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Growth and Starch Content Evaluation on Newly Released Cassava Cultivars, Rayong 9, Rayong 7 and Rayong 80 at Different Harvest Times

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ABSTRACT

The objectives of this study were to evaluate the growth and the starch content of cassava at different harvest times for four promoted cultivars (Rayong 5, Rayong 90, Kasetsart 50 and Huay bong 60), three newly released cultivars (Rayong 9 or CMR 35-64-1, Rayong 80 or CMR 35-22-196 and Rayong 7 or CMR 35-21-199) and one variety of CMR 35-55-166. The results showed that the newly released cultivars, Rayong 9 and Rayong 7, had good average growth. However, their plant and fresh root weights were not significantly different from the other cultivars. Huay bong 60 and Rayong 9 tended to have higher average plant and fresh root weights than the other cultivars. Rayong 80 had the highest starch content analysis using the Reimann scale balance method, followed by Rayong 9, Kasetsart 50 and Rayong 7, respectively. The newly released cultivars, Rayong 80 and Rayong 9, had good starch content based on both fresh and dry starch analysis when the roots were harvested at 10 or 12 months after planting. These cultivars could be recommended for growing in Prachinburi province and a suitable harvest time should be 10 or 12 months.

Keywords: cassava, growth, starch content, harvest times

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is a most important economic plant because of its starch production, which is a major source for the ethanol and food production industries and as a raw material for animal feed. Recently, in Thailand, there was a reported 7,750,413 rai of cassava planted with an average production rate of 3,246 kg rai^{-1} producing 25,155,797 ton per year (Office of Agricultural Economics, 2009). Several cultivars have been promoted, such as Rayong 5 (R5), Rayong 90 (R90), Kasetsart 50 (Ku50) and Huay bong 60 (HB60). Most of them are planted in two seasons, the early rainy season (March-May) and the late rainy season (November-February), depending on the growing area (Department of Agriculture, 2009). The harvest period is about 8-18 months, with the decision on when to harvest based on market price, not the root weight or starch quantity. The granule size of cassava starch is significantly influenced by the

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developmental stage and growing season. The size of the starch granules increases particularly in the first six months after cultivation. Planting in the rainy season produces a larger granule size than planting in the dry season (Teerawanichpan *et al*., 2008). R90 and Ku50 produce high average starch content in the early and late rainy seasons. In addition, harvesting cassava during the early rainy season caused a reduction in the amylose content and granule size (Boonseng *et al*., 1999). Five cassava cultivars were investigated to identify their fine amylopectin structure and granule chemical composition. The samples were divided into two groups: those containing starch with a low gelatinization temperature (R5 and R2) and those containing starch with a high gelatinization temperature (Ku50, Hanatee and Y002). Diverse amylopectin structural elements result in significant swelling power, viscoelastic properties and gel firmness (Charles *et al*., 2005). The objectives of this study were to evaluate the suitable harvest time based on growth in the field and the starch content of four promoted cultivars (R 5, R 90, Ku 50 and HB 60), three newly released cultivars (R9 or CMR 35-64-1, R80 or CMR 35-22-196 and R7 or CMR 35-21-199) and a variety of CMR 35-55-166.

MATERIALS AND METHODS

Plant materials

Seven cultivars (R5, R90, Ku50, HB60, R 9, R80 and R7) and one variety (CMR 35-55-166) of cassava were planted at the Prachin Buri Experimental Station of the Department of Agriculture, in the late rainy season (November, 2004) using a split plot in a randomized complete block (RCB) design, with three replications. The main plots comprised eight cassava cultivars, while sub plots comprised three harvesting times (8, 10 and 12 months after planting). Each plot consisted of five rows, with 10 plants per row and the spacing was 80 cm × 80 cm. Each treatment sample was randomly harvested at 8, 10 and 12 months after planting for further study.

Study on the plant height, plant weight and root weight

Samples were obtained at 4, 6, 8, 10 and 12 months after planting by cutting the outer row on both sides of the plot to produce 3×8 plants. Plant height was measured from the base to the shoot on 10 randomly selected plants per treatment and plant weight was similarly sampled. The roots were harvested, weighted and counted to calculate the average weight per root.

Fresh and dry starch content analysis by Reimann scale balance method

Cassava root samples were collected at 8, 10 and 12 months after planting. Each root was cut into small pieces before weighing using a Reimann scale balance.

The fresh starch content was calculated using Equation 1:

Starch content = 210.8 × (weight in air/(weight in air-weight in water) - 213.4 (1)

For the dry root, the starch content was calculated using Equation 2:

Starch content = 18.4+0.72 × (starch volume) (2)

Measurements were carried out at 13% relative humidity.

RESULTS

Influence of cassava cultivar and harvest time on the growth

Seven cultivars and one variety of cassava were studied based on the plant height, plant weight and the fresh and dry root weight at different harvest times of 8, 10 and12 months after planting. The average plant height was significantly ($p \leq 0.05$) different among the cultivars/variety and the harvest times. Ku50 and R9 had the greatest average plant height, followed

by R7, HB60, R80, R5, R90 and CMR-36-55-166, respectively. The average plant height at a harvest time of 8 months was significantly ($p \leq 0.05$) different from the height at 10 and 12 months after planting (Table 1). The average plant weight of the seven cultivars and one variety of cassava were not significantly ($p \leq 0.05$) different based on either cultivar or harvest time after planting (Table 2). The fresh root weight was not significantly ($p \leq 0.05$) different among the cultivars but the fresh root weights at 10 and 12 months harvest time were much greater than at 8 months (Table 3). The results showed that the newly released cultivars, R9 and R7, had better growth and were suitable for planting in the Prachinburi area with a harvest time of 10 or 12 months. However, based on the data in Tables 2 and 3, the plant and fresh root weights of the cultivars were not significantly ($p \leq 0.05$) different. HB60 and R9 showed a trend of higher average plant and fresh root weights than the other cultivars.

Table 1 Average plant height of cassava cultivars/variety measured at different harvest times after planting.

Cultivars/variety	Harvest time (months)			Height (cm)
	8	10	12	
Rayong 5	132	153	176	154 ^{bc}
Rayong 90	135	155	165	152 ^{bc}
Kasetsart 50	144	209	203	186^{a}
Huay bong 60	166	169	183	172^{ab}
Rayong 9	158	189	192	180^{a}
Rayong 80	146	162	178	162^{abc}
Rayong 7	163	173	185	174^{ab}
CMR-36-55-166	123	151	151	142^{c}
Average	146^{B}	170^{A}	179^{A}	

a,b,c = within column means followed by the same letter are not significantly different at $p \leq 0.05$.
A,B = within row means followed by the same letter are not significantly different at $p \leq 0.05$.

Table 2 Average plant weight of cassava cultivars/variety measured at different harvest times after planting.

Cultivars/variety	Harvest time (months)			Plant weight (kg)
	8	10	12	
Rayong 5	17.8	20.0	28.0	21.9^{ns}
Rayong 90	14.1	23.5	22.5	20.0 ^{ns}
Kasetsart 50	14.7	38.8	32.0	28.5 ^{ns}
Huay bong 60	31.7	28.8	30.3	30.3 ^{ns}
Rayong 9	22.5	35.0	26.7	28.1 ^{ns}
Rayong 80	31.2	16.5	30.5	26.1 ^{ns}
Rayong 7	26.5	26.3	27.7	26.8 ^{ns}
CMR-36-55-166	15.7	22.4	19.0	19.0 ^{ns}
Average	21.8^{NS}	26.4^{NS}	27.1^{NS}	

ns = within column means are not significantly different at $p \leq 0.05$.
NS = within row means are not significantly different at $p \leq 0.05$.

Table 3 Average fresh root weight of cassava cultivars/variety measured at different harvest times after planting.

Cultivars/variety	Harvest time (months)			Root weight (kg)
	8	10	12	
Rayong 5	28.2	52.8	63	48.0^{ns}
Rayong 90	36.8	50	75	53.9 ^{ns}
Kasetsart 50	27.8	67	82	58.9 ^{ns}
Huay bong 60	51.9	48	85.7	61.8 ^{ns}
Rayong 9	31.8	66.2	83.3	60.4 ^{ns}
Rayong 80	29.3	41	55	41.8 ^{ns}
Rayong 7	39.6	57.2	49.7	48.8 ^{ns}
CMR-36-55-166	22	44.7	87.7	51.4 ^{ns}
Average	33.4^{B}	53.4^{A}	72.7^{A}	

ns = within column means is not significantly different at $p \leq 0.05$.
A,B = within row means followed by the same letter is not significantly different at $p \leq 0.05$.

Starch content analysis

The starch content of seven cultivars and one variety of cassava harvested at 8, 10 and 12 months after planting were analyzed using the Reimann scale balance method. The fresh starch content in the samples was different. R80 showed a trend of highest starch content followed by R9, Ku50 and R7, respectively. The average fresh starch content at 10 (25.08%) and 12 months (25.91%) harvest time were significantly ($p \leq 0.05$) different from 8 months (22.15%) harvest time (Table 4). The average dry starch content of the cultivars was significantly ($p \leq 0.05$) different. The newly released cultivars, R80 and R9 had high dry starch content and the results correlated with the average fresh starch content. The average dry starch content at 8 (34.35%), 10 (35.93%) and 12 (37.36%) months after planting were significantly ($p \leq 0.05$) different (Table 5).

DISCUSSION

Evaluation of growth and harvest time for the seven cultivars and one variety produced very interesting results. The plant height and the plant and root weights of some newly released cultivars, R9, R7 and R80, were not significantly ($p \leq 0.05$) different from the currently promoted cultivars (Ku50 and HB60). The analysis of fresh and dry starch content showed that the highest starch content was in R80 (27.57%) followed by R9 (26.42%), Ku50 (25.37%), R7 (25.03%), R90 (24.27%), HB60 (23.37%), CMR 36-55-166 (21.70%) and R5 (21.31%), respectively. However, Boonseng *et al.* (2006) reported that the starch content of Rayong 7 (27.6%) was greater than R90 (26.81%), Ku50 (26.1%) and R5 (24.7%). Another experiment in Rayong province, reporting on the yields and starch content of R1, R5, R90 and Ku50 showed that R90 had the highest starch content (Petchalanuwat *et al.*, 1997). These combined results showed that the starch content depends on cultivar, harvest time and the planting/growing location.

CONCLUSIONS

The study provided updated information on the growth and starch content of the newly released cultivars for comparison with promoted cultivars. The results showed that R9, R7 and R80 had better growth and starch content and were suitable as recommended planting cultivars for Prachinburi province.

Table 4 Average fresh starch content of cassava cultivars/variety measured at different harvest times after planting.

Cultivar/variety	Harvest time (months)			Root weight (kg)
	8	10	12	
Rayong 5	18.0	22.5	23.5	21.31 ^{d}
Rayong 90	22.8	24.9	25.2	24.27^{abcd}
Kasetsart 50	23.7	23.6	28.8	25.37^{ab}
Huay bong 60	22.4	24.2	23.6	23.37^{bcd}
Rayong 9	22.9	27.2	29.2	26.42^{ab}
Rayong 80	24.5	27.8	30.5	27.57^{a}
Rayong 7	23.0	28.2	23.9	25.03^{abc}
CMR-36-55-166	20.1	22.3	26.0	21.70^{cd}
Average	22.15^{B}	25.08 ^{A}	25.91 ^{A}	

a,b,c,d = within column means followed by the same letter are not significantly different at $p \leq 0.05$.
A,B = within row means followed by the same letter are not significantly different at $p \leq 0.05$.

Table 5 Average dry starch content of cassava cultivars/variety at different harvest times after planting.

Cultivar/variety	Harvest time (months)			Root weight (kg)
	8	10	12	
Rayong 5	31.3	33.3	35.3	33.30 ^{c}
Rayong 90	34.8	36.3	36.5	35.88^{ab}
Kasetsart 50	35.4	35.4	39.1	36.67^{ab}
Huay bong 60	34.5	35.8	35.4	35.23^{bc}
Rayong 9	34.9	37.7	39.4	37.31^{ab}
Rayong 80	36.0	38.4	40.4	38.25^{a}
Rayong 7	35.0	38.7	35.6	35.2 1^{bc}
CMR-36-55-166	32.9	35.5	37.1	35.18^{bc}
Average	34.35^{C}	35.93 ^{B}	37.36 ^{A}	

a,b,c = within column means followed by the same letter are not significantly different at $p \leq 0.05$.
A,B,C = within row means followed by the same letter are not significantly different at $p \leq 0.05$.

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