Commercial herbicides trial against *Alocasia* sp. (wild yam) at oil palm plantation, Borneo, Malaysia

Commercial herbicides trial against *Alocasia* sp. (wild yam) at oil palm plantation, Borneo, Malaysia

M A Abas[1,*], M F A Karim[1], N Fitriani[2], M Z M Razikin[3] and Z Hamzah[1]

[1]Faculty of Earth Science, Universiti Malaysia Kelantan, 17600 Jeli, Malaysia
[2]Faculty of Mathematics and Natural Sciences, Universiti Padjadjaran, Indonesia
[3]Malaysian Agricultural Research and Development Institute, 43400 Serdang, Malaysia

*Corresponding author: azahar.a@umk.edu.my

Abstract. Weeds in oil palm plantations include any plant or vegetation that in any way interferes with the production of palms, resulting in a reduction in yield or quality. Alocasia sp. (wild yam) is a common weed at oil palm plantation in Borneo, Malaysia. This study was conducted to evaluate commercial herbicides' effectiveness (amine, ally, glyphosate, and paraquat) against *Alocasia sarawakensis, Alocasia robusta,* and *A. macrorrhizos*. Cocktail herbicide showed faster wilting, scorching and rotten and least/late regeneration within 30 days of monitoring. Combination of two chemicals reacted better and potentially long-lasting, and further observation can provide info on the difference between (systemic+contact), (contact+contact) and (systemic+systemic). Cost-effectiveness analysis showed herbicides cocktails Treatment 9 (amine + ally + surfactant), Treatment 11 (amine + paraquat + surfactant), and Treatment 12 (ally + paraquat + surfactant) were the most cost-effective (±RM0.58 cent/16 L) to control Alocasia sp. This study's finding would give an alternative solution for oil palm plantation to control weed, especially Alocasia sp.

1. Introduction

The Alocasia sp. (wild yam) is widely seen as a non-creeper broadleaf weeds at oil palm plantation in Borneo, Malaysia. They grow rapidly and compete with oil palm for many vital nutrients in the soil. They compete with immature to young oil palm plants (3-4 years old) and, if left untreated, may grow up to two metre in height [1]. Previous studies have highlighted that there is apparent nutrient demand between wild yam including *Alocasia sarawakensis, Alocasia robusta, and Alocasia macrorrhizos* and oil palm [2]. The special features of *A. sarawakensis* is the secondary venation distinctly prominent abaxially and forming well defined inter-primary collective veins [3]. Besides that, significant features for *A. robusta* are membranous leaf blade, often immense, abaxially waxy-glaucous and *A. macrorrhizos* special characteristics are male zone of spadix completely exerted from lower spathe chamber and always in association with human disturbance [4].

Control of weeds like Alocasia sp. become crucial in the oil palm cultivation to increase oil palm production. Weeds can be controlled using non-chemical (slashing) and chemical (herbicides) controls. Slashing is only practical for small patches of weeds. Hence, herbicides offer practical and economic effects of managing weeds. Various types of herbicides are commonly used in the oil palm cultivation such as paraquat, glyphosate, ally and amine. Each herbicide has a specific character to control weed based on a specific action mode [5]. Paraquat and Amine are usually used as contact herbicides which act by destroying the plant foliar system [6]. Glyphosate and Ally are categorized as

systemic herbicides. Systemic herbicides act as an inhibitor for the photosynthesis process and its action against protein synthesis in cells, affecting plant growth [7]. This study was conducted to evaluate the efficiency of several types of commercial herbicides against *A. sarawakensis, A. robusta, and A. macrorrhizos* (wild yam) where currently, oil palm plantation using Amine to control the wild yam. However, it is necessary to explore various options of herbicides with a specifical target and cost-effectiveness.

2. Methodology

This study commenced by selecting a suitable location for trial, which is the area that has *A. sarawakensis, A. robusta, and A. macrorrhizos* distribution at an oil palm plantation in Sabah. Preparation of the trial site has been done within one week. Total of 42 plots ($25m^2$/plot) has been established based on the number of treatment and three replicates for each treatment (Figure 1). One plot consists of more than five wild yams with various sizes. For each plot, one wild yam with height range between 0.5m-1.5m was selected as single monitoring. Preparation of trial sites is based on the treatment designed, consisting of 14 treatments (Table 1). Application of herbicides using spraying technique was conducted on the same day, starting from 7.00 a.m until 10.00 a.m. Observation of each plot was conducted in the field during monitoring and based on a photo taken to evaluate each treatment's bio-efficacy. During monitoring, parameters observed were the changes of wild yam's petioles and blades in every 2 days. The observation was conducted at the same point that has been marked for every plot to get consistent observation result [8].

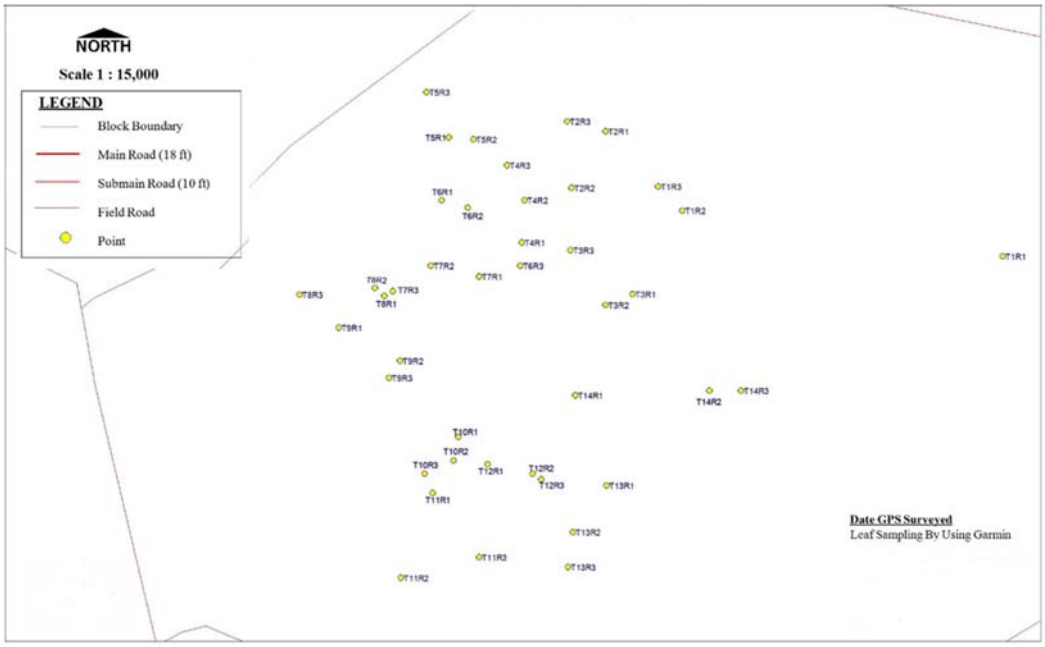

Figure 1. Location of plots that have been established at Oil Palm Plantation in Sabah.

3. Results and discussion

3.1. Bio-efficacy of herbicide based on treatments

Table 2 shows that each treatment derived from monitoring starts from 19 September 2020 until 18 October 2020 (30 days). The most efficient treatment until 30th day was the herbicides cocktail, which is a combination of glyphosate and paraquat with additional surfactant (T14). Bio-efficacy of all herbicide cocktail (T9, T10, T11, T12, T13, and T14) showed good response which required less time

average 2-6 days for petioles and blades to wilt and changing of colour from green to yellow. This study also found out that the herbicide cocktail (glyphosate and paraquat) treatment showed bud regeneration after 30th day. However, other herbicides cocktails did not show any regeneration of bud after 30th day of observation which is in line with the previuos study [9].

Table 1. Treatment preparation.

No	Treatment	Code	Active Ingredient	Type of Herbicide	Rate/16 L water
1.	Untreated (control)	T1	-	-	-
2.	Slashing	T2	-	-	-
3.	Leaf Skewers soaked in Amine and insert into basal part of petiole	T3	2,4 Dimethylamine-60%	(S-C)	Amine (40 ml)
4.	Leaf Skewers soaked in Garlon and Diesel and insert into basal part of petiole	T4	Triclopyr Butoxyethyl Ester 32.1%	(S-S)	Garlon (1 L) Diesel (9 L)
5.	Amine + Surfactant	T5	2,4 Dimethylamine- 60%	(S-C)	Amine (40 ml) Surfactant (20 ml)
6.	Ally + Surfactant	T6	Metsulfuron Menthyl-20%	(S-S)	Ally (5 g) Surfactant (20 ml)
7.	Paraquat + Surfactant	T7	Paraquat-13%	(N-C)	Paraquat (100 ml) Surfactant (20 ml)
8.	Glyphosate + Surfactant	T8	Glyphosate- 41%	(N-S)	Glyphosate (120 ml) Surfactant (20 ml)
9.	Amine + Ally + Surfactant	T9	2,4 Dimethylamine-60% + Metsulfuron Menthyl- 20%	(S-C) + (S-S)	Amine (30 ml) Ally (4 g) Surfactant (20 ml)
10.	Amine + Glyphosate + Surfactant	T10	2,4 Dimethylamine-60% + Glyphosate-41%	(S-C) + (N-S)	Amine (25 ml) Glyphosate (80 ml) Surfactant (20 ml)
11.	Amine + Paraquat + Surfactant	T11	2,4 Dimethylamine-60% + Paraquat-13%	(S-C) + (N-C)	Amine (25 ml) Paraquat (90 ml) Surfactant(20 ml)
12.	Ally + Paraquat + Surfactant	T12	Metsulfuron Menthyl-20% + Paraquat-13%	(S-S) + (N-C)	Ally (3 g) Paraquat (80 ml) Surfactant (20 ml)
13.	Ally + Glyphosate + Surfactant	T13	Metsulfuron Menthyl- 20% + Glyphosate- 41%	(S-S) + (N-S)	Ally (4 g) Glyphosate (80 ml) Surfactant (20 ml)
14.	Glyphosate + Paraquat + Surfactant	T14	Glyphosate- 41% + Paraquat-13%	(N-S) + (N-C)	Glyphosate (80 ml) Paraquat (60 ml) Surfactant (20 ml)

*Type of Herbicide: Selective/Contact (S-C), Selective/Systemic (S-S), Non-selective/Contact (N-C), Non-selective/Systemic (N-S)

Single herbicide treatment like amine and paraquat exhibited good response to kill Alocasia sp. until 14th day after treatment compared to other single treatment. However, glyphosate only showed the effect on wild yam blades colour at 14th day after spraying, and ally treatment did not respond to wild yam petioles and blades. However, single herbicide treatment showed the earliest sign of regeneration until 30th day.

Both treatments inserted the soaked leaf skewer in amine (T3) and Garlon with diesel (T4) into basal part of petiole exhibited slow-kill or action against wild yam [10]. However, leaf skewer that soaked in gallon and diesel showed better result by more petioles and blades wilted until 14th day after treatment compared to leaf skewer that soaked in amine. Bedsides, slashing is most effective quickly; however, it will increase the wild yam population in the future and require human resource or tree cutting machine [11].

Table 2. Symptoms observation of plants based on treatment from 19/9/2020 until 18/10/2020.

Code	Treatment	Observation of Symptoms	Photo (after 14 days)
T1	Control (untreated)	No symptoms observed at all part of *A. sarawakensis*.	
T2	Slashing	• **Petiole (slashed)**: Colour of petiole changed into yellow at 10th day until 14th day after treatment. • **Blade (slashed):** the colour started turning into yellow and wilted at 4th day until 14th day after slashing. • **Parts remain (stem/basal petiole):** The stem/basal petiole part remains turned into brown colour at 2nd day after spraying. The colour change starts from the middle part of the stem/basal petiole cross-section. Growth of new shoot noted from small wild yam that was slashed at 2nd day after slashing. The new blades start to open at 10th day after slashing.	
T3	Soaked oil palm leaf skewer with amine and insert into the basal part (above corm) of wild yam	• **Petiole:** wilted of petioles for wild yam height range between 0.5 m – 1.5 m at 4th day after spraying. However, no sign of petioles wilted noted for the wild yams height >1.5 m until 14th day after spraying. Petioles colour also does not change until 14th day after application. • **Blade:** wilted of blades at 4th day after treatment for small wild yam (0.5m –1.5m) and no change of colour observed.	

Code	Treatment	Observation of Symptoms	Photo (after 14 days)
T4	Soaked oil palm leaf skewer with garlon + diesel and insert into the basal part (above corm) of wild yam	• **Petiole**: wilted of petioles at 2nd and 4th day after treatment application. However, no change of colour observed until 14th day after treatment application. • **Blade**: wilted of blades at 2nd and 4th day after treatment application, but no change of colour observed until the 14th day.	
T5	Amine + Surfactant	• **Petiole**: wilted of petioles at 2nd day after treatment application. The petioles colour started turning into yellow at 12th day. • **Blade**: wilted of blades at 2nd day after treatment and blades colour started turning into yellow at 10th day. No sign of scorched observed at blade.	
T6	Ally + Surfactant	• **Petiole**: no change at petioles until 14th day of treatment application. • **Blade**: no change at blades until 14th day.	
T7	Paraquat + Surfactant	• **Petiole**: wilted of petioles at 2nd day after treatment application and the petioles colour started changing into yellow at 10th day. • **Blade**: wilted of blades at 4th day after treatment application. Scorched sign noted on blades surface at day 2 until day 14.	
T8	Glyphosate + Surfactant	• **Petiole**: wilted of petioles at 10th day after treatment application. Colour of petioles did not change until day 14**.** • **Blade**: wilted of blades at 10th day after treatment application. At day 14, the colour of blades starts turn into yellow. No sign of scorched observed at blade.	

Code	Treatment	Observation of Symptoms	Photo (after 14 days)
T9	Amine + Ally + Surfactant	• **Petiole**: wilted of petioles at 2nd day after treatment application. Colour of petioles change to yellow at day 12. • **Blade**: wilted of blades at 10th days after treatment application and some part of blades changed colour into yellow at day 6 and the whole blades change into yellow at day 14. There was no scorching observed at blades until 14th day.	
T10	Amine + Glyphosate + Surfactant	• **Petiole**: wilted of petioles start from 2nd day until 14th day after spraying and the petioles colour started changing to yellow at 12th until 14th day after treatment application. • **Blade**: wilted of blades start from 2nd day after spraying until 14th day after spraying. Colour of blades started changing into yellow from 8th day until 14th days after spraying. There was no scorched noted at blades until 14th days.	
T11	Amine + Paraquat + Surfactant	• **Petiole**: wilted of petioles start from 2nd day until 14th day after treatment application. The petioles colour started turning into yellow at 6th day until 14th day. • **Blade**: wilted of blades at 2nd days until 14th day. Scorched sign observed at blades at 2nd day until 14th day.	
T12	Ally + Paraquat + Surfactant	• **Petiole**: wilted of petioles at 2nd day until 14th day after treatment application. While the petioles colour started changing into yellow at 4th day until 14th day. • **Blade**: wilted of blades at 2nd day. Scorched of blades observed at 4th day until 14th day.	

Code	Treatment	Observation of Symptoms	Photo (after 14 days)
T13	Ally + Glyphosate + Surfactant	• **Petiole**: wilted of petioles at 4th day until 14th day. Petioles colour started changing into yellow at 14th day after treatment application. • **Blade**: wilted of blades at 4th day until 14th day and the colour of blades started changing to yellow at 12th day. There was no scorching sign observed until 14th day.	
T14	Glyphosate + Paraquat + Surfactant	• **Petiole**: wilted of petioles at 2nd day until 14th. The petioles colour started turning into yellow at 6th day after treatment application. • **Blade**: wilted of blades at 2nd day until 14th day. Scorched sign observed at blades surface start from 4th day until 14 day.	

3.2. Cost-effectiveness analysis of herbicide treatment

Based on the bio-efficacy analysis of herbicides, T5 – T14 showed significant result inhibiting *A. sarawakensis* and had been proceeded for cost-effectiveness analysis. Table 3 shows T9 (Amine + Ally + Surfactant), T11 (Amine + Paraquat + Surfactant) and T12 (Ally + Paraquat + Surfactant) was the most cost-effective herbicides to control *A. sarawakensis* in oil palm plantation. In average the total cost to prepare 16L cocktail herbicide was ±RM0.58 cent. According to Fillols *et al*., [12], better efficacy results from products with multiple active ingredients demonstrated the benefits of using mixtures of active ingredients to widen the spectrum of weed control efficacy and cost-effectiveness.

Table 3. Cost-effectiveness analysis.

Code	Treatment	Cost/pump(16L)
T5	Amine + Surfactant	RM 0.33
T6	Ally + Surfactant	RM 0.42
T7	Paraquat + Surfactant	RM 0.40
T8	Glyphosate + Surfactant	RM 1.04
T9	Amine + Ally + Surfactant	RM 0.25 + RM 0.34 = **RM 0.59**
T10	Amine + Glyphosate + Surfactant	RM 0.21 + RM 0.69 = **RM 0.90**
T11	Amine + Paraquat + Surfactant	RM 0.21 + RM 0.36 = **RM 0.57**
T12	Ally + Paraquat + Surfactant	RM 0.25 + RM 0.32 = **RM 0.57**
T13	Ally + Glyphosate + Surfactant	RM 0.34+ RM 0.69 = **RM 1.03**
T14	Glyphosate + Paraquat + Surfactant	RM 0.69 + RM 0.24 = **RM 0.93**

4. Conclusion

All herbicides cocktail treatment exhibited good bio-efficacy to inhibit the wild yam compare to single herbicide treatment. In the single herbicide treatment, contact herbicides like paraquat and amine exhibited fast killing action against several Alocasia sp. Systemic herbicides such as ally and glyphosate exhibited slow killing action against wild yam. Combination of contact and systemic herbicides showed significant cost-effectiveness as compared to the others. However, this herbicides trial is just a pilot study to evaluate the single and combination of commercial herbicides against *A. sarawakensis, A. robusta, and A. macrorrhizos*. Therefore, further study is needed to reduce

herbicides' dosage to find the minimum inhibition concentration (MIC) that could improve cost-effectiveness.

References

[1] Comte I, Colin F, Whalen J K, Grünberger O and Caliman J P 2012 Agricultural practices in oil palm plantations and their impact on hydrological changes, nutrient fluxes and water quality in Indonesia: a review *Adv. Agron.* **116** 71–124
[2] Boyce P C 2007 Studies on the Alocasia Schott (Araceae-Colocasieae) of Borneo: I. Two new species from Sarawak, Malaysian Borneo *Gardens Bull. Singapore* **58(2)** 141–54
[3] Zulhazman H, Norhazlini M Z and Boyce P C 2019 Notes on Araceae in Pulau Pangkor, Perak, Peninsular Malaysia *The Malaysian Forester* **82(1)** 161–71
[4] Zulhazman H, N Salleh and P C Boyce 2017 Studies on the Alocasia clade of Peninsular Malaysia: Alocasia farisii, sp. nov. from limestone in Kelantan *Nordic J. Botany* **35** 300–304
[5] Kushairi A, Loh S K, Azman I, Hishamuddin E, Ong-Abdullah M, Izuddin Z B M N, Razmah, G, Sundram S and Parveez G K A 2018 Oil palm economic performance in Malaysia and R&D progress in 2017 *J. Oil Palm Res.* **30(2)** 163–95
[6] Wibawa W, Mohamad R, Juraimi A S, Omar D, Mohayidin M G and Begum M 2009 Weed Control Efficacy and Short Term Weed Dynamic Impact of Three Non-Selective Herbicides in Immature Oil Palm Plantation *Int. J. Agric. Biol.* **11(2)** 145–40
[7] Abas M A, Hambali K A, Hassin N H, Karim M F A, Ismail L and Rosli H 2020 Antifungal activity of selected Malaysia's local medicinal plants against sick building syndrome (SBS) Fungi *Asian J. Plant Sci.* **19** 240–45
[8] Traore K, Soro D, Camara B and Sorho F 2010 Effectiveness of Glyphosate Herbicide in a Juvenile Oil Palm Plantation in Cote d'Ivoire *J. Anim. Plant Sci.* **6(1)** 559–56
[9] Beck L, Marsalis M, Lauriault L and Serena M 2020 Efficacy of various herbicides for the control of perennial plantago spp. and effects on alfalfa damage and yield *Agronomy* **10(11)** 1710
[10] Koprna R, Humplík J F, Špíšek Z, Bryksová M, Zatloukal M, Mik V, Novák O, Nisler J and Doležal K 2021 Improvement of tillering and grain yield by application of cytokinin derivatives in wheat and barley *Agronomy* **11(1)** 67
[11] Chang C S, Yusoff A H, Abas M A, Nor A N M, Sulaiman A Z, Amin M F M, Samsudin M F, Sulaiman M S and Mahmood A A 2020 Mineral identification on sediments of pergau dam intakes In *IOP Conf. Series: Earth Environ. Sci.* **549(1)** 012025
[12] Fillols E, Davis A M, Lewis S E and Ward A 2020 Combining weed efficacy, economics and environmental considerations for improved herbicide management in the Great Barrier Reef catchment area *Sci. Total Environ.* **720** 137481