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## Effect of Herbicides on Weed Control and plant growth in Immature Oil Palm (2-year old oil palm plantation)

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The experiment on the effects of herbicides on weed control and plant growth in immature oil palm (2-year old oil palm plantation) was conducted at Pakpoonsubdistrict, Chalermprakiat district, Nakhon Si Thammarat, Thailand, from February to May 2015. The experiment was designed using RCBD with 4 replications and 9 treatments : brush cutter, paraquat at the rate of 690 and 794g/ha, glyphosate at the rate of 513, 769 and 1,000g/ha, glufosinate-ammonium at the rate of 375, 563 and 938g/ha. Spraying of weeds was carried out using knapsack sprayer with 450 l/ha of volume application rate. The results showed that all treatments were effective weed control on the total mixed weed population for 8 weeks after application with no significant difference in the percentage of weed control (62.50-80.00 %). At the 10-week period after application glyphosate at the rate of 1,000g/ha was the highest percentage of the weed control at 80% with no significant differences from glufosinate-ammonium at the rate of 938 and 563g/ha and glyphosate at the rate of 769 and 513g/ha giving 78.75, 73.75, 72.25 and 71.15 % respectively, followed by paraquat at the rate of 794 and 690 g/ha with no significant differences in the percentage of the weed control at 60 and 57.50% respectively, while brush cutter and glufosinate-ammonium at the rate of 375g/ha gave the lowest in the percentage of weed control (40 %). The duration of effective weed control range from after application to 14-week period were produced by glyphosate at the rate of 1,000g/ha and glufosinate-ammonium at the rate of 938 and 563g/ha and glyphosate at the rate of 769g/ha with no significant differences in the percentage of the weed control giving 66.25 58.75 66.25 and 50% respectively. Brush cutter and herbicide treatments were not significantly differences on growth of 2-year old oil palm such as plant height, number of fronds per plant, rachis length, increasing of number fruit bunches/plant and increasing of number female inflorescences/plant during 16-week period after application.

**Keywords:** paraquat, glufosinate-ammonium, glyphosate, brush cutter, oil palm growth

### Introduction

Weed is a major component in oil palm production system. The composition of weed is a mixture of grasses, sedges and broad leaves which

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often changes according to the crop growth stage which provide specific climatic and environmental condition suitable for specific weed growth. (Mohamad *et al.*, 2010). A variety of approaches may be used to achieve a satisfactory level of weed control during the cultivation of crop. They include hand weeding, mechanical weeding, slashing, burning, flooding, covering with organic or inorganic materials (e.g. mulch or plastic sheeting) and treatment with chemical or biological substances (herbicides). The selection of approach will depend on many factor including, broadly, perceived effectiveness, availability, cost and the risks associated with their use. Chemical herbicides can be very effective, fast acting, reliable and straight forward to use. (Rutherford *et al.*, 2009). Three herbicides, glufosinate, glyphosate and paraquat, are non-selective and will therefore harm all vegetations which they come into contact but would be suitable for ground clearance prior to planting and maintenance of pathways for example. Glyphosate is considered to be systemic and will therefore move from the point of treatment to damage or kill the whole plant. Glufosinate and paraquat will affect only those plant parts that come into contact with the herbicide (Rutherford *et al.*, 2011). Paraquat and glyphosate are common herbicides that have been used to control weed in oil palm plantation in Thailand. Systematic herbicides are therefore not recommended for use in young immature stands of oil palm (von Uexkull and Fairhurst, 1991). This study examined the efficacy and duration of effectiveness in using the broad spectrum herbicides of paraquat, glufosinate-ammonium, glyphosate and the brush cutter on the total mixed weed population and effect on growth found in 2-year-old oil palm plantation.

## **Materials and methods**

The field experiment was carried out at Pakpoonsubdistrict, Chalermprakiat district, Nakhon Si Thammarat, Thailand from February to May 2015, in 2-year-oil palm plantation. The experiment was conducted in a randomized complete block design (RCBD) with 4 replications and 9 treatments, each experimental unit including two oil palm plants. The treatments consist of brush cutter, paraquat at the rate of 690 and 794 g/ha, glyphosate at the rate of 513, 769 and 1,000 g/ha, glufosinate-ammonium at the rate of 375, 563 and 938 g/ha. Spraying was carried out using knapsack sprayer with 450 l/ha of volume application rate.

Evaluation of treatment efficacy was performed by visual percentage of weed control, 0-100 % (Changsaluket *et al.*, 2010) 0% = no control, 100% = completely control

Evaluation of growth was performed at 0, 4, 8 and 16 week after treatment (WAT): plant height (from the soil surface to the lowest basal part of the ninth frond), number of frond/plant(counted from the base of the fresh-green to the first fully-opened frond), rachis length(from the lowest basal part to the tip of the leaf of the ninth front), increasing of number fruit bunches/plant and increasing of number female inflorescences/plant.

## Results

### *The efficacy of brush cutter and herbicides after treatment at 2 to 16 weeks*

For a period of 2 weeks, glyphosate treatments gave the lowest effective for weed control giving 22.5-32.50%. At the 4-week period after treatment glufosinated ammonium at the rate of 938 g/ha was the most effective for weed control (100%). followed by glufosinate – ammonium at the rate of 563 g/ha, brush cutter, paraquat at the rate of 794 and 690 g/ha and glyphosate at the rate of 1,000 g/ha with no significant difference in the percentage of weed control giving 81.25,73.75,72.50,68.75 and 67.50% respectively. Glufosinate-ammonium at the rate of 375 g/ha, glyphosate at the rate of 513 and 769 g/ha, gave the lowest effective for weed control 56.25, 48.75 and 46.25 % respectively. At the 6-week period after treatment glufosinated- ammonium at the rate of 938 g/ha was the most effective for weed control (86.25%). While brush cutter and others treatment were no significant difference in the percentage of weed control (77.50-66.25%). At the 8-week period after treatment the results showed that all treatments were no significantly difference in the percentage of weed control (80.00-62.50 %). At the 10-week period after application, glyphosate at the rate of 1,000 g/ha gave the highest percentage of the weed control (80%) with no significant difference from glufosinate–ammonium at the rate of 938 and 563 g/ha and glyphosate at the rate of 769 and 513 g/ha giving 78.75, 73.75, 72.25 and 71.15 % respectively, following by paraquat at the rate of 794 and 690 g/ha gave no significant difference in the percentage of the weed control giving 60 and 57.50% respectively, while brush cutter and glufosinate–ammonium at the rate of 375 g/ha gave the lowest in the percentage of weed control (40 %). At the 14-week period after application, glyphosate at the rate of 1,000 g/ha, glufosinate–ammonium at the rate of 938 and 563 g/ha and glyphosate at the rate of 769 g/ha gave no significant differences in the percentage of the weed control giving 66.25 58.75 66.25 and 50% respectively. At the 16-week period after treatment the results showed that no treatments were effective on weed control more than 50 %.The duration of effective weed control from after application to 14- week period

were produced by glyphosate at the rate of 1,000 g/ha and glufosinate–ammonium at the rate of 938 and 563 g/ha and glyphosate at the rate of 769 g/ha. (Table.1)

**Table1** The percentage of visual weed control (%) at 2,4,6,8,10,12,14 and 16 weeks after the treatment (WAT) with brush cutter, paraquat , glyphosate and glufosinate–ammonium to mixed weed composition

Treatment Rate (g/ha)	Visual weed control (%)								
	2 WAT	4 WAT	6 WAT	8 WAT	10 WAT	12 WAT	14 WAT	16 WAT	
1. Brush cutter	80.00 <sup>bc</sup>	73.75 <sup>b</sup>	68.75 <sup>b</sup>	72.50	40.00 <sup>d</sup>	43.75 <sup>c</sup>	35.00 <sup>bc</sup>	17.50 <sup>bc</sup>	
2. Paraquat 690	77.50 <sup>bc</sup>	68.75 <sup>bc</sup>	71.25 <sup>b</sup>	73.75	57.50 <sup>c</sup>	48.75 <sup>bc</sup>	45.00 <sup>abc</sup>	28.75 <sup>abc</sup>	
3. Paraquat 794	76.25 <sup>bc</sup>	72.50 <sup>b</sup>	70.00 <sup>b</sup>	70.00	60.00 <sup>bc</sup>	58.75 <sup>abc</sup>	47.50 <sup>abc</sup>	23.75 <sup>bc</sup>	
4. Glyphosate 513	22.50 <sup>d</sup>	48.75 <sup>d</sup>	66.25 <sup>b</sup>	73.75	71.25 <sup>abc</sup>	55.00 <sup>abc</sup>	47.50 <sup>abc</sup>	13.75 <sup>c</sup>	
5. Glyphosate 769	28.75 <sup>d</sup>	46.25 <sup>d</sup>	70.00 <sup>b</sup>	72.50	72.50 <sup>abc</sup>	63.75 <sup>abc</sup>	50.00 <sup>ab</sup>	28.75 <sup>abc</sup>	
6. Glyphosate 1,000	32.50 <sup>d</sup>	67.50 <sup>bc</sup>	73.75 <sup>b</sup>	77.50	80.00 <sup>a</sup>	72.50 <sup>ab</sup>	66.25 <sup>a</sup>	33.75 <sup>abc</sup>	
7. Glufosinate- 375 ammonium	66.25 <sup>c</sup>	56.25 <sup>cd</sup>	67.50 <sup>b</sup>	62.50	40.00 <sup>d</sup>	40.00 <sup>c</sup>	26.25 <sup>c</sup>	22.50 <sup>bc</sup>	
8. Glufosinate- 563 Ammonium	86.25 <sup>ab</sup>	81.25 <sup>b</sup>	77.50 <sup>ab</sup>	80.00	73.75 <sup>ab</sup>	70.00 <sup>ab</sup>	58.75 <sup>a</sup>	37.50 <sup>ab</sup>	
9. Glufosinate- 938 ammonium	97.50 <sup>a</sup>	100.00 <sup>a</sup>	86.25 <sup>a</sup>	76.25	78.75 <sup>a</sup>	76.25 <sup>ab</sup>	66.25 <sup>a</sup>	46.25 <sup>a</sup>	
F-test		*							
CV. (%)	.80	3.63	34	.90	.79	.32	.05	.1	

\* Means within the columns followed by the same letter are not significant different at the 5% level by Duncan's Multiple Range Test

\*\* Highly significant

ns non significant

### ***Effects of herbicide on oil palm growth***

Brush cutter and herbicide treatments were not significantly differences on growth of 2-year old oil palm.

Plant height before application, all treatments were no significant difference between 25.62-39.00 cm. After application at 4,8 and 16 WAT there were no significant difference on plant height between brush cutter and herbicide treatments with 30.00-42.00,34.75-45.38 and 44.63-54.63 cm. respectively.(Table2)

Rachis length before application, all treatments were no significant difference between 2.21-2.62 m. After application at 4,8 and 16 WAT there were no significant difference on rachis length between brush cutter and herbicide treatments with 2.26-2.62, 2.26-2.66 and 2.28-2.76 m. respectively. (Table 2)

Number of fronds per plant before application, all treatments were no significant difference between 31.25-34.37 fronds/plant. After application at 4,8 and 16 WAT there were no significant difference on number of fronds per plant between brush cutter and herbicide treatments with 32.87-36.25, 34.12-37.50 and 37.87-41.25 fronds/plant respectively. (Table 2)

**Table 2** Plant height, rachis length and number of fronds / plant at 0, 4, 8 and 16 WAT.

treatment	Rate (g/ha)	Plant height (cm)				Rachis length (m.)				Number of fronds /plant			
		0 WAT	4WA T	8WA T	16W AT	0WA T	4WA T	8WA T	16W AT	0WA T	4WA T	8WA T	16W AT
1. Brush cutter		32.0	35.5	39.0	49.2	2.3	2.5	2.3		34.2	36.2	37.5	41.2
-		0	0	0	5	6	8	8	2.49	5	5	0	5
2. Paraquat		39.0	42.0	45.3	54.6	2.6	2.6	2.4		34.3	36.2	37.3	40.7
690		0	0	8	3	2	2	0	2.76	7	5	7	5
3. Paraquat		36.2	38.7	41.0	50.3	2.3	2.5	2.4		31.6	33.2	34.2	37.8
794		5	5	0	8	1	2	0	2.52	2	5	5	7
4. Glyphosate		35.7	39.8	42.3	52.3	2.4	2.4	2.6		32.3	34.0	35.1	38.3
513		5	8	8	8	1	7	6	2.58	7	0	2	7
5. Glyphosate		33.7	37.2	40.6	48.5	2.3		2.3		33.2	35.1	36.3	39.5
769		5	5	3	0	6	2.4	3	2.45	5	2	7	0
6. Glyphosate		35.7	38.7	42.0	49.7	2.4	2.4	2.4		33.3	34.8	36.3	39.6
1000		5	5	0	5	5	3	5	2.47	7	7	7	2
7. Glufosinate-ammonium		32.7	37.5	41.7	50.0	2.4	2.4	2.4		32.3	33.5	35.0	38.1
375		5	0	5	0	3	5	5	2.46	7	0	0	2
8. Glufosinate-ammonium		32.8	36.1	38.6	47.6	2.4	2.5	2.4		31.8	33.7	35.1	37.8
563		8	3	3	3	0	5	2	2.56	7	5	2	7
9. Glufosinate-ammonium		25.6	30.0	34.7	44.6	2.2	2.2	2.2		31.2	32.8	34.1	37.8
938		3	0	5	3	1	6	6	2.28	5	7	2	7
F-test		ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
		15.6	14.1	11.3	10.3	8.8	8.4	8.7					
CV.(%)		5	7	8	6	1	3	2	9.87	9.28	8.85	8.76	8.35

ns non significant

Number of female inflorescences/plant before application, all treatments were no significant difference between 0.38-1.75 female inflorescences/plant. After application at 4, 8 and 16 WAT there were no significant difference on the increasing number of fronds per plant between brush cutter and herbicide treatments with 0.50-1.38, 0.37-1.63 and 0.25-1.12 fronds/plant respectively. (Table 3)

Number of fruit bunches/plant before application, all treatments were no significant difference between 4.75-7.12 bunches/plant. After application at 4, 8 and 16 WAT there were no significant difference on the increasing number of fruit bunches/plant between brush cutter and herbicide treatments with 0.37-0.87, 0.75-2.25 and 0.37-1.62 bunches/plant respectively. (Table 3)

**Table 3** Number of female inflorescences increasing / plant and number of fruit Bunches increasing / plant at 0, 4, 8 and 16 WAT.

Treatment	Rate (g / ha)	Number of female inflorescences increasing / plant				Number of fruit bunches increasing / plant			
		0 WAT	4 WAT	8 WAT	16WAT	0 WAT	4 WAT	8 WAT	16 WAT
1. Brush cutter	-	1.13	0.88	0.37	1.00	7.12	0.75	1.25	1.00
2. Paraquat	690	1.75	0.75	0.75	0.63	6.62	0.50	1.50	1.12
3. Paraquat	794	1.25	1.25	1.63	1.12	5.25	0.75	2.00	1.62
4. Glyphosate	513	1.00	0.88	1.00	0.50	5.37	0.37	0.75	0.37
5. Glyphosate	769	1.38	1.38	1.13	1.12	4.75	0.87	2.25	0.62
6. Glyphosate 1,000		1.38	0.75	1.25	0.50	4.75	0.87	1.25	1.37
7. Glufosinate -ammonium	375	1.50	0.50	0.75	0.75	5.37	0.37	1.12	0.87
8. Glufosinate -ammonium	563	1.38	0.88	1.00	0.63	5.87	0.75	1.62	1.12
9. Glufosinate -ammonium	938	0.38	1.13	0.63	0.25	6.00	0.75	1.00	1.00
F-test		ns	ns	ns	ns	ns	ns	ns	ns
CV. (%)		14.01	15.29	19.46	13.59	24.17	17.48	18.45	18.06

ns non significant

## Discussion

At the 2 and 4 week period after treatment glyphosate gave the lowest percentage of weed control, due to phytotoxic symptoms of glyphosate injury develop slowly. Unlike many contact herbicides, phytotoxic symptoms of glyphosate injury often develop slowly. Visible effect on most annual weeds occur within two to four days and may not occur for 7 days or more on the most perennial weeds (Gonzalo Luis Prez *et al.*, 2011). This experiment was done in the dry season period, glyphosate at the rate of 1,000 and 769 g/ha, glufosinate-ammonium at the rate of 938 and 563 g/ha had long time duration

for effective weed control 14 weeks after application, while brush cutter was effectively for weed control 8 weeks after application. Collins (1991) also reported that paraquat has limited efficacy on perennial weeds but is more effective on weeds, which are small, and in early establishing or vegetative phase growth some annual grasses may only be temporarily suppressed because low and enclosed growing points are not contacted by the spray. Wibawa (2007) reported that paraquat needed high rate, 600 and 800 g/ha, to control weeds effectively. However, lower rate of glufosinate-ammonium (200g/ha) and glyphosate (400g/ha) gave excellent weed control. Collins (1991) stated that glufosinate-ammonium is partially systemic while the glyphosate is a systemic herbicide and it is much more effective against weeds with well-developed root systems or underground storage organs.

Brush cutter and herbicide treatments gave no significant differences on growth of 2-year old oil palm. Wibawa (2007) reported that with no direct contact with the plants, paraquat, glufosinate-ammonium, and glyphosate had no adverse effect on the vegetative and generative growth of oil palm. Glyphosate had no adverse effect on the oil palm and significantly improved vegetative parameters by reducing competition with weeds for nutrients and other growth resources.(Ofosu-Budu *et al.*,2014).

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