

CHAPTER 4

RESULTS

4.1 Experiment 1: Effects of cassava stake priming with nutrient solution on growth and yield

Although there was no interaction between varieties and stake priming on fresh root weight (SP x V, $P > 0.05$), the effects of stake priming (SP, $P < 0.05$) and varieties (V, $P < 0.05$) were studied (Table 9). Stake priming significantly increased the fresh root weight of all cassava varieties. For dry root weight, there was interaction between priming and varieties (SP x V, $P < 0.05$). Priming significantly increased dry root weight of Rayong 9 and Rayong 72, and there was great response in dry root weight of Rayong 72; there was no effect in the other varieties (Figure 9).

Table 9 Effects of stake priming on fresh root weight of 5 cassava varieties at 12 months after planting.

Stake priming	Varieties					Mean
	Rayong 5	Rayong 7	Rayong 9	Rayong 72	KU 50	
<i>Fresh root weight (t ha⁻¹)</i>						
Nil-priming	56.8	37.8	49.5	60.6	61.8	53.3 ^B
Priming	73.8	51.5	56.2	75.7	58.2	63.1 ^A
Mean	65.3 ^{ab}	44.6 ^c	52.8 ^{bc}	68.1 ^a	60.0 ^{ab}	
F-test		SP*	V*	V x SP ^{NS}		
LSD _{0.05}		8.7	13	-		

SP = stake priming; V = varieties; * = F-test significant at $P < 0.05$; NS = F-test not significant at $P > 0.05$. Values in the same column followed by different upper case letters are significantly different by $LSD_{0.05}$. Values in the same row followed by different lower case letters are significantly different by $LSD_{0.05}$.

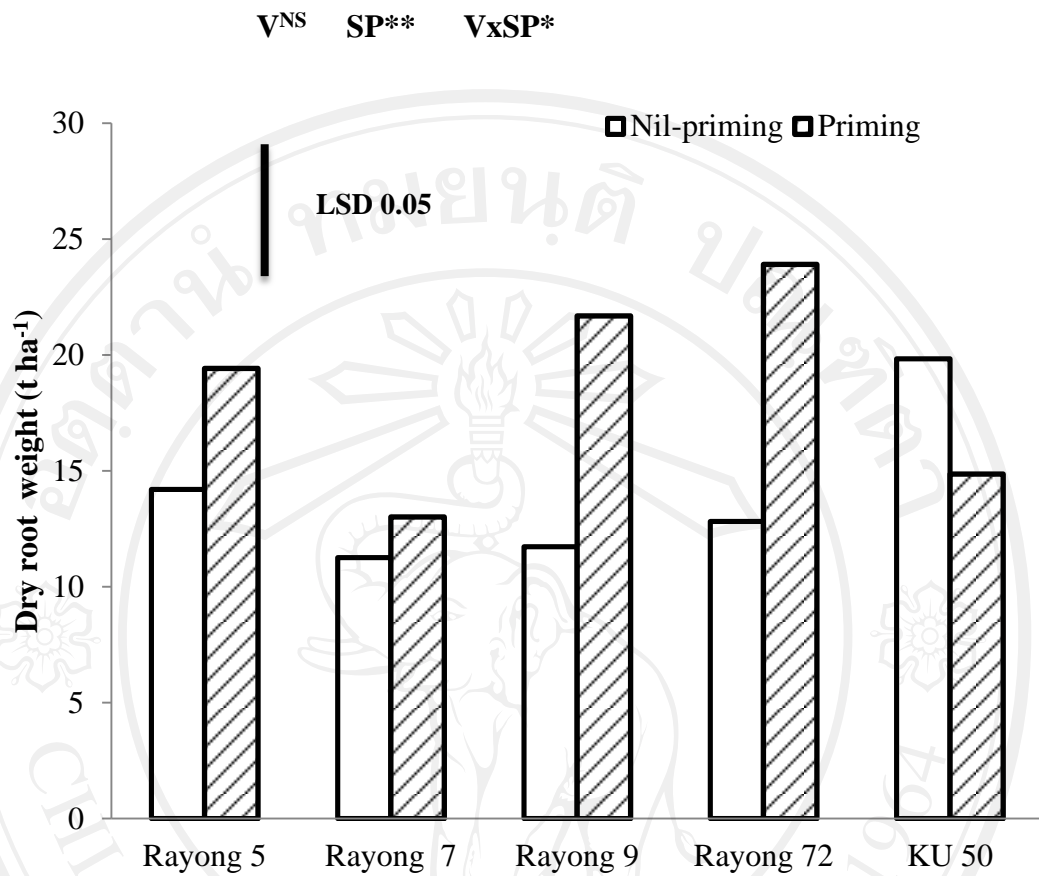


Figure 9 Effects of stake priming on dry root weight of cassava varieties at 12 months after planting. V = varieties, SP = stake priming, * = F-test significant at $P < 0.05$, ** = F-test significant at $P < 0.01$, and NS = F-test not significant at $P > 0.05$.

The effect of priming on dry aboveground weight was not found. The dry aboveground weight only depended on cassava varieties (Table 10). On the other hand, the root number per plant was increased by priming, but the effect of varieties and the interaction between varieties and priming were not found (Table 11).

Stake priming not only increased root yield and root number, but also increased starch content and starch yield (Tables 12 and 13). Starch content depended on priming and cassava varieties, but interaction between the two effects was not found. Priming increased starch content by 8% compared with nil-priming. On average starch content of Rayong 9 was the highest; whereas, Rayong 7 and Rayong 72 were the lowest (Table 12).

There was no interaction between priming and varieties on starch yield. Priming increased starch yield of all cassava varieties. On average, priming increased starch yield by 40%. Starch yield of Rayong 5, Rayong 9, Rayong 72 and KU 50 was about the same, and higher than Rayong 7 (Table 13).

Table 10 Effects of stake priming on total dry aboveground weight of cassava varieties at 12 months after planting.

Stake soaking	Varieties				Mean	
	Rayong 5	Rayong 7	Rayong 9	Rayong 72 KU 50		
<i>Dry aboveground weight (t ha⁻¹)</i>						
Nil-priming	7.4	6.2	7.4	8.0	10.3	7.2
Priming	6.6	7.3	9.4	7.3	12.6	7.7
Mean	7.0 ^{bc}	6.8 ^c	8.4 ^{ab}	7.7 ^{abc}	11.4 ^a	
F-test		SP ^{NS}	V*	SP x V ^{NS}		
LSD _{0.05}		-	3.8	-		

SP = stake priming; V = varieties; * = F-test significant $P < 0.05$; NS = F-test not significant at $P > 0.05$. Values in the same row followed by different lower case letters are significantly different by LSD_{0.05}.

Table 11 Effects of stake priming on root number per plant of cassava varieties at 12 months after planting.

Stake priming	Varieties					Mean
	Rayong 5	Rayong 7	Rayong 9	Rayong 72	KU 50	
	<i>Root number (root plant⁻¹)</i>					
Nil-priming	7.9	9.1	9.7	9.0	10.9	9.3 ^B
Priming	10.5	11.7	11.8	10.5	10.3	11.0 ^A
F-test		SP*	V ^{NS}		SP x V ^{NS}	
LSD _{0.05}		1.5	-		-	

V = varieties, SP = stake priming, * = F-test significant at $P < 0.05$, and NS = F-test not significant at $P > 0.05$. Values in the same column followed by different upper case letters are significantly different by LSD_{0.05}.

Table 12 Effects of stake priming on starch content in fresh roots of cassava varieties at 12 months after planting.

Stake priming	Varieties					Mean
	Rayong 5	Rayong 7	Rayong 9	Rayong 72	KU 50	
<i>Starch content (%)</i>						
Nil-priming	13.1	12.5	16.0	11.7	13.7	13.4 ^B
Priming	13.8	13.6	16.7	13.0	14.9	14.4 ^A
Mean	13.5 ^{ab}	13.1 ^{cd}	16.2 ^a	12.4 ^d	14.3 ^b	
F-test		SP**	V**		SP x V ^{NS}	
LSD _{0.05}		0.7	1.1		-	

V = varieties, SP = stake priming, ** = F-test significant at $P < 0.01$, and NS = F-test not significant at $P > 0.05$. Values in the same column followed by different upper case letters are significantly different by LSD_{0.05}. Values in the same row followed by different lower case letters are significantly different by LSD_{0.05}.

Table 13 Effects of stake priming on starch yield of cassava varieties at 12 months after planting.

Stake	Varieties					Mean
	Rayong 5	Rayong 7	Rayong 9	Rayong 72	KU 50	
Soaking						
	<i>Starch yield (t ha⁻¹)</i>					
Nil-priming	7.6	4.1	6.6	7.1	8.5	6.3 ^B
Priming	10.1	7.0	9.2	10	8.7	9.1 ^A
Mean	8.8 ^a	5.5 ^b	7.9 ^a	8.6 ^a	8.6 ^a	
F-test		SP**	V*	SP x V ^{NS}		
LSD _{0.05}		1.4	2.3	-		

V = varieties, SP = stake priming, * = F-test significant at $P < 0.05$, ** = F-test significant at $P < 0.01$, and NS = F-test not significant at $P > 0.05$. Values in the same column followed by different upper case letters are significantly different by LSD_{0.05}. Values in the same row followed by different lower case letters are significantly different by LSD_{0.05}.

Accumulations of N, P and K in cassava were influenced by cassava varieties and stake priming. There was significant interaction between the effect of priming and cassava varieties ($SP \times V$, $P < 0.01$) on plant N (Figure 10), P (Figure 11) and K (Figure 12) content.

Nitrogen content in the whole plant was increased by stake priming of all cassava varieties, except KU 50 in which stake priming had no effect. Stake priming increased N content in the whole plant of Rayong 9, Rayong 5, Rayong 72 and Rayong 7 by 70, 50, 25 and 12% respectively. In general, much larger proportions of plant N was partitioned in the leaves more than the roots and stem (Figure 10).

Priming increased P content in Rayong 5, Rayong 7 and Rayong 9 by 40, 36 and 25% respectively but the effect was not found in Rayong 72 and KU 50. Most of the P taken up by cassava was stored in roots and stems (Figure 11).

Potassium content of Rayong 5, Rayong 7 and Rayong 9 was also increased by stake priming while in Rayong 72 and KU 50 priming had no effect. More than half of K uptake was partitioned in the roots (Figure 12).

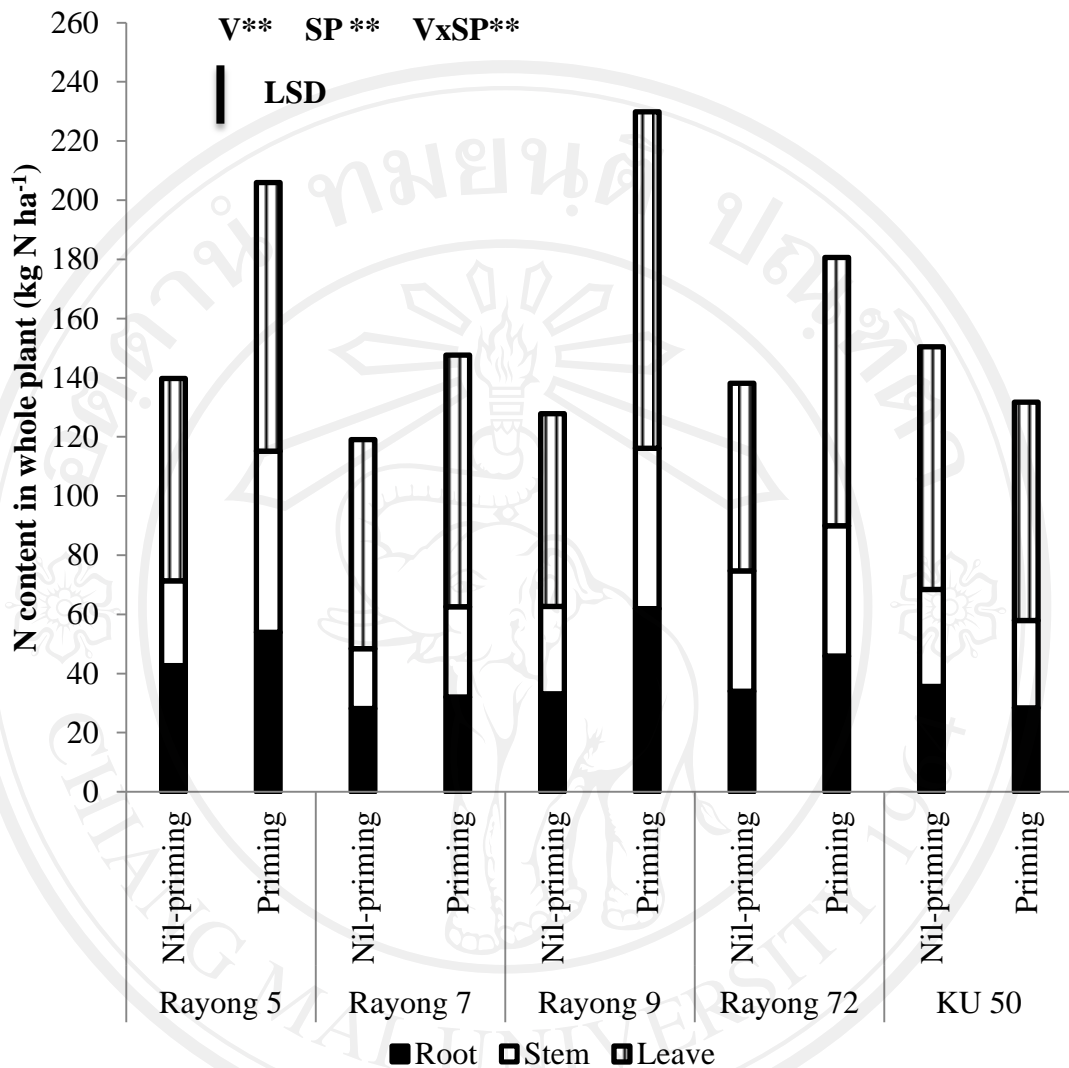


Figure 10 Effects of stake priming on N content in the whole plant as well as in roots, stems and leaves of cassava varieties at 12 months after planting. V = varieties, SP = stake priming, ** = F-test significant at $P < 0.01$.

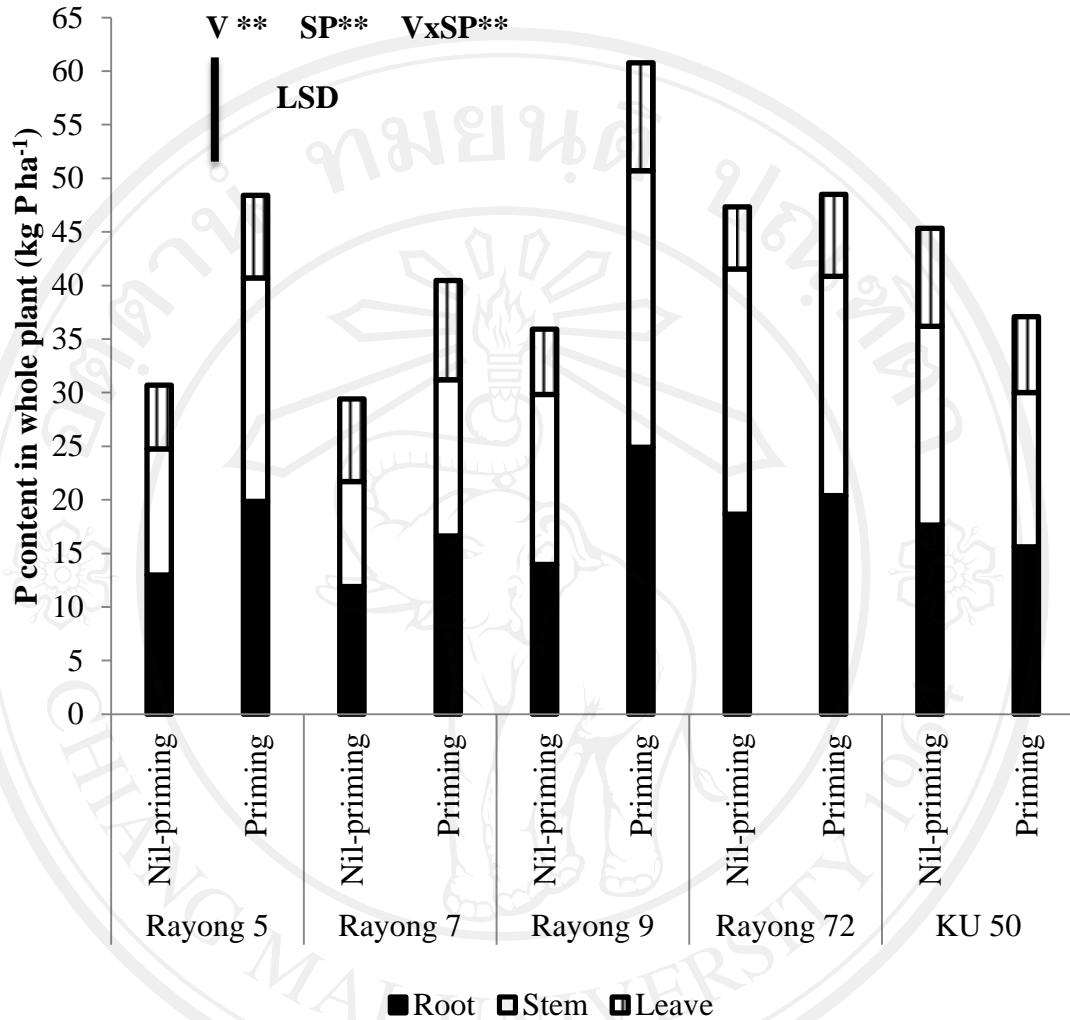


Figure 11 Effects of stake priming on P content in the whole plant as well as in roots, stems and leaves of cassava varieties at 12 months after planting. V = varieties, SP = stake priming, ** = F-test significant at $P < 0.01$.

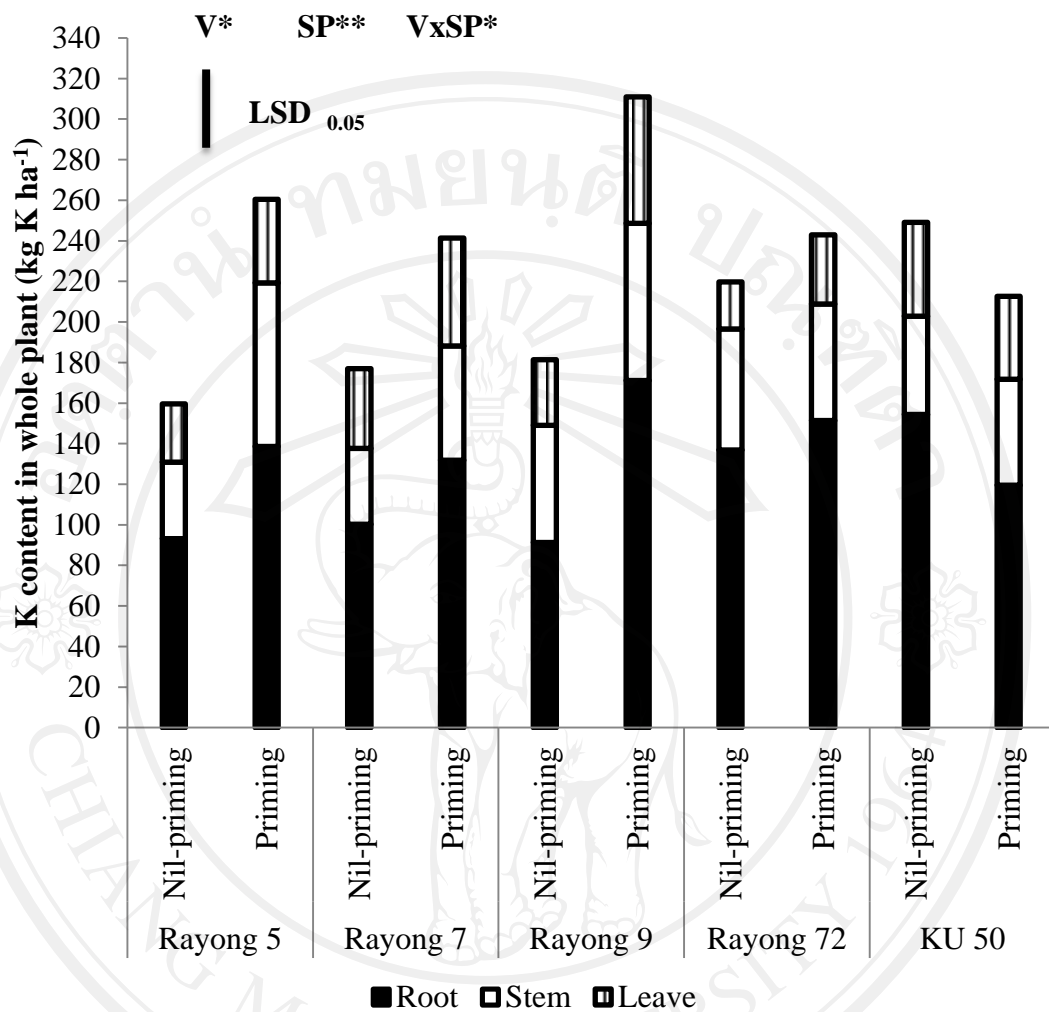


Figure 12 Effects of stake priming on K content in the whole plant as well as in roots, stems and leaves of cassava varieties at 12 months after planting. V = varieties, SP = stake priming, * = F-test significant at $P < 0.05$ and ** = F-test significant at $P < 0.01$.

4.2. Experiment 2: The responses to stake priming in KU 50 from different sources in Lao PDR on growth and yield.

First harvest at four months after planting

Stake priming (SP, $P > 0.05$), stake sources (SS, $P > 0.05$) and interaction between stake priming and stake sources (SP x SS, $P > 0.05$) had no effect on fresh root weight, aboveground fresh weight, starch content and starch yield (Tables 14, 15, 16 and 17). However, the effect of stake sources on root number per plant was noticed (SS, $P < 0.05$) while the effects of stake priming and interaction between stake priming and sources was not found (SP, $P > 0.05$ and SP x SS, $P > 0.05$). Plants grown from Naphok and Phaxay produced higher root number per plant than plants grown from Peak and Xay (Table 14).

Table 14 Effects of stake priming in KU 50 from different sources on fresh root weight.

Stake priming	Stake sources				Mean
	Naphok	Peak	Phaxay	Xay	
<i>Fresh root weight (t ha⁻¹)</i>					
Nil-priming	3.0	3.4	2.8	3.0	3.1
Priming	3.9	3.3	2.7	3.1	3.2
Mean	3.5	3.4	2.8	3.0	
F-test	SP ^{NS}		SS ^{NS}		SP x SS ^{NS}
LSD _{0.05}	-		-		-

SP = stake priming, SS = stake sources and NS = F-test not significant at P > 0.05.

Table 15 Effects of stake priming in KU 50 from different sources on root number.

Stake priming	Stake sources				Mean
	Naphok	Peak	Phaxay	Xay	
<i>Root number (root plant⁻¹)</i>					
Nil-priming	13.8	9.1	10.6	11.0	11.1
Priming	13.9	9.5	12.2	11.5	11.8
Mean	13.8 ^a	9.3 ^b	11.4 ^{ab}	11.2 ^b	
F-test	SP ^{NS}	SS*		SP x SS ^{NS}	
LSD _{0.05}	-	2.5		-	

SP = stake priming, SS = stake sources, * = F-test significant at $P < 0.05$ and NS = F-test not significant at $P > 0.05$. Values in the same column followed by different lower case letters are significantly different by LSD_{0.05}.

Table 16 Effects of stake priming in KU 50 from different sources on fresh aboveground weight.

Stake soaking	Stake sources				Mean
	Naphok	Peak	Phaxay	Xay	
<i>Fresh aboveground weight (t ha⁻¹)</i>					
Nil-priming	0.9	0.6	0.9	0.8	0.8
Priming	0.7	0.7	0.7	0.9	0.7
Mean	0.8	0.6	0.8	0.8	
F-test	SP ^{NS}	SS ^{NS}		SP x SS ^{NS}	
LSD _{0.05}	-	-		-	

SP = stake priming, SS = stake sources and NS = F-test not significant at P > 0.05.

Table 17 Effects of stake priming in KU 50 from different sources on starch content.

Stake priming	Stake sources				Mean
	Naphok	Peak	Phaxay	Xay	
<i>Starch content (%)</i>					
Nil-priming	13.3	11.5	14.4	13.0	13.1
Priming	13.0	11.1	14.3	14.7	13.3
Mean	13.2	11.3	14.4	13.9	
F-test	SP ^{NS}		SS ^{NS}		SP x SS ^{NS}
LSD _{0.05}	-		-		-

SP = stake priming, SS = stake sources and NS = F-test not significant at P > 0.05.

Table 18 Effects of stake priming in KU 50 from different sources on starch yield.

Stake priming	Stake sources				Mean
	Naphok	Peak	Phaxay	Xay	
<i>Starch yield (t ha⁻¹)</i>					
Nil-priming	0.4	0.4	0.4	0.4	0.4
Priming	0.5	0.4	0.4	0.5	0.4
Mean	0.4	0.4	0.4	0.4	
F-test	SP ^{NS}	SS ^{NS}		SP x SS ^{NS}	
LSD _{0.05}	-	-		-	

SP = stake priming, SS = stake sources and NS = F-test not significant at P > 0.05.

Final harvest at eight months after planting

There was no interaction between stake priming and stake sources (SP x SS, $P > 0.05$), but there was significant effect of stake priming and stake sources (SP and SS, $P < 0.05$) on fresh root yield. Stake priming increased fresh root weight by 20%. Stakes from Phaxay produced the highest fresh root weight followed by Peak, Xay and Naphok respectively (Table 19).

The effect of stake priming on root number depended on stake sources (SP x SS, $P < 0.05$). Root number was raised by priming in plants grown from stakes from Naphok and Phaxay but not with plants grown from stakes from the other sources (Figure 13).

For fresh aboveground weight, stake priming depended on stake sources (SP x SS, $P < 0.01$). Fresh aboveground weight was increased by priming in plants grown from stakes from Phaxay but not with plants grown from the other sources (Figure 14).

The effects of stake priming, stake sources and interaction between stake priming and stake sources on starch content were not found (SP, SS and SP x SS, $P > 0.05$) (Table 20). Starch yield was increased by priming by 25% (SP, $P < 0.05$), but the effect of stake sources and interaction between stake priming and stake sources on starch yield was not found (SS and SP x SS, $P > 0.05$) (Table 21).

Table 19 Effects of stake priming in KU 50 from different sources on fresh root weight.

Stake soaking	Stake sources				Mean
	Naphok	Peak	Phaxay	Xay	
<i>Fresh root weight (t ha⁻¹)</i>					
Nil-priming	14.7	15.4	19.6	18.4	17.0 ^B
Priming	16.8	21.6	26.5	18.5	20.9 ^A
Mean	15.8 ^b	18.5 ^{ab}	23.0 ^a	18.5 ^{ab}	
F-test		SP*	SS*	SP x SS ^{NS}	
LSD _{0.05}		3.4	4.9	-	

SP = stake priming, SS = stake sources, * = F-test significant at $P < 0.05$ and NS = F-test not significant at $P > 0.05$. Values in the same row followed by different upper case letters are significantly different by LSD_{0.05}. Values in the same column followed by different lower case letters are significantly different by LSD_{0.05}.

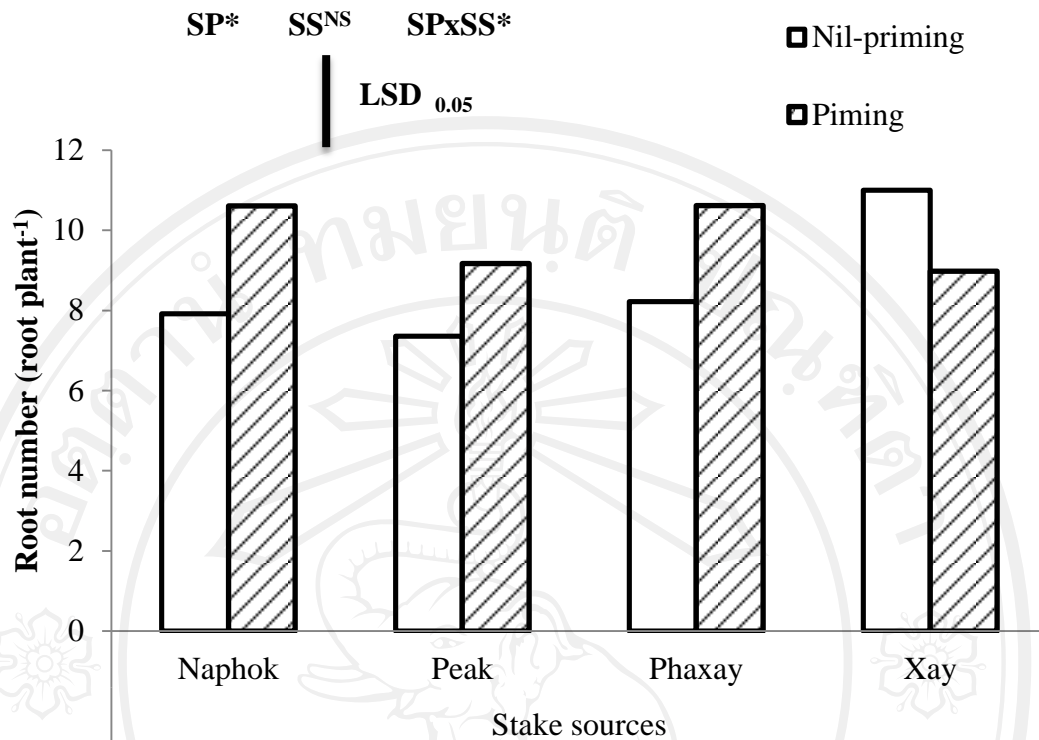


Figure 13 Effects of stake priming on root number in KU 50 from different sources. SP = stake priming, SS = stake sources, * = F-test significant at $P < 0.05$ and NS = F-test not significant at $P > 0.05$

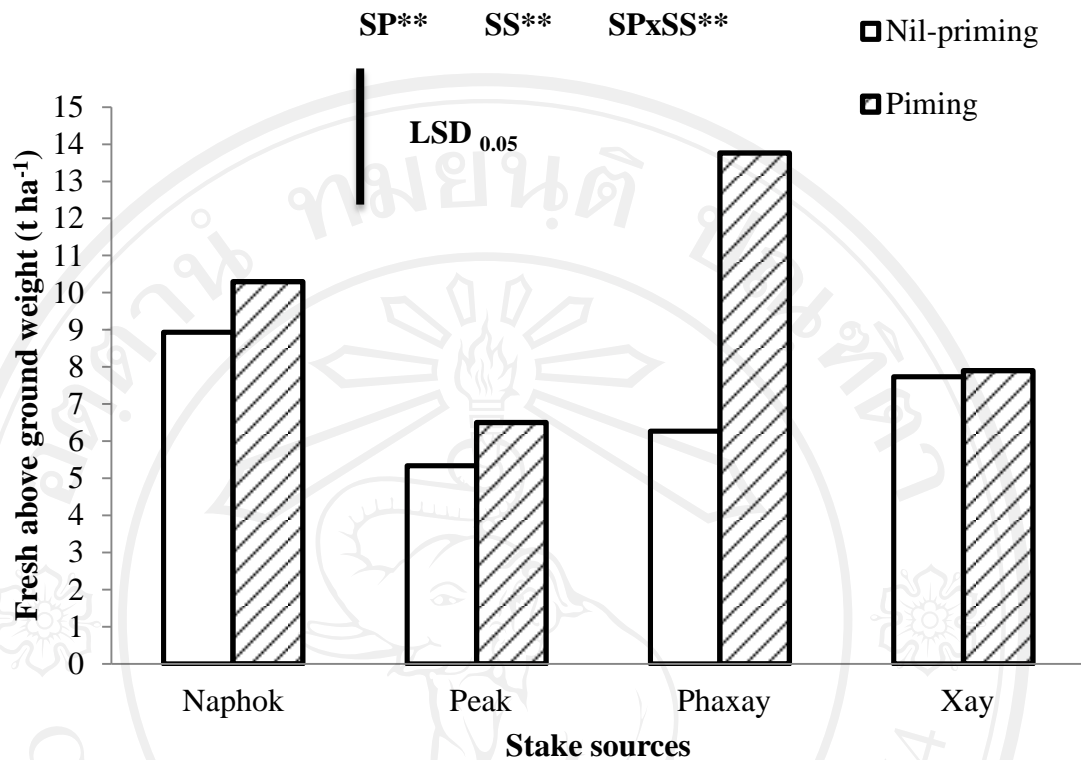


Figure 14 Effects of stake priming in KU 50 from different sources on fresh aboveground weight. SP = stake priming, SS = stake sources, ** = F-test significant ($P < 0.01$) and NS = F-test not significant at $P > 0.05$.

Table 20 Effects of stake priming in KU 50 from different sources on starch content.

Stake priming	Stake sources				Mean
	Naphok	Peak	Phaxay	Xay	
<i>Starch content (%)</i>					
Nil-priming	28.8	27.8	27.7	28.1	28.1
Priming	28.5	29.8	28.1	27.8	28.5
Mean	28.7	28.8	27.9	28.0	
F-test	SP ^{NS}	SS ^{NS}	SP x SS ^{NS}		
LSD _{0.05}	-	-	-		

SP = stake priming, SS = stake sources and NS = F-test not significant at P > 0.05.

Table 21 Effects of stake priming in KU 50 from different sources on starch yield.

Stake soaking	Stake sources				Mean
	Naphok	Peak	Phaxay	Xay	
<i>Starch yield (t ha⁻¹)</i>					
Nil-priming	4.3	4.3	5.4	5.2	4.8 ^B
Priming	4.9	6.5	7.4	5.2	6.0 ^A
Mean	4.6	5.4	6.4	5.2	
F-test	SP*	SS ^{NS}		SP x SS ^{NS}	
LSD _{0.05}	1.0	-		-	

SP = stake priming, SS = stake sources, * = F-test significant at $P < 0.05$ and NS = F-test not significant at $P > 0.05$. Values in the same row followed by different upper case letters are significantly different by LSD_{0.05}.

4.3. Experiment 3: Response to stake priming in cassava varieties from different sources in Thailand on growth, yield and nutrient accumulation.

First harvest at four months after planting

There was significant interaction among varieties via priming and stake sources on fresh and dry root weight ($V \times SP \times SS$, $P < 0.01$) (Figures 15 and 16). Priming increased fresh and dry root weight in Rayong 72 with stakes from Mahasarakham and in KU 50 with stakes from Chiang Mai only; stakes of the two varieties from other sources had no effect.

Although there was no significant interaction among varieties via stake priming and stake source in their effects on dry above ground weight ($V \times SP \times SS$, $P > 0.05$), there was interaction between varieties and stake sources ($V \times SS$, $P > 0.05$) and stake priming and stake sources ($SP \times SS$, $P < 0.01$) (Table 22). Differences in aboveground dry weight of plants grown from stakes from different sources varied whether the stakes were primed or not. With nil-priming, stakes from Chiang Mai and Mahasarakham produced significantly more dry aboveground weight than stakes from Mukdahan. With priming, plants grown from stakes from Chiang Mai produced more dry aboveground weight than stakes from Mahasarakham and Mukdahan. Thus the lowest dry aboveground weight was found with nil-primed stakes from Mukdahan, while the highest dry aboveground weight was found with primed stakes from Chiang Mai.

Similarly for root number, there was no significant interaction among varieties, stake priming and stake sources ($V \times SP \times SS$, $P > 0.05$). However, the effect of priming on root number depended on stake sources ($SP \times SS$, $P < 0.01$) (Table 23). Root number was increased by priming with plants grown with stakes from Chiang Mai and Mahasarakham but not with stakes from Mukdahan. The effect of cassava varieties on root number also depended on stake sources ($V \times SS$, $P < 0.05$). In Rayong 72 stakes from Chiang Mai produced higher root number than stakes from Mahasarakham and Mukdahan, and in KU 50 stakes from Chiang Mai produced the highest root number followed by Mahasarakham and Mukdahan respectively.

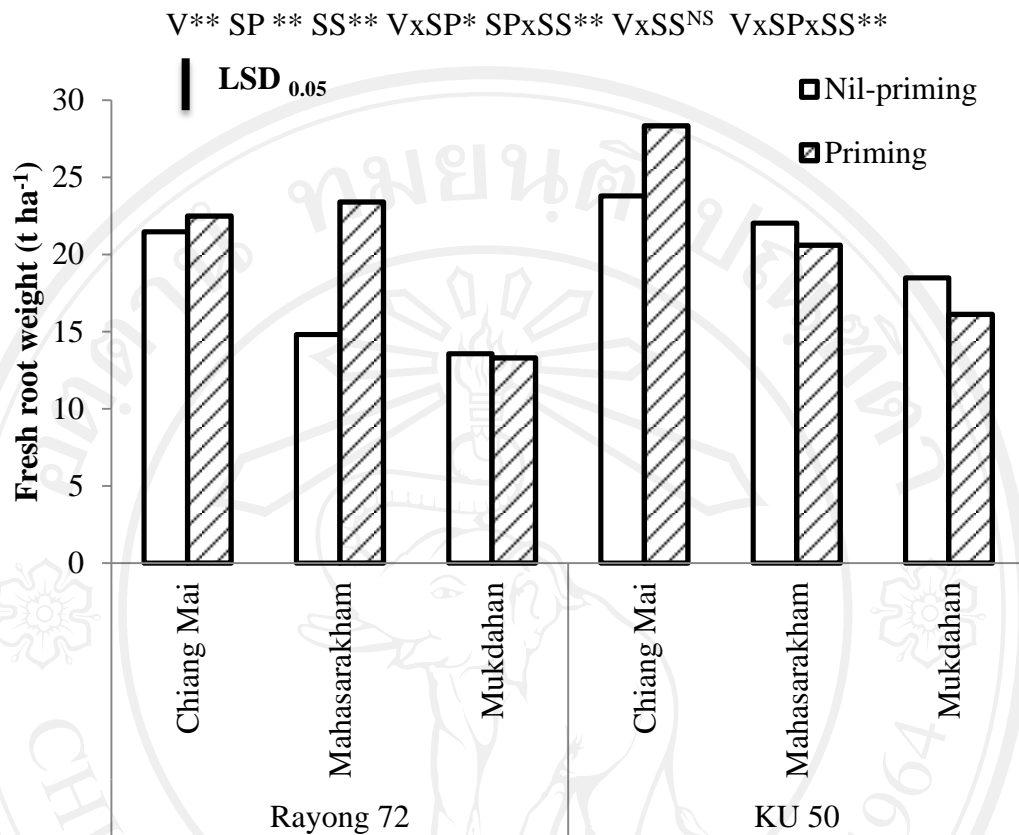


Figure 15 Effects of stake priming in KU 50 and Rayong 72 from Chiang Mai, Mahasarakham and Mukdahan on fresh root weight. V = varieties, SP = stake priming, SS = stake sources, * = F-test significant at $P < 0.05$, ** = F-test significant at $P < 0.01$ and NS = F-test not significant at $P > 0.05$.

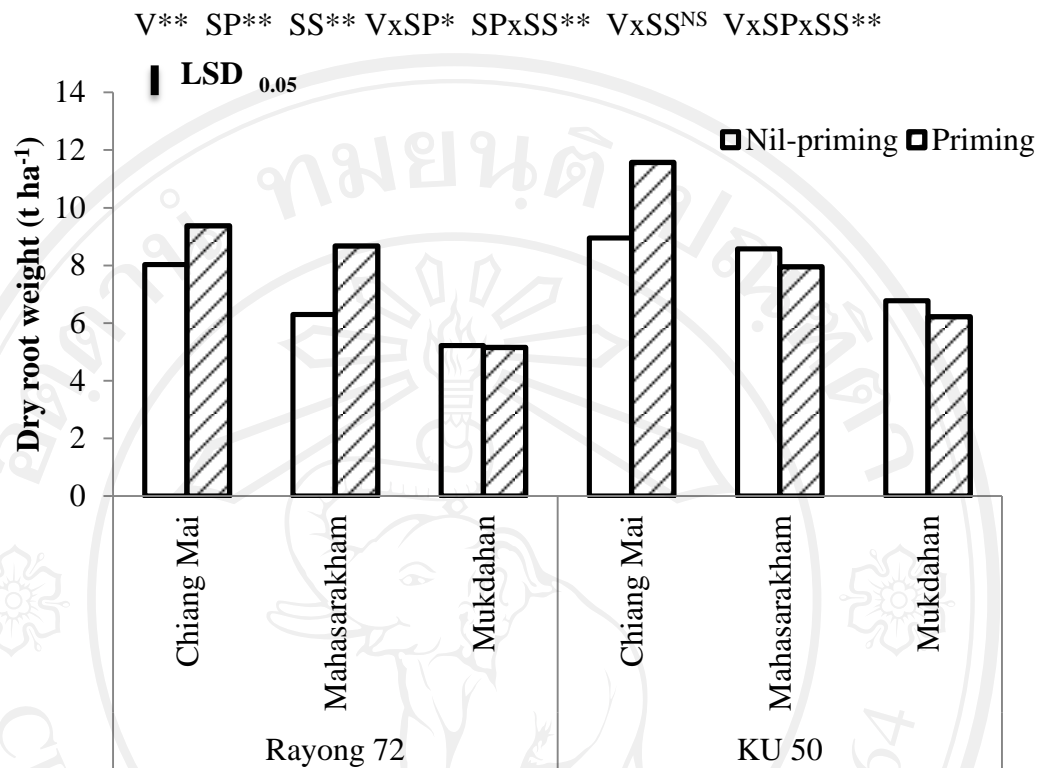


Figure 16 Effects of stake priming in KU 50 and Rayong 72 from Chiang Mai, Mahasarakham and Mukdahan on dry root weight. V = varieties, SP = stake priming, SS = stake sources, * = F-test significant at $P < 0.05$, ** = F-test significant at $P < 0.01$ and NS = F-test not significant at $P > 0.05$.

Table 22 Effects of stake priming in KU 50 and Rayong 72 from Chiang Mai, Mahasarakham and Mukdahan on dry aboveground weight.

Variety	Stake priming	Stake source			Mean
		Chiang Mai	Mahasarakham	Mukdahan	
<i>Dry aboveground weight (t ha⁻¹)</i>					
Rayong 72	Nil-priming	0.5	0.4	0.3	0.4
	Priming	0.5	0.3	0.4	0.4
KU 50	Nil-priming	0.4	0.6	0.3	0.4
	Priming	0.6	0.5	0.3	0.5
Mean		0.5 ^a	0.4 ^a	0.3 ^b	
Mean	Rayong 72	0.5 ^a	0.3 ^b	0.4 ^b	0.4
	KU 50	0.5 ^a	0.6 ^a	0.3 ^b	0.5
Mean	Nil-priming	0.5 ^{abc}	0.5 ^{ab}	0.3 ^d	0.4
	Priming	0.6 ^a	0.4 ^{bcd}	0.4 ^{cd}	0.4
F-test		V ^{NS} SP ^{NS} SS**	V x SP ^{NS} V x SS**	SP x SS* V x SP x SS ^{NS}	
LSD _{0.05}		- - 0.1	- 0.1	0.1 -	

V = varieties, SP = stake priming, SS = stake sources, * = F-test significant at P < 0.05, ** = F-test significant at P < 0.01 and NS = F-test not significant at P > 0.05. Values in the same row followed by different lower case letters are significantly different by LSD_{0.05}.

Table 23 Effects of stake priming in KU 50 and Rayong 72 from Chiang Mai, Mahasarakham and Mukdahan on root number.

Variety	Stake priming	Stake source			Mean		
		Chiang Mai	Mahasarakham	Mukdahan			
<i>Root number (root plant⁻¹)</i>							
Rayong 72	Nil-priming	10.9	8.9	8.3	9.4		
	Priming	13.4	11.2	9.4	11.4		
KU 50	Nil-priming	14	12.2	10.9	12.4		
	Priming	17.4	14.9	10.3	14.2		
Mean		13.9	11.8	9.7			
Mean	Rayong 72	12.2 ^c	10.1 ^d	8.9 ^e	10.4 ^B		
	KU 50	15.7 ^a	13.6 ^b	10.6 ^d	13.3 ^A		
Mean	Nil-priming	12.4 ^b	10.5 ^c	9.6 ^c	10.9 ^B		
	Priming	15.4 ^a	13.1 ^b	9.9 ^c	12.8 ^A		
F-test	V**	SP**	SS**	V x SP ^{NS}	V x SS*	SP x SS**	V x SP x SS ^{NS}
LSD _{0.05}	0.6	0.6	0.8	-	1.1	1.1	-

V = Varieties, SP = stake priming, SS = stake sources, * = F-test significant at P < 0.05, ** = F-test significant at P < 0.01 and NS = F-test not significant at P > 0.05. Values in the same column followed by different upper case letters are significantly different by LSD_{0.05}. Values in the same row followed by different lower case letters are significantly different by LSD_{0.05}.

Priming also increased starch content and starch yield as well. The effect of priming on starch content and starch yield depended on varieties and stake sources (V x SP x SS, $P < 0.01$) (Figures 17 and 18). Starch content was raised by priming in Rayong 72 with stakes from Mahasarakham but not with stakes from the other sources. In KU 50 priming had a significant effect on starch content with stakes from Chiang Mai but not with stakes from the other sources. In Rayong 72 priming increased starch yield in plants grown from stakes from Mahasarakham only. Priming increased starch yield in KU 50 when grown with stakes from Chiang Mai but not with stakes from the other sources.

Accumulations of N, P and K in Rayong 72 and KU 50 were influenced by stake priming and sources (V x SP x SS, $P < 0.05$). Priming increased N accumulation by Rayong 72 with stakes from all sources while it increased N accumulation in KU 50 only in those plants grown from stakes from Chiang Mai but not in plants grown from stakes from the other sources (Figure 19). Priming had no effect on whole plant P in both cassava varieties when planted with stakes from Mukdahan, and in KU 50 with stakes from Mahasarakham (Figure 20). Priming had a slight effect on whole plant P in Rayong 72 with stakes from Mahasarakham and a larger effect with stakes from Chiang Mai. The largest effect of priming was found in KU 50 grown from stakes from Chiang Mai. Cassava varieties, stake source and priming had similar effects on whole plant K as they did on plant P. Priming increased K accumulation in Rayong 72 in plants grown from stakes from Chiang Mai and Mahasarakham but not in plants grown from stakes from Mukdahan. In KU 50, priming increased accumulation of K from plants grown from Chiang Mai but not from plants grown from the other two sources (Figure 21).

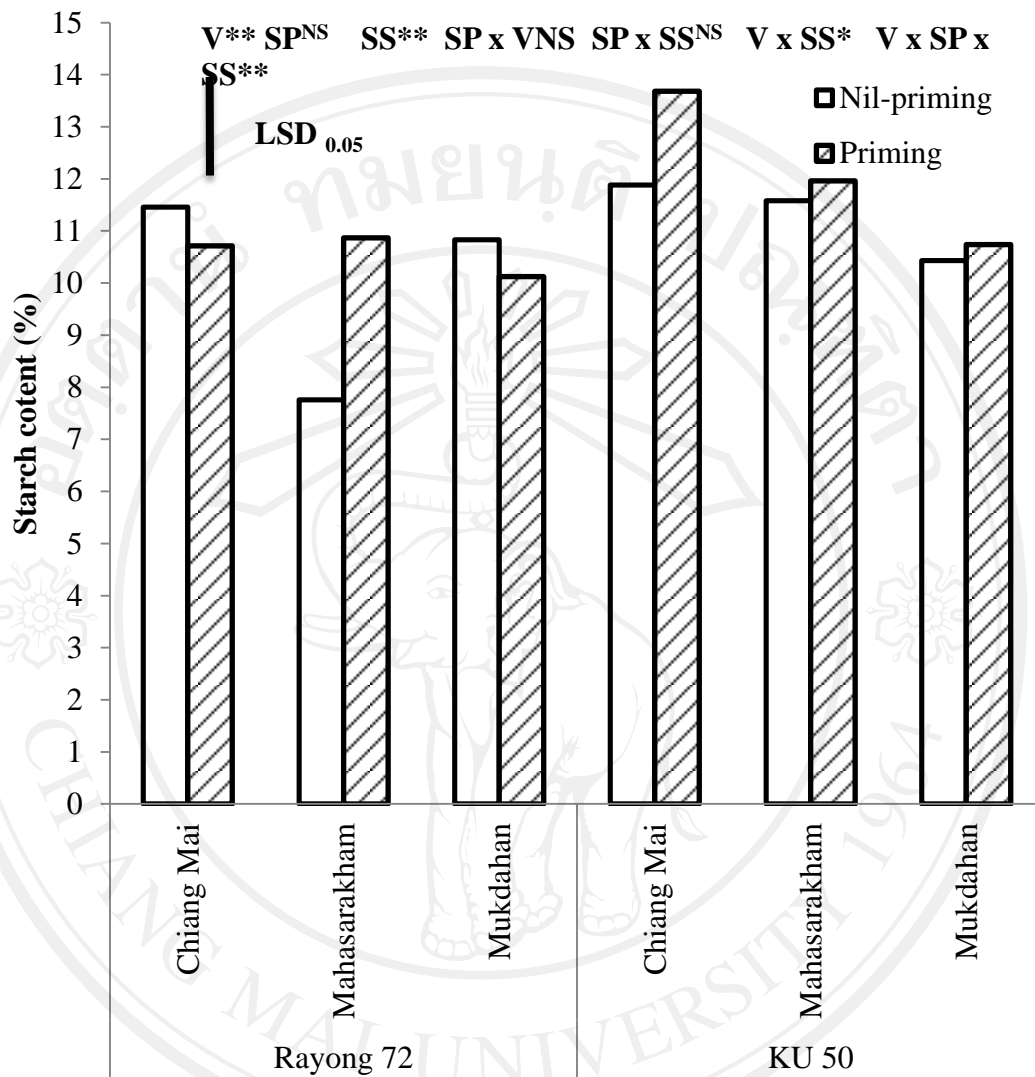


Figure 17 Effects of stake priming in KU 50 and Rayong 72 from Chiang Mai, Mahasarakham and Mukdahan on starch content. V = varieties, SP = stake priming, SS = stake sources, * = F-test significant at $P < 0.05$, ** = F-test significant at $P < 0.01$ and NS = F-test not significant at $P > 0.05$.

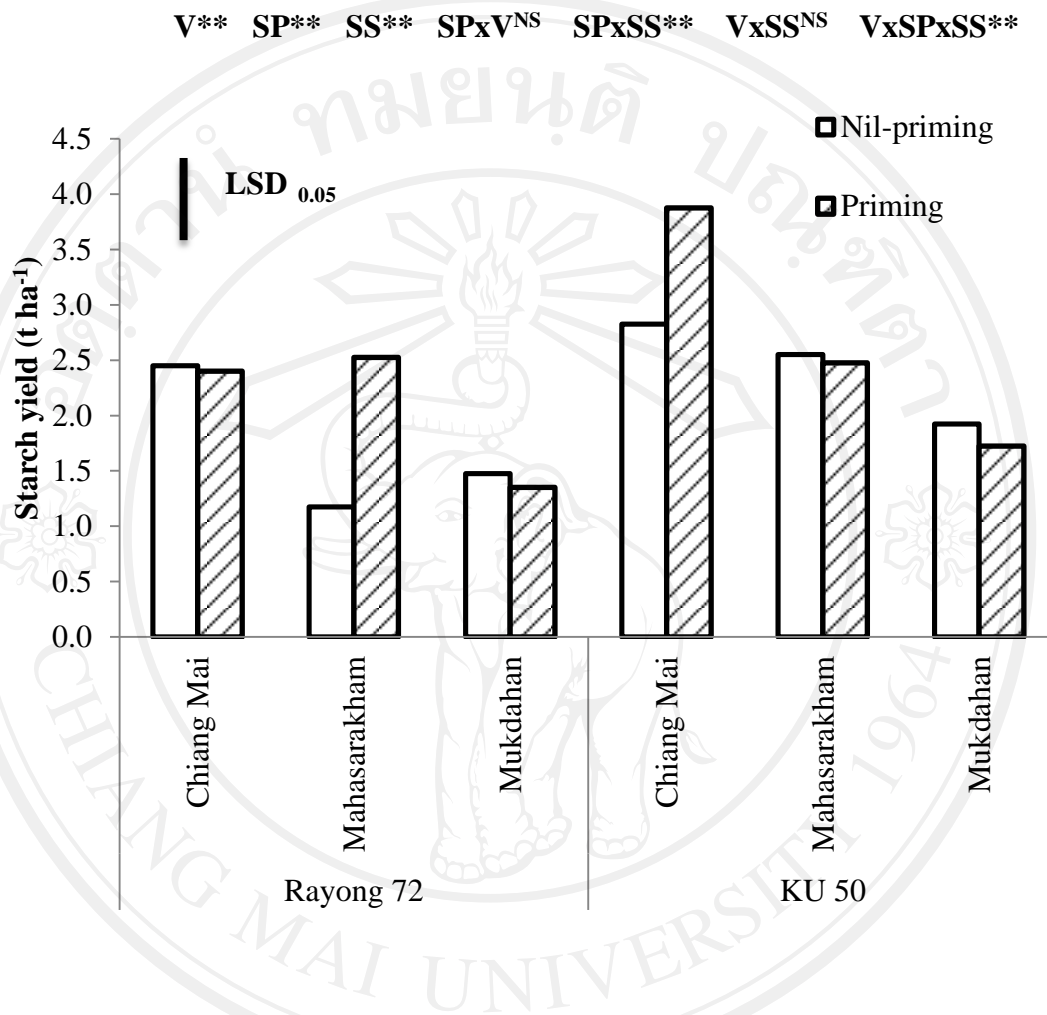


Figure 18 Effects of stake priming in KU 50 and Rayong 72 from Chiang Mai, Maharakham and Mukdahan on starch yield. V = varieties, SP = stake priming, SS = stake sources, ** = F-test significant at $P < 0.01$ and NS = F-test not significant at $P > 0.05$.

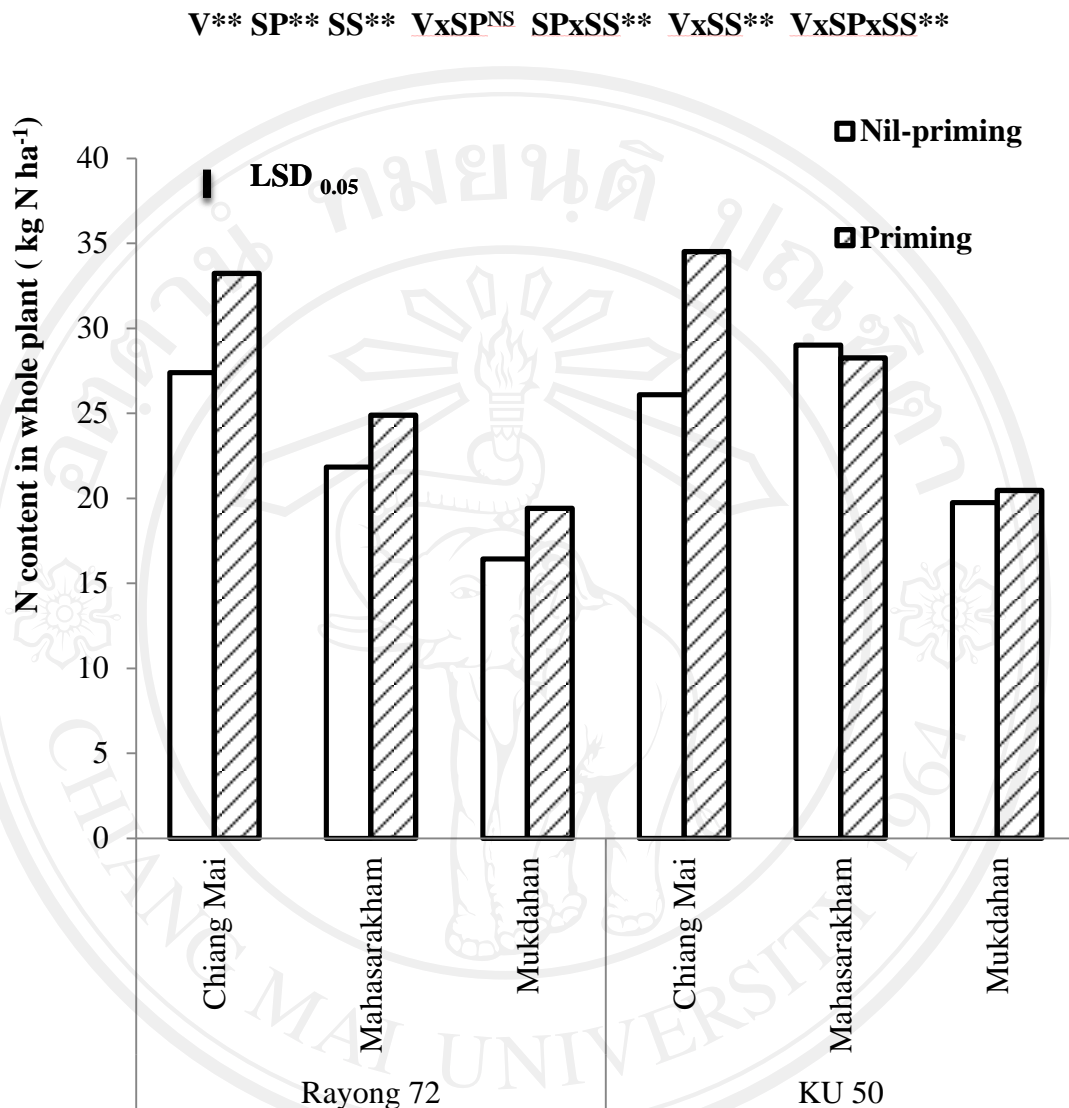


Figure 19 Effects of stake priming in KU 50 and Rayong 72 from Chiang Mai, Mahasarakham and Mukdahan on N content in the whole plant. V = varieties, SP = stake priming, SS = stake sources, ** = F-test significant at $P < 0.01$ and NS = F-test not significant at $P > 0.05$.

V** SP** SS** VxSP^{NS} SPxSS** VxSS** VxSPxSS**

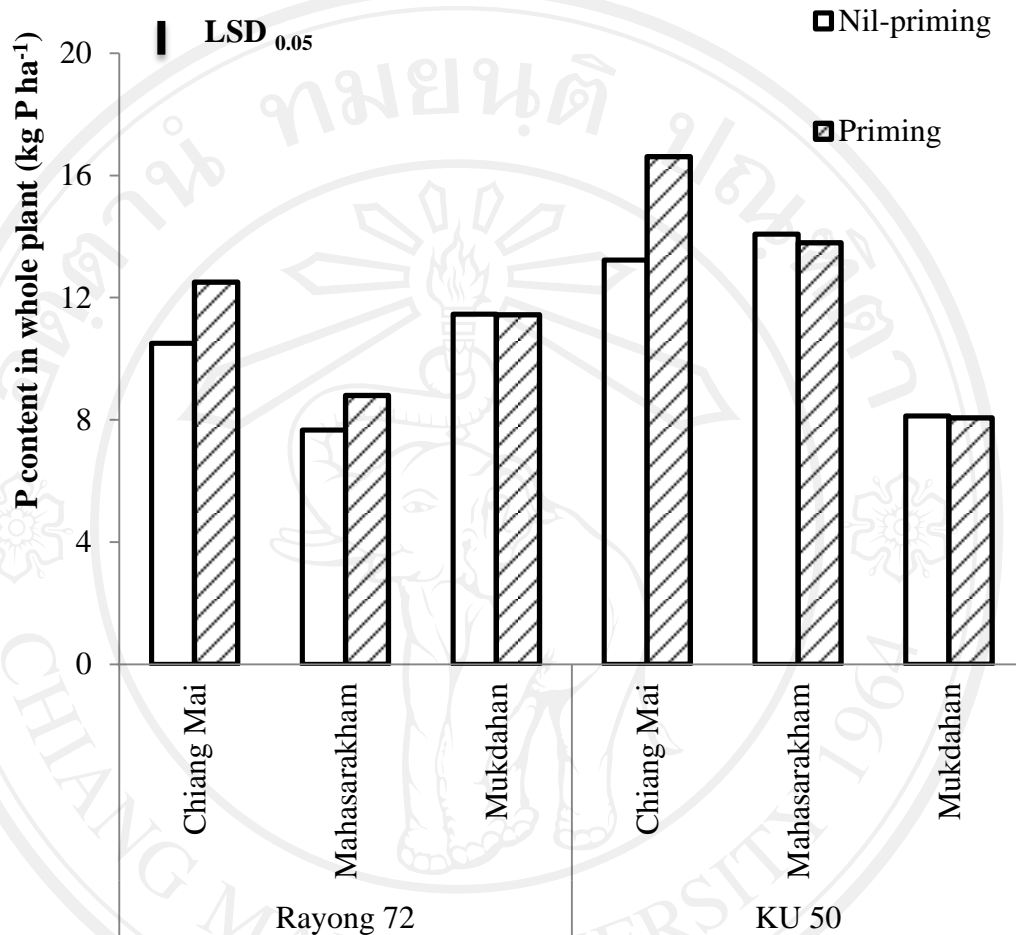


Figure 20 Effects of stake priming in KU 50 and Rayong 72 from Chiang Mai, Mahasarakham and Mukdahan on P content of the whole plant. V = varieties, SP = stake priming, SS = stake sources, ** = F-test significant at $P < 0.01$ and NS = F-test not significant at $P > 0.05$.

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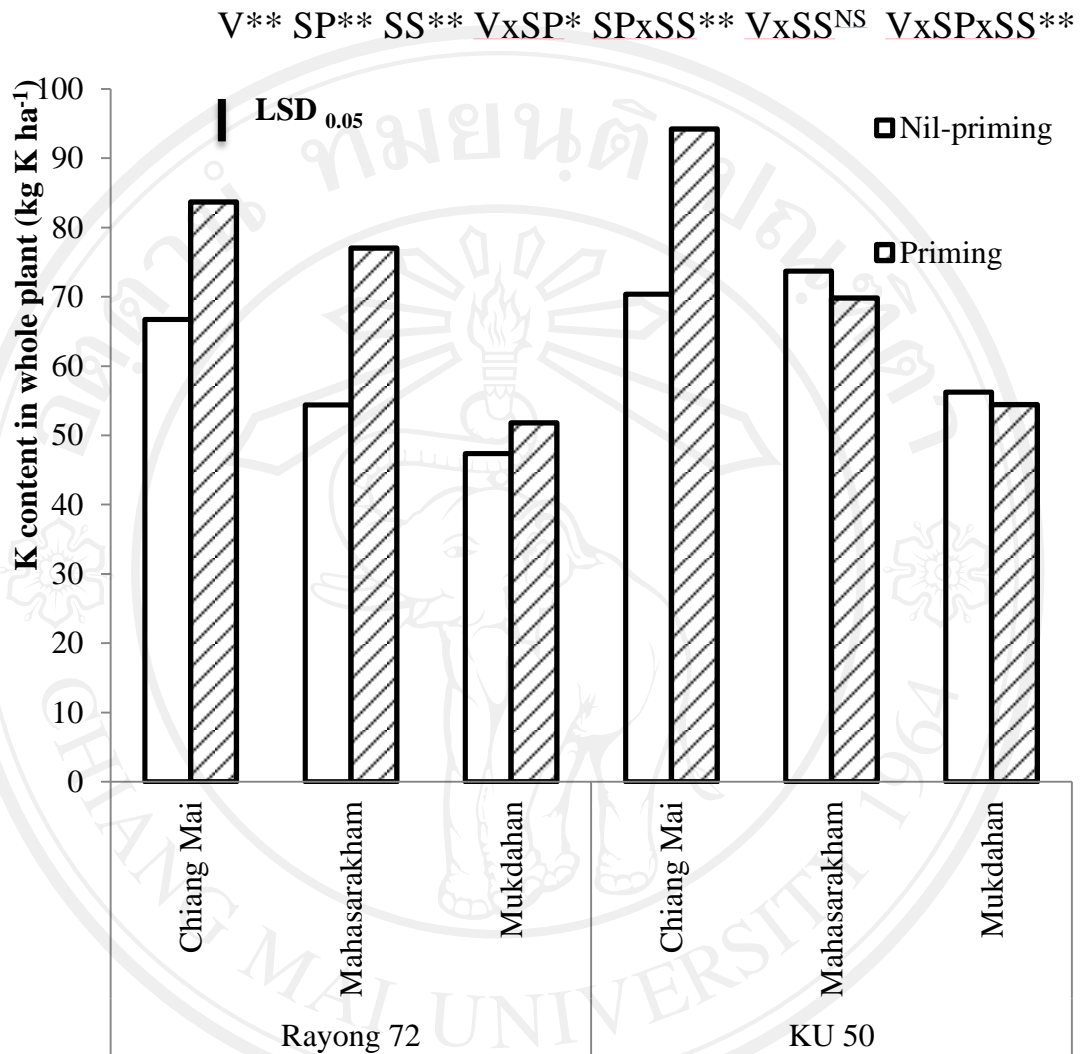


Figure 21 Effects of stake priming in KU 50 and Rayong 72 from Chiang Mai, Mahasarakham and Mukdahan on K content in the whole plant. V = varieties, SP = stake priming, SS = stake sources, ** = F-test significant at $P < 0.01$ and NS = F-test not significant at $P > 0.05$.

Final harvesting at eight months after planting

The effect of priming on fresh root weight depended on cassava varieties (V x SP, $P < 0.05$) and stake sources (SS x SP, $P < 0.05$) (Table 24). In KU 50 priming increased fresh root weight while the effect was not found in Rayong 72. Priming had no effect on fresh root weight with stakes from Chiang Mai and Mukdahan, but increased fresh root weight by 50% with stakes from Mahasarakham. Interaction among varieties, priming and stake sources on dry root weight was significant (V x SP x SS, $P < 0.05$). In Rayong 72 priming had no effect on root dry weight regardless of stake sources. In KU 50 priming increased root dry weight up to 100% with stakes from Mahasarakham but not with stakes from the other two sources (Figure 22).

The effect of cassava varieties on dry aboveground weight also depended on stake source (Table 25). Rayong 72 with stakes from Chiang Mai gave lower dry aboveground weight than plants grown with stakes from Mahasarakham while dry aboveground weight of plants grown with staked from Mukdahan was in between the two sources. In KU 50 stakes from Chiang Mai and Mahasarakham had higher dry aboveground weight than stakes from Mukdahan (V x SS, $P < 0.01$). The effect of priming on dry aboveground weight also depended on stake source (SP x SS, $P < 0.01$). Dry aboveground weight was raised by priming in plants grown from stakes from Chiang Mai and Mahasarakham but not with stakes from Mukdahan (Table 25).

There was significant interaction among varieties, priming and stake sources on root number (V x S x SS, $P < 0.01$) (Figure 23). Priming had no effect on root number in Rayong 72 regardless of stake sources. In contrast, root number in KU 50 was about doubled by priming with stakes from Mahasarakham but not with stakes from the other two sources.

Table 24 Effects of stake priming in KU 50 and Rayong 72 from Chiang Mai, Mahasarakham and Mukdahan on fresh root weight.

Variety	Stake	Stake source			Mean		
	Priming	Chiang Mai	Mahasarakham	Mukdahan			
<i>Fresh root weight (t ha⁻¹)</i>							
Rayong 72	Nil-priming	44.2	37.5	47.1	43.0 ^{AB}		
	Priming	50.5	41.5	43.4	45.1 ^{AB}		
KU 50	Nil-priming	42.6	34.3	37.7	38.2 ^B		
	Priming	47.2	66.5	42.3	52.0 ^A		
Mean	Rayong 72	47.4 ^{ab}	39.5 ^b	45.2 ^{ab}	44		
	KU 50	44.9 ^{ab}	50.4 ^a	40.0 ^b	45.1		
Mean	Nil-priming	43.4 ^{ab}	35.9 ^b	42.4 ^{ab}	40.6 ^A		
	Priming	48.9 ^{ab}	54.0 ^a	42.8 ^{ab}	48.6 ^B		
F-test	V ^{NS}	SP ^{**}	SS ^{NS}	V x SP [*]	V x SS [*]	SP x SS [*]	V x SP x SS ^{NS}
LSD _{0.05}	-	5.1	-	7.2	8.8	8.8	-

V = varieties, SP = stake priming, SS = stake sources, * = F-test significant at P < 0.05, ** = F-test significant at P < 0.01 and NS = F-test not significant at P > 0.05. Values in the same column followed by different upper case letters are significantly different by LSD_{0.05}. Values in the same row followed by different lower case letters are significantly different by LSD_{0.05}.

Table 25 Effects of stake priming in KU 50 and Rayong 72 from Chiang Mai, Mahasarakham and Mukdahan on dry aboveground weight.

Variety	Stake		Stake source			Mean	
	Priming		Chiang Mai	Mahasarakham	Mukdahan		
<i>Dry aboveground weight (t ha⁻¹)</i>							
Rayong 72	Nil-priming		4.5	3.0	4.9	4.1 ^B	
	Priming		4.2	4.4	4.4	4.3 ^B	
KU 50	Nil-priming		7.2	3.8	3.5	4.8 ^B	
	Priming		7.9	8.1	4.0	6.7 ^A	
	Mean		6.0 ^a	4.8 ^b	4.2 ^b		
Mean	Rayong 72		4.4 ^{bc}	3.7 ^c	4.6 ^{bc}	4.2 ^B	
	KU 50		7.5 ^a	6.0 ^{ab}	3.7 ^c	5.7 ^A	
Mean	Nil-priming		5.8 ^{ab}	3.4 ^c	4.2 ^{bc}	4.5 ^B	
	Priming		6.1 ^a	6.3 ^a	4.2 ^{bc}	5.5 ^A	
F-test	V**	SP**	SS**	V x SP*	V x SS**	SP x SS**	V x S x L ^{NS}
LSD _{0.05}	2.0	2.0	3.0	3.8	5.3	5.2	-

V = varieties, SP = stake priming, SS = stake sources, * = F-test significant at P < 0.05, ** = F-test significant at P < 0.01 and NS = F-test not significant at P > 0.05. Values in the same column followed by different upper case letters are significantly different by LSD_{0.05}. Values in the same row followed by different lower case letters are significantly different by LSD_{0.05}.

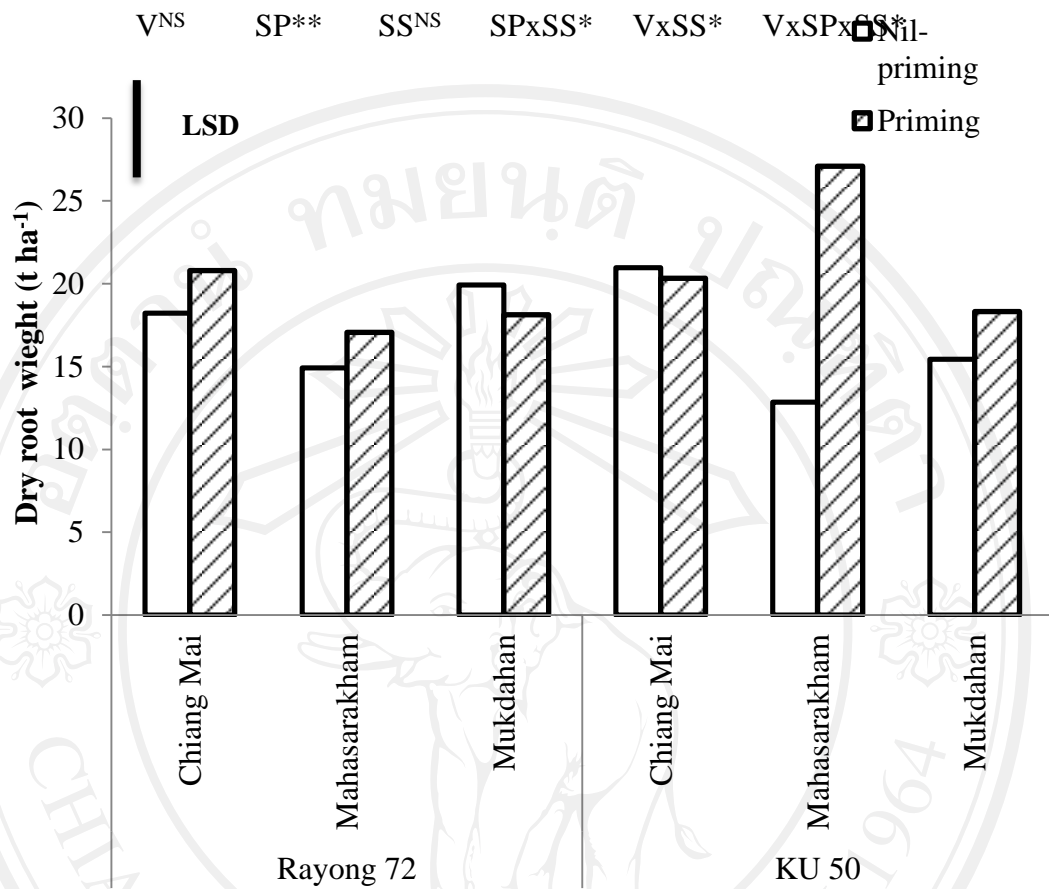


Figure 22 Effects of stake priming in KU 50 and Rayong 72 from Chiang Mai, Mahasarakham and Mukdahan on dry root weight. V = varieties, SP = stake priming, SS = stake sources, ** = F-test significant at $P < 0.01$ and NS = F-test not significant at $P > 0.05$.

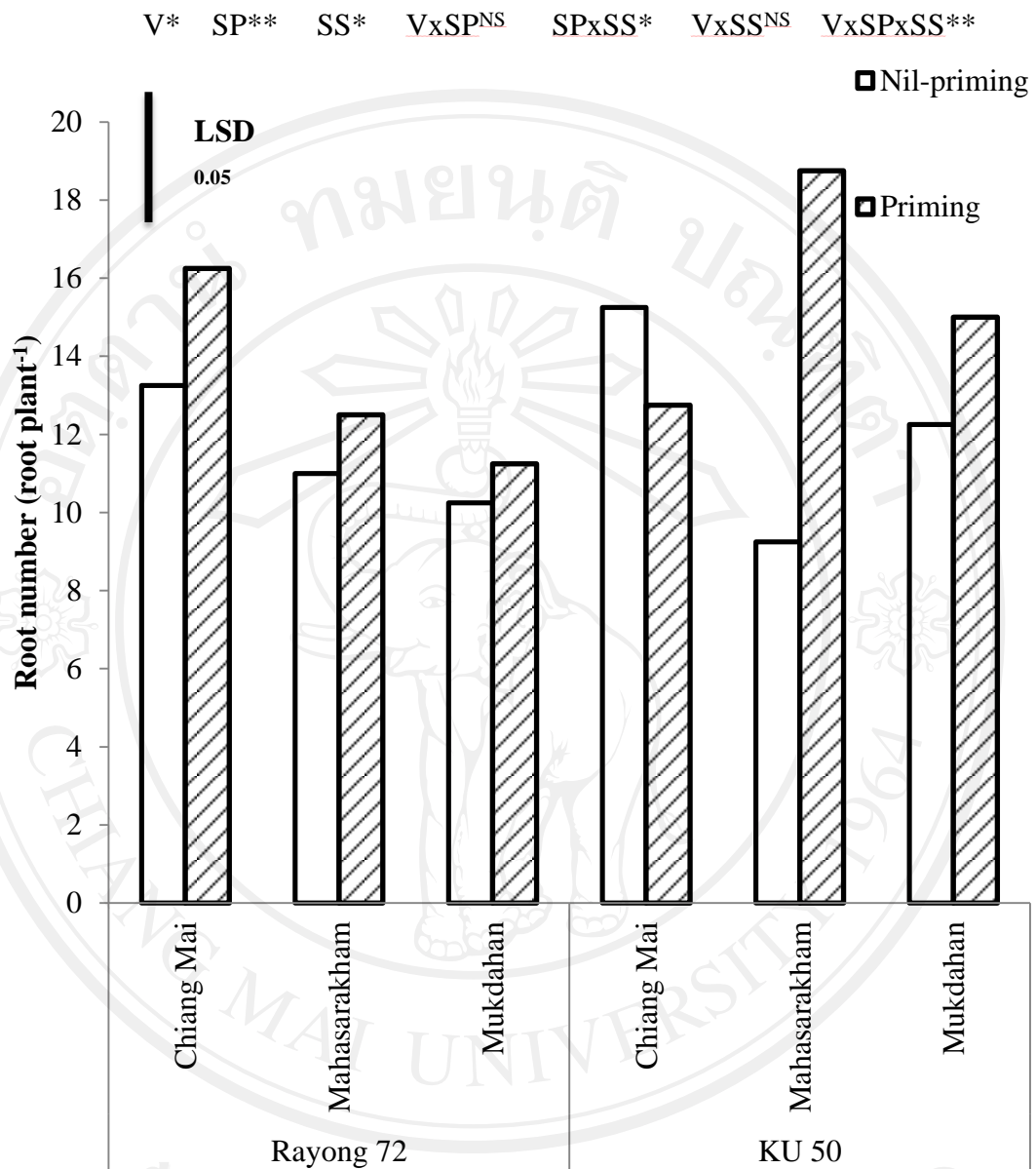
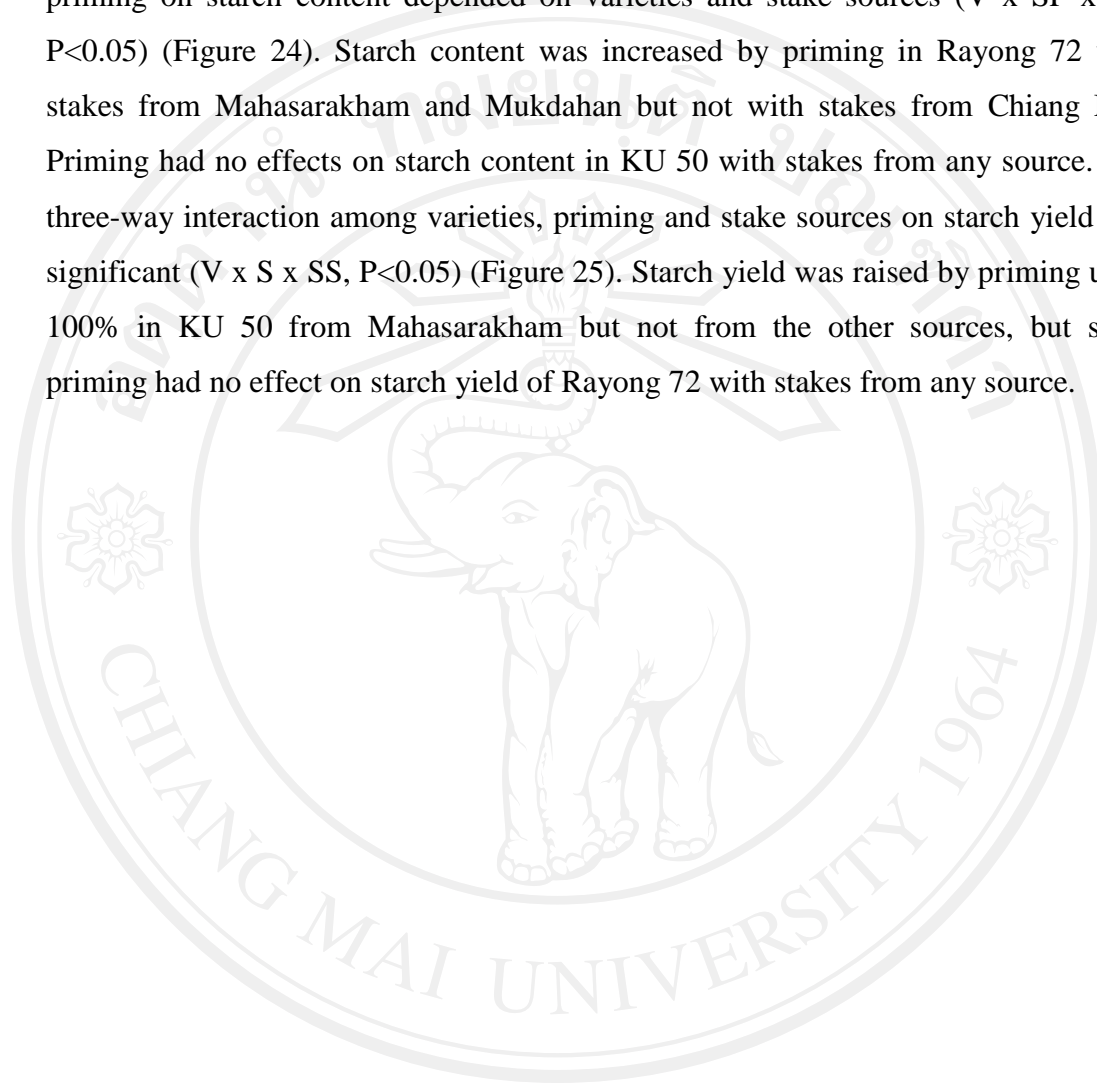


Figure 23 Effects of stake priming in KU 50 and Rayong 72 from Chiang Mai, Mahasarakham and Mukdahan on root number. V = varieties, SP = stake priming, SS = stake sources, ** = F-test significant at $P < 0.01$ and NS = F-test not significant at $P > 0.05$.

Priming not only increased root yield, dry aboveground weight and root number, but it also affected starch content and starch yield as well. The effect of priming on starch content depended on varieties and stake sources (V x SP x SS, $P < 0.05$) (Figure 24). Starch content was increased by priming in Rayong 72 with stakes from Mahasarakham and Mukdahan but not with stakes from Chiang Mai. Priming had no effects on starch content in KU 50 with stakes from any source. The three-way interaction among varieties, priming and stake sources on starch yield was significant (V x S x SS, $P < 0.05$) (Figure 25). Starch yield was raised by priming up to 100% in KU 50 from Mahasarakham but not from the other sources, but stake priming had no effect on starch yield of Rayong 72 with stakes from any source.



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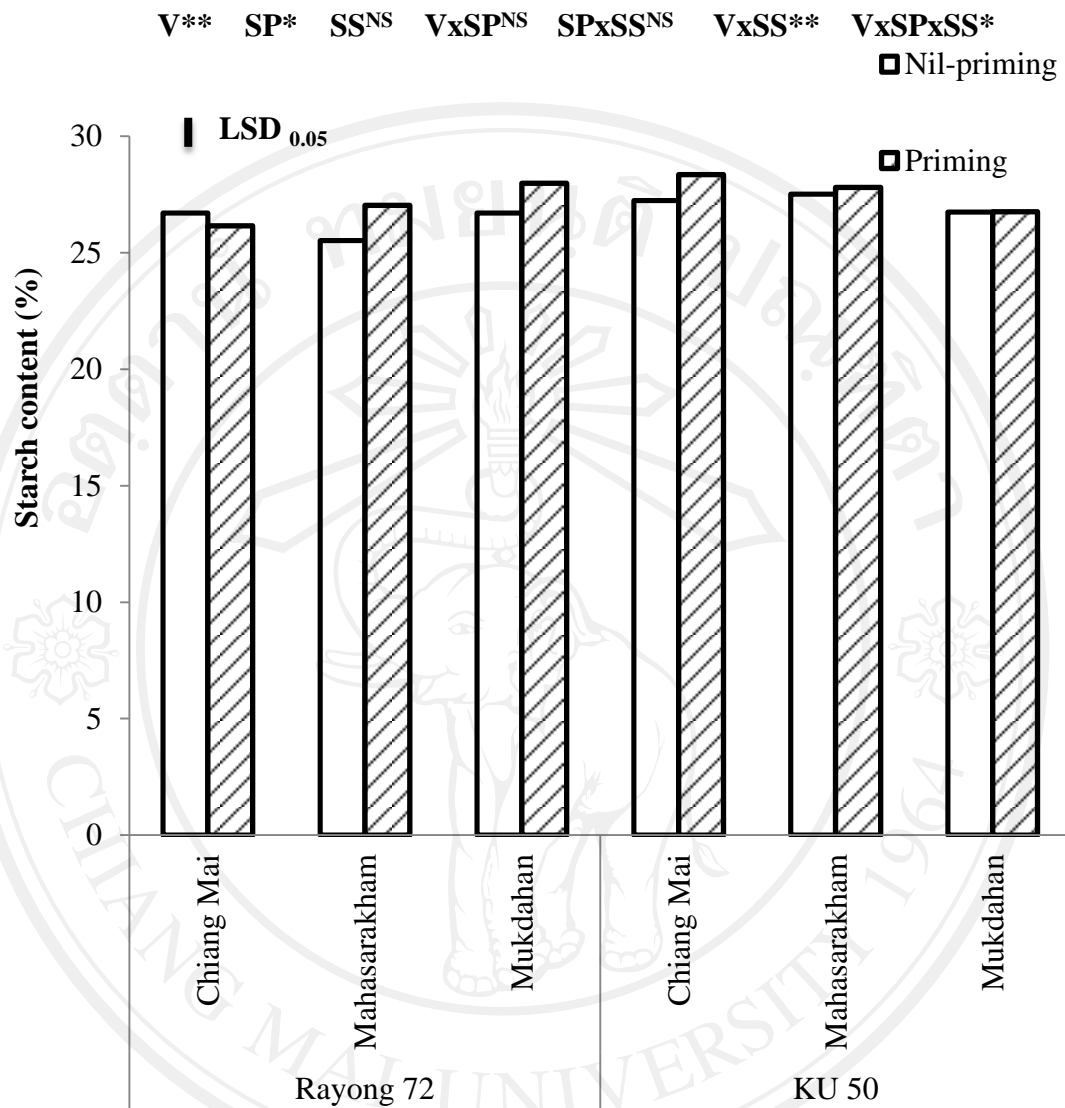


Figure 24 Effects of stake priming in KU 50 and Rayong 72 from Chiang Mai, Maharakham and Mukdahan on starch content. V = varieties, SP = stake priming, SS = stake sources, ** = F-test significant at $P < 0.01$ and NS = F-test not significant at $P > 0.05$.

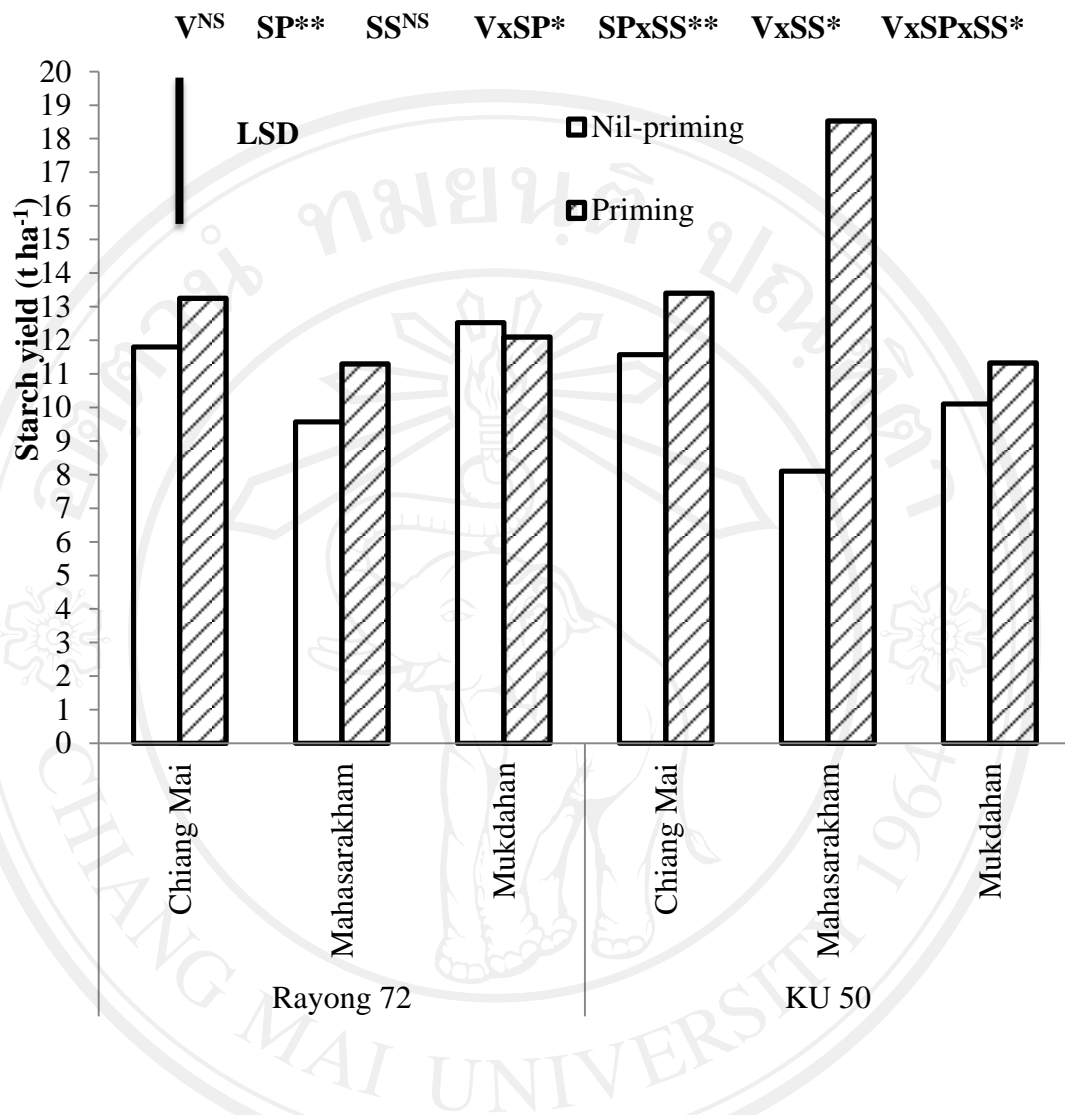


Figure 25 Effects of stake priming in KU 50 and Rayong 72 from Chiang Mai, Mahasarakham and Mukdahan on starch yield. V = varieties, SP = stake priming, SS = stake sources, ** = F-test significant at $P < 0.01$ and NS = F-test not significant at $P > 0.05$.

Accumulation of N, P and K in the two cassava varieties were influenced by stake source and stake priming. Significant interaction was found between the effect of the variety and the stake source ($V \times SS$, $P < 0.01$) and stake priming and the stake source ($SP \times SS$, $P < 0.01$) on the whole plant regarding N (Table 26), P (Table 27) and K (Table 28) content. In general, KU 50 accumulated less N than Rayong 72, especially with stakes from Mahasarakham and Mukdahan. Priming, on the other hand increased the whole plant N content of cassava only when grown from stakes from Mahasarakham (Table 26).

For whole plant P, KU 50 grown from stakes from Chiang Mai and Mahasarakham had higher P content than plants grown from stakes from Mukdahan. In Rayong 72, stake sources had no effect on P content. Priming increased whole plant P content most strongly with stakes from Mahasarakham, followed by stakes from Chiang Mai; there was little effect with stakes from Mukdahan (Table 27).

The differences between KU 50 and Rayong 72 regarding their whole plant K content varied with the source of stakes. The K content was about the same with stakes from Mahasarakham, slightly higher in KU 50 with stakes from Chiang Mai but with stakes from Mukdahan the K content of Rayong 72 was some 40% higher than that of KU 50. Priming had no effect on the K content of cassava plants grown from stakes from Mukdahan, increased it slightly with stakes from Chiang Mai, but increased it by almost 80% with stakes from Mahasarakham (Table 28).

Table 26 Effects of stake priming in KU 50 and Rayong 72 from Chiang Mai, Mahasarakham and Mukdahan on N content in the whole plant.

Variety	Stake	Stake source			Mean		
	priming	Chiang Mai	Mahasarakham	Mukdahan			
<i>N content in the whole plant (kg N ha⁻¹)</i>							
Rayong 72	Nil-priming	98.8	97.5	106.4	100.9		
	Priming	97.4	146.7	112.0	118.7		
KU 50	Nil-priming	95.2	89.5	84.5	89.7		
	Priming	108.4	118.7	85.8	104.3		
	Mean	101.8 ^b	113.1 ^a	97.2 ^b			
Mean	Rayong 72	98.1 ^b	122.1 ^a	109.2 ^b	109.8 ^A		
	KU 50	101.8 ^b	104.1 ^b	85.2 ^c	97.0 ^B		
Mean	Nil-priming	97.0 ^b	93.5 ^b	95.5 ^b	95.3 ^B		
	Priming	102.9 ^b	132.7 ^a	98.9 ^b	111.5 ^A		
F-test	V**	SP**	SS**	V x SP ^{NS}	V x SS**	SP x SS**	V x SP x SS ^{NS}
LSD _{0.05}	6.7	6.7	8.2	-	11.5	11.5	-

V = varieties, SP = stake priming, SS = stake sources, ** = F-test significant at P < 0.01 and NS = F-test not significant at P > 0.05. Values in the same column followed by different upper case letters are significantly different by LSD_{0.05}. Values in the same row followed by different lower case letters are significantly different by LSD_{0.05}.

Table 27 Effects of stake priming in KU 50 and Rayong 72 from Chiang Mai, Mahasarakham and Mukdahan on P content in the whole plant.

Variety	Stake	Stake source			Mean		
	priming	Chiang Mai	Mahasarakham	Mukdahan			
<i>P content in the whole plant (kg P ha⁻¹)</i>							
Rayong 72	Nil-priming	29.0	28.4	31.7	29.7		
	Priming	33.9	41.2	33.5	36.2		
KU 50	Nil-priming	34.2	26.0	23.6	28.0		
	Priming	37.3	47.8	27.4	37.5		
Mean		33.6 ^a	35.8 ^a	29.6 ^b			
Mean	Rayong 72	31.4 ^c	34.8 ^{abc}	32.6 ^{bc}	32.9		
	KU 50	35.8 ^{ab}	36.9 ^a	25.5 ^d	32.7		
Mean	Nil-priming	31.6 ^c	27.2 ^d	27.7 ^d	28.8 ^B		
	Priming	35.6 ^b	44.5 ^a	30.5 ^{cd}	36.8 ^A		
F-test	V ^{NS}	S**	L**	V x S ^{NS}	V x L**	S x L**	V x S x L ^{NS}
LSD _{0.05}	-	2.5	2.1	-	3.6	3.6	-

V = varieties, SP = stake priming, SS = stake sources, ** = F-test significant at P < 0.01 and NS = F-test not significant at P > 0.05. Values in the same column followed by different upper case letters are significantly by LSD_{0.05}. Values in the same row followed by different lower case letters are significantly different by LSD_{0.05}.

Table 28 Effects of stake priming in KU 50 and Rayong 72 from Chiang Mai, Mahasarakham and Mukdahan on K content in the whole plant.

Variety	Stake priming	Stake source			Mean		
		Chiang Mai	Mahasarakham	Mukdahan			
<i>K content in the whole plant (kg K ha⁻¹)</i>							
Rayong 72	Nil-priming	168.9	133.3	198.6	166.9		
	Priming	206.5	239.2	183.6	211.4		
KU 50	Nil-priming	196.9	135.8	129.8	154.2		
	Priming	212.8	235.8	148.1	198.9		
	Mean	196.3 ^a	186.0 ^a	165.0 ^b			
Mean	Rayong 72	187.7 ^{ab}	186.3 ^{ab}	191.1 ^{ab}	189.2 ^a		
	KU 50	204.8 ^a	185.8 ^b	138.9 ^c	176.5 ^B		
Mean	Nil-priming	182.9 ^c	134.6 ^c	164.2 ^d	160.5 ^B		
	Priming	209.7 ^b	237.5 ^a	165.8 ^{cd}	205.1 ^A		
F-test	V*	SP**	SS**	V x SP ^{NS}	V x SS**	SP x SS**	V x SP x SS ^{NS}
LSD _{0.05}	10.8	10.8	13.2	-	18.6	18.6	-

V = varieties, SP = stake priming, SS = stake sources, ** = F-test significant at P < 0.01 and NS = F-test not significant at P > 0.05. Values in the same column followed by different upper case letters are significantly different by LSD_{0.05}. Values in the same row followed by different lower case letters are significantly different by LSD_{0.05}.



(A)



(B)

Figure 26 Cassava roots of experiment 3; harvesting at (A) 4 and (B) 8 months after planting.

4.4 Experiment 4: Response to stake priming with nutrient solution on germination and early growth.

There was a significant effect of stake priming on cassava germinated ($P < 0.01$). For stake priming with CN, Ca, Zn and B germinated at more rapid rates than nil-priming at five, six and seven days after planting. The germination of all treatments was complete at nine days after planting (Figure 27).

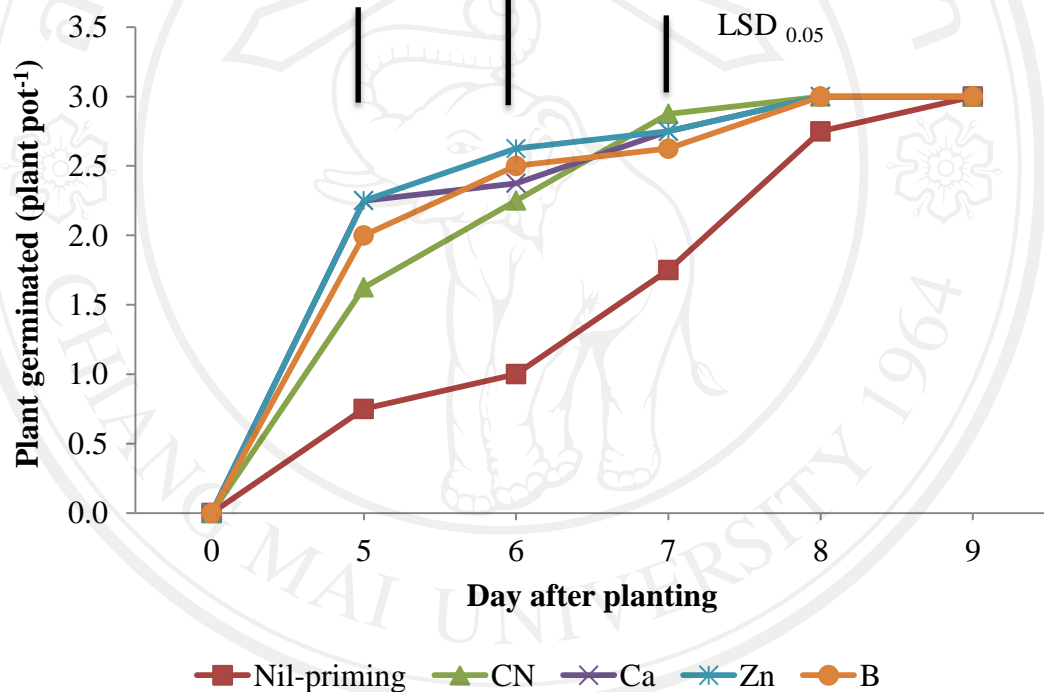


Figure 27 Effects of stake priming with nutrient solution on germination rate of cassava. CN = complete nutrient solution. $LSD_{0.05}$ = significant.

First harvest at 15 days after planting

There was significant effect of stake priming on dry root weight, root number, shoot and total plant dry weight ($P < 0.01$) (Figures 28, 29, 30 and 31). Stake priming with CN, Ca, B and Zn increased dry root weight by 30% to 50% (Figure 28). Root number per pot was also increased by stake priming, but with about the same effect of different stake priming solutions (Figure 29). On dry shoot weight, stake priming increased shoot dry weight, except stake priming with Zn (Figure 30). Similarly for total dry plant weight, stake priming with Zn had no effect, but the effect was found by stake priming with CN, Ca and B (Figure 31).

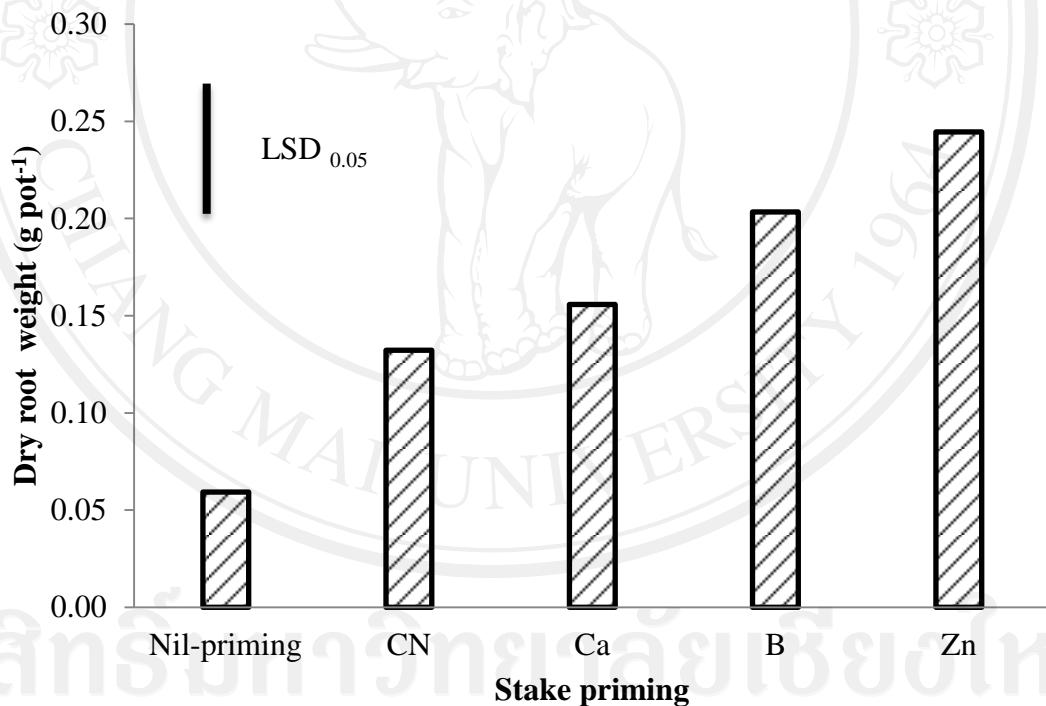


Figure 28 Effects of stake priming with nutrient solution on dry root weight of cassava. CN = complete nutrient solution, Ca = CaCl_2 , B = H_3BO_3 , Zn = ZnSO_4 and $\text{LSD}_{0.05}$ = significant.

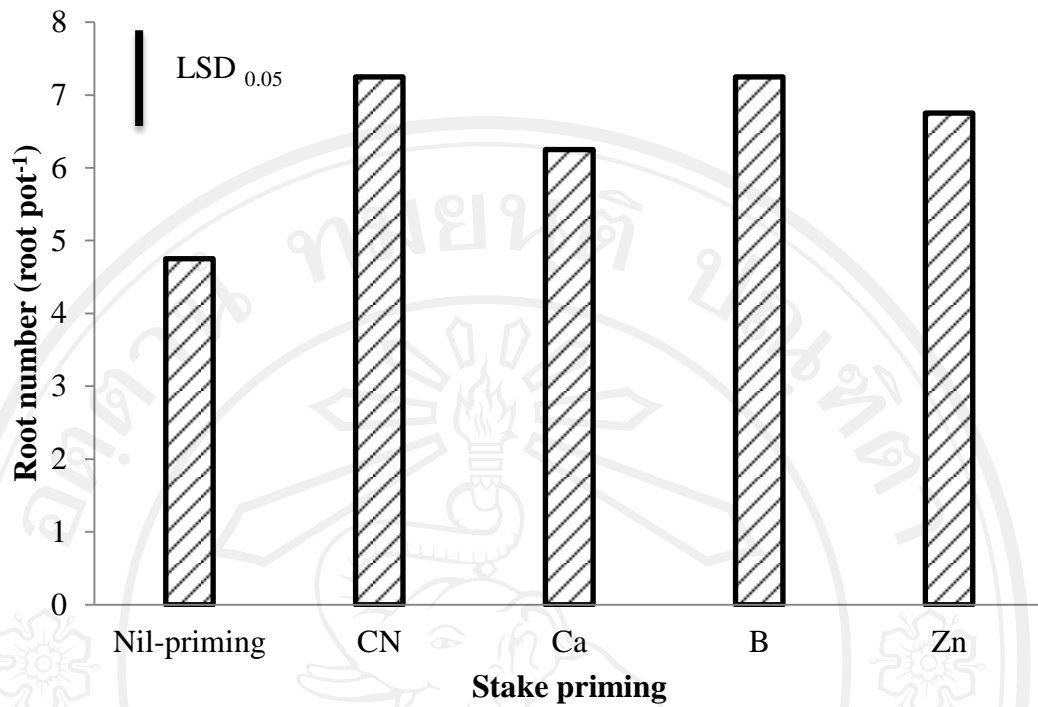


Figure 29 Effects of stake priming with nutrient solution on root number of cassava. CN = complete nutrient solution, Ca = CaCl_2 , B = H_3BO_3 , Zn = ZnSO_4 and $\text{LSD}_{0.05}$ = significant.

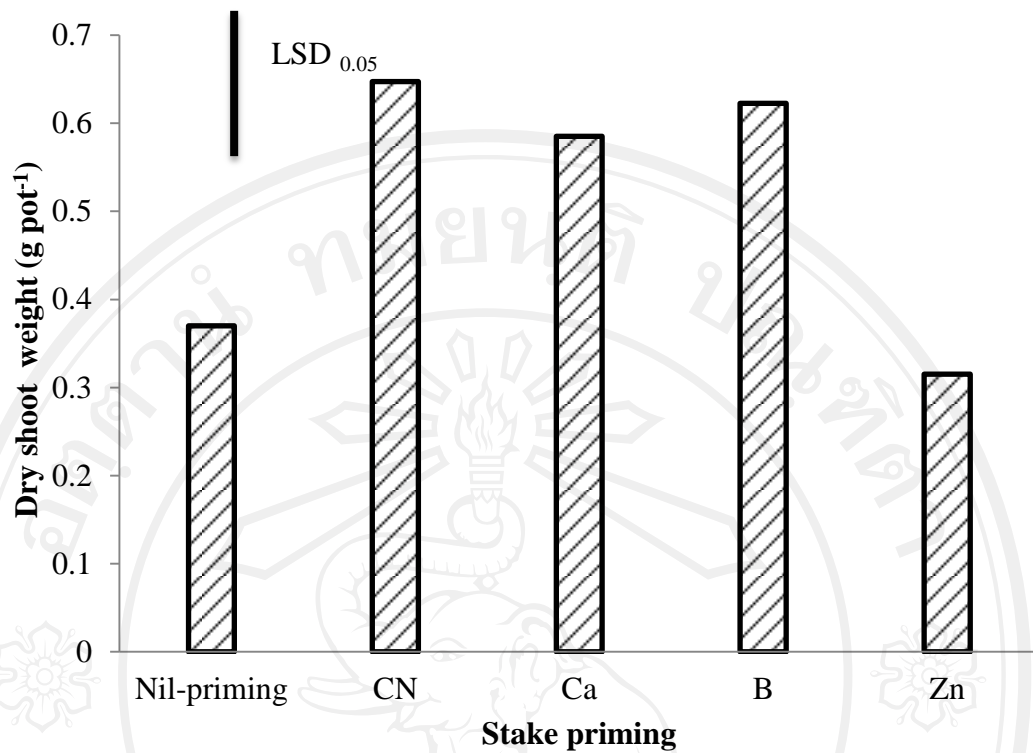


Figure 30 Effects of stake priming with nutrient solution on dry shoot weight. CN = complete nutrient solution, Ca = CaCl₂, B = H₃BO₃, Zn = ZnSO₄ and LSD_{0.05} = significant.

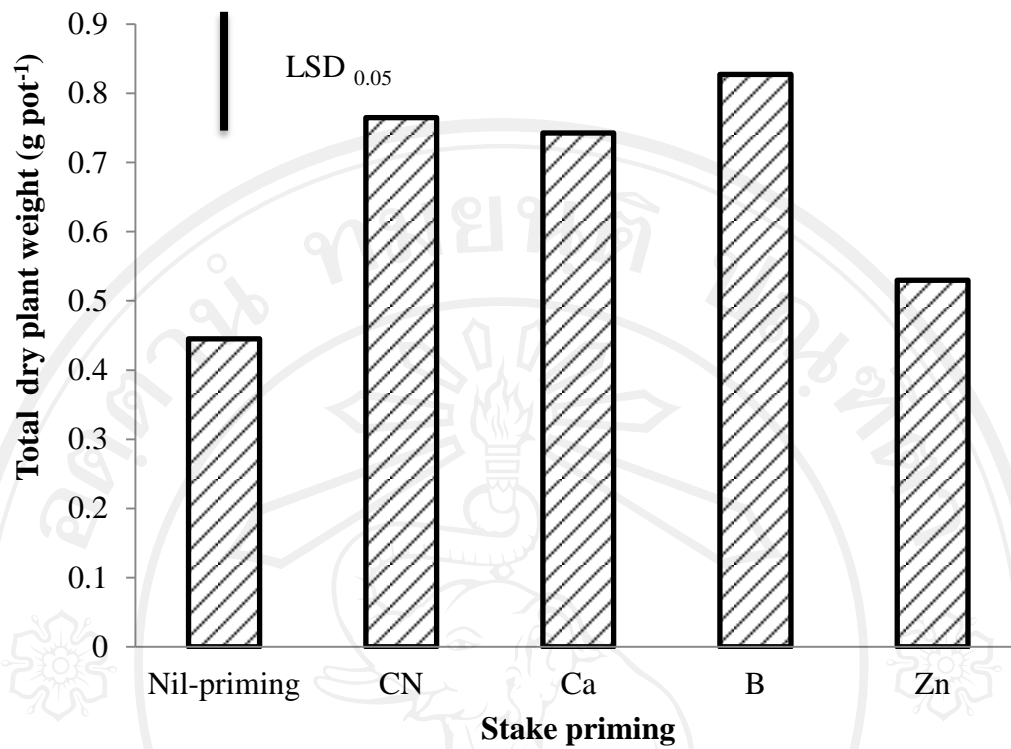


Figure 31 Effects of stake priming with nutrient solution on total dry plant weight. CN = complete nutrient solution, Ca = CaCl₂, B = H₃BO₃, Zn = ZnSO₄ and LSD 0.05 = significant.

Final harvest at 30 days after planting

There was significant effect of stake priming on dry root weight, root number, shoot and total dry plant weight ($P < 0.01$) (Figures 32, 33, 34 and 35). Dry root weight was increased by stake priming by over 50% compared with nil-priming; in particular, stake priming with Ca increased dry root weight to the greatest extent, by 80% (Figure 28). Root number per pot was also raised by stake priming. Stake priming with Zn had the highest root number followed by CN, Ca and B while the lowest root number was obtained by nil-priming. Moreover, root number was doubled by stake priming with CN, Zn and B (Figure 32). Stake priming with B and Ca increased dry shoot weight, CN and Zn did not (Figure 33). Stake priming also increased total plant dry weight, especially; stake priming with Ca and B had a strong effect while CN and Zn had lesser effects (Figure 34).

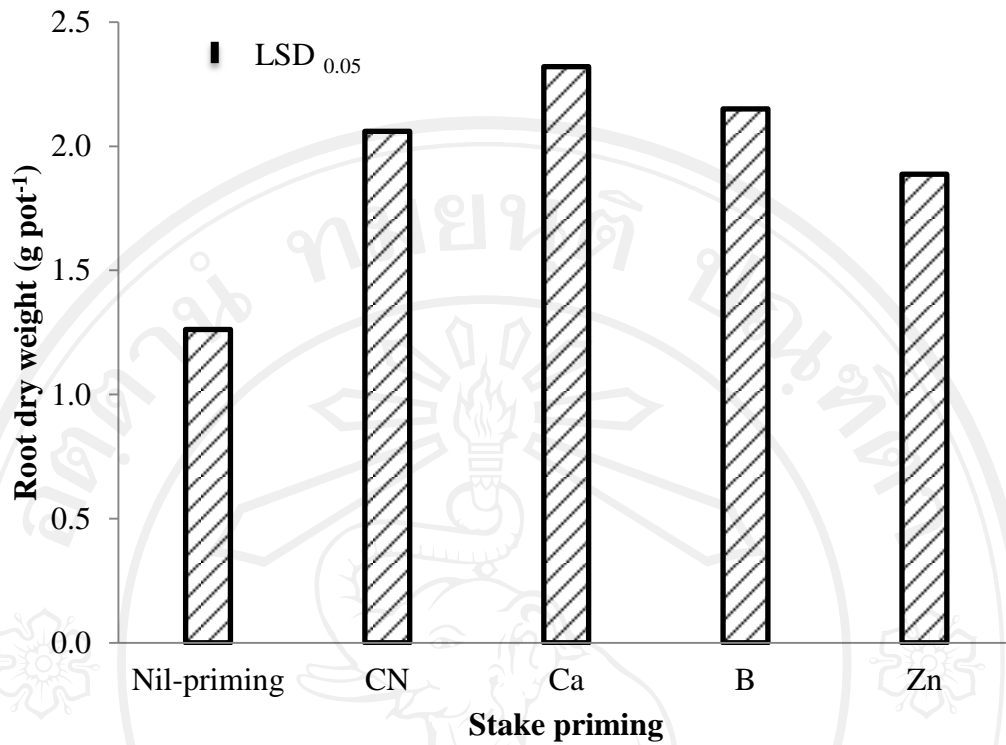


Figure 32 Effects of stake priming with nutrient solution on dry root weight. CN = complete nutrient solution, Ca = CaCl₂, B = H₃BO₃, Zn = ZnSO₄ and LSD_{0.05} = significant.

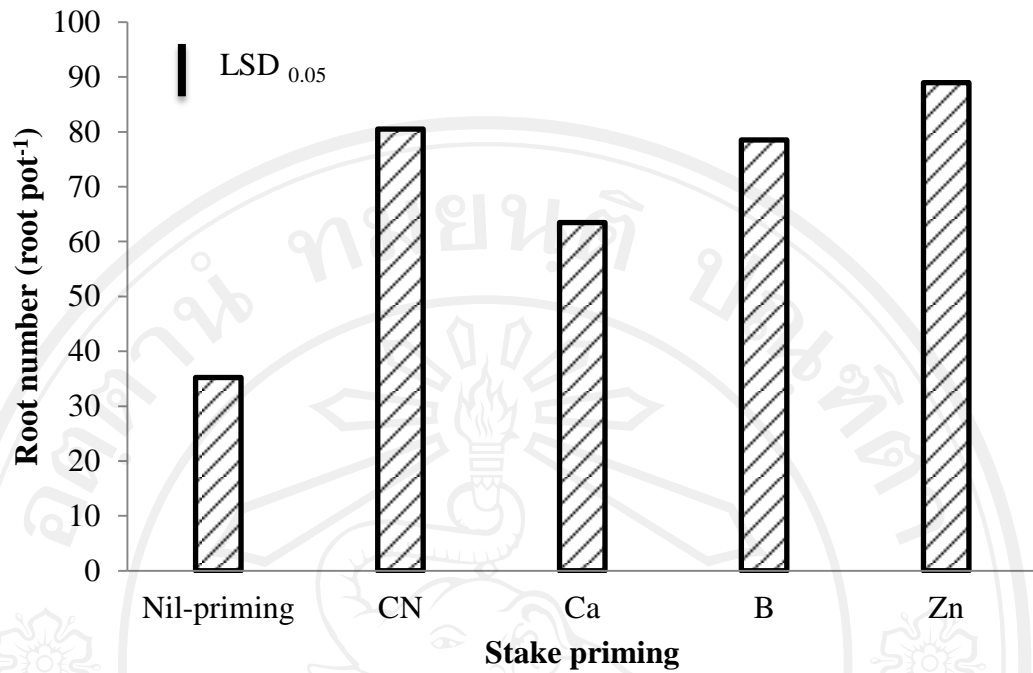


Figure 33 Effects of stake priming with nutrient solution on root number. CN = complete nutrient solution, Ca = CaCl₂, B = H₃BO₃, Zn = ZnSO₄ and LSD 0.05 = significant.

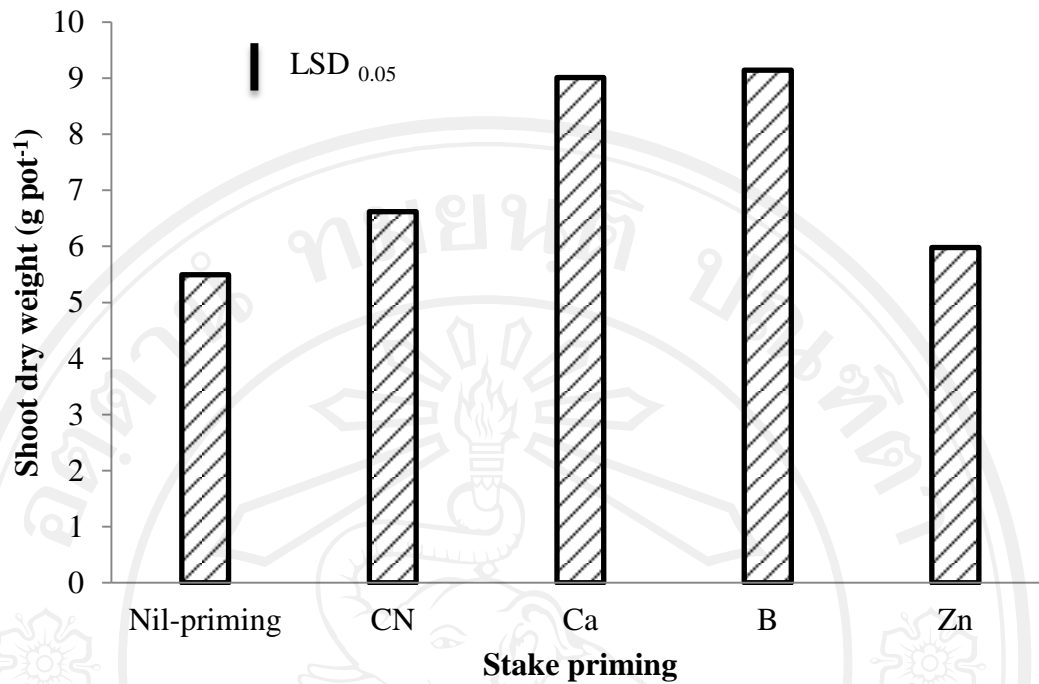


Figure 34 Effects of stake priming with nutrient solution on dry shoot weight. CN = complete nutrient solution, Ca = CaCl₂, B = H₃BO₃, Zn = ZnSO₄ and LSD 0.05 = significant.

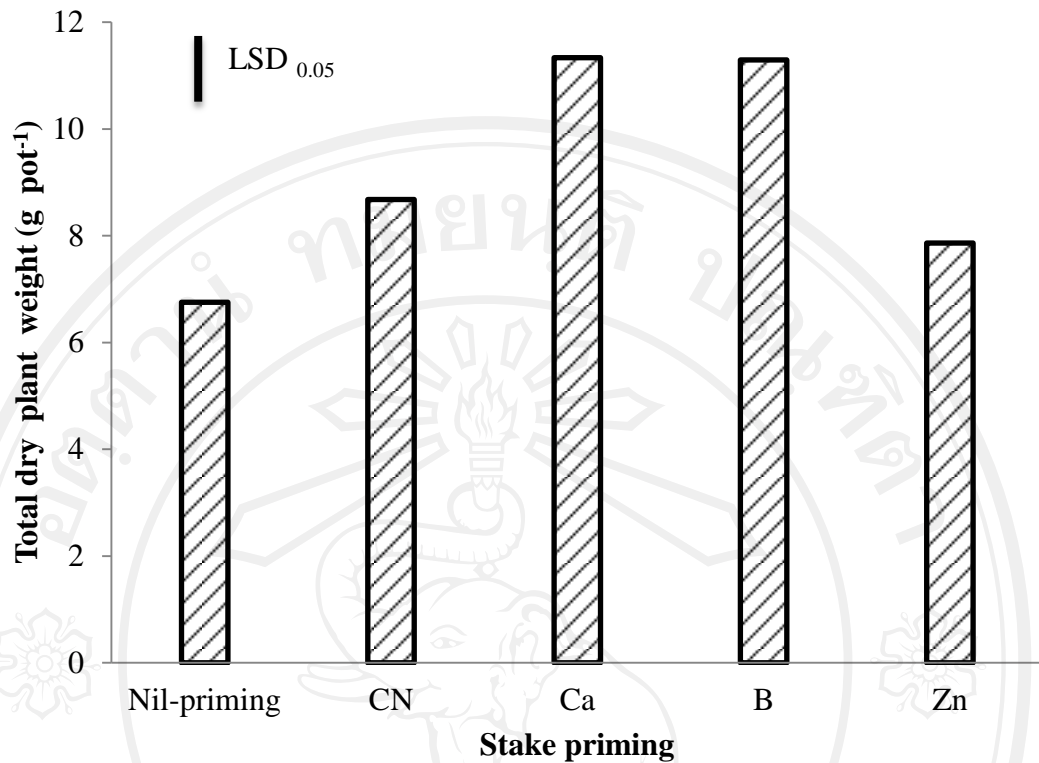
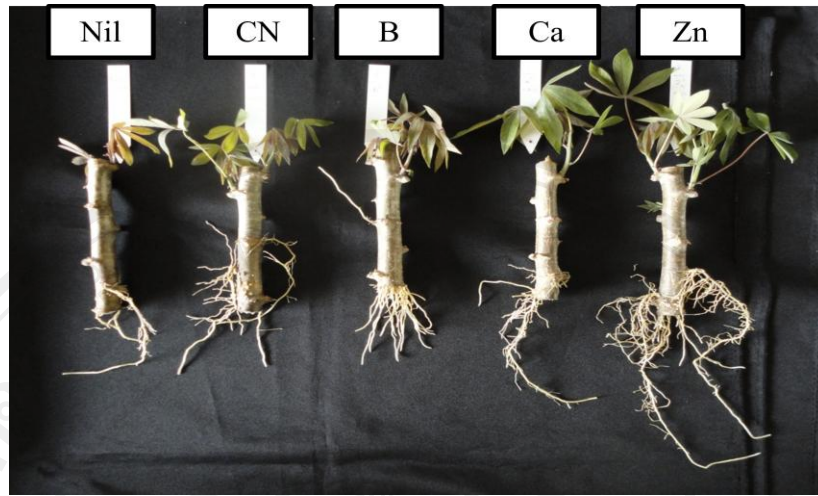


Figure 35 Effects of stake priming with nutrient solution on total dry plant weight. CN = complete nutrient solution, Ca = CaCl₂, B = H₃BO₃, Zn = ZnSO₄ and LSD_{0.05} = significant.



(A)



(B)

Figure 36 Effect of stake priming on cassava plant growth at (A) 15 and (B) 30 days after planting. Nil = nil-priming with nutrient solution, CN = priming with complete nutrient solution, Ca = priming with CaCl_2 solution, B = priming with H_3BO_3 and Zn = priming with ZnSO_4 .