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OCCURRENCE AND MANAGEMENT OF RESISTANT WEED SPECIES IN FGV PLANTATION IN MALAYSIA : A REVIEW

Kamalul Adham bin Che Ruzlan[1, 2]* and Muhammad Saiful Ahmad Hamdani[2]

[1]Agronomy Division, Felda Global Ventures Research and Development Sdn. Bhd. (FGV R & D), PPP TunRazak, 26400 Jengka, Pahang, Malaysia.

[2*]Department of Crop Science, Faculty of Agriculture, Universiti Putra Malaysia, Malaysia.

Abstract

Oil palm, currently the world's main vegetable oil crop, is characterized by a large productivity and a long life span (≥25 years). Weeds are the unwanted plants that grow aggressively, restrict sunlight and compete with desirable plants for nutrients. Weeds population is mainly a mixture of grasses, sedges, broad-leaved weeds plants and fernsin oil palm plantation management. *Asystasia gangetica* (creeping broad leaf weed), *Clidermia hirta* (upright woody weed) and *Dicranopteris linearis* (fern) are amongst noxious weeds under the "must be eradicated"list because of their high tendency to aggressively absorb nutrients and water. In Malaysia alone, since 2004, the use of herbicides has been 67.49% of the total pesticides used. The application of herbicides (e.g. glyphosate, glufosinate, metsulfuron-methyland the recently banned paraquat) in plantations is a common practice even though farmers understand that they are harmful to both applicators and crops if not carefully used. Understanding the mode of herbicidal action is also very useful when diagnosing symptoms of herbicide injuries and to reduce the risk of resistance development in weed populations. Resistance frequently occurs with herbicides that come with very great efficacy to specific weed species, be it acute kill or chronic/slow effect. Herbicide resistance phenomenon in weeds is very depending on the type of herbicides being used (mode of action and selectivity), the period they have been used for, spray dose of the herbicides, the residual effect of the herbicides, the biology and genetic of the weed species being targeted, and existence of other crop management practices that farmers employ.Therefore, weed resistance in Malaysian oil palm plantation is crucial and must be hadle with care to avoid unnecessary effect from herbicide resistance.

Key words: Oil palm, resistant weeds, occurrence, management

Introduction

Weeds are plants that are generally considered as undesirable, unwanted or unattractive for human use (Rao, 2000). The most destructive part is that they compete with crops for soil nutrients, water, space and canopy, and light. Weeds often play host to insect pests and diseases bearing pathogens harmful to growth, development and yield of plants (Capinera, 2005). Their roots and leaves have been known to exudate or leachate materials toxic to plant growth and also increase the cost of labour during crop maintenance. Previous studies reported that the presence of weeds in crops not only prevent the absorption of nutrients and water but also increase the probability of a plant being infected with a disease that eventually reduces the yield (Fernández-Aparicio, 2016).

In order to increase production, farmers opted for weed control by applying different systems and procedures such as land preparation and cultivation of interventions that are mostly aimed to control weeds. Nevertheless, in more conservative agricultural system, controlling of weeds is generally defined to include minimal soil disturbance or no-till, with helps of permanent soil cover, diversified crop associations and also rotations (Johansen *et al*., 2012). The number of tillage operations is much reduced. In vast plantation perennial crops however, the only feasible option available to farmers other than chemical approach is cover crops or release of grazing animals when suitable. There are drawbacks nonetheless associated with the two, in which because of their creeping-climbing behavior, cover crops need to be consistently de-crept (using herbicides or manually), so they would not climb or smoother plantation crops. As

***Author for correspondence :** E-mail : adham.cr@feldaglobal.com

for grazing mammals, it is only applicable for mature crop plants (7 years or older), since the grazing herbivores would be able to reach leaves or fronds of young crops, which are no denying more palatable than the weeds. Hence, decision on selection of weed control in cropping systems need to be done carefully to ensure it is done effectively and efficiently.

Oil Palm in Malaysia

The oil palm; *Elaeis guineensis,* can be identified by its large feather-palm coming with a single columnar stem (Akpakpan, 2012). Its characteristic 'shaggy' appearance, in contrast to the coconut palm (*Cocos nucifera*), is related to the irregular insertion angle of leaflets along the leaf rachis (Hartley, 1988). The economic species of oil palm was named by Jacquin in 1763 on the basis of studies carried out on palms introduced from West Africa.

Oil palm trees can reach 60 feet or more. The barks of young and mature trees are robust and rough because they are wrapped in fronds around them. In contrast, the old trees' barks are smoother because the fronds have fallen. Palm trees begin to produce fruit after 30 months of planting and are always economical for the next 20-30 years. Fresh bunches are known as Fresh Fruit Bunch (FFB). Palm oil commonly grown in malaysia is from Tenera varieties; hybrid between Dura and Pisifera (Basiron, 2007). Tenera varieties produce approximately 4 to 5 tons of raw palm oil (CPO) per hectare per year and approximately 1 ton of palm oil.Oil palm is the world's most efficient oil crop, where it requires only 0.26 hectares of land to produce one tonne of oil compared to soybeans, sunflower and rapeseed which requires 2.22, 2 and 1.52 hectares, respectively to produce the same amount.

Impact of Weeds in Oil Palm Plantation

Asystasia gangetica, Clidemia hirta (creeping broadleaf weeds) *Dicranopteris linearis (fern) and Imperata cylindrica (grass)*are noxious weeds that should be eradicated because of their high tendency to aggressively absorb nutrients and water. One species, *Asystasia gangetica,* produces 27 million seeds/ha from a single matured plant (Westaway *et al*., 2016). Moreover, it has persistent and long-term survival of buried seeds. Consequently, resistance to several SOAs, including glyphosate, paraquat, ALS, auxin, ACCase and glufosinate, have been documented in species such as *Eleusine indica, Hedyotis verticillata, Clidemia hirta* and *Chromolaena odorata (*Peterson, Collavo, Ovejero, Shivrain, & Walsh, 2018). Successful weeds control depends on knowledge of plant identifications, life history of plant and proper selections of control methods. The loss of revenues because of increasing cost in weeding accounted for 17 to 27 percent of the total upkeep cost in immature or mature oil palm (Goh *et al.,* 1999).

Weeds compete with crops for obvious resources - light, nutrients, soil and water. Compared to other crop pests (insects, fungi, *etc.*), weeds have the greatest impact on crop yield because they are all-season pests, and if left uncontrolled can result in more than 80% yield loss. Weeds account for over 25% yield loss in developing countries despite an average of 10 to 50 hours per acre of manual labour expended on weed control (Akobundu, 1991). In 1992, losses from weeds were evaluated at more than U.S. $8 billion per year in the USA despite growers spending more than U.S. $7 billion per year on herbicides and cultivation only as an effort to control weeds (Gianessi and Reigner, 2006).

Weed Control in Oil Palm Plantation

It has become imperative to conduct weed control in plantation management. The use of chemical herbicides has become a practice in oil palm estates at several stages of plant development which witnessed the most commonly used toxins (glyphosate and paraquat) (Mohamad *et al*., 2010). Glyphosate is a wide range of selective and systemic herbs that are formulated as amino acid isopropyl or trimetilsulfonium and is used to control annual and artificial weeds, including *Imperata cylindrica* (Spear Grass), *Panicum maximum* (Guinea grass) and *Cynodon dactylon* (Bermuda grass). The limitation is for paraquat that it does not work against weeds. Paraquat is used for over 40 years, and is a herbicide commonly used in Malaysian fields (Mohamad *et al*., 2010). The ban on the use of the poisons opens to more safer poisoning options. Some other common safe spectrum herbicides available in the Malaysian market are glufosinate-ammonium and metsulfuron-methyl. Glufosinate-ammonium is used as post-emergence herbicide, while metsulfuron-methyl as pre- and early post-emergence herbicide (Mohamad *et al*., 2010). In order to assess operating profit, the cost of herbicides used is one of the factors to consider. Wibawa *et al*.,(2010) calculate the year^{-1} ha^{-1} weed control costs taking into account 3 or 4 cost components, including herbicide costs, labor costs, 1-year rotational spray number and water transport. According to Matthews *et al*., (2008), growers choose effective herbicides with acceptable costs. Therefore, to determine the effectiveness of treatment when it is used, the effectiveness of each herbicide should be calculated.

Weeding Policy and Approach to Control

Reducing competition for nutrients and moisture

It is found that the highest yield of palm oil production can only be achieved when the early growth of palm oil is at an excellent level (Verheye, 2010). This means that the crop must be kept free from any adverse effects of the more competitive weeds.

Allowing easy access within the field

During the early years of oil palm growth, all field operations must be carried out with least difficulty and that the operations can be properly supervised. Absence of good access and supervision inevitably leads to poor maintenance standards (Khan *et al*., 2018).

Preventing harvesting problems

In mature plantings, poor weeding results in problems with all aspects of harvesting, particularly loose fruits collection (Bond *et al*., 2001). Studies have shown that accurate weeding procedure produces much larger loose fruits quantities.

Preventing soil erosion

Although the weeding process is important, the conditions of the lands which are too clean and deserted have exposed the lands to erosion. Suitable soil and less risk of erosion should be provided long before planting the oil palm trees(Uddin *et al.*, 2017).

Weed Science Practices and Concepts

Procedures and protocols used for pest management, including weed management, have a slightly affected genetically in treated population, not mutations. Strawed weeds to the prolific poison will result in a stronger new individual and increasingly difficult to control (Fitzherbert *et al*., 2008).

This has occurred in the United States of America that uses pesticides for commercial crops and since then, weed became one of the major problems since the 1970s. However, not all parties agree with the use of these pesticides, especially the traditional growers (Markwick, 2000). They assume the use of plant-resistant herbs will create a diversity of weed management techniques previously used in large areas. In short, the maintenance of a variety of weed procedure, without attention to a specific technique, is important to maintain the use of herbicide options (Mortensen *et al*., 2000).

Weed control using herbicides

In Malaysia alone, in 2004, the use of herbicides was 67.49% of the total pesticide used (Directory and Index of Malaysia Agriculture, 2003/2004). The use of herbicides in farms is a common practice even though farmers understand that they are not completely safe for use (Jallow *et. al*., 2017). As a measure of the conservation and optimization of the use of weed control poisoning, spills need to be performed at certain times in identified locations. Costs incurred should be noted whenever weed control is done according to area. However, before the use of herbicides, several factors need to be taken into consideration before starting the spraying program.

If the farmer wishes to achieve the optimum use of poison costs, the most appropriate herbicide selection, or herbicide mixture, and the most effective method. The most common herbicides mixture are paraquat, glyphosate, and glufosinate ammonium (Wibawa *et al.*, 2003). In fact, no single herbicide is suitable for all conditions, with the most accurate mix. Often, for some situations, the use of herbicides changes is necessary to reduce the level of residuals in the soil (Hasan *et al.*, 2018). Flexibility in evaluating good or bad effects is another aspect of the use of weed pox because often new weed poisons are introduced in the market.

Herbicides

Presently, about 250 active ingredients are available commercially around the world enabling control of almost all weeds of major and minor crops. The effectiveness of currently available herbicides allows farmers to grow profitable crops repeatedly on the same land and to optimize their incomes (Vencill *et al.*, 2000). It is very important to understand how herbicides kill weeds (ie herbicide poison action) which is useful when selecting and using herbicides that are suitable for the problem of herbs given and preventing poison resistance. Understanding the mode of herbicidal action is also very useful when diagnosing symptoms of herbicide injuries. Generally, herbicides are widely used in seven major action modes: growth regulation, inhibition of amino acid synthesis, lipid synthesis inhibition, seed growth inhibition, seed growth inhibition, cell membrane disorders, and pigment (George *et al.*, 2005). If a particular family of herbicides was exposed to weeds over a period of years,herbicide resistance probably develops naturally according to biotypes of those weeds. Therefore, different herbicide families with different mode of action should be considered when selecting herbicides to control weeds.

Nature and Mode of Action of Selected Herbicides

Glyphosate*(*N*-(phosphonomethyl) glycine*)

This refers to the broad spectrum systemic herbicides and plant heating materials.It additionally an organophosphorus compound, particularly phosphonate that is usually wont to kill weeds, particularly annual broad-leafed weeds and grasses that content with alternative plants (Menalled *et al*., 2001). It was discovered by Monsanto's John E. Franz pharmacist in 1970. The year

2007 noted that glyphosate was the most widely used herbicide in the US agricultural and most widely used home, garden, government, industry, and even commerce. Glyphosate acts in the absorption of leaves and roots (Sherrick *et al*.,1986). The development of glyphosate resistance in weeds is taken into account as valuable. Whereas gypsosms and formulations like Roundup are approved by restrictive bodies around the world, issues regarding its impact on humans and also the setting still exist and lots of typically question it.

Glufosinate-ammonium

It is a non-selective herbicide produced through synthetic compounds from chemical phosphate acids. Glufosinate-ammonium was originally derived from two species of Streptomyces fungi (Tothova *et al*., 2010). Glufosinate-amonium acts on the touch, but only with minimum systemic effects that are always used as foliar spray and soil treatments. Glufosinate-ammonium works through the inhibition of glutamine synthetase enzymes that produce ammonium ions in plant tissues, thus preventing photosynthesis. Whitening begins within 2 - 3 days and death usually occurs within 3 weeks. Glufosinate-ammonium is also not selective and suitable for all plant weeds. Interestingly, Glufosinate-ammonium is also used as soluble concentrate that is supplied in amounts of 60 g / l and 150 g / l.

Metsulfuron-methyl

This results from the remaining sulfonylurea used as pre-selected and post-emergence herbicides. Because it is a systemic compound with foliar activity and soil, it works fast. It acts by preventing cell division in the shoots and roots of the plant, even with low consumption. It can also be used with other herbicides, and is commonly used in cereals. This herbicide poison is commercialized in the form of dry flow formulations (Zain *et al*., 2013). To use it, a certain time needs to be advised as it is active in the soil and requires time to decompose before the plants are sown. Metsulfuron-methyl can be used as a foliar spray and soil treatment for both pre-mature and post-mature weeds.

Paraquator N, N2 -dimethyl-4, 42 -bipyridinium dichloride

This is acompound with statement [(C6H7N) 2] Cl2. It's classified as viologen, oxidoreduction active heterococcal family with similar structures. Paraquat is produced by Chevron. It is quick to effectively and kill all kinds of weeds (Terry *et al*., 1996). However, it's venomous to humans and animals due to its oxidation-reduction activity can turn out superoxide. Paraquat has been classified as herbicidal poisons without selective. The main feature that distinguishes it from another agent is that it acts very fastly.

Herbicide Resistance

Herbicide resistance is global and not a new phenomenon. Resistance occurs normally if a particular herbicide has been applied repeatedly for at least three to five years times to certain sensitive species (Tranel *et al*., 2002). Speaking about the resistance of herbal medicine, it refers to the ability to grow and treat herbs as the deadly herbicides can not kill them. Hazardous herb weeds occur in both herbicide-resistant plants and conventional plants following the reaction to the selective pressure from herbicides imposed on them.Resistance frequently occurs with herbicides that come with very great efficacy to other specific weed species. This is because they possess intense selection on the weed species, which in turn are controlled efficiently. In fact, only the resistant individuals are allowed to pass their genes to the next generation (Jasieniuk *et al*., 1996). Herbicides that fail to kill the weeds promote the growth of weeds that are more resistant to weed poisoning. After generations, they will become increasingly invincible and difficult to destroy. On the other hand, transgenic and non-transgenic genetic plants are resistant to certain herbicides as they have been propagated to persist in the use of herbicides (RastogiVerma, 2013). Therefore, genotypes of vulnerable plants can be killed by herbicides while cultivars can not survive. Therefore, when the conventional cultivation identity is mistaken for being cultivated in the field, conventional cultivars are killed or severely injured by endangered herbicides resistant to poultry without adverse effects.There has also been reported herbicide resistance cases in the state of Pahang, Perak, Johor, Kedah, Penang and Melaka (Green *et al*., 2010). These herbicide resistance cases were found in vegetable farms, rice fields, oil palm plantations and rubber plantations. Almost all the herbicide resistant weed species detected at these areas have developed resistance towards acetolactate synthase (ALS) inhibitor herbicides, paraquat, synthetic auxin herbicides or glyphosate (Green *et al*., 2010)).

Managing Herbicide Resistance in Using Chemical Control

Herbicide resistant weeds are covered in this section in relation to herbicide tolerant crops. Whenever agricultural weed control practices remain the same, then weeds will eventually adapt and circumvent the weed control mechanisms. The repeated uses of herbicides in the absence of other control measures show no exception (Mack, 2000). So much so, herbicide resistant weeds is very depending on the type of herbicides being used, the period they have been used for, the weed species being targeted, and many other crop management practices that farmers employ. Once weeds become resistant they can impact the profitability of a farming operation. Profitability is also affected by the cost of management practices (e.g., use of multiple herbicides) to reduce the potential for resistance to develop.

The history proves that since the introduction of glyphosate-tolerant plants, the amount and spread of glyphosate resistant weeds increased rapidly (Benbrook, 2012). The first appearance of glyphosate-resistant grass was not caused by the introduction of glyphosate-tolerant plants, having occurred long before these crops were introduced. Rigid ryegrass (*Loliumrigidum*) in Australia and goosegrass (*Eleusine indica*) in Malaysia (Bostamam *et al*., 2002) were the types of grass first reported field cases of glyphosate resistant weeds, and they were in orchard situations. However, horseweed (*Conyza canadensis*), interestingly had become the first case of a glyphosate resistant weed appearing in a glyphosate tolerant crop (glyphosate tolerant soybean), as found in Delaware and Tennessee in the U.S. (Van Gessel, 2001). Glyphosate resistance in horseweed is believed to have emerged from the repetition of glyphosate use in the absence of an IWM programme.

Conclusion

Herbicide-based weed management is an important and sophisticated aspect of plantation management for Malaysia's main crops of oil palm. Successful herbicide control of weeds requires a good technical understanding of the various weed species and the mode of action of each available recommended herbicide so as to create a precise and cost-effective system of chemical application control techniques with low risk to human, crop and environmental safety.

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