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Original Research

Determining an effective way to control weeds in the Olam Palm, Kango (Gabon) using herbicide treatment

Authors:
Nguema Ndoutoumou P*, Mbeang Beyeme AM, Mouele Balimbi J and Leboussy Ayenengoye SU

Institution:
University of Science and Technology of Masuku, National Higher Institute of Agronomy and Biotechnology (INSAB). Poto-Poto BP 99 Franceville, Gabon.

Corresponding author:
Nguema Ndoutoumou P

ABSTRACT:

The fight against weeds in forest areas is a major constraint to agricultural production; indeed, the loss of production there are around 25%. The use of herbicides for control remains common. This study aims to propose an appropriate herbicide against weeds in the young palms of central Gabon region.

The protocol is based on the observation and analysis of the effects of three herbicide formulations (T_1 = 30 ml Finish + 2g Ally; T_2 = 50 ml Roundup + 2g Ally and T_3 =100 ml of "mixing 150 ml of Finish + 150 ml water 2g + Ally") on the dominant weeds and their impact on the growth of palm trees. The data are collected on the time taken for drying of weeds, time of recurrence of weeds, the growth of leaves and changing the size of the arrows.

The treatment T_2 is the most effective way to induce speed drying of weeds, their period of resurgence and growth of oil palm seedling. However, the species *Marantochloa purpurea* Ridl., perennial broadleaf weed is the most common resistant. This characteristic is related to the length of the leaves protecting the base of the screw-to-weed herbicide and screw to advanced growth stage. In addition, this species has a higher resistance compared to grasses (*Centotheca lappacea* L. and *Paspalum conjugatum* Berg).

In conclusion, treatment with the molecules of glyphosate and metsulfuron methyl are most suitable for weed control in the palm of OLAM Palm, Kango.

Keywords:
Palm oil, efficiency, weeds, herbicides, growth, dryness, growth

Email Id:
pamphilen@hotmail.com

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INTRODUCTION

The oil palm (*Elaeis guineensis* Jacq.) is a perennial plant belonging to the monocot family-Arecaceae from Africa (Coulibaly, 1999).

According to Hekimian *et al.* (2002), it is mainly grown for its fruit which has fats that are extracted for multipurpose with a higher yield compared to peanut and soybean. Fruit pulp provides edible oil, fats and soaps. Almond oil palm gives exploitable amount of yield in nature. The cake obtained after the extraction of these oils is used for animal feed. Excess sap of palm oil are collected in jars, ferment quickly and give the palm wine. Its leaves are used for many purposes: roofs, fences, straw etc., (Pantzaris, 1988; Jacquemard, 1995; Ofosu-Budu and Sarpong, 2013).

This tropical plant with continued growth requires a constant annual climate condition; any deviation from the optimum leads to a decrease in the production (Hekimian *et al*., 2002).

According to Adje and Affoyon (1994) and Traore *et al*. (2010), in tropics, weeds are a major brake on development in crop productivity through the phenomena of direct competition for the various inputs. The man had to fight as soon as he began to cultivate plants for their needs. For the effectiveness of this struggle, it is important to have a good knowledge of weeds and herbicides (Montegut and Merlier, 1982; Hornus *et al.* 1990; Dore, 2008). According to these previously tested authors, weeds dissociate into three groups, including grasses, sedges and broadleaf weeds. This classification joins those by Barnes (1990), Johnson (1997) and Traore *et al*. (2005 and 2010).

Weeding in a palm grove is basically to eliminate weeds around the palm to reduce or limit weed competition on the one hand, and to prevent the cover crop cluttering the palm on the other hand. The weeding may be chemical or manual. In general, chemical weed control is achieved with Roundup or Finish, where the active ingredient is glyphosate base. In these products, the glyphosate concentration is between 120 g/l and 480 g/l, but the most common is 360 g/l (Lemercier, 2009). These herbicides are foliar, systemic, non- selective and effective in controlling grasses.

Finally, herbicides having metsulfuron methyl allow the inhibition of cell division in the shoots and roots. They disrupt the physiology of the plant. The ensuing block, prevents the growth of the plant resulting in early senescence. It is rapidly absorbed by plants at the roots and foliage level (Tissut *et al.,* 2006; Pipon, 2013).

In Gabon, the company Olam plans for the production of 25,000 tons of oil for the country to become the leading palm oil producer in Africa by 2020. The plantations are still young. Several parameters, including weed competition can undermine these forecasts.

Indeed, production losses due to weeds affect global agricultural production; the developing countries are the most affected targets as they can't invest in high volumes. Loss rates are higher (25% of production) when compared to developed countries (5%), (Adou and Ipou Ipou, 2007).

The application of herbicides has become a common way to fight against weeds in the modern agricultural practice (Mischler *et al.,* 2007; Bertonnier *et al.,* 2012). The significance of this study lies precisely based on the fact that the competition weeds with the crop may limit its growth. It is the question of determining impact of three formulations of herbicides on weeds in the dominant Olam Palm Kango and then to measure their impact on the growth of young oil palms. It is therefore proposed to check the Olam Palm Kango effective herbicide treatment for getting best suited to combat the expectations for the conduct of the palm.

MATERIALS AND METHODS

Site Characterization

The site Olam Palm Kango is located on the 0°02' latitude and 10°12' longitude. The experimental plot is located at 0°03' South latitude and 0°11' east longitude.

It is an area of rainforest where a succession of hills and plateaus are seen. The climate is equatorial marked by two dry seasons and two rainy seasons in the year. The months of March, April and December are endowed with heavy rainfall above 300 mm average. These are also the months which record the highest temperatures (average above 27°C). The driest months are June, July and August.

Samples analyzed using a 52 cm soil pit shows that the soil is acidic and ferralitic kind. The texture of the soil is sandy loam.

Plant and technical equipment

Five weeds were identified in the experimental plot. For the purposes of collecting and analyzing data, they are coded as MH (weed) and assigned a number from one to five. The following species are the dominant weed in the palm of Olam Palm Kango:

Centotheca lappacea L. (Grass) = MH_1

Marantochloa purpurea (Ridl.) Milne-Redh. (Marantaceae) = MH_2

Paspalum conjugatum Berg (Grass) = MH_3

Dissotis rotundifolia (Sm.) Triana (Mélastomatacée) = MH_4

Mikania micrantha Kunth (Asteraceae) = MH_5

The study covers a total of 36 oil palm (*Elaeis guineensis* Jacq.), aged two years. These palms are derived from crosses of improved varieties. Preliminary work on the plantation took place a year in advance.

Herbicides used in this study are: Roundup (glyphosate 360 g/l), the Finish (glyphosate 360 g/l) and Ally (metsulfuronméthyle). Ally is usually used in combination with other herbicides. In the experiment, it is sometimes associated with Roundup but now with Finish. It is a selective herbicide for pre and post-emergence that control broadleaf weeds, annual weeds and some grasses.

100 ml beaker was used to contain the amounts of herbicides removed from their original packaging, using a 20 ml syringe. A backpack sprayer with a capacity of 15 liters was used for processing around the palm while a 200 liters drum was used as a reserve for the preparation of boiled water.

METHODS

Selection and identification of weeds

Site selection was taken into account for determining the diversity of weed flora in the oil palm plantation region. Weeds were selected following the enumeration of different species in the plot. The following species have been identified with their attendance: *Centotheca lappacea* (MH_1, 72.2%), *Marantochloa purpurea* (MH_2, 55.5%), *Paspalum conjugatum* (MH_3, 83.3%), *Dissotis rotundifolia* (MH_4, 75%) and *Mikania micrantha* (MH_5, 25%). These rates correspond to the number of times, the weeds were found around 36 palms of the experimental site.

Species identification was done using a magnifying glass and utilized the work of Johnson (1997) for characters comparison. A final notice was given by the National Herbarium of Gabon.

Treatments and experimental design

The test was conducted according to an experimental device, completely randomized in blocks at once. It consists of three blocks (B1, B2 and B3) and three experimental units per block. Each unit has four palm trees. Treatments are randomly assigned within the blocks.

Weeds identified were subjected to the following experimental treatments:

T_1 : 30 ml Finish + 2g Ally

T_2 : 50 ml Roundup + 2g Ally

T_3 : 100ml mixture "150ml Finish + 150ml water + 2g Ally."

The mixtures were made in a water container of 15 liter. These treatments are common in the Olam Palm Kango.

Observed parameters and analysis

Drying weed

Drying weed corresponds to the period of first yellowing weed in the perimeter of the spray. Observations are made to the total drying of various weeds. Five stages of dryness were selected:

The Resistance (R): No treatment effect on weeds;

Yellowing (Y): The beginning of desiccation;

The Significant Yellowing (YS): Transition between yellowing and drying of weeds;

The Desiccation (D): Onset of senescence of weeds.

The Significant Dryness (DS): Total desiccation of weeds.

Recurrence weed

Recurrence weed is the observation period for recurrence of any weed on the treated plot. Shades are made according to the identified flora.

The growth parameters of the palm on one hand are related to the number of sheets issued by the palm plant, and on the other hand, the size of the arrow until maturity. Finally, the time required for the arrows to becoming true leaves was also determined.

Data collection is weekly for the different parameters studied. Analyses of the size of the boom, the number of leaves and respawning of weeds were made using the XLSTAT software. Duncan test was used for making comparison between means.

For the number of leaves and the size of the arrow, an analysis of variance on repeated measurements was made, thereby enabling monitoring of the evolution of these parameters until the end of the experiment. For the respawn of weeds, analysis of variance (ANOVA) was performed.

For the statistical analysis of time taken for drying weed, the five levels of dryness were scored from 0 to 4, respectively for levels R, J, JS, DS and D; then the observations were transformed into log values (X + 1) and compared using analysis of variance (ANOVA) and on repeated measurements separated by the LSD at 5% when the difference was significant. This analysis was performed using SAS software.

RESULTS AND DISCUSSION

Drying time of weed

Figures 1 to 4 present the effects of treatments T_1, T_2 and T_3 on weeds MH_1, MH_2, MH_4 and MH_5, over time.

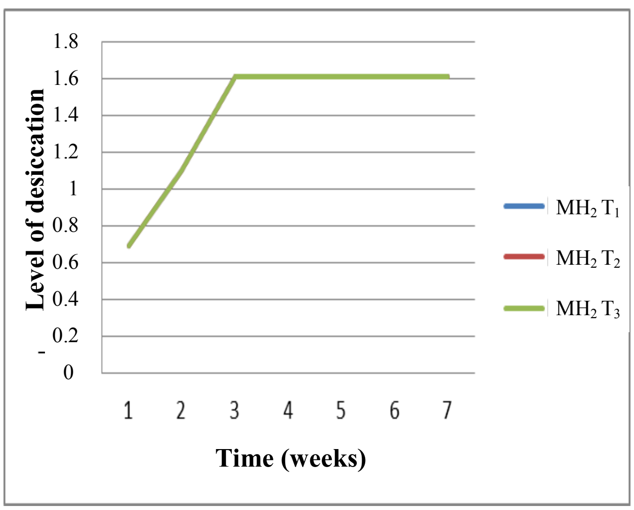

Figure 1 Evolution of drying MH_1 (*Centotheca lappacea*) among treatments.

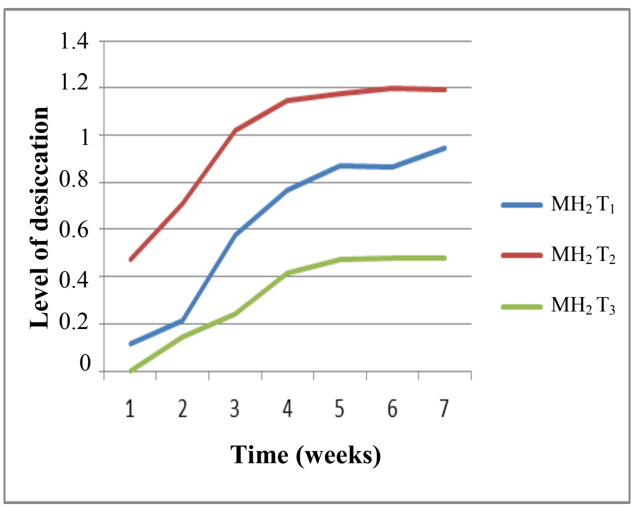

Figure 2 Evolution of drying MH_2 (*Marantochloa purpurea*) among treatments.

The effect of the three treatments (T_1, T_2, T_3) are identical in MH_1 (*Centotheca lappacea*), where the superposition of the curves representing that effect over time (Figure 1).

The effect of treatments on *Centotheca lappacea* (MH_1), *Paspalum conjugatum* Berg (MH_3) and *Mikania micrantha* (MH_5) was achieved after three weeks to the last level of dryness (DS). As these are short-cycle species mainly following vegetative propagation, they undergo rapid drying out three weeks after the different treatments.

Dissotis rotundifolia (MH_4) reacts differently to other weeds (MH_1, MH_3 and MH_5) with respect to the three treatments. Indeed, in the sixth and seventh weeks, all the three treatments have the same behavior. These results are explained by the fact that *Dissotis rotundifolia* is a perennial broadleaf and therefore more resistant to herbicides compared to grasses.

Formulations T_1 and T_3 in the same way act on *Marantochloa purpurea* (MH_2). Their effectiveness on this weed is less compared to that of T_2 with which they will reach a higher level of drying (JS) after three weeks. In general, *Marantochloa purpurea* is resistant to these three treatments. It is a plant with large leaves and rhizomes, where foliage limit absorption of the herbicide and rhizomes promote regeneration.

The overall results showed that the most resistant weed is MH_2 (*Marantochloa purpurea*). In addition, the treatment T_2 seems to be more effective in the fight against these weeds.

From a statistical point of view, if we take into account the probability effect of different sources of variation, it appears at first as a highly significant difference in response between the three treatments given to five weed species. This result seems to be that the life cycle of annual grasses are thus relatively short. More recent to this, they reproduce only sexually, unlike broadleaf weeds (*Marantochloa purpurea*) and have longer life cycles.

In the second step, there is a significant difference between three formulations applied to the herbicides. The treatments do not work with the same effectiveness on weeds. This difference is explained by the fact that Roundup does not contain metsulfuron methyl while the Finish contains enough active form of this adjuvant.

Finally, the probability of interaction (treatment x species) confirms the effect of differences between the data for three treatments or behavior differences in weed species which meet these three species treatments.

The speed of drying out is higher in grasses than broadleaf weeds. Similarly, in general, the time and

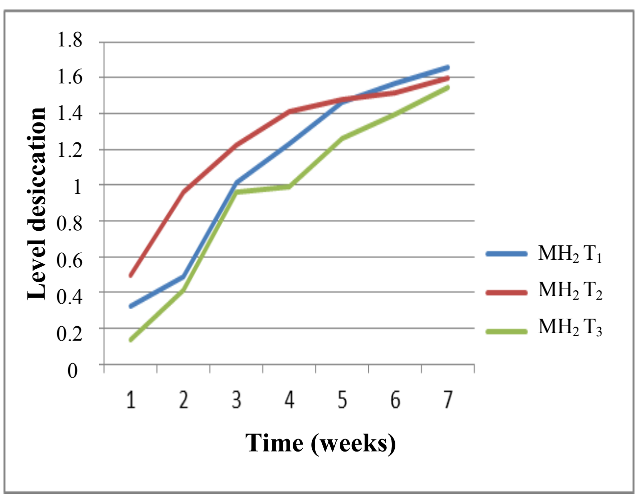

Figure 3 Evolution of drying MH_4 (*Dissotis rotundifolia*) among treatments.

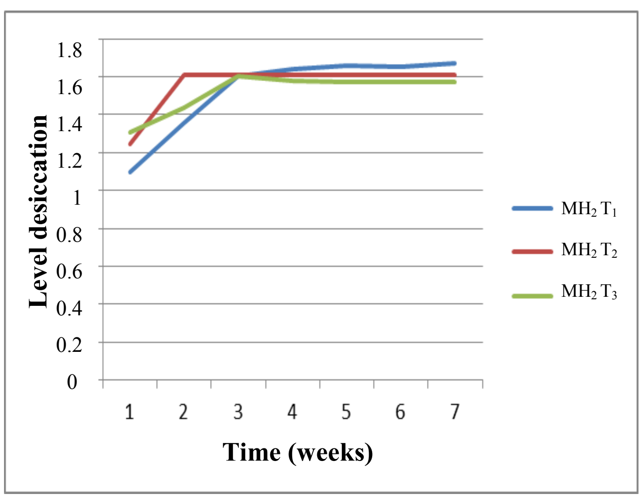

Figure 4 Evolution of drying MH_5 (*Mikania micrantha*) among treatments.

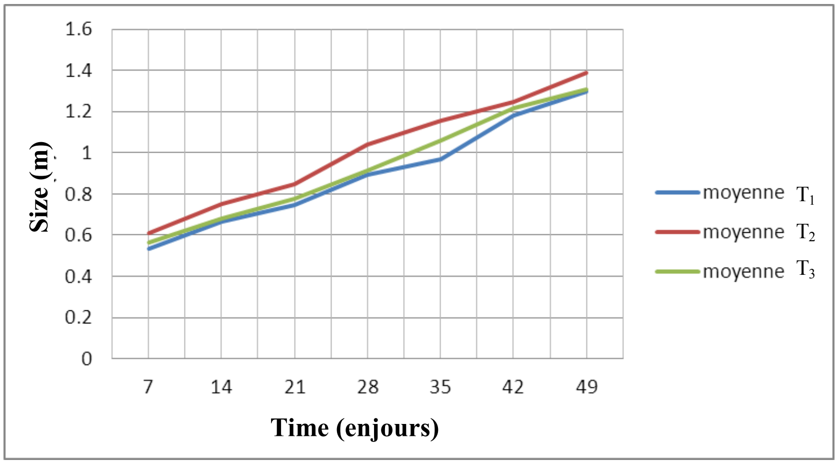

Figure 5 Evolution of the size of the arrow.

dryness is greater when the treatment is accelerated with T_2. Analysis of the differences between treatments revealed that for the "drying time of weed" parameter, treatment T_2 is much better than T_3.

Treatment T_1 occupies an intermediate position between T_2 and T_3 in the analysis of interactions (species x treatment). Its effectiveness on *Marantochloa purpurea* remains lower compared to the effect of treatment T_2 of the same species. The treatment T_2 has a better efficacy on weed control treatments than T_1 and T_3.

Size of the arrow

The curves of the three treatments have a constant gradual pace. However, regarding the processing curve of T_2 (Roundup + Ally) it is above the curves representing experimental units having received treatment with $T_1$and T_3.

Indeed, the reduction of competition enable palms to increase their export of mineral, water and soil as well as their ability to capture light for photosynthesis. This promotes the growth and development of the palm of the arrows. All treatments allow a better development of the size of the arrows. In addition, weeds can be a habitat for some palm pests. Removing them allows expelling the pests of cultivated areas. Although various treatments have a positive impact on the growth of the size of the arrows of palms; treatment T_2 proves to be the best.

Number of sheets

Growth in the number of leaves is not significant during the period of observation. Indeed, this parameter does not vary between treatments received by palm plants. However, experimental units having received the treatment T_2 exhibit better growth compared with the other units which received other two treatments. Indeed, the growth of the arrows cause an increase in the number of leaves; ultimately, the application of different herbicides on weed formulations allow the increase of palm leaves.

Respawn weed

Treatments followed by T_1, T_2 and T_3 are significantly different at the 5% level.

There are significant differences between treatments T_1 and T_2, on one hand, and between treatments T_1 and T_3, on the other hand, while the effects of treatments on the respawn of weeds are similar to

Table 1 Analysis of the differences between treatments for the respawn of weeds.

Treatments	Means and standard deviations
T_3	$94.08^a \pm 23.12$
T_2	$90.16^a \pm 10.69$
T_1	$73.16^b \pm 09.99$

treatments T_3 and T_2.

The mean time for recurrence of palms receiving treatment T_2 and T_3 treatments are very close. The effect of treatment T_2 and T_3 on weeds can greatly delay the time to recurrence weeds. Treatments T_2 and T_3 are effective in delaying the onset of weeds and promote the harmonious growth of the oil palm. Nevertheless, one can notice that the standard deviation of the respawn units receiving treatment T_3 is very high (23.12). Application of the treatment T_3 is obtained promptly to recur weeds. The treatment T_3 does not allow time to obtain a balanced and stable recurrence. Against by standard deviation units, receiving treatment T_2 is low and therefore stable (10,69), this treatment allows for respawn close to the average. Indeed, the Finish contains not only glyphosate as the active ingredient but also as metsulfuron methyl builder. It is therefore possible that these two substances in certain concentrations reduce the effectiveness of the fight against weeds. While in the treatment T_2, the only source of the product is Metsulfuron methyl Ally as Roundup has only glyphosate as active ingredient. The treatment T_2 seems more stable and allows for respawn which is almost uniform.

Respawned weed and palms which received the treatment T_1 is 73 days on average. This duration is less than three months. It is significantly lower than the respawn of weeds in units that have received treatments T_2 and T_3. The respawn in units that received the herbicide formulations T_2 and T_3 are 90 days and 94 days respectively and correspond to three months on average.

All treatments can slow the recurrence of weeds, although the treatment T_3 and T_2 are used to obtain respawn of longer weeds. Indeed, the stage of weed growth is a key factor for weed control in an effective way.

DISCUSSION

Resistance to treatment

In terms of drug resistance, it would be wise to treat weeds in stage two or three leaves, so the treatment frequency is quarterly. The different treatments were applied while weeds had overtaken the juvenile stage development. In fact, the observed resistance of *Dissotis rotundifolia* could be explained. Indeed, early weed control is important for effective control and yields. This is consistent with the observations of Johnson (1997).

The conduct of palm monoculture promotes weed resistance vis-à-vis herbicides (Mangara *et al.,* 2010). *Marantochloa purpurea* is the only weed that truly has broad leaves and rhizomes. Indeed, perennials are much more resistant to herbicides than grasses (Johnson, 1997).

Finish, Round up and Ally are the main herbicide used, they contain glyphosate (active ingredient) at a concentration of 360 g/l. Some weeds such *Marantochloa purpurea* may acquire resistance to glyphosate due to the repeated use of the same herbicide. Indeed, the work of Baylis (2000) showed that this fact promotes weed resistance.

Determining the type of weeds is essential to effectively fight against their impact on culture. Perennial weeds have a high resistance compared to the other. Resistance of *Marantochloa purpurea* is also explained by the fact that it has a long life cycle. *Marantochloa purpurea* can be propagated vegetatively, unlike species *Paspalum conjugatum*, *Centotheca lappacea* and *Mikania micrantha* which can reproduce that sexually. This faculty of reproduction gives *Marantochloa purpurea* a better resilience compared to other weeds, such as stated by Aubert and Glachant (2009).

Effectiveness of treatment T_2 compared to T_1 and T_3

The treatment T_2 (Roundup + Ally) is better compared to the other two treatments. Indeed, it only contains glyphosate Roundup outside its adjuvants. In

Finish, it contains not only glyphosate but also metsulfuron-methyl which is a sulfonylurea substance.

The combination of the Ally and Finish increased the content of metsulfuron-methyl mixture. It thus seems clear that the presence of metsulfuron-methyl in the solution is a factor limiting the effectiveness of the herbicide treatment. These results confirm the resistance shown by weeds that deal with sulfonylurea herbicides substances, up to 60-100%, according to Rodriguez (2005) and Chauvel and Guillemain (2013).

Foliar and root herbicides should be applied earlier. Indeed, three weeks after herbicide treatment, different weeds have very different spectra of activities in accordance with the work of Tissut *et al.* (2006).

The Roundup association and Ally (T_2) is a combination of herbicides that can fight against a wide range of weeds (perennial, annual or biennial). Due to its composition, it is recommendable to young weeds. Indeed, metsulfuron methyl by its mode of action or essentially leaf and root penetration destroys stolons, rhizomes and tubers. However, Roundup association and Ally (T_2) may be ineffective on some weeds; this was evidentially proved by Valantin-Morison *et al.* (2008) and Bertonnier *et al.* (2012).

Effects of herbicides on weed growth and oil palm

As in this study, the work of Echezona *et al.* (2011) on plantain showed that the combination of glyphosate (the active ingredient in Roundup and Finish) and sawdust for weed control improves and facilitates the growth of the crop. It is important to better understand, weeds and herbicides for effective control, according to Schaub (2010).

CONCLUSION

The three treatments that have proven effects on weed control are encountered on this site. However, broadleaf species such as *Marantochloa purpurea* are the most resistant, while grasses *Centotheca lappacea* and *Paspalum conjugatum* Berg are very sensitive to three treatments. The treatment T_2 is significantly different from the other two treatments. It has a long respawn time of weeds, a different curve drying weeds over other treatments and a greater influence on the growth parameters of oil palm. This treatment combines the molecules of glyphosate (Roundup) and metsulfuron methyl (Ally) which is most suitable for weed control in the palm of Olam Palm Kango.

These results would be improved by taking into account the identification of other weeds present in the field, the combination of herbicide treatment in round weeding around the palm trees, the quarterly frequency of herbicide treatment and the use of cover crop (*Pueraria javanica*) with its various beneficial effects on the culture.

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