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Agronomic Characteristics of Mustard (*Brassica juncea* L.) on the Application of Fertilizer Solution and Flannel Size at Wick Hydroponic System

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ABSTRACT

The aimed of the study is to determine the agronomic characteristics of mustard cultivated hydroponically using wick system on the application of liquid fertilizer and flannel size. The research was conducted at screen house of the Faculty of Agriculture, Islamic University of North Sumatera, Medan as long as January-February 2016. The research is field experiments, using two-factor completely randomized design with three replications. The first factor is concentration of liquid fertilizer, consisted of 0.0 mL/L, 2.5 mL/L, 5.0 mL/L, and 7.5m L/L of water, and the second factor is widths of flannel cloth, consisted of 1 cm, 2 cm, and 3 cm. The results showed that concentration of liquid fertilizer at 7.5 mL/L of water and 1 cm of flannel has the highest plant height, leaf number, leaf area, knop diameter, and fresh weight. Based on the scatter plot, fresh weight is more influenced by the knop diameter than plant height, leaf number, and leaf area.

INTRODUCTION

Mustard or also known as *caisim* (*Brassica juncea* L.) is one of horticultural crops which can be used as vegetable and drug ingredient due to good nutrition, including protein, fat, carbohydrate, Calcium, Phosphor, Zink, Vitamin A, Vitamin B, and Vitamin C (Aji, 2009). Mustard can be used as medicine to relieve throat itching for patients that suffer cough, cure the headaches, blood cleaning materials, improve kidney function, and improve and facilitate digestion (Cahyono, 2006).

Mustard production, particularly in North Sumatra, has decreased since 2005-2012. In 2005, the production amounted to 79.850 t/ha and decreased to 60.471 t/ha in 2012 (Central Bureau of Statistics, 2013). The production decline is partly due to reducing productive land caused by competition for others land use such as plantation, climate conditions such as heavy rainfall and droughts, land degradation, and lack of appropriate agricultural technology information.

Recently, It has been developed an agricultural technology to produce healthy, low content of harmful chemicals, and can be cultivated anywhere even by urban households. Such technology innovation is hydroponic technology.

One of simple hydroponic technology is wick systems. In hydroponics, wick system is a passive system because there are no moving parts and utilize the capillarity principle in such away nutrient solution is directly absorbed by plants through the wick (Lee *et al*., 2010). This system is also one of the many systems developed by farmers or agribusiness entrepreneurs in Indonesia (Sumarni, 2005).

The success of the mustard production in the wick hydroponic system is influenced by the composition of nutrient solution, type and size of wick cloth, growing media and substrates, Electrical Conductivity (EC) value, pH solution as well as the microclimate in research area. Nutrient solution is an important factor for growth and quality of hydroponic plants. Nutrition is given in the form of a solution containing macro and micro elements to support plant growth. Each type of nutrient has a different composition (Perwitasari *et al*., 2012) and must be dissolved in water, so the concentration of fertilizer solution must be carefully calculated according to

plant needs. Concentration of the nutrient solution needs to be known because all of plant nutrients needs in hydroponic is fed from given nutrient solution (Hirawan, 2003).

Wick quality is crucial to drain water and nutrients from nutrient solution basin into the planting medium. Type and size of the wick which has lower capillarity can inhibit the supply of nutrient solution. In another hand, planting medium used in hydroponics must be free from harmful substances, inert, having good water holding capacity, good drainage and aeration (Susanto, 2002).

Some research indicates that the use of sand growing medium and homemade nutrients solution gives the highest yield in celery plants (Mas'ud, 2009). The use of coco charcoal powder as growing media and liquid nutrients of 2-5 mL/L of water gives the highest growth and yield of tomatoes (Indrawati *et al*., 2012). The growing media of bamboo leaves compost provide growth and the highest yield on tomato (Wijayanti and Susila, 2013). Nutrient solution 1000 ppm with planting medium of rice husk, sand or a mixture of rice husk and sand give the best growth and yield for *pakcoy* (Akasiska *et al*., 2014). However, research on the wick size has not yet be conducted. Accordingly, it is necessary to study the agronomic characteristics of mustard on the application of liquid fertilizer in different concentrations and at various flannel sizes.

MATERIAL AND METHODS

The research was conducted at screen house, Faculty of Agriculture, Islamic University of North Sumatera, Karya Wisata Gedung Johor, District of Medan Johor, Municipality of Medan at altitude ± 25 m above the sea level with flat topography from January to February 2016.

Materials and tools used in this research is mustard seed of Tosakan varieties, hydroponics nutrition, water, rock wool, flannel cloth, sulfuric acid, NaOH, Dithane M 45, nursery box, seed tray 40 cm x 30 cm in size, net pots, buckets, pH meter, TDS meter, UV plastic, table, nutrients weighed, knives, scissors, tape, hand sprayer, treatment board, stationery and materials and other support tools.

The research is field experiments, using two-factor completely randomized design with three replications. The first factor is concentration of liquid fertilizer, consisted of 0.0 mL/L, 2.5 mL/L, 5.0 mL/L, and 7.5 m /L of water, and the second factor is size of flannel cloth, consisted of 1 cm,

2 cm, and 3 cm. The observed variables were plant height (cm), number of leaves (leaf), leaf area (cm^2) using the formula LD = p x L x 0.6825, knop diameter (cm), and plant fresh weight (g).

Research Implementation

Before planting, previously the mustard is seedling at 53 cm x 28 cm of seed tray using rock wool growing medium. Before sowing, the seeds soaked in a Dithane M-45 solution to sterilize from pathogens. Once the seeds sown in the seed tray, then watering was conducted using hand sprayer and covered with a plastic sheet for 3-4 days to maintain moisture in the seed tray (Figure 1).

While waiting for seedlings growth in nursery, a 40 cm x 30 cm of square basin was prepared as net pot, flannel cloth, and styrofoam sheets which cut according to the size of plant container surface and punched to the planting hole with a distance of 15 cm x 15 cm. Then flannel cloth fitted in the bottom of net pot according to treatment wide, that is 1 cm, 2 cm and 3 cm. Flannel cloth hanging down to the base of net pot in order to drain the nutrient solution to the planting medium (Figure 2).

Applied nutrition is synthetic in with composition of 4% N-total, 4% K_2O, 3.5% Ca, 0.13% Fe and 0.07% Mn. Then, the nutrients were dissolved in water at a ratio of 1: 1. Once the nutrients are dissolved in water, then nutrient solution prepared at corresponding treatment namely 0.0 mL/L, 2.5 mL/L, 5.0 mL/L and 7.5 mL/L of water and put in the planting container. The applied nutrient solution should be stirred on daily basis so that the nutrients is not settled because wick system hydroponics does not use aerator to circulate the nutrient and the nutrient solution is replaced once a week, by removing the net residual nutrient solution inside the planting container, then enter new nutrient solution in accordance with the treatment (Figure 2).

Data Analysis

Data were analyzed using ANOVA; further testing used Duncan Multiple Range Test (DMRT) at 5% significant level. Data were analyzed using the Statistical Analysis System (SAS) Software 9.1. (SAS, 2004).

A B C D

Figure 1. Mustard seedling: seed selection (A); seeds soaking in Dithane M-45 solution (B); planting seeds in the seed tray (C); and seed tray covered with plastic (D)

A B C D

E F

Figure 2. Planting: preparation of planting container (A); application of nutrient solution into the planting container (B); mustard seedling on planting container (C); nutrient solution stirring (D); mustard at 2 weeks after planting (E); mustard at age 3 weeks after planting (F)

RESULTS AND DISCUSSION

Agronomic characteristics of Mustard

Application of liquid fertilizer and flannel size was significantly affected agronomic characteristics of mustard, while the interaction of treatment did not significantly affect the characteristics (Table 1).

Table 1 shows the analysis results of plant height, leaf number, leaf area, knop diameter, and the fresh weight of mustard at three weeks after planting (3 WAP). Increasing concentration of fertilizer solution in hydroponic planting container will increase plant height, leaf number, leaf area, knop diameter, and the fresh weight of mustard at 3 WAP.

In hydroponic cultivation system, appropriate provision of nutrient solution will produce optimal results for growth and yield of mustard. This finding confirmed the research of Warganegara *et al*. (2015) on lettuce, Erawan *et al*. (2013) in mustard, Perwitasari *et a*l. (2012) on *pakchoi* that increasing concentration of fertilizer solution followed by increasing plants growth.

Mustard requires sufficient and available nutrients for vegetative growth to generate maximum production. One nutrient that has an important role in the vegetative growth is nitrogen. Nitrogen serves to increase vegetative growth, so that leaves become wider, greener and more quality (Wahyudi, 2010). In this experiment, the applied fertilizer solution is contain 4% N-total, 4% K_2O, 3.5% Ca, 0.13% Fe and 0.07% Mn. This shows that high N-total in fertilizer is used to form better vegetative part so the metabolic processes are better (Surtinah, 2006).

Table 1. Plant height, leaf number, leaf area, knop diameter, and the fresh weight of mustard

Concentration of Nutrient Solution (Ml/L)	Plant Height (cm)	Leaf Number (leave)	Leaf Area (cm^2)	Knop Diameter (cm)	Fresh Weight (g)
0.0	4.49 d	3.08 d	1.67 d	0.12 d	0.51 c
2.5	16.61 c	6.06 c	24.57 c	0.29 c	10.93 b
5.0	19.88 b	6.78 b	41.77 b	0.38 b	20.88 a
7.5	22.41 a	7.28 a	54.83 a	0.44 a	22.68 a
Flannel Size (cm)					
1	17.23 a	6.21 a	33.63 a	0.35 a	18.90 a
2	15.59 b	5.77 b	30.55 b	0.30 b	14.42 b
3	14.73 c	5.42 c	27.96 c	0.27 b	7.93 c
Interaction	(-)	(-)	(-)	(-)	(-)

Note: Row in the same column followed by the same letter were not significantly different at 5% level by Duncan test

(-) Interaction was not significantly different

Concentration of fertilizer solution applied to the plant will determine the growth of mustard. This means fertilizer solution at concentration of 7.5 mL/L of water will accelerate plant height and leaf formation because nutrients requirement especially N elements which crucial for vegetative phase are fulfilled (Lingga and Marsono, 2007). Novizan (2005) also states that nitrogen is essential for plant growth and development, such as making the plant more fresh greens and contain chlorophylls, accelerate plant growth (height, leaf number, leaf area, knop diameter, and fresh weight), and increasing the protein content.

Flannel size is also significantly influenced agronomic characteristics of mustard (Table 1), that is by increasing of flannel width, mustard growth will decrease. This is because the wider flannel size then the amount of nutrient solution up to the root zone is constantly and the roots become moist and experiencing O_2 deficiency. Reduction of O_2 in the root zone causes decreased ability of the roots to absorb the nutrient solution, as a result the mustard experiencing nutrients shortage for growth. According to Zakaria (2014), the weakness of wick hydroponic system is not all the plants grow well with a constant water supply that led to the growing medium always in moist condition. Moist growing medium will prevent aeration in the root zone and the roots withered.

In addition to causing O_2 shortage in the root zone, the size of flannel >1 cm also causes to nutrients settled in the wick (flannel) that impede nutrient absorption by the roots of mustard. Riana *et al*. (2015) represent that one of the obstacles in wick hydroponic systems is limited ability to supply water needs at the time evapotranspiration rate is higher than the capillary flow rate of water through the wick that causes excess nutrient salts in the growing medium.

Heru and Andoko (2014) also stated that oxygen and nutrient solution is deposited on the wick hydroponic system because the water does not move, so that the plants do not get sufficient supply of oxygen and nutrients. Bad aeration in the root zone make oxygen deficiency in the rooting zone and consequently inhibited root respiration and reduced absorption energy thereby inhibiting the metabolism and growth of roots (Salvina, 2014). Low oxygen in the root zone will also cause decreased of cell membrane permeability that maked cell walls increasingly difficult to be penetrated and consequently plants will lack of water (Damar, 2015).

Two Dimensional Mapping Between agronomic characteristic

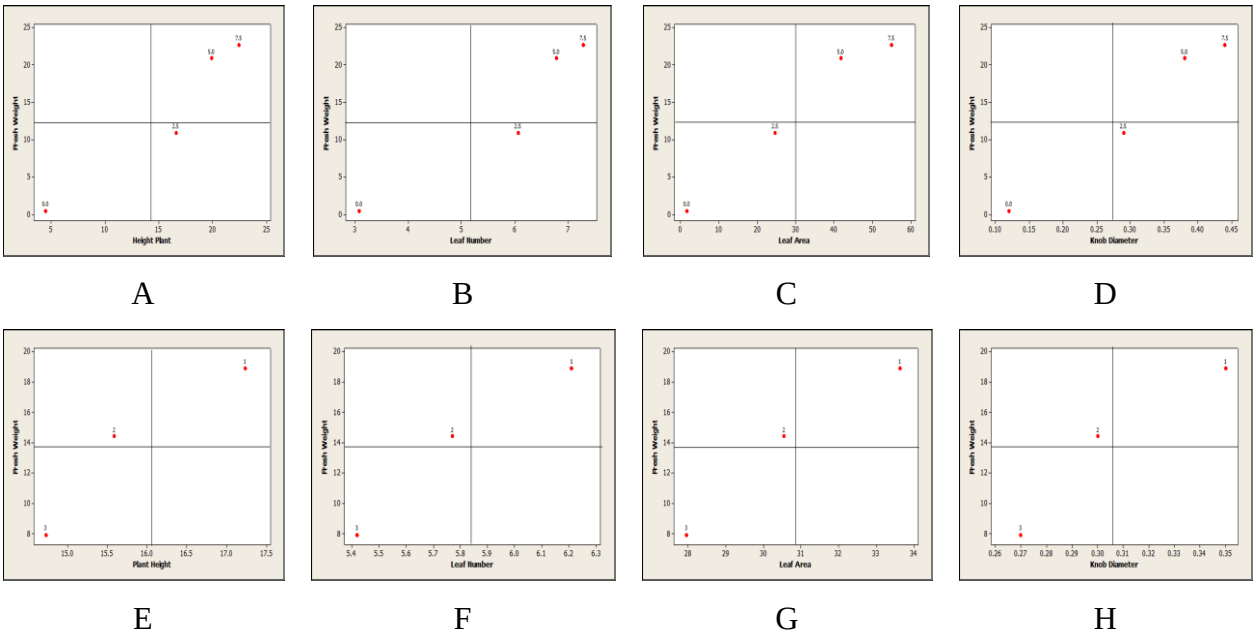

Figure 3. Identification of the best fertilizer solution treatment (A-D) and flannel size (E-H) for fresh weight, plant height, leaf number, leaf area, and knop diameter

Two dimensional mapping between fresh weight and plant height, leaf number, leaf area and knop diameter in concentration of fertilizer solution treatment and flannel size showed that the higher fertilizer concentration and the smaller flannel size produce the highest fresh weight, plant height, leaf number, leaf area, and knop diameter (Figure 3). The boundary line among quadrant shows 95% of confidence interval.

Figures 3 show that according to two-dimensional mapping of fresh weight with plant height, leaf number, leaf area, and knop diameter, to obtain the highest fresh weight, plants height, leaf number, leaf area, and knop diameter then mustard in wick hydroponic system should be given a nutrient solution at concentration of 7.5 mL/L of water with from 1 cm of flannel.

Relationship between Agronomic Characteristics

Scatter plot, as shown in Figure 4, used to determine the agronomic characteristics that affect fresh weight of mustard. The figure shown that the fresh weight is influenced by plant height, leaf number, leaf area, and knop diameter of mustard.

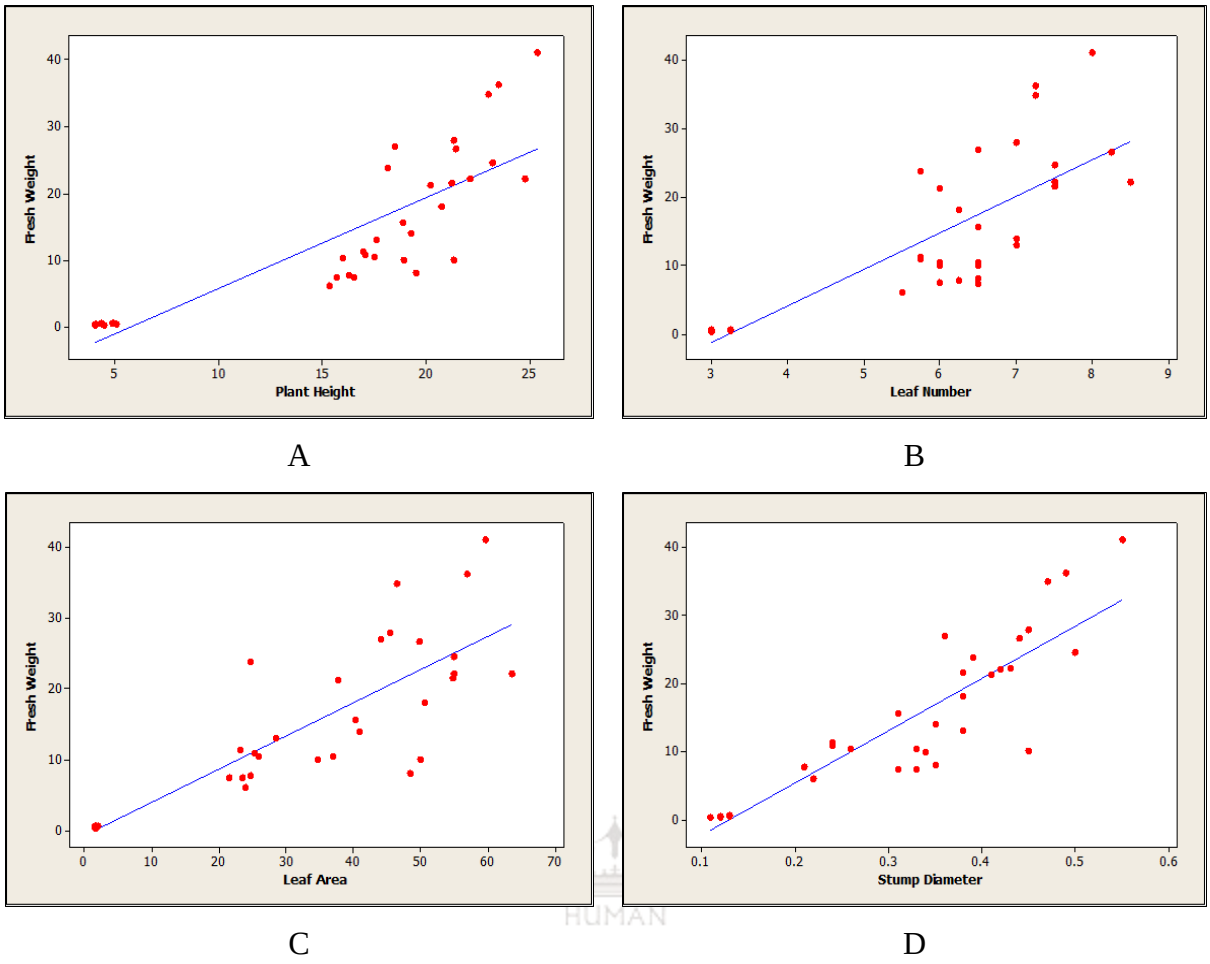

Figure 4. Relationship between fresh weight and plant height (A), leaf number (B), leaf area (C), and knop diameter (D) of mustard at different concentration of fertilizer solution and flannel size.

Figure 4 shown that increase in plant height, leaf number, leaf area, and knop diameter will increase the fresh weight of mustard. The regression equation shown that Fresh Weight = -7.698 + 1.353 Plant Height (R^2=70.5%), Fresh Weight = -17.11 + 5.323 Leaf Number (R^2=65.2%), Fresh Weight = -0.617 + 0.4678 Leaf Area (R^2=70.1%), and Fresh Weight = -9.869 + 76.75 Knob Diameter (R^2=80.3%).

Among the variables, knop diameter shown the highest effect on fresh weight as indicated by the determination coefficient (R^2) which is greater than R^2 value of other variables which is 80.3%. This is because knob is a thickening of the leaves and plant height increases. The regression equation between knob diameter and plant height, leaf number, and leaf area showing almost the

similar R^2 values, 87.0%, 83.9%, and 89.5% respectively. The highest R^2 values are indicated by relationship of knop diameter and leaf area. Leaf is the main organ where the photosynthesis process takes place that produces photosynthate to be translocation to other plant organs (Gardner *et al*. 1991). Hasanuddin *et al*. (2000) show that soybean varieties with higher value of leaf area will increase the seeds weight of Soybean. Gesch *et al*. (2002) represent that plants with optimum leaf area is provide broader leaf surface as the site of photosynthesis, so the leaves will catch optimum sunlight and photosynthesis generated will be maximized.

CONCLUSION

Application of fertilizer solution at concentration of 7.5 mL/L of water as a nutrient solution on mustard in wick hydroponic system is able to produce the highest plant height, leaf number, leaf area, knop diameter and fresh weight of mustard compared to concentration of 0.0, 2.5 and 5.0 mL/L of water. While flannel as wick with a width of 1 cm in wick hydroponic system is able to produce the highest plant height, leaf number, leaf area, knop diameter, and fresh weight of mustard compared to 2 cm and 3 cm.

Based on the scatterplot, fresh weight of mustard is more influenced by knop diameter than plant height, leaf number, and leaf area.

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