snake bean is locally known as *kacang panjang*. Snake bean can be classified in the family of Fabaceae or Leguminosae (Peter and Abraham, 2007). Snake bean is grown all over the place which has tropical climate such as Asia, East Africa and Central Africa and it is believed originate from China (Che Abdullah, 2013). Snake bean is the most popular vegetables regularly consumed by Malaysian (Jabatan Pertanian Negeri Pulau Pinang, 2016). Snake bean has been reported as one of nine selected vegetables that has contributed to sufficient domestic supply (Jabatan Pertanian Malaysia 2010). In addition, snake bean can either be cooked in variety of meals or eaten raw (Chin, 1999). Snake bean is most important vegetables crops that can enhanced the economy in Malaysia (Benchari and Bairaman, 2010). Snake bean can be found on sale where the daily market, grocery and supermarket are crisp and fresh at prices ranging from RM 2.00 to RM4.00 per kilogram depending on the season or weather area marketing (Harress, 2017).

Table 1.1 shows was recorded the vegetables given emphasises for domestic market in 9th in MalaysiaDevelopment Plan from 2006 until 2010. There are two types of vegetables which are lowland vegetables and highland vegetables. The areas planted of the snake bean were about 3,290 hactares from 2006 to 2010. Snake bean was the second highest of area planted after the leaf mustard. So, snake bean was very important vegetables for the Malaysia market demand.

Table 1.1 : Vegetables given emphasises for domestic market in 9th Malaysia Development Plan (2006-2010)

Common name	Area Planted (ha)
Lowland Vegetables	
Leaf mustard	10,397
Snake bean	3,290
Cucumber	2,870
Water convolvulus	2,645
Spinach	2,474
Chilli	2,125
Lady's finger	1,537
Lufa	1,175
French bean	1,112
Chinese kale	1,108
Highland Vegetables	
Cabbage	1,4005
Lettuce	994
Tomato	753

Source from Food and Agriculture Organization, (2014).

Intensification of agriculture can be defined as an increase in production of agricultural per unit of inputs such as labour, land, time, fertilizer, seed, feed or money. According to the humans population in Malaysia, the demand of the snake bean production is higher and still cannot fulfill the demanding of the Malaysian (Food and Agriculture Organization, 2014).

Extensification can be defined as the process of expanding a more extensive system of production such as one which utilizes wide areas of land, but with minimal inputs and expenditures of capital and labor. The area land of snake bean is only was planted in the state such as Johor and Pahang. The area planted also does not wide and cannot produce the maximum production of snake bean. The capital that provided by the government does not much to pay the labour. There also does not have expertise in this field to suggest the better production of snake bean that can support the production of system in snake bean growth. Hence, Malaysia must stop to export the snake bean another country and only focus to market demand in Malaysia. So, there was a way to increase the production of snake bean in Malaysia by improving the available cultivars using the mass selection technique (Food and Agriculture Organization, 2014).

Mass selection is a type of breeding method of self-pollinated species and it is probably the most simple conventional plant breeding method and from the classic breeding method since it has been practiced from long ago (Chaisan, 2013). Besides, according to Che Abdullah (2013) mass selection technique is a one of method based on the phenotypic selection by rise in snake bean yield and improved yield productivity and stability.

1.2 Problem Statement

Snake bean is the local vegetable and have the high demand in Malaysia. Malaysia does not have enough supplies of snake bean and need to import from the other country to fulfill the demand of the customers in the market (Acquaah, 2007). To fulfill the demand the use of the high yielding cultivars is needed. This research is trying to improve the existing cultivar by improving the pod length that is one of the yield component, using mass selection method.

1.3 Objectives

The main objective of this experiment was to select the longest pod from the current population of grown from selected seeds from previous generation. The seeds from selected pods from their population will be grown for the next generation.

1.4 Hypothesis

The mean of pod length of their generation (fifth generation) will be longer than that of previous generation (fourth generation).

1.5 Scope of the Study

This research based on the selection of the seed according to its pod length produced and highest yield. Mass selection method was be chosen as the technique for this research. The research was continuation of the four generation population of snake bean. The seeds selected from fourth generation were grown to generate fifth generation of snake bean. The longest pods from their generation will be selected again and used as basis for next generation.

1.6 Significant of the Study

Mass selection refers to a methods of improvement in which individual plants are selected on the basis of phenotype from a mixed population. Their seeds are bulked and used to grow next generation. In this research, the seeds from the longest pods will be collected then they will be grown for the next generation. So, this research will contribute in producing a high yielding cultivar by improving the pod length.

1.7 Limitation of the Study

In this research, the total number of seeds obtained from the previous generation being sown were 512 seeds. However, only 240 seeds survived in the tray due to some environment factor and low seed viability. Then, only 240 of the seeds of survived plants were transplanted to the bed and some of them did not survive. Then, about 128 plants that survived due to some factor affect the snake bean.

CHAPTER 2

LITERATURE REVIEW

2.1 Botany of Snake Bean

2.1.1 Taxonomy and varieties

There are five popular snake bean types grown in Malaysia such as light green, dark green, white seeds, black seed and crunchy varieties (Anem, 2012). There are two varieties of snake bean that known in Malaysia which are with snake bean White Bean and snake bean with Black Bean. In the seed market it is sold in the name of Black Seed which includes of Wira Black Seed (No. 388), Black Seed Purple Seed (No. 389), Red Cloud Long Bean (No. 399), White Seed Long Bean (No. 398) and other varieties (Harress, 2017). Snake bean is also known as vegetable cowpea, asparagus bean, string bean, snake bean, snake pea and snap pea (Anem, 2011).

The taxonomy of snake bean that include the kingdom, class, order, family, genus and species which is :

Kingdom : Plantae

Subkingdom : Tracheobionta

Superdivision : Spermatophyta

Division : Magnoliophyta

Class : Magnoliopsida

Subclass : Rosidae

Order : Fabales

Family : Fabaceae

Genus : *Vigna Savi*

Species : *Vigna unguiculata* (L.) Walp

Subspecies : *Vigna unguiculata* (L.) Walp. ssp. *sesquipedalis* (L.) Verdc.

2.1.2 Origin and Distribution

According to Poffley and Owens (2003), snake bean probably originated from South China and is distributed throughout Asia, Carribean, tropical and sub-tropical as the most important vegetables in this region and it is also grown economically in Europe, Oceania and North America (Lawrence and Moore, 2012 :,Che Abdullah, 2013).

In Malaysia, snake bean is commercially grown in Johor, Pahang and also in Perak since 2006 while the largest snake bean cultivation are in Pahang and Johor (Anem, 2011).

About 3,319 hectare of snake bean was grown with 45,924 mt production in 2006 decreasing to only 2,820 hectare with 38,360 of production in 2009 (Anem, 2011). According to the statistic report from DOA (Department of Agriculture), in 2009, the largest snake bean is grow in Bentong District in Pahang with 257 hectare followed by Muar, Johor with 185 hectare and Kuantan, Pahang with 129 hectare respectively (Anem, 2011). Recently KNYS No 398 variety was popular in Muar District (Anem, 2011).

2.1.3 Morphology

Snake bean is annual herb plant. It has trailing and climbing growth pattern, yet dwarf form of snake bean plants also exist (Poffley and Owens, 2006). The range of pods is from 30 to 90 cm with the kidney appearance (Peter and Abraham, 2007). The stem of snake bean can grow up to 4 meter (Gopalakrishnan, 2007). The snake bean is the type of climbing plant and supported with the woods (Jabatan Pertanian Negeri Pulau Pinang, 2016). The diameter of snake bean stem is around 0.6 cm to 1.0 cm while the shaped is straight and cylinder and also has green colour with smooth surface (Harress, 2017). Then, the snake bean has a spine roots system and grows extensively with lateral roots. Snake bean has variety colour of flowers which found in groups of three to six caps per flower stalk (Jabatan Pertanian Negeri Pulau Pinang, 2016). Then, the pod of snake bean was round and oval shaped on the side and brown colour (Harress, 2017). Snake bean fruit was 20 cm to 70 cm length according the variety that was planted (Harress, 2017). Snake bean is a very impressive plant to grow because need to check or harvest in everyday. It is because they grow very quick in warm climates. However, snake bean also sensitive to the temperature and grows slowly in mild or cold environments (Anem, 2016).

2.1.4 Agronomy

Snake bean can be fertile especially in tropical and subtropical areas. The planted area must have a good water drainage system to prevent the occurrence of drowning when the rainy season hit the area. The planted area of snake bean must be plowed and irrigated two weeks before the cultivation process takes place. The trellis system is attached to the border that support with the piece of wood to facilitate the snake bean plant to climb and twist for healthy growth. Preferably, the sprinkler system is needed to install between the trellis so that the watering process can be done smoothly and the crop gets enough water to enable for survive. Then, snake bean must be irrigated about two times a day such as in the morning and evening. Snake bean is resistant to dry weather if the water supply is cut off. Unfortunately, snake bean still can grow well (Harress, 2017).

2.1.5 Pest and Disease

Snake bean can be damaged by virus diseases such as snake bean aphid-borne mosaic virus and snake bean witches' broom virus and attack by rust and mildew diseases (Poffley and Owens, 2006). The virus can be controlled by destroying infected plant materials and by controling of aphids, whiteflies, leafhoppers and beetles that serve as virus vectors (Poffley and Owens, 2006). Snake bean varieties often are relatively pest-free compared to green bean varieties; however, the bean shoot fly and the bean pod fly may hamper plant growth and pod production (Poffley and Owens, 2006). Among popular pests attacking snake bean are aphids (*Aphis craccivora*), bean fly (*Melanagrommyza phaseoli*), pod borer (*Marucca testutalis*), pod borer (*Euchrysops cnejus*) and thrips (Thrips spp). The pesticides can be used and sanitation approach can be applies to control pests attack. The recommended insecticides for snake bean sprayed are diaznon, dimehhoate, deltramethrin, diafenthiuron and cypermethrin.

The diseases attacked snake bean are antracnose (*Collectotricum lindemuthianum*) that attacks leaf and fruit and can be controlled by carbendezim or copper oxychloride. Other diseases are leaf spot (*Cercospora canecens*), rust (*Uromyces appendiculates*), leaf mozaic (*Mozaic virus*) and root rot (*Rhizoctonia solani*) (Anem, 2011).

2.1.6 Harvesting

Snake bean started flowering and producing the pods at 35 to 45 days after planting. The pods can be produced with a weight of between 10 grams to 12 grams. The snake bean can be harvested around two months after being cultivated and harvesting can be done everyday as the plant will constantly producing pods (Lawrence and Moore, 2012). According to Poffley and Owens (2006), the perfect time to harvest is when the snake bean have reached maximum length, but before the seeds contained in the pods starting to swell and get times dried. Snake bean must be harvested once it started to produce pods in order to ensure a continuous production of the pods. The pods are best to be eaten within one to two days after being harvested (Rosenfeld and Cunningham, 2011). Once the snake bean turns into dark green, it can easily broken and flavorful (Harress, 2017).

2.1.7 Usage and Nutrition

In Malaysian dishes, snake bean is often cooked as stir-fried with chillies and shrimp paste (*belacan*) or used in salads (*kerabu*) (Jabatan Pertanian Negeri Pulau Pinang, 2016). The sweetness and freshness of snake bean content either when raw or after cooking make this plant a frequent user choice. Snake bean is a good source of protein, vitamin A, thiamin, riboflavin, iron, phosphorus, and potassium, and a very good source for vitamin C, folate, magnesium and manganese (Jabatan Pertanian Negeri Pulau Pinang, 2016). A serving of 100 grams of snake bean contains 47 calories, 0 g of total fat, 4 mg sodium (0% daily value),8 g of total carbohydrates (2% daily value) and 3 g of protein (5% daily value) (Jabatan Pertanian Negeri Pulau Pinang, 2016). Snake bean is also good for digestive and digestive system. It contains very low calorie and sugar content that can be used as one of the alternatives to preventing diabetes. It also can help lower the sugar level in the blood and cause a person to have a sugar level in a controlled blood (Harress, 2017).

2.2 Mass Selection

Mass selection is an oldest method of breeding self-pollinated plant which breeders can save seed from desirable plant for next generation crop and improve the population based on plant phenotype and need generation cycle (Acquaah, 2012). The advantages of the mass selection are rapid, low cost, straightforward and large population can be handled by use one generation per cycle (Acquaah, 2007). Besides that, the cultivar based on phenotype with uniformity even though it is mixed of pure line, making it genetically broad-based, adaptable and stable (Acquaah, 2007). Then, for disadvantage of mass selection are the traits of interest must have high heritability to be effectiveness and achieve optimal selection. It is should conducted in uniform environment because mass selection is based on phenotypic values (Acquaah, 2007).

The example crop using the mass selection method is maize which the diverse selection environment can cause differential response to maize (*Zea mays* L.) (Arboreda-Rivera and Comptom, 1974). The purpose of mass selection method use in maize is to improve the yield based on visual selection of the plants bearing and the best aspect of ear characteristics (Morales *et al*., 1999).

Mass selection consists of various steps that based on selection of base population, selection of desirable plants from base population and mixing their seeds to rise next generation, evaluation in field trials, and releasing as a new variety (Lawrence and Moore, 2012). There are the procedure of the mass selection. First year was an unimproved old variety or land race is used as a base population which is grown in a large plot (Lawrence and Moore, 2012). Then individual plants between 55 to 1000 are selected on the basis of phenotypic performance for characters like height, maturity, disease resistance, productivity (Lawrence and Moore, 2012). The selected plants are harvested at maturity and their seeds are mixed together to grow next generation (Lawrence and Moore, 2012).. This process is repeated till desirable results are achieved. Then, the next year was the crops are grown from the bulk seed of selected plants in a separate field using standard variety as a check for comparison of performance (Lawrence and Moore, 2012). In other words, the material is evaluated in preliminary yield trial. If mass selection is used for purification of old mixed variety, the same old variety can be used as check for comparison (Lawrence and Moore, 2012). Next, the performance of bulk is evaluated for yield and adaptation in main yield trials for 3 to 4 years using standard check for comparison. Lastly, was the variety is released and named in seventh year and seed is multiplied. In the eighth year the seed is ready for distribution (Lawrence and Moore, 2012).

CHAPTER 3

METHODOLOGY

3.1 Place, time and planting materials

This experiment was done at Agropark UMK Jeli starting from July until the end of November 2018 for cultivation of the sixth generation of snake bean. The plants materials in this research were one hundred and fourthy two snake bean seeds which were selected with the best of pod length and yield from fourth generation. Other materials were used for this research included the gardening tools, plastic silver shine, compost, fertilizers such as NPK and urea fertilizer.

3.2 Methodology

3.2.1 Land preparation

Land preparation was very important because it was the starting step before planting. The land was cleared from any vegetation plant, rocks and unwanted material. Those was because to prevent from any harmful things when starts to plough the soil. After that, the soil was ploughed using the tools. The purposes for ploughing the soil for sowing the seed or looses the soil. It was also to bring the fresh nutrients that contanined in the soil into the surface and to burying the weeds that can allow the microorganisms to break down.

After the land was ploughed, then the soil was mixed with compost fertilizer, NPK fertilizer and urea fertilizer to increase the soil fertility. There were about 270 gram of NPK, 270 g of urea fertilizer and 9 kilogram of compost.

The land was loosened by using hoe in depth 30 cm. The nine planting bed was made for cultivation of snake bean. The planting beds was covered by plastic silver shine for conserving the moisture of the soil and suppressing the weeds.

Before the bed was covered with plastic silver shine, the soil was watered because to keep the humidity of the soil and to balance the fertilizers and nutrients in the soil. After that, 30 holes were made for each bed to plant the snake bean.

3.2.2 Sowing, trellis and transplanting

The seeds were planted by sowing seeding method. The seeds were sowed about 2 cm in depth. Thirteen holes was made on each planting bed for seed propagation. The seeds were sowed in the tray about a week. The seeds should be in the wet and humidity condition to keep the growing of the seed. After planted the plant, the irrigation in order done to allow it germinated with successful.

Then, the trellises was setup. It is to set up because the snake bean grew by climbing to the trellis. However, the trellis cannot be set up too high because it will be difficult to harvest the snake bean, since the snake bean were able to developed until top of the stand. After the seeds germinated, the snake bean plant were transplanted into the bed.

3.2.3 Watering and harvesting

The snake bean plants were irrigated regularly until it reached the flowering stage as the snake bean flower developed into pod set. Usually, the irrigation of the plant was done in early morning and late evening. The snake bean harvested after a month of seeding. The snake bean was harvested every three days interval until the plants producing pods. The snake bean pod having length more than 75 cm were not harvested. They will be used for the next generation.

3.3 Data Collection

The data collection of this were the plant height and number of leaves from week one until week eight after the planting of snake bean. The data of the weight of snake bean per plot, pod length of snake bean per plot and yield counted along the harvesting time.

3.4 Experimental Layout

The seedbeds were prepared based on the propagation layout as represented in Figure 3.4.

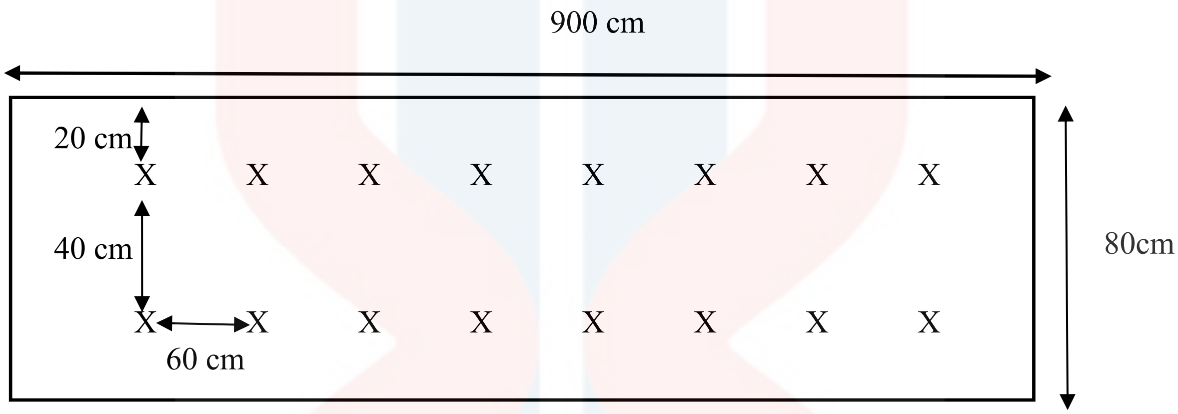

Figure 3.4 : Layout for snake bean bed

3.5 Variables Observed

The starting of population is called zero generation population and the previous research is fourth generation population. In this research, the mass selection used to improve the pod length of *Vigna unguiculata* and the desirable phenotype is the pod length that is more than 75 cm. Each soil beds was planted with thirty seeds of *Vigna unguiculata* that were obtained from the previous research. Fifty four plants of the *Vigna unguiculata* were marked as the samples for data collection. The pods that were more than 75 cm selected and were not harvested and the seeds from the selected pods were bulked and grown for the next generation.

Data collection included :

a) Plant height (cm) : the height of plant stem from above soil level until shoot tips

b) Number of leaves per plant: total leaves produced by plant

c) Number of flowers per plant: total flower produced by plant

d) Pod length (cm)

e) Pod weight (g)

f) Yield per plant

k) Yield per plot

CHAPTER 4

RESULT AND DISCUSSION

4.1 Vegetative Parameter

4.1.1 Plant Height

Based on the Figure 4.1, the most dominate of the plant height is Bed 1, Bed 3 and Bed 6. While for the least is Bed 9.

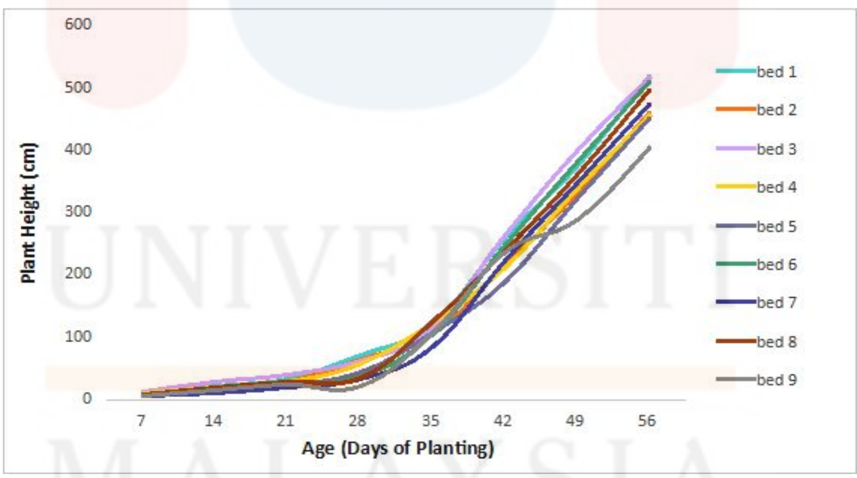

Figure 4.1 : Average of plant height per week

The graph show the increasing of the plant height by week to another week. So, that show the growth of the snake bean needs the requirement such as fertilizers and water.

Plant height is very important data for this research that show the growth performance of the snake bean. The plant height of this plant was determined by using the measuring tape that was provide by the Agropark. The data was taken by week to week, that start from the week one after transplant until week eight. The plant height was determined about six sample of plant per plot. Each plant sample measured from the bottom of the plant until it growth. This is because of the increased use of nutrient efficiency.

The variation in height of plant due to source from the nutrient was related with the variation in the availability of main nutrients. The imperfect performance in terms of height of plant can be related of the soil that content of NPK which is under the critical level.

4.1.2 Number of leaves

Based on the Figure 4.2, the most dominate of the number of leaves is Bed 7, Bed 3 and Bed 1. While for the least is Bed 5.

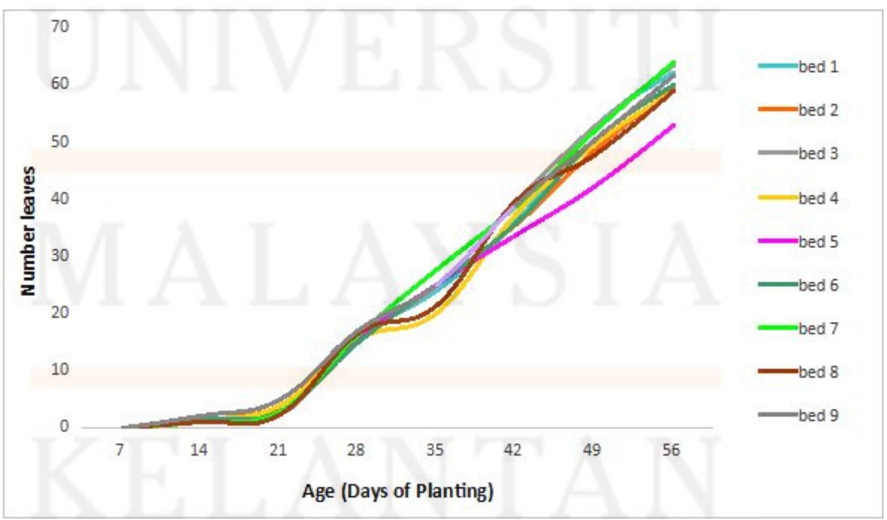

Figure 4.2 : Average number of leaves

The graph show the increasing of the number of leaves by week to another week that needs for the photosynthesis of the plant.

The growing of the plant is also include the growth of the leaves. The leaves of the plant were counted by week. The growth of the leaves require the needs of the water, sunlight and nutrients from the soil for the plant to make the photosynthesis. The more of light interception towards the leaves, the more production of leaves and can increased the yield.

According Maya and Naomi (2014), the development of plant leaves follows a common principal program that is flexible and is adjusted according to species, development stage and environmental condition. The leaves began from flanks of the shoot apical meristem and develop into flat structures of variable sizes and forms. When the plant get enough of the nutrition especially the leaf, results can increase the number of leaf by the increase of capacity plant of absorption of nutrient. As a results can get better development of root and increased the translocation of carbohydrates from the growing points. Then, the higher nitrogen concentration can increase the cell number of leaf and size of cell with the overall production of leaf.

4.2 Generative Growth

4.2.1 Number of flowers

Based on the Figure 4.3, the most dominate of the number of flowers is Bed 6, Bed 9 and Bed 8. While for the least is Bed 1. The graph show the increasing of the number of flowers by week to another week.

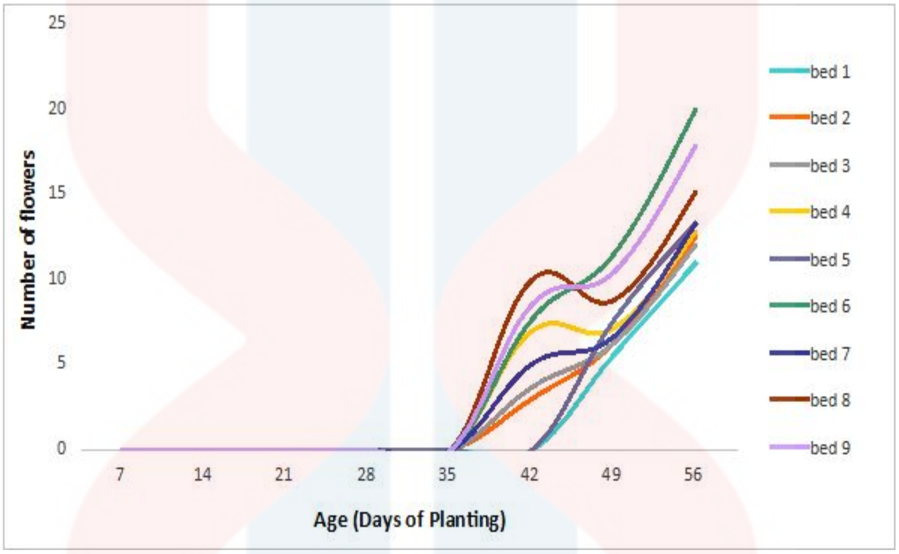

Figure 4.3 : Average number of flowers

The flowers is very important to generate the pod of the plant. The flowers will generate the fruits of the plants. So, the number of flowers can determine the number of the pod that will be generate by the plants.

4.2.2 Average of Number of Pods per Plant and Average of Yield per Plot

The Table 4.1 represented the average of number of pods per plant and average of yield per plot that were measured and recorded.

Table 4.1 : The Average Number of Pods per Plant and Average of Yield per Plant

Plot	Average Number of Pods per Plant	Average of Yield per Plant (g)
1	39	422
2	24	271
3	28	314
4	23	196
5	19	216
6	28	265
7	37	377
8	44	416
Total	**242**	**2477**

For Plot 8 and Plot 1 were planted by the seed that has higher pod length and yield characteristics compared to other plot.

However, the environment factor can be the causes the snake bean produces. During the research, in July to December were having heavy rain and windy weather that can affect the snake bean plant. There have about a few trellis that fall causing of the wind. Moreover, the acidity of the soil that contain low nutrient that cannot supply to the plant because of the planted area does not sterility properly after planting. There also a few disease that attack the seeds and the flower of the plant.

The yield pattern may fluctuate relying on factors like types of soil, management application and climate. Another cause for unimportant result on pod number parameter is probably because of the environment during the time from flowering to formation of pod, which experienced continuous rain with high amount of water, a lot of clouds and hence little light, resulting in less flowering. Snake bean is self-pollinated plant and sometimes can be crossed-pollinated by wind or insect. However, a strong wind during the rainy season at the time of initiation of flower and setting of pod may decrease the flower number, thus affect the number of formed of pod. The yield of snake bean was highest under organic fertilizer because of high and continuous mineralization of nutrient.

4.2.3 Number of Pods per Plot and Yield per Plot

The Table 4.2 represented the number of pods per plot and yield per plot that were measured and recorded.

Table 4.2 : The Number of Pods per Plot and Yield per Plot

Plot	Number of Pods per Plot	Yield per Plot (g)
1	445	6350
2	380	5908
3	307	4990
4	370	3997
5	447	6183
6	516	10619
7	494	6073
8	498	8114
Total	**3457**	**52234**

For Plot 6 and Plot 8 were contained more pod than the other plot. However, during the research, in July to December were having heavy rain that cause a few trellis that fall. So, about three plant that cannot continue until the last harvesting. Moreover, the diseases attacked the leaves and pod so can got low result in this research.

4.2.4 Pod Length

Based on Table 4.3, it is shown that the mean is increasing from the zero generation to fifth generation.

Table 4.3 shows the zero generation (49.63 cm), first generation (51.32 cm), second generation (54.72 cm), third generation (56.17 cm). While for the fourth generation is slightly decrease into (54.31 cm). However, fifth generation is increasing into (56.49 cm) . Then, the standard deviation for first generation to first generation is decrease from 8.5 to 8.43. While, standard deviation for second generation to third generation is increase fro 9.72 to 11.13. However, for fourth generation decrease into 10.80 but increase back into 10.84.

From the research, the variability of the third generation was higher than the variability from the zero generation, first generation, second generation, fourth generation and fifth generation . This indicated that the plant are still segregating and the probability of the plants to produce longer pod length in the next generation was high.

Table 4.3 : Frequency of Different Range of Pod Length in the Zero Generation. First Generation, Second Generation, Third Generation and Fourth Generation (a).

	Frequency of Pod in					
Pod Length (cm)	Zero Generation (%)	First Generation (%)	Second Generation (%)	Third Generation (%)	Fourth Generation (%)	Fifth Generation (%)
15-19.9	0 (0)	0 (0)	0 (0)	1 (0.02)	1 (0.01)	3 (0.08)
20-24.9	0(0)	19 (0.43)	3 (0.05)	14 (0.29)	21(0.3)	25 (0.68)
25-29.9	3(0.38)	30 (0.68)	11 (0.19)	37 (0.76)	76 (1.09)	30 (0.81)
30-34.9	4 (0.51)	49 (1.11)	43 (0.76)	63 (1.31)	265 (3.79)	113 (3.05)
35-39.9	6(0.76)	122 (2.77)	88 (1.55)	187 (3.88)	397 (5.67)	126 (3.41)
40-44.9	26 (3.30)	661(14.99)	234 (4.13)	421 (8.73)	598 (8.55)	265 (7.16)
45-49.9	172(21.86)	727(16.49)	456 (8.05)	654 (13.56)	911(13.02)	301 (8.14)
50-54.9	185(23.51)	1173 (26.60)	762(13.45)	777 (16.11)	1144 (16.35)	579(15.65)
55-59.9	178(22.62)	1369 (31.04)	1197 (21.13)	817 (16.94)	1293 (18.48)	853(23.06)
60-64.9	110(13.98)	116 (2.63)	1157 (20.42)	730 (15.13)	1077 (15.39)	549(14.84)
65-69.9	73 (9.28)	56 (1.27)	858(15.14)	569 (11.79)	794(11.35)	514(13.90)
70-74.9	28 (3.56)	55 (1.25)	533 (9.41)	333 (6.90)	349 (4.99)	293 (7.92)
75-79.9	2 (0.25)	20 (0.45)	232 (4.09)	142 (2.94)	58 (0.83)	36 (0.97)
80-84.9	0 (0)	12 (0.27)	64 (1.13)	52 (1.08)	8 (0.11)	9 (0.24)
85-89.9	0 (0)	1 (0.02)	25 (0.44)	20 (0.41)	4 (0.06)	2 (0.05)
90-94.9	0 (0)	0 (0)	3 (0.05)	7 (0.15)	1 (0.01)	1 (0.03)
Total	787	4410	5666	4824	6997	3699
Mean	49.63	51.32	54.72	56.17	54.31	56.49
Standard deviatio n	8.5	8.43	9.72	11.13	10.80	10.84

(a) Data were obtained from the previous generation from the first generation, second generation, third generation and fourth generation.

Figure 4.4 shown the various range of pod length that consists of the zero generation, first generation, second generation, third generation, fourth generation and fifth generation. The graph shown the mean of each generation continue increase from zero generation to third generation. However, graph slightly decrease on fourth generation but continue increase in fifth generation. So, it indicated the generation is continue increase from generation to the next generation (shift to the right). The improvement of the pod length can continue longer that selected from the parents. The produce of the pod length can increase the number of the pod and the yield of the plant.

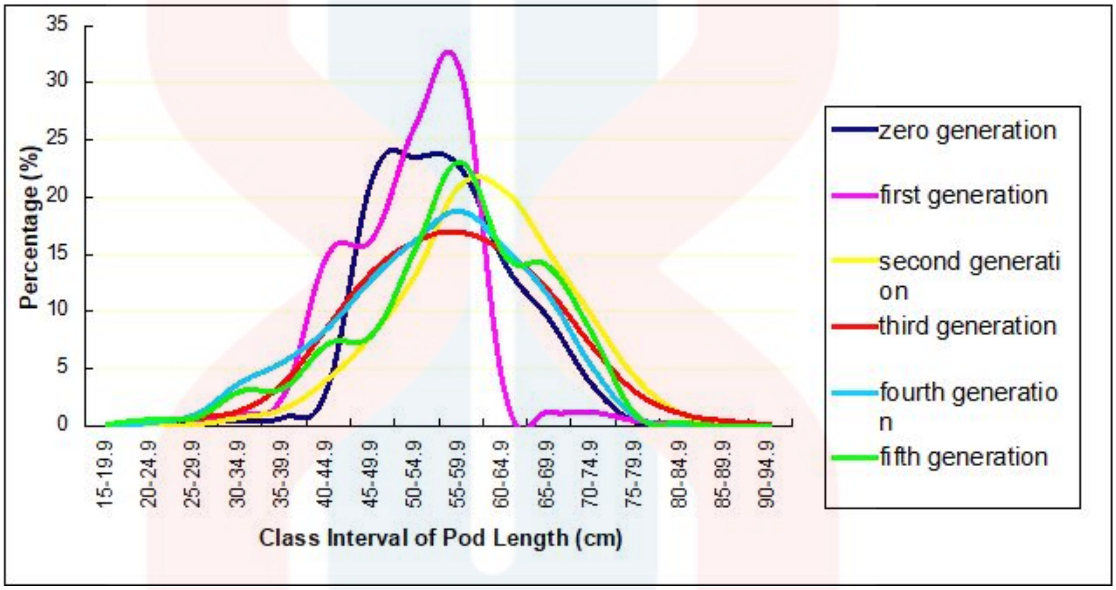

Figure 4.4 : Range of Pod Length

4.3 Heritability

Based on the Table 4.4 below, the mean population (54.31), mean of offspring (56.49) and mean of selected parents (79.27). The difference between mean of offspring and mean of population is 2.18 and the difference between mean of selected parents and mean of population is 24.96. Therefore, the heritability of population for this research is 0.09 which is 9% had potential to be selected for the next generation.

Table 4.4 : Narrow Sense Heritability of Fifth Generation

Generation	Fifth Generation
μ, mean of population	54.31
T_o, mean of offspring	56.49
T_s, mean of selected parents	79.27
R (T_o - μ)	2.18
S (T_s - μ)	24.96
$h^2 = R/S$	0.09

CHAPTER 5

CONCLUSION AND RECOMMENDATION

As conclusion, the research shown that there were increasing of pod length from the fourth generation to fifth generation and this can be proven by the increasing value mean, which is fourth generation is 54.31cm while fifth generation is 56.49 cm. While for the yield of snake bean is decreased from 169.9 kg (fourth generation) into 52.23 kg (fifth generation). This is because the seeds cannot survived due to some factor affect the snake bean while doing the research. The heritability value was 0.09 or 9% to be selected for the next generation which is the further generation. Therefore, the mass selection method was useful, suitable and has been proven to be improve the pod length of the snake bean.

For the recommendation, the condition of the soil pH must be suitable for planting the plant. Then, the planting area must be exposed with the sunlight to get enough nutrient. Next, the area also must be sterility without contained any of pests and diseases that can harm the plant.

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APPENDIX A

Figure 1: Sowing in tray

Figure 2 : Land preparation

Figure 3 : Transplanting

Figure 4 : Trellis setting

Figure 5 : Weeding

Figure 6 : Harvesting

Figure 7 : Matured snake bean

APPENDIX B

Table 4.1.1 : The average value of plant height of sample plant per week

	Week							
Plot	1	2	3	4	5	6	7	8
1	10.6	23.2	33.9	72.6	122.0	260.0	375.5	520.7
2	11.2	18.2	28.7	66.4	105.7	217.8	333.0	461.4
3	14.5	28.4	41.2	62.2	115.6	263.8	400.2	516.4
4	11.0	19.9	28.6	58.5	124.6	212.4	339.0	457.4
5	9.7	17.4	25.1	44.8	109.2	190.3	324.2	451.7
6	9.0	15.2	23.9	38.4	106.3	249.1	380.8	509.7
7	6.8	12.4	19.8	34.6	86.1	223.0	347.1	474.7
8	9.7	20.7	30.4	36.9	125.5	240.1	361.9	496.4
9	7.4	14.7	23.7	57.9	109.2	236.9	288.3	405.4

Table 4.1.2 : The average value of number of leaves of sample plant per week

	Week							
Plot	1	2	3	4	5	6	7	8
1	0	1.0	2.7	16.0	24.2	36.2	52.8	62.3
2	0	1.2	3.2	16.3	25.3	35.8	48.5	59.5
3	0	1.5	2.5	15.7	24.8	39.7	52.8	63.5
4	0	1.3	3.8	15.5	20.3	37.7	49.5	59.0
5	0	1.3	3.0	15.5	25.3	33.8	42.2	53.2
6	0	1.7	3.3	15.0	25.2	36.0	50.3	60.2
7	0	1.2	3.0	16.2	27.8	38.8	52.0	64.0
8	0	1.0	2.5	16.7	21.7	39.8	47.7	59.0
9	0	2.2	5.0	17.0	25.3	39.2	50.5	61.8

Table 4.2.1 : The average value of number of flowers of sample plant per week

	Week							
Plot	1	2	3	4	5	6	7	8
1	0	0	0	0	0	0	5.7	11.0
2	0	0	0	0	0	3.0	6.3	12.5
3	0	0	0	0	0	3.2	6.3	12.0
4	0	0	0	0	0	7.0	7.2	12.8
5	0	0	0	0	0	0	7.7	13.3
6	0	0	0	0	0	7.7	11.5	20.0
7	0	0	0	0	0	5.0	6.7	13.3
8	0	0	0	0	0	10.0	8.8	15.2
9	0	0	0	0	0	8.5	10.5	17.8