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# Effect of Herbicides on Weed Control and Plant Growth in Immature Oil Palm in the Wet Season Nakhon Si Thammarat, Thailand

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The experiment on the effects of herbicides on weed control and plant growth in immature oil palm in the wet season was conducted in 2-year old oil palm plantation at Tham Yai sub-district,Thungsong district, Nakhon Si Thammarat, Thailand, from August to November 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 herbicide treatments were effective weed control (visual percentage of weed control) on the total mixed weed population for 8 weeks after application. At the 8-week period after application, glufosinate–ammonium at the rate of 938g/ha. was the highest percentage of the weed control at 63.75% with no significant differences from glyphosate at the rate of 1,000 g/ha and paraquat at the rate of 794 g/ha giving 56.25 and 55.00 %, respectively, followed by glufosinate–ammonium at the rate of 563 g/ha(52.50%), meanwhile glyphosate at the rate of 513 g/ha gave 37.50% with no significant differences from glyphosate at the rate of 769 g/ha, glufosinate–ammonium at the rate of 375g/ha and paraquat at the rate of 690 g/ha giving 42.50,46.25 and 46.25%, respectively. Brush cutter gave the lowest in the percentage of weed control (10 %). Brush cutter was the effective weed control for 4 weeks giving 53.75% of the 4-week period. For the weed dry weigh before application, all treatments were no significant differences in the weed dry weigh between 57.97-72.46 g/0.25m$^2$. At the 8-week period after application, glufosinate–ammonium at the rate of 939 g/ha gave the lowest weed dry weigh 13.53g/0.25m$^2$ with no significant differences from paraquat at the rate of 794 g/ha(14.81g/0.25m$^2$), followed by glyphosate at the rate of 1,000g/ha(16.38g/0.25m$^2$). Brush cutter gave the weed dry weigh 28.16g/0.25m$^2$ with no significant differences from glufosinate–ammonium at the rate of 563 and 375 g/ha, paraquat at the rate of 690 g/ha, glyphosate at the rate of 769 and 513g/ha giving 17.74, 25.41, 29.44, 32.37 and 32.93g/0.25m$^2$, 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 inflorescenes/plant during 16-week period after application.

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

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## Introduction

Weed infestation is a major problem during the early stage of establishment of oil palm plantation. Weeds interfere with oil palm growth by competing one or more growth-limiting resource such as moisture, nutrients and light. The composition of weed is a mixture of grasses, sedges and broad leaves which often changes according to the crop growth stage which provide specific climatic and environmental condition suitable for specific weed growth. Weeds in plantation are managed using several methods such as cultural, mechanical, integrated production system of using livestock to control the weeds, or chemical (herbicide) (Mohamad *et al.*, 2010). The selection of approach will depend on many factors 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 (Ruther ford *et al.*, 2009). For the mechanical, the brush cutter is used for weeding in oil palm plantation in Thailand. Glyphosate is considered to be systemic and will therefore move from the point of treatment to damage or kill the whole plant. Glufosinate-ammonium and paraquat will affect only those plant parts that come into contact with the herbicide (Ruther ford *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).

Objectives: This study examined the efficacy and duration of effectiveness in using the broad spectrum herbicides of paraquat, glufosinate-amminium glyphosate and the brush cutter weeding on the total mixed weed population and effect on growth found in 2-year-old oil palm plantation in the wet season.

## Materials and methods

The field experiment was carried out at Tham Yai sub-district, Thungsong district, Nakhon Si Thammarat, Thailand, from August to November 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 consistent of 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 was carried out using knapsack sprayer with 450 l/ha of volume application rate.

Weed samples were collected randomly by using quadrat(0.5x0.5 $m^2$) 2 locations on each experimental unit to identify weed composition.

Above ground weed vegetation was harvested, sun-dried for 4 day and then oven-dried at 75° C for 48 h for evaluation of weed dry weigh.

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

Evaluation of growth was performed at 0, 4, 8 and16 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 frond), increasing of number fruit bunches/plant and increasing of number female inflorescenes/plant.

## Results

The number of overall of weeds /0.25 $m^2$ before treatments were not significantly different, ranging from 65.00-90.75 plants /0.25 $m^2$ . (Table 1) The dominance broad leaves were *Bidens pilosa*, *Ageratum conyzoides* ,*Asystasia gangetica, Borreria latifolia* , *Eclipta prostrata, Ludwigia hyssopifolia, Phyllanthus niruri*, *Cleome rutidosperma, Celosia argentea*, *Mikania cordata*, *Melastoma malabathricum* and *Mimosa pudica* with the relative density,39.44,22.96, 13.24, 3.01, 2.96, 1.92,1.85, 1.19, 0.55, 0.35, 0.24 and 0.06% respectively. The dominance narrow-leaf weeds were *Commelina diffusa* , *Cyperus pulcherrimus, Cyperus brevifolius, Cyperus rotundus, Digitaria ciliaris and Eleusine indica* with the relative density 6.34 , 2.59, 1.54, 0.92, 0.55 and 0.27 % respectively. (Table 2)

**Table 1** The number of weed/ 0.25 $m^2$ before treatment.

| Treatment | Rate g/ha | Number of weed /0.25 $m^2$ [1/] | | |
|---|---|---|---|---|
| | | Narrow-leaf weeds | Broad-leaf weeds | Overall |
| 1. Brush cutter | - | 18.25[b] | 72.50 | 90.75 |
| 2. Paraquat | 690 | 8.50[c] | 79.25 | 87.75 |
| 3. Paraquat | 794 | 22.25[a] | 61.50 | 83.75 |
| 4.Glyphosate | 513 | 7.75[cd] | 64.50 | 72.25 |
| 5.Glyphosate | 769 | 5.00[cd] | 70.00 | 75.00 |
| 6. Glyphosate | 1,000 | 4.75[cd] | 60.25 | 65.00 |
| 7. Glufosinate -ammonium | 375 | 4.00[d] | 64.00 | 68.00 |
| 8. Glufosinate -ammonium | 563 | 6.50[cd] | 75.25 | 81.75 |
| 9. Glufosinate -ammonium | 938 | 8.75[c] | 70.00 | 78.75 |
| F-test | | ** | ns | ns |
| C.V. (%) | | 28.69 | 20.76 | 18.51 |

[1/] Mean followed by a common letter are not significant at 5% probability level by DMRT
ns Non significant ** Hightly significant

**Table 2** The density of weed species (number of plant/0.25 $m^2$) and relative density (%) before treatment

| Species | Type | Number of plant / 0.25 $m^2$ | Relative density (%) * |
|---|---|---|---|
| *Bidens pilosa* | B | 30.75 | 39.44 |
| *Ageratum conyzoides* | B | 17.90 | 22.96 |
| *Asystasia gangetica* | B | 10.32 | 13.24 |
| *Borreria latifolia* | B | 2.35 | 3.01 |
| *Eclipta prostrata* | B | 2.31 | 2.96 |
| *Ludwigia hyssopifolia* | B | 1.50 | 1.92 |
| *Phyllanthus niruri* | B | 1.44 | 1.85 |
| *Cleome rutidosperma* | B | 0.93 | 1.19 |
| *Celosia argentea* | B | 0.43 | 0.55 |
| *Mikania cordata* | B | 0.27 | 0.35 |
| *Melastoma malabathricum* | B | 0.19 | 0.24 |
| *Mimosa pudica* | B | 0.05 | 0.06 |
| *Commelina diffusa* | N | 4.94 | 6.34 |
| *Cyperus pulcherrimus* | N | 2.02 | 2.59 |
| *Cyperus brevifolius* | N | 1.20 | 1.54 |
| *Cyperus rotundus* | N | 0.72 | 0.92 |
| *Digitaria ciliaris* | N | 0.43 | 0.55 |
| *Eleusine indica* | N | 0.21 | 0.27 |
| Total | | 77.96 | 100 |

B Broad – leaf weeds
N Narrow- leaf weeds
* Relative density (%) = Number of plant in each species X 100
Total number of plant all species

***The efficacy of brush cutter and herbicides after treatment at 2 to 12 weeks***

For a period of 2 weeks glufosinate-ammonium at the rate of 938 g/ha gave the highest percentage of weed control at 88.70% with no significant different from paraquat at the rate of 794g/ha, glufosinate-ammonium at the rate of 563g/ha and paraquat at the rate of 690g/ha, giving 87.50,83.75 and 82.50%, respectively. Brush cutter gave the percentage of weed control, 73.75% with no significant differences from glufosinate-ammonium at the rate of 375g/ha, giving 67.50%. Glyphosate at the rate of 513g/ha gave the lowest percentage of weed control at 25 % with no significant different from glyphosate at the rate of 769g/ha giving 26%, while glyphosate at the rate of 1,000g/ha gave the percentage of weed control at 43.37%.(Table 3)

For a period of 4 weeks glufosinate-ammonium at the rate of 938 g/ha gave the highest percentage of weed control at 90.00% with no significant different from glufosinate- ammonium at the rate of 563 g/ha giving 83.75%, followed by paraquat at the rate of 794 and 690g/ha and glyphosate at the rate of 1,000g/ha gave no significant different in the percentage of weed control giving 78.75 72.50 and 71.25%,

respectively,meanwhile glufosinated ammonium at the rate of 375g/ha gave the percentage of weed control at 66.25%. Brush cutter gave percentage of weed control at 53.75%. Glyphosate at the rate of 513 and 769 g/ha gave the lowest percentage of weed control, 35.00 and 42.50%, respectively. (Table 3)

**Table 3** The percentage of visual weed control (%) at 2,4,6,8,10 and12 weeks after the treatment (WAT) with brush cutter, paraquat , glyphosate and glufosinate-ammonium to mixed weed composition

| Treatment | Rate (g / ha) | Visual weed control (%) [1/] | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2 WAT | 4 WAT | 6 WAT | 8 WAT | 10 WAT | 12 WAT |
| 1. Brush cutter | - | 73.75$^{bc}$ | 53.75$^{e}$ | 25.00$^{e}$ | 10.00$^{e}$ | 10.00$^{c}$ | 10.00$^{d}$ |
| 2. Paraquat | 690 | 82.50$^{ab}$ | 72.50$^{cd}$ | 60.00$^{c}$ | 46.25$^{bcd}$ | 15.00$^{bc}$ | 15.00$^{cd}$ |
| 3. Paraquat | 794 | 87.50$^{a}$ | 78.75$^{bc}$ | 70.00$^{b}$ | 55.00$^{ab}$ | 25.00$^{a}$ | 25.00$^{ab}$ |
| 4. Glyphosate | 513 | 25.00$^{e}$ | 35.00$^{f}$ | 37.50$^{d}$ | 37.50$^{d}$ | 10.00$^{c}$ | 10.00$^{d}$ |
| 5. Glyphosate | 769 | 26.25$^{e}$ | 42.50$^{f}$ | 51.25$^{c}$ | 42.50$^{cd}$ | 22.50$^{ab}$ | 22.50$^{abc}$ |
| 6. Glyphosate | 1,000 | 43.75$^{d}$ | 71.25$^{cd}$ | 75.00$^{ab}$ | 56.25$^{ab}$ | 30.00$^{a}$ | 30.00$^{a}$ |
| 7. Glufosinate-ammonium | 375 | 67.50$^{c}$ | 66.25$^{d}$ | 55.00$^{c}$ | 46.25$^{bcd}$ | 22.50$^{ab}$ | 20.00$^{bc}$ |
| 8. Glufosinate-ammonium | 563 | 83.75$^{ab}$ | 83.75$^{ab}$ | 73.75$^{ab}$ | 52.50$^{bc}$ | 22.50$^{ab}$ | 22.50$^{abc}$ |
| 9. Glufosinate-ammonium | 938 | 88.75$^{a}$ | 90.00$^{a}$ | 80.00$^{a}$ | 63.75$^{a}$ | 27.50$^{a}$ | 25.00$^{ab}$ |
| F-test | | ** | ** | ** | ** | ** | ** |
| CV. (%) | | 12.71 | 9.57 | 10.40 | 14.20 | 27.49 | 26.89 |

[1/] Means within the columns followed by the same letter are not significantly different at the 5% level by Duncan's Multiple Range Test

** Hightly significant

For a period of 6 weeks glufosinate-ammonium at the rate of 938 g/ha gave the highest percentage of weed control at 80.00% with no significant different from glyphosate at the rate of 1,000g/ha and glufosinate- ammonium at the rate of 563 g/ha,giving 75%and73.5% ,respectively ,followed by paraquat at the rate of 794g/ha,(70%). Paraquat at the rate of 690 g/ha gave the percentage of weed control at 60% with no significant different from glufosinate-ammonium at the rate of 375g/ha and glyphosate at the rate of 769g/ha,giving 55%and 51.25%, respectively. Brush cutter gave the lowest percentage of weed control at 25.00%.,while glyphosate at the rate of 513g/ha, gave the percentage of weed control at 37.50%.(Table 3)

For a period of 8 weeks after application, glufosinate–ammonium at the rate of 938g/ha gave the highest percentage of the weed control at 63.75% with no significant differences from glyphosate at the rate of 1,000 g/ha and paraquat at the rate of 794 g/ha giving 56.25 and 55.00 %, respectively, followed by glufosinate–ammonium at the rate of 563 g/ha(52.50%), meanwhile glyphosate at the rate of 513 g/ha gave the percentage of weed control at 37.50% with no significant differences from glyphosate at the rate of 769 g/ha, glufosinate–ammonium at the rate of 375g/ha and paraquat at the rate of 690 g/ha giving 42.50,46.25 and 46.25%, respectively. Brush cutter gave the lowest percentage of weed control (10 %).(Table 3)

For a period of 8 to12 weeks after application, no treatments gave percentage of the weed control more than 50%.(Table 3)

### *Effects of herbicide on weed dry weigh*

Before application (0 WAT), weed dry weigh of all treatments were no significant difference between 57.97-72.46g/0.25 $m^2$.(Table 4)

**Table 4** Weed dry weigh (g / 0.25$m^2$) at 2, 4, 6, 8,10,12 and 16 weeks after the treatment (WAT) with brush cutter, paraquat , glyphosate and glufosinate-ammonium

| Treatment | Rate (g / ha) | Weed dry weigh (g / 0.25$m^2$) [1/] | | | |
|---|---|---|---|---|---|
| | | 0 WAT | 4 WAT | 8 WAT | 12 WAT |
| 1. Brush cutter | - | 72.46 | 25.06$^{a}$ | 28.16$^{ab}$ | 35.97$^{a}$ |
| 2. Paraquat | 690 | 62.61 | 22.98$^{a}$ | 29.44$^{a}$ | 35.09$^{a}$ |
| 3. Paraquat | 794 | 57.97 | 5.17$^{d}$ | 14.81$^{cd}$ | 20.67$^{d}$ |
| 4. Glyphosate | 513 | 64.41 | 24.58$^{a}$ | 32.93$^{a}$ | 36.63$^{a}$ |
| 5. Glyphosate | 769 | 69.93 | 17.36$^{abc}$ | 32.37$^{a}$ | 31.22$^{ab}$ |
| 6. Glyphosate | 1,000 | 62.90 | 11.62$^{bcd}$ | 16.38$^{c}$ | 25.26$^{bcd}$ |
| 7. Glufosinate-ammonium | 375 | 66.87 | 24.66$^{a}$ | 25.41$^{abc}$ | 30.01$^{abc}$ |
| 8. Glufosinate-ammonium | 563 | 59.50 | 19.25$^{ab}$ | 17.74$^{abc}$ | 22.56$^{cd}$ |
| 9. Glufosinate-ammonium | 938 | 63.03 | 10.48$^{cd}$ | 13.53$^{d}$ | 21.71$^{cd}$ |
| F-test | | ns | ** | ** | ** |
| CV. (%) | | 12.71 | 9.57 | 10.40 | 14.20 |

[1/] Means within the columns followed by the same letter are not significantly different at the 5% level by Duncan's Multiple Range Test

** Hightly significant

For a period of 4 weeks, paraquat at the rate of 794g/ha gave the lowest weed dry weigh at 5.17 g/0.25 $m^2$ with no significant differences from glufosinate–ammonium at the rate of 938g/ha. and glyphosate at the rate of 1,000g/ha, giving 10.48 and 11.62g/0.25 $m^2$, respectively. Brush cutter gave the highest weed dry weigh at 25.06 g/0.25 $m^2$ with no significant differences from glufosinate–ammonium at the rate of 375g/ha, glyphosate at the rate of 513 g/ha, paraquat at the rate of 690 g/ha**,** glufosinate–ammonium at the rate of 563 g/ha and glyphosate at the rate of 769 g/ha,giving 24.66,24.58,22.98,19.25 and 17.36g/0.25 $m^2$, respectively.(Table 4)

For a period of 8 weeks, glufosinate–ammonium at the rate of 938g/ha. gave the lowest weed dry weigh at 13.53 g/0.25 $m^2$ with no significant differences from, paraquat at the rate of 794g/ha (14.81 g/0.25 $m^{2)}$. Glyphosate at the rate of 1,000g/ha gave weed dry weigh16.39 g/0.25 $m^2$ with no significant differences from glufosinate–ammonium at the rate of 563 g/ha and glufosinate–ammonium at the rate of 375g/ha,giving 17.74 and 28.41 g/0.25 $m^2$, respectively,meanwhile glyphosate at the rate of 513 g/ha gave the the highest weed dry weigh at 32.93 g/0.25 $m^2$ with no significant differences from glyphosate at the rate of 769 g/ha, paraquat at the rate of 690 g/ha and brush cutter,giving 32.37, 29.44 and 28.16 g/0.25 $m^2$, respectively.(Table 4)

For a period of 12 weeks, paraquat at the rate of 794g/ha gave the lowest weed dry weigh at 20.67 g/0.25 $m^2$ with no significant differences from glufosinate–ammonium at the rate of 938g/ha, glufosinate–ammonium at the rate of 563 g/ha and glyphosate at the rate of 1,000 g/ha, giving 21.71,22.56 and 25.26 g/0.25 $m^2$, respectively ,while glyphosate at the rate of 513 g/ha gave the the highest weed dry weigh at 36.63 g/0.25 $m^2$ with no significant differences from brush cutter, paraquat at the rate of 690 g/ha, glyphosate at the rate of 769 g/ha and glufosinate–ammonium at the rate of 375g/ha giving 35.97,35.09,31.22 and 30.01 g/0.25 $m^2$, respectively.(Table 4)

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

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

Plant height before application, all treatments were no significantly difference between 37.38-48.75 cm. After application at 4,8,12 and 16 WAT there were no significantly difference on plant height between brush cutter and herbicide treatments with 40.00-52.63,44.13 -56.75, 48.63-61.25and53.00-65.75 cm. respectively. (Table 5)

Rachis length before application, all treatments was no significantly difference between 3.04-3.29 meter. After application at 4,8,12 and 16 WAT there were no significantly difference on rachis length

between brush cutter and herbicide treatments with 3.15-3.52,3.15 - 3.66,3.41-3.79 and 3.54-4.10 meter. respectively. (Table 5)

**Table 5** Plant height (cm) and rachis length (meter) at 0, 4, 8, 12 and 16 weeks after the treatment (WAT)

| treatment | Rate (g/ha) | Plant height (cm) [1/] | | | | | Rachis lenght (meter) [1/] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 WAT | 4WAT | 8WAT | 12WAT | 16WAT | 0WAT | 4WAT | 8WAT | 12WAT | 16WAT |
| 1. Brush cutter | - | 44.00 | 47.63 | 52.00 | 57.00 | 60.25 | 3.22 | 3.27 | 3.43 | 3.55 | 3.83 |
| 2. Paraquat | 690 | 43.75 | 47.63 | 52.25 | 56.88 | 60.63 | 3.29 | 3.19 | 3.61 | 3.61 | 3.91 |
| 3. Paraquat | 794 | 42.13 | 45.88 | 49.88 | 54.00 | 58.25 | 3.04 | 3.20 | 3.27 | 3.41 | 3.54 |
| 4. Glyphosate | 513 | 40.88 | 44.38 | 48.50 | 52.63 | 56.25 | 3.05 | 3.41 | 3.65 | 3.79 | 4.10 |
| 5. Glyphosate | 769 | 48.75 | 52.63 | 56.75 | 61.25 | 65.75 | 3.25 | 3.42 | 3.66 | 3.78 | 3.96 |
| 6. Glyphosate | 1,000 | 37.38 | 40.00 | 44.13 | 48.63 | 53.00 | 3.22 | 3.52 | 3.31 | 3.55 | 3.90 |
| 7. Glufosinate -ammonium | 375 | 43.88 | 47.38 | 51.50 | 55.63 | 60.38 | 3.21 | 3.41 | 3.15 | 3.64 | 3.82 |
| 8. Glufosinate -ammonium | 563 | 41.00 | 44.38 | 48.63 | 52.38 | 56.00 | 3.05 | 3.15 | 3.31 | 3.42 | 3.56 |
| 9. Glufosinate -ammonium | 938 | 41.00 | 44.88 | 49.38 | 54.25 | 57.88 | 3.24 | 3.31 | 3.48 | 3.46 | 3.71 |
| F-test | | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| CV.(%) | | 15.94 | 15.91 | 14.77 | 13.44 | 12.17 | 11.66 | 11.34 | 11.67 | 10.82 | 13.83 |

[1/] Means within the columns followed by the same letter are not significantly different at the 5% level by Duncan's Multiple Range Test

ns Non significant

Number of fronds per plant before application, all treatments were no significantly difference between 27.88-32.25fronts/plant. After application at 4,8,12 and 16 WAT there were no significantly difference on number of fronds per plant between brush cutter and herbicide treatments with 29.25-33.38,31.50 -37.13,34.00-39.50 and 37.50 -41.75 fronts/plant respectively.(Table 6)

Number of male inflorescenes/plant before application, all treatments was no significantly difference between 1.06-1.58 inflorescenes/plant. After application at 4,8,12 and 16 WAT there were no

significantly difference on the increasing number of male inflorescenes per plant between brush cutter and herbicide treatments with 1.00-1.37,1.00 - 1.45,1.06 -1.41 and 1.06 -1.47 inflorescenes /plant respectively.(Table 6)

**Table 6** Number of fronds/plant and number of male inflorescences increasing / plant at 0, 4, 8, 12 and 16 weeks after the treatment (WAT)

| treatment | Rate (g/ha) | number of fronds /plant [1/] | | | | | number of male inflorescences increasing/plant [1/] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 WAT | 4 WAT | 8 WAT | 12 WAT | 16 WAT | 0 WAT | 4 WAT | 8 WAT | 12 WAT | 16 WAT |
| 1. Brush cutter - | | 29.63 | 31.13 | 33.38 | 35.88 | 38.00 | 1.25 | 1.10 | 1.00 | 1.06 | 1.06 |
| 2. Paraquat 690 | | 30.25 | 31.63 | 34.00 | 36.63 | 38.75 | 1.47 | 1.10 | 1.10 | 1.21 | 1.06 |
| 3. Paraquat 794 | | 28.50 | 29.63 | 31.50 | 34.00 | 37.50 | 1.58 | 1.16 | 1.00 | 1.06 | 1.06 |
| 4. Glyphosate 513 | | 31.25 | 32.63 | 34.88 | 38.50 | 40.63 | 1.06 | 1.15 | 1.00 | 1.06 | 1.16 |
| 5. Glyphosate 769 | | 32.13 | 33.50 | 37.13 | 39.50 | 41.75 | 1.42 | 1.20 | 1.31 | 1.35 | 1.21 |
| 6. Glyphosate 1,000 | | 27.88 | 29.25 | 31.63 | 37.88 | 40.00 | 1.52 | 1.37 | 1.45 | 1.41 | 1.47 |
| 7. Glufosinate -ammonium | 375 | 31.13 | 32.25 | 34.13 | 36.38 | 38.38 | 1.49 | 1.00 | 1.10 | 1.16 | 1.31 |
| 8. Glufosinate -ammonium | 563 | 30.00 | 30.13 | 32.00 | 34.38 | 36.75 | 1.06 | 1.06 | 1.15 | 1.24 | 1.39 |
| 9. Glufosinate -ammonium | 938 | 32.25 | 33.38 | 35.63 | 37.75 | 39.75 | 1.10 | 1.10 | 1.18 | 1.16 | 1.06 |
| F-test | | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| CV.(%) | | 6.75 | 6.77 | 7.46 | 9.09 | 8.99 | 32.30 | 18.69 | 17.39 | 21.23 | 18.03 |

[1/] Means within the columns followed by the same letter are not significantly different at the 5% level by Duncan's Multiple Range Test
ns Non significant

Number of female inflorescenes/plant before application, all treatments was no significantly difference between 1.11-1.67 female inflorescenes/plant. After application at 4,8,12 and 16 WAT there were no significantly difference on the increasing number of female inflorescenes/plant between brush cutter and herbicide treatments with 1.20-1.56, 1.43 -1.64, 1.15-1.59 and 1.36-1.90 inflorescenes/plant respectively.(Table 7)

Number of fruit bunches/plant before application, all treatments were no significantly difference between 2.72-3.24 bunches/plant. After application at 4,8,12 and 16 WAT there were no significantly difference on the increasing number of fruit bunches/plant between brush cutter and herbicide treatments with1.00-1.26,1.00-1.54,1.38-1.77and1.16-1.54 bunches/plant respectively. (Table 7)

**Table 7** Number of female inflorescences increasing / plant and number of fruit bunches increasing / plant at 0, 4, 8,12 and 16 weeks after the treatment (WAT)

| Treatment | Rate (g / l) | Number of female inflorescences increasing / plant [1/] | | | | | Number of fruit bunches increasing / plant [1/] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 WAT | 4 WAT | 8 WAT | 12 WAT | 16 WAT | 0 WAT | 4 WAT | 8 WAT | 12 WAT | 16 WAT |
| 1. Brush cutter | - | 1.52 | 1.22 | 1.43 | 1.29 | 1.49 | 3.22 | 1.06 | 1.42 | 1.54 | 1.45 |
| 2. Paraquat | 690 | 1.62 | 1.36 | 1.56 | 1.46 | 1.60 | 3.03 | 1.16 | 1.31 | 1.60 | 1.31 |
| 3. Paraquat | 794 | 1.67 | 1.46 | 1.64 | 1.59 | 1.90 | 2.72 | 1.21 | 1.34 | 1.71 | 1.16 |
| 4. Glyphosate | 513 | 1.64 | 1.21 | 1.50 | 1.15 | 1.62 | 3.24 | 1.06 | 1.25 | 1.77 | 1.54 |
| 5. Glyphosate | 769 | 1.66 | 1.41 | 1.55 | 1.49 | 1.59 | 3.15 | 1.26 | 1.54 | 1.64 | 1.25 |
| 6. Glyphosate | 1,000 | 1.11 | 1.26 | 1.45 | 1.33 | 1.36 | 2.95 | 1.00 | 1.00 | 1.45 | 1.30 |
| 7. Glufosinate -ammonium | 375 | 1.49 | 1.20 | 1.53 | 1.59 | 1.68 | 2.86 | 1.16 | 1.36 | 1.67 | 1.40 |
| 8. Glufosinate -ammonium | 563 | 1.37 | 1.27 | 1.61 | 1.36 | 1.56 | 3.04 | 1.06 | 1.30 | 1.38 | 1.17 |
| 9. Glufosinate -ammonium | 938 | 1.55 | 1.56 | 1.52 | 1.39 | 1.66 | 3.22 | 1.11 | 1.46 | 1.76 | 1.26 |
| F-test | | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| CV. (%) | | 20.56 | 16.43 | 16.35 | 21.24 | 19.86 | 38.10 | 16.94 | 17.64 | 17.64 | 19.15 |

[1/] Means within the columns followed by the same letter are not significantly different at the 5% level by Duncan's Multiple Range Test

ns Non significant

## Discussion

The experiment took place during the wet season in Thungsong district, Nakhon Si Thammarat,Thailand, approximately 688.50 mm. of rain was recorded during the 4 months of experimentation from August to

November 2015. The composition of weeds were broad-leaf weeds more than narrow- leaf weeds. Herbicide treatments needed the high rate of paraquat glyphosate and glufosinate-ammonium at the rate of 794, 1,000 and 938 g/ha respectively for the effective weed control, showed the percentage of weed control more than 50% for the 8 weeks period, while brush cutter weeding was effectively for weed control for the 4 weeks period, due to rainfall ensured sufficient for weed germination and regrowth. Thongjua (2015) reported that in the dry season period, ,glyphosate at the rate of 1,000 and 769g/ha, glufosinate–ammonium at the rate of 938 and 563g/ha had long time duration for effective weed control 14 weeks after application, while brush cutter weeding was effectively for weed control 8 weeks after application. Wibawa *et al*. (2007) reported that paraquat needed high rate, 600 and 800g/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.

For the weed dry weigh found that after application treatments, weed dry weigh was decreased at the early of weeks period and increased at the later of weeks period. The relationship between the percentage of weed control and weed dry weigh were adversely, while the percentage of weed control was high the weed dry weigh was low in all treatment at the weeks period. The weed dry weigh influenced the reduction of weed growth which reflected the relative capability of a treatment to suppress weed growth. The dry weigh of weed measured the productivity of the weed community (Mohamad *et al*.,2010)

Brush cutter and herbicide treatments were not significantly differences on growth of 2-year old oil palm in the wet season. Thongjua (2015) reported that Brush cutter and herbicide treatments were not significantly differences on growth of 2-year old oil palm in the dry season. Wibawa *et al*., (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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