THE RESPONSE OF FIVE TIDAL SWAMP GROWN PAPAYA CULTIVARS FROM THE COLLECTION OF THE INDONESIAN TROPICAL FRUIT RESEARCH INSTITUTE (ITFRI) TO PHOSPHORUS FERTILIZATION

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A B S T R A C T

The research was intended to analyse the response of five papaya varieties to phosphorus fertilization in tidal swamp areas. The research was conducted at the Peatland Project (PLG) in Mentangai, Kapuas, Central Kalimantan, from August 2007 to April 2008. A split plot design was used. The main plot had the following P application: 100; 200; 300 g P/plant, and the subplot had the following varieties of papaya: Bt1; Bt2; Bt3; Bt4; Bt7. There were 3 replications and 10 plants per unit of treatment. The observed parameters were: (1) vegetative growth (plant height, stem diameter, internode number); (2) and fruit quality (fruit number, fruit weight, fruit length, fruit circumference, flesh thickness, and total soluble solid). The research result showed that four of five papaya varieties, namely Bt1, Bt2, Bt4, and Bt7 proved to have a higher growth and production response than Bt3. Therefore, the four varieties Bt1, Bt2, Bt4, and Bt7, show good prospects for development in the tidal swamp areas. P application affected significantly plant height only, but did not have an effect on other parameters of plant growth and fruiting. These findings could be used as a guide for choosing varieties suitable for cultivation in the tidal swamp areas.

Key words: varieties, P, growth, production, papaya, tidal swamp

INTRODUCTION

Papaya is a fruit commodity that has good economic prospects. The fruit is not only consumed fresh, but can also be processed for various food products, beverages, medicines and cosmetics. This commodity is widely known and consumed by all levels of society.

Lately, papaya cultivation has been directed at lands that are not optimal or marginal, such as peat-tidal swamp areas. In Indonesia, the availability of peatland includes 33.40 million hectares or 16.80% of the total land area (Sawiyo et al., 2000). The Peatland project (PLG) entails a million hectares in Central Kalimantan,. The project is one potential location for the centre of papaya development, particularly in tidal swamps type C and D.

Generally, peat tidal swamp land is dominated by the type of soil problematic for the cultivation of papaya. It can be difficult to grow papaya in tidal swamp areas because the swamps are influenced by the tide or shallow water table, have a very high acidity (pH 3.0 to 4.0), and the presence of toxic compounds such as pyrite, scarcity of nutrients, especially P, K, Ca, Mg and some micronutrients can be found there. Phosphorus is one of the nutrients with low availability in tidal swamp areas, though it is very important for plants. For papaya, P is one of the most important nutrients after K and N (Villegas, 1992). P is an essential mineral for growth and plant defence in natural ecosystems (Aleel, 2008). Phosphorus is needed in the process of energy metabolism. P is a component of sugar phosphates, nucleic acids, nucleotides, coenzymes, phospholipids, phytic acid, etc. and has a major role in reactions where ATP is involved (Prawiranata et al., 1992). P deficiency causes impaired growth and reduces crop yields worldwide by up to 30-40% (Wissuwa, 2003; Wissuwa et al., 2005).

Besides optimizing nutrient availability, especially P, planting varieties of papaya that are able to adapt to the tidal swamps is an alternative effort, which would need to be done to minimize the input of management. It would be necessary to obtain varieties that have the potential to be developed in tidal swamps. Indonesia Tropical Fruit Research Institute has conducted a series of studies to obtain productive papaya varieties with high quality and favoured by the market. Five varieties selected for the experiment: Bt1, Bt2, Bt3, Bt4, and Bt7, have the advantage both in terms of quality and consumer acceptance. All five varieties have never been planted in the tidal swamp areas. The objective of the experiment was to evaluate their growth and fruiting at the tidal swamp site.

MATERIAL AND METHODS

The study was conducted from August 2007 to April 2008, at the Peatlands project (PLG), a million hectares in Sub Mantangai, Kapuas, Central Kalimantan.

The study plot was prepared in the split plot design. As the main plot of P was: 100, 200; 300 g P/plant. The sub plot contained the papaya varieties: Bt1, Bt2, Bt3, Bt4, Bt7, with 3 replications. Each treatment unit consisted of 10 plants. Papaya seeds were planted in beds, the planting hole size was 50 x 50 cm, spacing was 3 x 3 m. Fertilization was done one, three and five months after planting, each 1/3 of dose treatment. Fertilization was done by throwing it in a circle under the canopy of plants. Urea and KCl fertilizer as basal fertilizer given 250 g/plant in conjunction with P fertilizers (treatment). To increase soil pH to 5.5 to 6.5, dolomite lime was put into the planting hole two weeks before planting. As much as 300 g/plant was used and mixed evenly with 20 kg of manure. The variables observed were: (1) vegetative growth (plant height, stem diameter, and internode number), (2) and fruit quality (fruit number, fruit weight, fruit length, fruit circumference, flesh thickness, and total soluble solid).

Data were analyzed with analysis of variance and the significances of different treatments were tested further using the test DMRT at 5% level.

RESULTS AND DISCUSSION

The nature of the soil study sites

The experiment was conducted in tidal swamp, based on type C. Land sites are very acidic, organic C content is high, N content medium, available P, K, Ca, Mg low. Physical and chemical properties before treatment are presented in Table 1.

Vegetative Growth of Plants

Analysis of variance showed that the interaction between P and the varieties is not significant on all parameters of vegetative growth. Providing only P significantly affected plant height but did not affect the parameters of other observations. While the papaya varieties showed significant effects otherwise in all the growth parameters (Tab. 2).

Fertilization with phosphorus caused an increase of plant height and stem diameter (insignificant). The internode number was not severely affected by adding P. The tidal swamp containing low P causes nutrient imbalances in the soil which inhibits plant growth.

There were variations in plant height, stem diameter and internode number between the varieties tested. In this study, plant height among the varieties can be divided into 2 groups, namely high varieties (Bt2, Bt3, Bt4, Bt7) with plant height between 104.72-109.86 cm, and Bt1 categorized as the variety with low height (62.31 cm). Likewise, stem diameter between varieties can be divided into 2 groups, large stem diameters (Bt2, Bt3, Bt4, Bt7) with a diameter of 6.69-6.83 cm, and Bt1 the one variety that had a small diameter (5.86 cm). The internode number for each variety also showed differences and was divided into 2 groups. Bt1 had the fewest internode number (31.35 cm), and varieties of Bt2, Bt4, Bt3, and Bt7 had more internodes (sections were 35.53-37.00). From the overall observation of vegetative growth, variety Bt1

Table 1. Physical and chemical properties of the soil before the experiment

Physical Properties	Value	
Sand fraction [%]	0.10	
Dust fraction [%]	51.43	
Coarse clay fraction [%]	26.37	
Fine clay fraction [%]	21.60	
Chemical Properties	**value**	**status**
pH H_2O	4.10	Very acid
Organic C [%]	9.27	Very high
N total [%]	0.30	Medium
C/N	27	Very high
P_2O_5[ppm]	19	Low
K_2O [ppm]	11.93	Low
K [ppm]	0.08	Very low
Ca [ppm]	1.71	Very low
Mg [pp]	0.89	Low
Cation Change Capacity	38.58	High

Table 2. The effect of P fertilization and variety on plant height, stem diameter, and internode number at the age of 12 weeks after planting

Treatment	Plant Height [cm]	Stem Diameter [cm]	Internode Number
Phosphorus			
P1 (100 g/plant)	93.95 b	6.59 a	35.16 a
P2 (200 g/plant)	99.23 ab	6.68 a	35.53 a
P3 (300 g/plant)	102.47 a	6.73 a	35.07 a
Variety			
V1 (Bt1)	62.31 b	5.86 b	31.35 b
V2 (Bt2)	104.72 a	6.83 a	35.53 b
V3 (Bt3)	111.14 a	6.85 a	36.29 a
V4 (Bt4)	104.72 a	7.02 a	36.11 a
V5 (Bt7)	109.86 a	6.69 a	37.00 a

*Means in the same column followed by the same letter are not significantly different at 5% DMRT test

showed lower growth than the other varieties. The physical appearance of this Bt1 variety in the field was shorter and smaller than the other varieties. Bt1 variety is a good choice for farmers who generally prefer a short crop because it is easy to maintain and harvest.

Fruit Quality

From the analysis of variance, the interaction between phosphorus and the varieties was not significant in all fruit quality parameters. This means that P had no significance in all the parameters of papaya fruit quality observations. Conversely, the variety factor significantly affected fruit number, fruit weight, fruit length, fruit circumference and flesh thickness, but had no significant effect on total soluble solids content (Tab. 3).

Fertilization with P had no significant effect on any of the parameters of fruit quality allegedly because the content of P in the tidal swamp soil was originally classified as low (Tab. 1), so to get the maximum, a high dose of P is required. High P concentration in soil solution is needed to encourage the diffusion of nutrients to the surface of the roots. Roots that respond to P will provide sucrose and auxin (Williamson et al., 2001). The addition of a P dose is recommended because if the element of P is given in small amounts it will interfere with metabolic processes in plants. Rooting will then be limited, so fruit production will decline (Sutapradja and Sumarni 1996). This is consistent also with the statement of Nishina et al, 2000, that P fertilizer should be added to the soil for the growth and yield of papaya. According to Rosliani et al, 2006, to increase the yield of cucumber fruit on ground that has a high acidity and poor nutrients – especially P, then the plants need a higher dose of P (at least 200 kg P_2O_5/ha).

The fruit number between several varieties showed significant variation. Bt4 had the highest number of fruit. Values of fruit weight were from 591.02 to 888.43 grams. The lowest fruit weight was from the BT3 variety, and the largest from Bt7. The fruit length of each variety was different. Bt3 had the shortest fruit, followed by Bt4, Bt7, Bt2, and Bt1. Bt3 had the smallest fruit circumference, followed by Bt1, Bt4, Bt2, and Bt7. Flesh thickness showed values which ranged from 2.48 to 3.07 cm. Bt3 was thinnest, while Bt1 had the thickest flesh. From the parameters of fruit weight, fruit length, fruit circumference, and flesh thickness, Bt3 had the lowest value. Therefore, varieties of Bt1, Bt2, Bt4, and Bt7 are more likely to develop in tidal swamp areas.

In general, the varieties used were not a big in size. These varieties are accordance with the market trend. Now the market preference is for small to medium sized papayas because one such a fruit is enough for one person. Chan et al. (1992) reported that papaya 'Exotica' is able to boost the market in Malaysia because it is medium sized; between 600-800 grams. 'Sekaki' is a choice variety in Malaysia because it has a large market and it is small to medium size, tastes sweet and is long-shaped (Ibrahim, 2007). Also according to Wisnu et al. (1991), the 'Sunrise' variety is very popular with the middle class consumer and has high export possibilities because this variety does not weigh much.

The total soluble solid of each variety ranged between 13.00-13.86 °Brix. The total soluble solid range in this study was good enough, as it is still in accordance with papaya plants idiotype (≥ 13.5 °Brix) (Indriyani, 2007).

Table 3. Effect of P fertilization and variety on fruit number, fruit weight, fruit length, fruit circumference, flesh thickness and total soluble solids content

Treatment	Fruit number per tree	Fruit weight [g]	Fruit length [cm]	Fruit circum-ference [cm]	Flesh thickness [cm]	Total Soluble Solids content [°Brix]
Phosphorus						
P1 (100 g/plant)	23.55 a	712.17 a	18.33 a	30.94 a	2.79 a	13.33 a
P2 (200 g/plant)	21.93 a	831.72 a	19.04 a	32.67 a	2.69 a	13.32 a
P3 (300 g/plant)	25.40 a	818.56 a	19.28 a	31.70 a	2.81 a	13.20 a
Variety						
V1 (Bt1)	20.65 b	857.22 ab	20.59 a	29.87 b	3.07 a	13.21 a
V2 (Bt2)	24.06 ab	879.63 a	20.06 a	33.12 a	2.71 bc	13.35 a
V3 (Bt3)	22.78 ab	591.02 c	16.10 c	29.88 b	2.48 c	13.86 a
V4 (Bt4)	26.83 a	721.11 bc	18.08 b	32.17 ab	2.82 ab	13.00 a
V5 (Bt7)	23.83 ab	888.43 a	19.60 ab	33.81 a	2.76 bc	13.01 a

* Means in the same column followed by the same letter are not significantly different at 5% DMRT test

Overall, the varieties grown in this tidal swamp, can grow and be able to produce good fruit in environmental conditions that are less favourable. This means the tidal swamp areas show big possibilities for cultivating papaya.

CONCLUSION

1. Phosphorus fertilization affected significantly plant height only but did not affect the other observed parameters. The variety of papaya had a significant effect on vegetative growth, fruit number, fruit weight, fruit length, fruit circumference, and flesh thickness.
2. Of the five varieties of papaya grown in the tidal swamp areas, Bt1, Bt2, Bt4, and Bt7 showed growth potential and a relatively uniform production, which was better than that of Bt3. So all four varieties: Bt1, Bt2, Bt4, and Bt7 are likely to be cultivated in the tidal swamp areas, on a large scale.

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WPŁYW NAWOŻENIA FOSFOREM NA WZROST I OWOCOWANIE PIĘCIU ODMIAN MELONOWCÓW, POCHODZĄCYCH Z KOLEKCJI INDONEZYJSKIEGO INSTYTUTU OWOCÓW TROPIKALNYCH, UPRAWIANYCH NA MOKRADŁACH PŁYWOWYCH

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STRESZCZENIE

Badanie miało na celu określenie wpływu nawożenia fosforem na wzrost i owocowanie pięciu odmian melonowców rosnących na terenie mokradeł pływowych. Doświadczenia przeprowadzono od sierpnia 2007 do kwietnia 2008 roku w ramach

Projektu Torfowiskowego w Mentangai, Kapuas na środkowym Borneo, w układzie bloków podzielonych w trzech powtórzeniach, po 10 roślin każde. Badaniami objęto pięć klonów melonowca: Bt1; Bt2; Bt3; Bt4; Bt7. Zastosowano następujące nawożenie fosforem – 100, 200, 300 g P na roślinę. Badano (1) wzrost wegetatywny (wysokość roślin, średnicę łodyg, liczbę międzywęźli) oraz (2) plon i jakość owoców (liczbę, wagę, długość, obwód i jędrność owoców oraz zawartość ekstraktu w owocach). Wyniki wykazały, że rośliny genotypów Bt1, Bt2, Bt4 i Bt7 rosły szybciej i lepiej plonowały niż rośliny genotypu Bt3, co wskazuje, że mogą być uprawiane na terenach mokradeł pływowych. Nawożenie fosforem miało pozytywny wpływ tylko na wysokość roślin, ale nie miało wpływu na inne badane parametry. Wyniki te mogą być wskazówką przy doborze odpowiednich odmian melonowca do uprawy na terenach mokradeł pływowych.

Słowa kluczowe: odmiany, wzrost, produkcja, melonowiec, mokradła pływowe