Faculty of Resource Science and Technology

EFFECT OF PLANTING DENSITY AND GROWING MEDIA ON GROWTH AND FRUIT PRODUCTION OF OKRA (*ABELMOSCHUS ESCULENTUS* (L.) MOENCH)

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Bachelor of Science with Honours
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Effect of Planting Density and Growing Media on Growth and Fruit Production of Okra (*Abelmoschus esculentus* (L.) Moench)

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APPROVAL SHEET

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DECLARATION

I hereby declare that the Final Year Project 2015 is based on my original work excepts for quotations and citations, which have been duly acknowledged. I also declare that is has not been or concurrently submitted for any other degree at UNIMAS or institutions of higher learning.

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TABLE OF CONTENT

LIST OF ABBREVIATION

MARDI	Malaysian Agricultural Research and Development Institute
D1	25 cm x 50 cm Planting Density
D2	50 cm x 50 cm Planting Density
M1	1:1 Top soil : sand
M2	1:1 Top soil : coco peat
M3	100% coco peat
CEC	Cation Exchange Capacity
FFB	Fresh Fruit Bunches
PBA	Palm Bunch Ash
SDW	Shoot Dry Weight
RDW	Root Dry Weight

LIST OF TABLES

LIST OF FIGURES

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ABSTRACT

Abelmuschus esculentus (L.) Moench,*is* the vegetable that popular in Malaysia which originated from India. These plants are easy to grow and give fruit production in short time. The experiment was designed as 2 x 3 factorial design experiment. In this experiment, okra are in complete block variety with plant density which is 25cm x 50cm (D1) and 50cm x 50cm (D2). The growth of okra were compared in different media which is 1:1 topsoil:sand (M1); 1:1 topsoil:coco peat (M2); and hundred percent coco peat (M3). Hence the objectives of this study were to determine the best planting density and growing media on growth and fruit production okra. The result showed that the planting density was not significantly affecting growth and fruit production, while in the growing media, there were significantly affecting in number of leaf, number of branch, and diameter at specific week. There was significantly difference affecting the number of leaf, number of branch and growth of fruit in the relations between planting density with growing media. Seedling in D1 give the highest reading in all the growth performance of plants in their height, diameter, number of branch,number of leaf, total leaf area and shoots as biomass. Meanwhile in reading of fruits growth, D2 give the highest reading. Moreover, in growing media, M1 give the best reading of growth performance in height, diameter, number of leaf, total leaf area and biomass. In fruit performance growth, M3 gave the highest result. As the conclusion, D1 and M1 is the best planting and growing media for the growth of okra. While, D1 and M3 is the best planting density and growing media for fruit production.

Keyword : *Abelmuschus esculentus,* planting density, growing media,growth performance

ABSTRAK

Abelmuschus esculentus (L.) Moench, adalah sayur yang popular di Malaysia yang berasal dari India. Tumbuhan ini mudah untuk berkembang dan mengeluarkan buah dalam masa yang singkat. Eksperimen ini direka sebagai percubaan reka bentuk 2 x 3 faktorial. Dalam eksperimen ini, bendi berada dalam blok pelbagai lengkap dengan kepadatan tanaman iaitu 25cm x 50cm (D1) dan 50cm x 50cm (D2). Pertumbuhan bendi akan dibandingkan dalam media berbeza iaitu 1: 1 tanah atas: pasir (M1); 1: 1 tanah atas: hampas kelapa (M2); dan seratus peratus hampas kelapa (M3). Oleh itu objektif kajian ini untuk menentukan kepadatan tanaman yang terbaik dan media berkembang pada pertumbuhan dan pertumbuhan hasil buah. Keputusan menunjukkan bahawa kepadatan tanaman tidak tidak memberi kesan kepada pertumbuhan dan penghasilan buah, manakala di media pertumbuhan , ada yang memberi kesan kepada bilangan daun, bilangan dahan dan diameter pada minggu tertentu. Selain itu, dalam hubungan antara kedapadatan tanaman dengan media penanaman terdapat kesan kepada bilangan daun, bilangan dahan dan penghasilan buah. Pokok-pokok dalam D1 memberikan bacaan yang tertinggi dalam semua prestasi pertumbuhan anak benih pada ketinggian.diameter, bilangan dahan, bilangan daun, keluasan daun dan pucuk sebagai biomass. Sementara itu, D2 memberikan bacaan tertinggi dalam prestasi pertumbuhan buah. Selain itu, dalam media penanaman, M1 memberikan bacaan yang terbaik kepada prestasi pertumbuhan tinggi, diameter, bilangan daun, keluasan daun dan biojisim. Dalam pertumbuhan buah, M3 memberikan hasil yang paling tinggi. Sebagai kesimpulan, D1 dan M1 adalah kepadatan tanaman yang terbaik dan media penanaman untuk pertumbuhan bendi. Walaupun begitu, D1 dan M3 adalah kepadatan tanaman dan media pernanaman terbaik untuk penghasilan buah.

Kata kunci: *Abelmuschus esculentus*, kepadatan tanaman, media penanaman, prestasi pertumbuhan

1.0 INTRODUCTION

Okra or it scientific name *Abelmoschus esculentus* (L.) Moench, also known as ladies' finger belongs to family Malvaceae. Okra is a warm-season crop that is considered to have originated from India , and it is a traditional vegetable crop commercially cultivated in West Africa, India, Southeast Asia, the southern United States, Brazil, Turkey and northern Australia (Duzyaman, 1997). The fruits are a green capsule containing numerous white seeds when immature and the flowers (Figure 1) and upright plants give okra an ornamental value (Duzyaman, 1997). The okra fruit can be classified based on the shape, angular or circular (Figure 2). Fresh okra is a popular ingredient of soups and stews where a highly viscous consistency is desired (Baxter, 1990). Okra has a high nutritional value and grows very quickly with high temperatures, which lends its production to more tropical parts of the world. Okra seeds are a source of oil, protein and are also used as a coffee substitute, while ground-up okra seeds have been used as a substitute for aluminum salts in water purification.

Figure 1: Okra flower

Figure 2: Okra fruit

Okra production can be affected by planting density and the composition of growing media used to grow it. The okra can grow between 3-4 weeks and more to give its production. The suitable media are needed to allow the good production of the Okra. The three types of media will be used are soil, sand and chipped coconut husk (commonly known as coco peat). Topsoil is the upper, outermost layer of soil, usually the top 2 inches (5.1 cm) to 8 inches (20 cm). It has the highest concentration of organic matter and microorganisms and is where most of the Earth's biological soil activity occurs. The soil have their own nutrients (Table 1) which is needed for growth the plant.

Table 1: Nutrients contain in top soil

Nutrients	Functions
Nitrogen	This is the main growth nutrient and is required for the growth of leaves and stems
Phosphorus	The principal nutrient concerned with plant growth and development
Potassium	Performs an important photosynthetic function within the plant, whilst also promoting flower and fruit development
Magnesium	This nutrient is a constituent of chlorophyll, the green pigment which enables plants to photosynthesis

Based on University of Maryland Extension (2014.) growing medium has three main functions which are supply roots with nutrients, air, and water, allow for maximum root growth, and physically support the plant. Roots grow in the spaces between individual particles of soil. Air and water also travel through these pore spaces. Water is the medium that carries nutrients that plants need to fuel their growth, and air is needed for root growth and the health of soil microorganisms that help supply plants with nutrients.

Irrigation water moves through the pore spaces, pushing out the air. If excess water cannot drain away, fresh air cannot enter and roots will suffocate. Light and fluffy growing media must be selected for good aeration and root growth.

To improve a sandy soil, dig in organic matter which will increase its water and nutrient retention. Watering is needed to be carried out regularly. Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. The composition of sand is highly variable, depending on the local rock sources and conditions. Sand also have good aeration which is necessary for root adaption. Coco peat has high lignin and cellulose content. Coco peat can be processed from the fiber extracted material. It will be collected and washed to remove excess salt content on it. The unwashed coco peat the salt level is high this is not suitable for many plants. After natural washing the coco peat is naturally dried and the dry material is transported to factory for compression. The clean washed coco peat has the lower electrical conductivity level. According to Seribu-Bio System (2014), the advantage of coco peat is has lower electrical conductivity level that favors the plant growth which is suitable after process. Soil pH affects the availability of certain key nutrients. While a lime test is advisable, it is possible to generalize as follows: sands and peats tend to be acid; whilst heavier soils such as clays and loams tend to be neutral or slightly alkaline; chalky soils and soils that have experienced marine flooding or have been reclaimed from the sea also tend to be alkaline. The pH in coco peat is 5.5 to 6.7 which is suitable for plants. It also retains moisture eight times of its volume and have high aeration and oxygenation resulting in good root formation.

The planting density can be described by the number of the plant in the certain given area. In short, the planting density is the distance of plant with closest neighbouring plant. The impact of this cultural practice is the health or the growth of the plants. Logically, the more dense plant in the curtain area will give bad impact in their growth. This is because they must compete to get the enough nutrients and water. But, not all plant species give the same result because it depends on types of plantation. According to Nasir *et.al* (2007), they mentioned that planting density greatly influenced quality, texture, taste and yield of onion that they already studied even within a particular variety.

1.1 Problem Statement

The growth of the okra is depend on climatic and cultural practices. This type of plant that has been chosen to be studied are economical species in many country and this assumed to be more high quality in growth production based on planting density and the growing media.

There are many different planting density required to qualify based on the plant or species. The crop and forest plantation have their own specific planting density that enhance the growth production of the plant.

The different of this planting density become the factor to study the effects of planting density towards Okra.There are many research had been done in application of chemical contain or fertilizer in media that trigger the root formation and effect the growth of the plant. The lacks of research about growing media are lead the study on it to be done.

1.2 Objective

- To determine the effect of planting density on the growth and fruit production of okra
- To determine the effect of growing media on growth and fruit production

2.0 LITERATURE REVIEW

2.1 Introduction

Okra is originally from India and was cultivated by the Egyptians. It is also very popular in many parts of Brazil, among many other countries. India is on the top of the rank in the world by producing this crop. Malaysia are in 14^{th} among all the country contributed to produce this kind of vegetables as commercial domestic production. In Malaysia, there are many companies that involve in agriculture that planted okra and import them to others country like Brunei and Singapore. Roughly, Malaysia produce about 20,000 tons of okra per year and this values keep on increase starting from 1990. In 2009, Johore was the largest state that produces okra with 381 hectare followed by Kedah, Sarawak and Kelantan.

Planting density can influence the growth of the plant. Generally the high planting density will result low growth productivity of plant. But, not all the species of plant need the suitable planting density to grow well. This is because planting density in plantation sector do not apply the same planting density with food crop and forestry. The aeration and composition of soil also can give affect towards plant growth which is important in root formation of plant.

2.2 Effect of Planting Density on Yield

Planting density has been argued to affect the yield of the most crop. For instance a study were conducted by Tropical Agriculture and Research Extension (2005) in south west Nigeria to evaluate the response of sunflower (*Helianthus annuus* L.) to different plant population densities under rain fed conditions during the late rainy season cropping of 2002 and 2003. In both years, three open pollinated varieties namely: Funtua (a local adapted variety), Record and Isaanka (exotic varieties) were grown at three spacings, 60 x 15, 60 x 30 and 60 x 45cm. Funtua flowered matured and grew taller than Record and Isaanka in 2002 and 2003. This study found that planting density significantly affect the plant diameter, height and flower size respectively by the year. The highest plant population density produced significantly higher seed yield than the intermediate and the lowest by about 37 and 64%, and 75 and 98% in 2002 and 2003, respectively. Next, the research of plant density was carried out at the Horticultural Farm, NWFP Agricultural University, Peshawar by Nasir *et al.,* (2007) to investigate the effect of three regimes of planting densities (40, 60 and 80 plants/4m^2) on onion varieties namely Swat-1. Terich-02 and Gilassi local. The results show that lower planting density significantly increased the number of leaves per plant and large bulbs weight.. The medium planting density has significant effect only on weight of double bulbs. Higher planting density significantly increased leaf length , weight of small bulbs , weight of medium bulbs, single bulbs weight and total yield of bulbs. The results indicated that Terich-o2 has shown good performance with higher weight of medium bulbs (995.00 g), large bulbs (742.39 g), single bulbs (1515.44 g) and double bulbs (552.00 g). Greater leaf length (51.87 cm) and weight of small bulbs (483.67 g) were examined in Swat-1, while Gilassi local was found to have poor performance for all the parameters except for number of leaves per plant which were maximum. The interaction between planting density and varieties was significant only for bulb yield.

2.3 Effect of Planting Density on Growth

According to Nasir *et al.,* (2007), mentioned that in onion varieties maximum number of leaves per plant (14) were obtained at the lower planting density of 40 plants m^{-2} and minimum number of leaves per plant (12) were found at the higher planting density of 80 plants m^{-2}. The results was similar to another researcher in 1994 where he reported that increasing plant competition significantly decreases seedling leaf number. They also reported that lower planting density resulted in higher number of leaves per plant. The assumptions are also similar to other researchers who conducted their experiment and stated that greater number of leaves was found at wider spacing. Besides, leaf size shown that maximum leaf length (52.51 cm) was measured at the highest planting density of 80 plants $4m^{-2}$, whereas the minimum (47.79 cm) leaf length was recorded at the lowest planting density of 40 plants $4m^{-2}$. Verma *et al.,* in 1994 reported the same results. They reported average branch length (leaf length) increased between low and medium spacing of 30 x 45 cm and 45 x 45 cm. They reported that lower planting density was the best with regard to leaf length, in paradigm, high planting density indulged the plants in competition for light due to which it grow taller to exploit it up to the maximum extent. The results indicated that leaf length was not different for all the varieties statistically.

Based on Will *et al.,* (2006) mentioned that planting density affect the proportion of biomass partitioned to stem growth, a main factor controlling stand growth and yield. During the fourth growing season, they determined the biomass partitioned to leaf, branch, stem, and fine root of intensively managed loblolly pine (*Pinus taeda* L.) stands in the Upper Coastal Plain and Piedmont of Georgia growing at 6 densities ranging from 740 to 4,440 trees ha^{-1}. Current annual increment during the fourth growing season increased from 4,573 to 12,671 kg ha^{-1} as stand density increased from 740 to 4,440 trees ha^{-1}. Stem, leaf, and branch biomass all significantly increased with increasing planting density. However stem biomass increased to a more extent. Therefore, biomass partitioning to stem relative to other stand components increased with increasing stand density. As stand density increased, the ratio of stem growth per foliage biomass increased from 1.02 to 1.54, the ratio of standing stem biomass to branch biomass increased from 1.77 to 3.27, and the ratio of standing stem biomass to fine root biomass increased from 3.56 to 7.79.

Besides, there was experiment conducted by Ijoyah and Dzer (2012), in yield performance of okra and maize as affected by time of planting maize in Makurdi, Nigeria. Field experiments were conducted from June to October during 2010 and 2011 cropping seasons at the Research Farm, University of Agriculture, Makurdi, Nigeria, to evaluate the yield performance of okra-maize mixture as affected by time of planting maize. The experiment consisted of three maize planting dates (maize planted at the same time as okra in mid-June, maize planted 2 and 4 weeks later, respectively, in late June and early July) to okra plots. Monocrop okra and maize constituted the control plots. The results obtained showed that the greatest intercrop yield of okra was obtained when maize was planted 4 weeks later (in early July), while the greatest intercrop yield of maize was produced when planted at the same time as okra in mid-June. Planting okra and maize at the same time in mid-June not only recorded the lowest competitive pressure, but also gave the highest land equivalent ratio (LER) values of 1.78 and 1.75, respectively, in years 2010 and 2011, indicating that greater productivity per unit area was achieved by growing the two crops together than by growing them separately. With these LER values, 43.8% and 42.9% of land were saved, respectively, in 2010 and 2011. Both crops were found most suitable in mixture when planting was done at the same time in mid-June.

In crop plantation, the research about planting density was carried out by Mohd Taiyib *et al.,* (2002), one such trial was carried out in 1985 at Malaysia Palm Oil Board (MPOB) peat research station in Teluk Intan testing two replicates of a split-plot design in which three planting densities (120, 160 and 200 palms ha^{-1}) were in the main plots and the sub-plots tested fertilizer treatment in 2:32:32 NPK factorial combination. Guthrie commercial Depth x Planting materials were used in the trial. Thirteen years of Fresh Fruit Bunches (FFB) yield and bunch analysis data were used to calculate the financial performance of the three planting densities by examining the variable costs and determining the internal rate of return (IRR), the net present value (NPV) assumed at a discount rate of 10% and the benefit to cost ratio (BCR). Analysis carried out was based on the actual annual market FFB prices obtained over the years of the trial (1988,2000) and all costs incurred by the plantations management. Based on the observation, the results based on 13 years of yield record (or 16 years planting) showed continued increase in average and cumulative FFB yield with increase in planting densities observed in spite of the relatively higher Ganoderma incidence on palms at the higher densities (i.e . 14.8% at 120 palms ha^{-1}, 15.4% at 160 palms ha^{-1} and 20.8% at 200 palms ha^{-1} at 16 years of planting). Yield fluctuation observed was also due to leaning palms affecting yield about seven to eight years after planting. The palms took about four years to recover and yield normally. Based on the bunch analysis carried out over the years (slightly over 1000 bunches/density), an increase in the planting density increased the oil/bunches which was largely due to improvements in the fruit-set and oil/dry mesocarp. While, economic analysis carried out showed that at all three levels of general charges tested, oil palm planted at 200 palms ha^{-1} gave the highest internal rate of return (IRR), the net present value (NPV) and the benefit to cost ratio (BCR) values even though the payback period of seven years was equal between 160 and 200 palms ha^{-1}. Palms planted at 120 palms ha^{-1} performed the worst.

2.4. Effect of Growing Media on Growth

There were many research had been done before about the effect of growing media towards the. This study was conducted by Navindra *et al.,* (2011) to determine the potential of raising roselle (*Hibiscus sabdariffa* L.) seedlings, using different types of coarse and sieved media in various pot sizes up to thirty days after germination. Roselle seeds of cultivar 'Locale' and formulated rooting media were characterized for certain physico-chemical characteristics. The media were different in terms of pH, electrical conductivity (EC), container capacity and percent aeration porosity ($p<0.05$). Root dry weight (DW) of roselle seedlings differed significantly among rooting media ($p<0.05$) and pot sizes ($p<0.05$). Root DW of roselle seedlings from medium fourth (2-mm sieved scoria) was 0.188±0.046 g, while under the control treatment (soil), root DW was much lower (0.069±0.020 g). Number of leaves and shoot DW of seedlings from medium fourth treatment were considerably higher than the control seedlings. Scoria has the potential as soilless substrate for roselle seedling production.

Kiran *et al.,* (2007) had study the effect of the growing media on growth of *Dahlia pinnata.* They mentioned that different growing media had significant effect on the dahlia plant height. The maximum plant height (42.08 cm) was recorded in media (sand + silt + leaf mold) followed by (36.41 cm) in (silt + leaf mold) and (36.19 cm) in (leaf mold). Besides, they also mentioned the results of dahlia stem thickness, (sand + silt + leaf mold) has produced the maximize stem thickness (1.93 cm) followed by (1.86 cm) in (silt + leaf mold). The good stem thickness (1.14, 1.16, and 1.06 cm) are reported in (sand + leaf mold), (sand + silt) and (leaf mold). Furthermore the number of the leaves per plant also significant. About more 42.55 leavers per plant were produced by the planting rowing in (leaf mold), followed by (sand + silt + leaf mold) , (silt + leaf mold), (sand + leaf mold) with 34.02,33.81 and 33.62 leaves per plant respectively.

According to Adjei-Nsiah and Obeng (2013), they had study the Effect of Palm Bunch Ash Application on Soil and Plant Nutrient Composition and Growth and Yield of Garden Eggs, Pepper and Okra. Based on their experiment has shown that PBA application can trigger vegetative growth and increased yield in garden eggs, okra and pepper. The results also mention that, PBA can be used as a liming material to correct pH of acidic soils as well as a nutrient supplement in soils with leached nutrients. Application of PBA contributed to the improvement in soil chemical properties of the acid soils used in this study by increasing soil pH and the level of macro nutrients such as N, P, K, Ca and Mg in the soil. This experiment can conclude that there are some application can trigger the soil condition to give good results in crop yield include the potting media

According to Restrepo *et al.,* (2013), the increasing demand for soilless media for horticultural crop production and the rising environmental concerns about the use of non-renewable resources such as peat as substrate has led to the search for alternative materials as constituents of growing media, such as waste organic by-products. Also, biogas production through the anaerobic digestion of organic wastes generates a potential fertilizer, the digested substrate (digestate). The aim of this work was to study the feasibility of using the composted solid fraction of a digestate obtained after the codigestion of cattle manure and maize–oat silage as a component in the formulation of growing media for the commercial seedling production of three species: tomato (*Lycopersicon esculentum* Mill.), muskmelon (*Cucumis melo* L.), and pepper (*Capsicum annuum* L.). Four substrates were compared which is pure peat (control) and three mixtures containing 25%, 50%, and 75% by volume of compost with the corresponding amount of peat. Physical, physicochemical, and chemical analyses of the different growing media were carried out and the effects of the different mixtures of peat/compost on seed germination and on the nutritional status of the seedlings were also studied. In general, compost addition neither influence negatively the physical and physicochemical properties nor produced any reduction in the germination rate in the species studied, but it did enhance the seedling nutritional status. Besides, according to Navindra *et al.,* (2011), they mention that soil is not a proper medium for containerised plant production as it settles down, leading to drainage and aeration problems. Thus, okra might have possible