

Chemical Weed Control in the Oil Palm Sector with Particular Reference to Smallholders and Nursery Operators

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ABSTRACT

This article attempts to assess the impact to the oil palm smallholders and the nursery operators when there is a change from using paraquat to other kinds of weed killers in the oil palm and nursery areas. Surveys via face-to-face interviews with independent smallholders and 56 nursery operators were conducted. The study found that the impact of paraquat was insignificant among the smallholders, with only 0.65%, 1.30% and 0.32% having problems related to skin, nose bleeds and nails, respectively. The cost comparison of spraying herbicides in the smallholders' areas revealed that RM 221/ha/yr was incurred when using paraquat while RM 365/ha/yr was spent with the use of Round-up. At the nursery, annual spraying using paraquat and Basta incurred costs of RM 492.74/ha and RM 763.44/ha, respectively. The study revealed significantly that both the smallholders and the nursery operators were knowledgeable about the danger and handling of herbicides. Paraquat was the most preferred herbicide because it neither reduced the productivity of the oil palms nor affected the growth of the oil palm seedlings. It was also claimed that the use of paraquat helped to improve the texture of the soil. This indirectly led to efficient uptake of fertilizers and hence increased productivity of the oil palms.

INTRODUCTION

Improvement in food production is a function of two factors: first, an increase in land used for agriculture, and second, better agricultural technologies. The increased consumption of agricultural chemicals also suggests the important role of technologies in enhancing agricultural output. In 2001, global consumption of crop protection chemicals was estimated at about USD 25.76

billion. These technologies have resulted in increases in efficiency (using fewer resources to produce more food and other crops). Despite the use of such technologies, a large amount of global agricultural produce is still lost to pests, with weeds accounting for a significant proportion of these losses. Herbicides such as paraquat are important because weeds compete vigorously with crops for water, light and nutrients. As a result, if they are not suppressed they will

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reduce crop yields. Until paraquat was developed, farmers had a limited range of options for dealing with weeds. Paraquat therefore has significantly enhanced agricultural productivity in many crops in many parts of the world. Following extensive trials and tests in Malaysia, ICI began to market paraquat in the country, under the brand name *Gramoxone*, in 1962. Over the past 40 years, paraquat's unique properties have made it one of the most popular agricultural chemicals in the world.

Over the past 30 years, oil palm has become the dominant crop in Malaysian agriculture. Both total cultivated area and productivity have increased significantly over these years. Currently, oil palm has become a major source of foreign exchange revenue. One of the reasons oil palm has become such an important and successful crop in Malaysia is the effectiveness of modern herbicides, specifically paraquat, in combating weeds that would have reduced oil palm productivity. As a result, the oil palm plantations are the most significant consumers of herbicides, and paraquat remains the preferred herbicide of oil palm plantation owners.

In Malaysia, attempts to assess crop losses caused by specific weed species have been made. For example, *Asystasia gangetica* was found to be competitive to oil palm and caused a yield depression of 13% (Rajaratnam *et al.*, 1977), and in cocoa, a reduction of 50% to 100% cocoa yield (Chung and Lam, 1991). A depression in oil palm yield ranging from 10% to 20% due to *Mikania micrantha* has also been reported (Gray and Hew, 1968; Teoh and Chew, 1980). In Malaysia, a more comprehensive review on crop losses due to weeds in plantation, fruit and field crops was given by Chee *et al.* (1991). The total eradication of a certain weed species may

lead to colonization by another weed species. This phenomenon is simply termed as weed succession. While weed succession has been reported in the 1980s (Chee, 1989; Khairudin and Teoh, 1990), it has become an increasingly serious problem in Malaysian plantations over the last few years.

Weed control was relatively simple in 1980s, when total weed eradication was the answer to all weed problems, regardless of the types of weeds present at the site. Today, attitudes towards weed control have changed. These changes arise from a better understanding of weed ecology and biology, their interaction with crops, soil and the herbicides that are used to control them. The widespread, continuous use of only a few herbicides has been reported to have adverse biological repercussions, on aspects such as weed succession and the emergence of resistant weeds. A successful control and eradication programme of a certain weed can result in the build-up of other equally serious weeds. This is ascribed to the persistent use of a particular herbicide leading to the colonization of tolerant or resistant weeds. Similarly, *Eleusine indica* was found to be tolerant to one herbicide, *e.g.* a paraquat mixture in an oil palm nursery.

The more widespread use of glyphosate, a systemic herbicide, and its mixtures for weed control in recent years has also resulted in weed succession problems. After one or more rounds of successful spraying, grass weeds were effectively eradicated, and were rapidly succeeded by herbaceous broadleaf weeds such as *Ageratum conyzoides*, *Asystasia gangetica* and *Borreria latifolia*. In some cases, wild bitter gourd (*Momordica charantia*) became the dominant weed and caused serious encroachment problems in immature oil palm. The problems

of herbicide resistance are not new in world agriculture. In Malaysia, so far only a few estates have reported this phenomenon. Some examples of emerging resistant weeds are *Eleusine indica*, *Conyza sumatrensis*, *Amaranthus lividus* and *Crassocephalum erepidioides*.

JUSTIFICATION OF THE STUDY

Malaysia is the first Asian country to make the ground-breaking decision on 27 August 2002 to phase out the use of paraquat which is very harmful to human health. Paraquat under the brand name of *Gramoxone* is marketed by Syngenta (the world's biggest agrochemical company). In Malaysia, paraquat has been a major cause of concern due to frequent cases of poisonings suffered by plantation workers, especially the pesticide sprayers who are mostly women. Because of its effects on the workers and users of paraquat, Malaysia classified it as a Class I (extremely hazardous) pesticide, a higher classification than the World Health Organization's Class II (highly hazardous) designation. The government justified its decision by pointing out that more cost-efficient and less dangerous alternatives are readily available in the market.

However, in early 2007, the Minister of Agriculture and Agro-based Industries said that his ministry had decided to review the ban after various representations had been made to his ministry by smallholders and key industry players. The government's decision to reconsider the ban on paraquat was indeed shocking and unbelievable to the Pesticide Action Network in the Asia Pacific (PAN AP) when it was announced in the *New Straits Times* (15 April 2007). The Network insisted that the government's action showed that industry's profits have overridden

the health considerations of the people. The forward-looking agricultural producers are working to improving the safety of their workers and to protecting the environment by banning paraquat from their plantations. Nevertheless, these fears must be substantiated and not become the justification for undermining the right of some farmers to choose technologies that are appropriate to their circumstances.

This article attempts to examine the impact on the oil palm smallholders and the nursery operators when there is a change from using paraquat to other kinds of weed killers in their oil palm planted areas. The article also evaluates the costs and benefits of using paraquat compared to other herbicides.

METHODOLOGY

This study was done by way of a survey via face-to-face interviews with the use of questionnaires. The respondents were oil palm smallholders and nursery operators. The samples were based on a stratified random sampling approach in which stratification was based on the states in which they were operating. In each state, they were randomly selected based on computer-generated numbers. The interviews were facilitated by a questionnaire and were carried out at the FFB dealers' sites for smallholders and at the premises of the nurseries for oil palm nursery operators.

RESULTS AND DISCUSSION

Profile of the Independent Oil Palm Smallholders

Four hundred and twenty-seven independent oil palm smallholders were interviewed (*Table 1*). Three main races of independent oil palm smallholders were noted.

TABLE 1. DISTRIBUTION OF OIL PALM SMALLHOLDERS

State	No. of smallholders interviewed	Percentage of total (%)
Johor	170	39.81
Sarawak	85	19.91
Selangor	51	11.94
Perak	37	8.67
Pahang	35	8.19
Negeri Sembilan	16	3.75
Melaka	10	2.34
Terengganu	7	1.64
Kelantan	6	1.41
Kedah	5	1.17
Pulau Pinang	5	1.17
Total	427	100.00

They were mainly the Bumiputras, Chinese and Indians. Based on the total number of independent smallholders interviewed, 269 or 63% were Bumiputras, 151 or 35% were Chinese and 7 or 2% were Indians.

In terms of educational background, the majority of the independent oil palm smallholders had formal education but at a minimum level. About 66.43% of them had primary school certificates. The rest of them had PMR/SRP/LCE (3.5%), SPM/MCE (8.20%), STPM/diploma (1.87%) or a bachelor's degree (0.5%) while about 19.50% of them did not have any kind of formal education at all.

Choice and Prices of Herbicides

The analysis revealed that 23 brands of herbicides were used by the oil palm smallholders who were interviewed. The most popular herbicide among the oil palm smallholders is the family of paraquats. It was observed that three different types of paraquat were used, namely, paraquat at 13% a.i., paraquat at 25% a.i.

(*Gramoxone*) and paraquat at 13.60% a.i. (*Kopi-O*). About 25% of the oil palm smallholders used these types of paraquat. Meanwhile, the second most popular brand of herbicide among the oil palm smallholders was *Round-up* (21%), followed by *Ecomex* (16%), *Ken-up* (10%) and *Century* (6%). Other brands made up less than 5%. These observations are depicted in *Figure 1*.

With regard to the prices of herbicide, the analysis indicates that the 4-litre packing of herbicides were sold to the smallholders at prices ranging from RM 35 to RM 125 in 2007. The cheapest brand of herbicide in the market, *Mosanto*, was sold at RM 35 for 4 litres. Meanwhile, *Basta* was the most expensive herbicide, sold at RM 125 per 4 litres. As for paraquat, three different prices were quoted for the three different brands used by the smallholders.

Paraquat at 13% a.i. was purchased at RM 49 for 4 litres, while *Gramoxone* was purchased at RM 55 for 4 litres and *Kopi-O* at RM 52. Meanwhile, the prices of the other brands, *Round-up*, *ICI*, *Kentex*, *Spark*, *Ken-up* and *Powex*, were

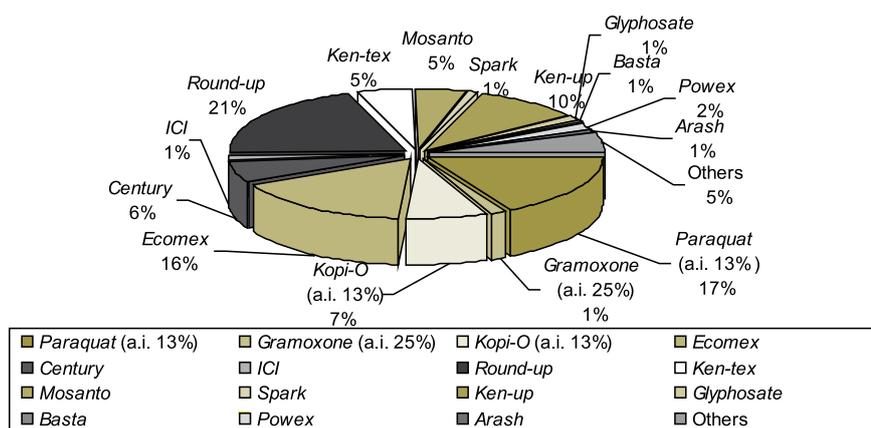


Figure 1. Brands of herbicide used by oil palm smallholders.

RM 58, RM 55, RM 48, RM 56, RM 38, and RM 41, respectively, for 4 litres. Other brands such as Ecomex, Century, Glyphosate and Arash were priced at RM 45 per 4 litres (Table 2).

Knowledge on Safety in Herbicide Spraying

In general, the smallholders were observed to be very conscious

of risks to their health when spraying herbicides. However, there were some who could not care less about their health because they failed to practice safety precautions although they were knowledgeable about the handling of herbicides. All of the respondents knew the safety elements of spraying herbicides and the dangers posed by the herbicides if they failed or neglected the recommended

precautions.

Those who cared about their health observed and followed the recommended techniques for spraying. They normally read the instructions on the labels of the containers and then followed the recommended rate of spraying. The tanks were checked to ensure no leakage in addition to using hand gloves when handling and mixing the herbicides. They wore boots to protect their feet and covered their noses and mouths to protect against accidental inhalation of the herbicides. Through their experience they were also aware that spraying against the direction of the wind was a wrong practice as this could directly endanger their health while indirectly causing ineffective spraying and thus increase the spraying costs. On the other hand, there were also some smallholders who scarcely took precautions. They only used gloves and boots, and claimed to have no problems spraying their oil palms with minimum safety precautions.

TABLE 2. BRANDS AND PRICES OF HERBICIDES (2007)

Brand of weedicide	No. of respondents	Average price	
		(RM/4 litres)	(RM/litre)
Paraquat:			
i) Paraquat (13% a.i.)	74	49	12.25
ii) Gramoxone (25% a.i.)	5	55	13.75
iii) Kopi-O (13.60% a.i.)	32	52	13.00
Round-up	87	58	14.50
Ecomex	70	45	11.25
Century	26	45	11.25
ICI	4	55	13.75
Ken-tex	21	48	12.00
Mosanto	20	35	8.75
Spark	4	56	14.00
Ken-up	42	38	9.50
Glyphosate	5	45	11.25
Basta	4	125	31.25
Powex	7	41	10.25
Arash	4	45	11.25
Others	22	50	12.50
Total	427	-	-

Note: a.i – active ingredient.

Frequency of Spraying

Table 3 iterates results of analysis on the frequency of spraying done by the smallholders in their planted areas. The smallholders sprayed their oil palm areas with herbicide once to six times a year depending on the age of the oil palm. Young oil palm areas (aged below five years) were sprayed annually from four to six times. Meanwhile, for smallholders whose oil palm were aged more than 10 years, their spraying frequency was reduced to only three times a year. However, the analysis revealed that 147 of the independent oil palm smallholders practiced herbicide spraying of their oil palm areas three times annually. This represents about 34.43% of total number of smallholders who were interviewed.

Frequency of Spraying Paraquat

Figure 2 illustrates the frequency of spraying paraquat as practiced by the smallholders. They normally sprayed their oil palm areas from one to six times annually. This was very much dependent on the age of the oil palm. For younger palms, spraying was done more frequently as compared to older palms. However from the survey, it was found that most of the smallholders sprayed twice a year. This represents about 36% of the respondents as compared to the other frequencies of spraying.

Frequency of Spraying Round-up

Figure 3 shows the frequency of spraying Round-up by the oil palm smallholders. Similar to spraying with paraquat, the frequency ranged from one to six times in a year. This also depended on the age of the palms. Many of them (36%) sprayed Round-up three times a year.

Storage of Herbicides

The herbicides used by the smallholders were stored in various places as listed in Table 4. Five types of herbicide storage were practiced by the smallholders. The herbicides were kept in a store outside but near home (32.08%), kept in a store at home (30.44%), stored at the farm (12.88), just kept outside the house without a proper store (16.16%) or kept inside the house (8.44%).

It can be said that the majority of the smallholders (75%) did store the herbicides in proper places while 25% of them did not do so. Those who did not have proper storage for their herbicides claimed that they used only a small amount as their hectareage was small. Hence they did not feel the need for proper storage.

TABLE 3. FREQUENCY OF SPRAYING

Frequency (times per year)	Number of respondents	Percentage (%)
None	1	0.23
Once	20	4.68
Twice	138	32.32
Thrice	147	34.43
Fourth	107	25.06
Fifth	6	1.41
Sixth	8	1.87
Total	427	100.00

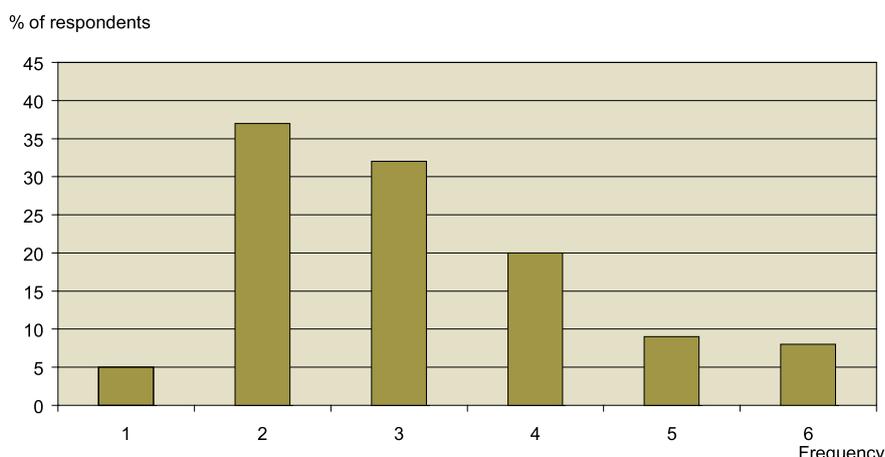


Figure 2. Frequency of spraying paraquat.

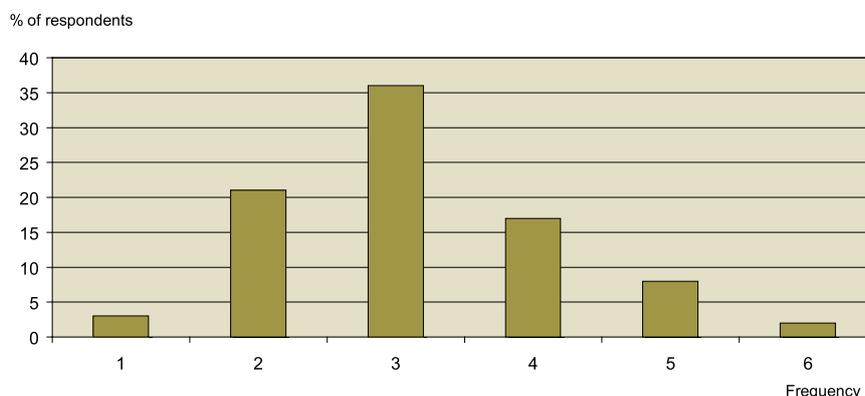


Figure 3. Frequency of spraying Round-up.

TABLE 4. TYPES OF HERBICIDE STORAGE

Type of storage	Number of respondents	Percentage (%)
Store outside but near home	137	32.08
Store in home	130	30.44
Store at farm	55	12.88
Outside the house, but no store	69	16.16
In the house, but no store	36	8.44
Total	427	100.00

Impact of Paraquat Use on the Health of Herbicide Sprayers

The smallholders who used paraquat in their spraying activities were specifically interviewed to discover whether they experienced health problems such as nose bleeds, nail and skin problems, headaches, itchiness, *etc.* Any of these complaints would reflect the impact of paraquat use on the health of the smallholders. It was noted that there existed minor cases of health problems among the herbicide sprayers who used paraquat. These were mainly skin problems, nose bleeds and nail problems (*Table 5*) involving only two, four and one smallholders, respectively. This means that from the overall total of 306 respondents who controlled weeds using paraquat, only 0.65%, 1.30% and 0.32% had the above problems. These sprayers admitted that they took the least precautionary measures when using herbicides to control weeds in their oil palm areas. The survey therefore suggests that there seemed to be insignificant impact on the health of the sprayers who used paraquat in their oil palm areas.

Why the Independent Smallholders Used/Preferred Paraquat

Elements relating to the preference of paraquat as compared to other weedicides were also discovered in the face-to-face interviews with the independent smallholders. The study revealed

that there were six main reasons why they still used or preferred paraquat to control weeds in their oil palm planted area. These were as follows:

- i) Paraquat did not give negative effects to oil palm.
 - All respondents who had experience in using paraquat reported that they observed healthy growth of their oil palm.
 - Paraquat when sprayed on the weeds only scorched the leaves of the weeds and finally killed the weeds, but did not kill the roots of the palms.
 - Weeds once killed resulted in making the soils friable and thus helped improve the soil conditions. In addition, this also assisted in the better absorption of water and fertilizers by the oil palm.
- ii) Paraquat killed all kinds of weeds immediately.
 - The characteristics of paraquat as a contact herbicide and its effectiveness in killing a broad spectrum of weeds had made paraquat the preferred herbicide of the smallholders. As a result about 91.77% of the respondents agreed that paraquat was better than other herbicides because it gave an immediate effect in killing all kinds of weeds growing under their palm

trees.

- iii) Spraying could be done even during rainy days.
 - This was due to the characteristic of paraquat that gave an immediate kill of a broad spectrum of weeds. Thus, about 85% of the smallholders preferred to use paraquat.
- iv) Paraquat improved the fertility of the soil.
 - About 80% of the respondents agreed that paraquat scorched the leaves of the weeds while at the same time this helped to improve the fertility of the soil.
- v) Paraquat did not affect the active roots of oil palm.
 - This is because paraquat acted by only scorching the leaves of the weeds.
 - About 80% of the respondents agreed to this. However, there is no scientific study yet to support this claim.
- vi) Paraquat did not produce negative effects on oil palm seedlings.
 - About 82% of the respondents insisted that there was in fact a positive effect of paraquat on the seedlings.

Based on the efficiency of paraquat in controlling a broad spectrum of weeds by killing them without affecting the growth and productivity of the palm, the smallholders (94.93%) who had experience in using paraquat were in favour of the appeal that the government should lift the ban on paraquat. Paraquat could help reduce the smallholders' annual cost of spraying herbicides

TABLE 5. THE IMPACT OF PARAQUAT ON THE HEALTH OF HERBICIDE SPRAYERS

Health problem	Number of respondents affected	Percentage of respondents affected (%)
Skin problem	2	0.65
Nose bleed	4	1.30
Nail problem	1	0.32

compared to the use of other herbicides.

Cost Comparison

Table 6 shows the cost comparison between paraquat and Round-up as weed killers in the oil palm planted areas. The average price of paraquat with 13% a.i. was RM 49/4 litres (or RM 12.25/ litres), whereas the average price of Round-up was RM 58/4 litres (or RM 14.50/litres). This means that Round-up was about 18.36% more expensive than paraquat. The total average usage of Round-up for each hectare of oil palm per year was 14.82 litres as compared to 9.88 litres for paraquat. This indicates a difference of about 50%. The average labour cost for spraying was RM 50/ha. If a smallholder used paraquat for spraying, it would cost him RM 100/ha/yr. However, the cost for using Round-up was RM 150/yr. This was 50% more expensive than paraquat because of the frequency of spraying which was more for Round-up than for paraquat (Figures 2 and 3).

Table 6 indicates that the annual costs of using paraquat and Round-up were RM 221 and RM 365, respectively, for each hectare of oil palm owned by the smallholders. As the smallholders owned an average of 4.2 ha of oil palm each, the total annual cost of herbicides incurred by the smallholders was RM 928 and RM 1533 for paraquat and Round-up, respectively.

PROFILE OF THE OIL PALM NURSERY OPERATORS

Fifty-six oil palm nursery operators were interviewed (Table 7). Most of them were located in Perak, Johor, Selangor and Pahang.

TABLE 6. COST COMPARISON BETWEEN USING PARAQUAT AND Round-up (ha/yr)

	Paraquat	Round-up
Average price	RM 49 (4 litres) RM 12.25 (1 litre)	RM 58 (4 litres) RM 14.50 (1 litre)
Total usage	9.88 litres/ha/yr @ 2 times/yr	14.82 litres/ha/yr @ 3 times/yr
Labour cost	RM 100/yr @ RM 50/round	RM 150/yr @ RM 50/round
Total cost/ha/yr	RM 221	RM 365

TABLE 7. DISTRIBUTION OF NURSERY OPERATORS

State	No. of nursery operators interviewed	Percentage for each state
Johor	10	17.86
Perak	13	23.21
Selangor	6	10.71
Sabah	3	5.36
Pahang	6	10.71
Sarawak	3	5.36
Kedah	3	5.36
Negeri Sembilan	1	1.79
Melaka	4	7.14
Pulau Pinang	1	1.79
Terengganu	4	7.14
Kelantan	2	3.57
Total	56	100.00

Brands of Herbicide Utilized by Oil Palm Nursery Operators

Eight brands of herbicide were used by the oil palm nursery operators (Figure 4). It was noted that the most popular brand of herbicide was Basta, with 62% of the nursery operators using this brand. Meanwhile, the second most popular herbicide was paraquat. It is found that 14% among the nursery operators used paraquat with 13% a.i., while 7% utilized paraquat with 25% a.i.

(Gramoxone). Other preferred brands of herbicides were Round-up 5%, and 3% for Century, Ken-up, Ken-tex and Mosanto.

The prices of 4 litres of herbicides were found to range from RM 40 to RM 125 (Table 8). Among the cheapest brands purchased by the operators was Century, sold at RM 40 for 4 litres. Meanwhile, the most expensive was Basta, which cost RM 125 per 4 litres. However, there were two different prices for two different brands of paraquat used by the nursery operators. The

prices for a 4-litre bottle were RM 45 for paraquat with 13% a.i. and RM 52 for paraquat with 25% a.i. A 4-litre bottle of *Round-up*, *Ken-tex* and *Ken-up* cost RM 55, RM 50 and RM 45, respectively.

Frequency of Spraying

At the oil palm nurseries, the oil palm planting materials need to be taken care against not just attacks from pests and insects, but also from weeds. Weeds if not controlled will greatly affect the growth of oil palm seedlings. *Table 9* illustrates the frequency of spraying by the nursery operators to control weeds at their nurseries. *Table 9* also shows that most of the operators (55%) sprayed 12 times in a year. However, around 23% of the operators did the spraying manually.

Frequency of Spraying Paraquat

Table 10 depict the frequency of spraying paraquat by the nursery operators. About 43% of the operators used paraquat to control weeds with a spray frequency ranging from twice to 12 times a year, and with 50% of them spraying 12 times a year.

Frequency of Spraying Basta

Figure 5 shows the frequency of spraying *Basta*. About 45% of the 56 operators interviewed used *Basta*. Their annual usage was between once and 12 times a year, with most of them practicing 12 rounds of spraying (68%).

Impact of Paraquat on the Sprayers at the Oil Palm Nurseries

The impact of using paraquat on the sprayers at the oil palm nurseries was assessed through their health condition (*Table 11*). The sprayers admitted that they had experienced skin irritation

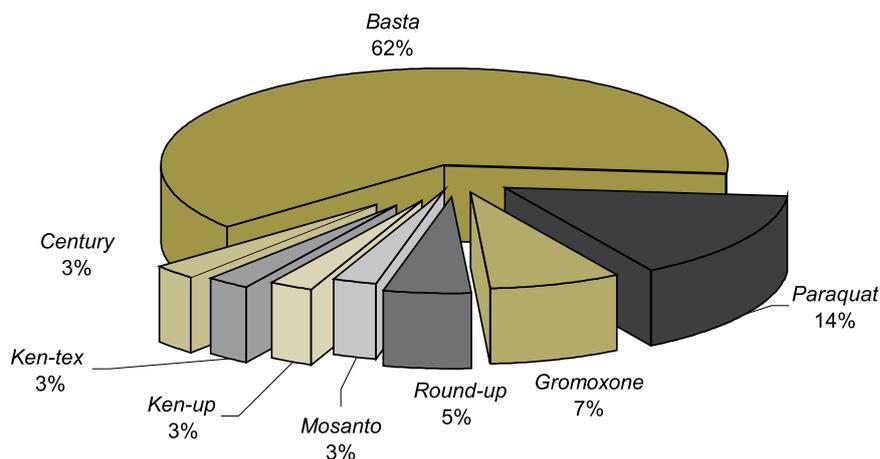


Figure 4. Brands of herbicide used by oil palm nursery operators.

TABLE 8. PRICES OF SELECTED BRANDS OF HERBICIDES

Brand of weedicide	Average price (RM/4 litres)	Average price (RM/ litre)
Paraquat:		
i) <i>Paraquat</i> (13% a.i.)	45	11.25
ii) <i>Gramoxone</i> (25% a.i.)	52	13.00
<i>Basta</i>	125	31.25
<i>Round-up</i>	55	13.75
<i>Ken-tex</i>	50	12.50
<i>Ken-up</i>	45	11.25
<i>Mosanto</i>	40	10.00
<i>Century</i>	40	10.00

TABLE 9. FREQUENCY OF SPRAYING AT THE NURSERIES

Frequency	Number of respondents	Percentage of total
None	13	23.21
Once	1	1.79
Twice	1	1.79
Thrice	2	3.57
Four times	3	5.36
Six times	3	5.36
10 times	2	3.57
12 times	31	55.35
Total	56	100.00

as well as dizziness. These were somehow overcome by taking herbal medicines. To them these were not serious at all because they knew how to overcome the problems. They also admitted that

they knew the safety precautions that should be taken when spraying not only paraquat but any kind of herbicide. Most of the sprayers (90%) said that they only used hand gloves and boots while

TABLE 10. FREQUENCY OF SPRAYING PARAQUAT

Frequency	Number of operators using paraquat	Percentage of total
Twice	1	4.17
Four times	2	8.33
Six times	1	4.17
Eight times	1	4.17
10 times	7	29.17
12 times	12	50.00
Total	24	100.00

Note: Total number of nursery operators interviewed = 56.

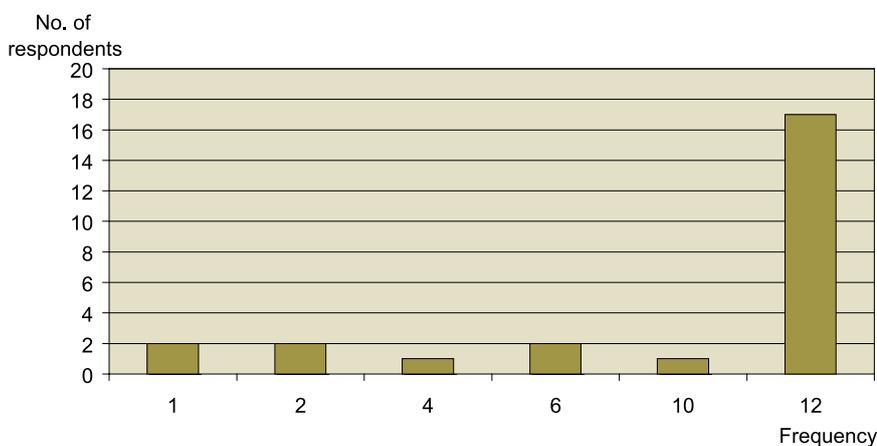


Figure 5. Frequency of spraying Basta.

TABLE 11. VIEWS ON SPRAYING PARAQUAT AT THE OIL PALM NURSERIES

Statement	Yes	No	Percentage Yes
Paraquat did not cause health problem to the operators or their workers who had experience in spraying paraquat	31	25	55
Number of operators who preferred the government to lift the ban on paraquat	51	5	91
Paraquat is better than other herbicides	51	5	91
Paraquat does not affect the growth of oil palm seedlings	49	7	86
Paraquat can reduce cost of herbicide application	48	8	86
Operator or worker knows safety precautions when spraying	56	-	100

Note: Total number of nursery operators interviewed = 56.

spraying. A minority of them (15%) used masks to cover their mouth and nose while spraying.

About 90% of them admitted that paraquat was better than other herbicides. While not affecting the growth of oil palm seedlings, paraquat also helped to reduce the cost of spraying at the nursery. They therefore requested that the government lift the ban on paraquat to enable them obtain healthier growth of oil palm seedlings through better control of weeds at the nurseries.

Cost Comparison

As mentioned above, nursery operators used several types of herbicides. However, the two most popular chemicals were paraquat and *Basta*. Their cost comparison is given in *Table 12*. The average price of paraquat with 25% a.i. was RM 52 per 4 litres (or RM 13/litre), while the average price of *Basta* was RM 125 per 4 litres (or RM 31.25/litre). *Basta* was therefore 140% more expensive than paraquat (25% a.i.). The total average usage of either *Basta* or paraquat was the same for 1 ha of oil palm nursery, i.e. about 14.83 litres annually. The average labour cost per sprayer was RM 25/ha for one round of spraying. Therefore, the annual labour cost was RM 300 for 12 sprayings.

Table 12 shows that the annual total cost of using paraquat and *Basta* was RM 492.74 and RM 763.44, respectively, for each hectare of oil palm nursery. Thus, using *Basta* would increase weeding cost by about 55% as compared to using paraquat.

CONCLUSION

The study revealed that both the smallholders and the nursery operators preferred to use paraquat rather than other herbicides to protect against weeds that could reduce oil palm yields and the

TABLE 12. COST COMPARISON BETWEEN PARAQUAT AND Basta

	Paraquat	Basta
Average price	RM 52 (4 litres) RM 13 (1 litre)	RM 125 (4 litres) RM 31.25 (1 litre)
Total usage	14.83 litres /ha/yr @ 12 rounds/yr	14.83 litres/ha/yr @ 12 rounds/yr
Labour cost	RM 300/yr RM 25/round	RM 300/yr RM 25 once
Total cost/ha/yr	RM 492.74	RM 763.44

growth of oil palm seedlings. Another herbicide preferred by the smallholders was *Round-up*. The perceived benefit from using paraquat such as improving the soil texture that indirectly leads to efficient uptake of fertilizers by oil palm increased the preference for paraquat usage by both the smallholders and the nursery operators. Other reasons for preferring paraquat included

the belief that paraquat did not affect the growth of the oil palm seedlings, could be used during the rainy season and could reduce the cost of herbicide applications. Most pertinent was the fact that using paraquat can help in reducing costs of application in both the smallholdings as well as the oil palm nurseries.

Herbicides can be regarded as necessary inputs whose

efficacy should be maintained and continuously improved. Yet, herbicides can fail due to weed resistance when they are used persistently. The smallholders and the nursery operators were somewhat aware of this. They were also aware that there are other ways to control weeds in their smallholdings and nurseries, such as the adoption of an integrated farming system. The challenge is therefore for them to use the herbicides sustainably. The findings somehow suggest that chemical weeding will continue into the foreseeable future as the most cost-effective weed control method in oil palm smallholdings as well as in the nurseries. Given the cost-effective advantage and its special characteristics as an efficient herbicide, there are justifiable reasons to lift the ban on paraquat.

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