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Evaluation of different pre-emergence herbicides for early-stage planting of pineapple *(Ananas comosus)*

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DECLARATION

I hereby declare that I acknowledge this work is by my own work except the excerpt and summary each of which I have explained the sources.

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Evaluation of Different Pre-Emergence Herbicides for Early-Stage Planting of Pineapple *(Ananas comosus)*.

ABSTRACT

The presence of weeds slows down the growth of pineapple trees (*Ananas comosus*) and affects the quality of the fruit. This is because pineapple plants and weeds compete to get enough sunlight, water, and nutrients in the soil for the process of photosynthesis and plant respiration. The study aims to investigate the effect of two different types of pre-emergence herbicide application to the early vegetative growth stage of pineapple. The pineapple variety MD2 was used for this study. Three different treatments were conducted: untreated (control) and treated (diuron and atrazine) pre-emergence herbicide. Vegetative growth of pineapple was measured by plant height (cm), leaf length (cm) (longest central leaf), number of leaves and leaf width (cm). A field trial was conducted at early stage of pineapple planting. Weed population (m^2) was measured in 25 days and 50 days after spraying the different herbicides The result showed that there are no significant differences ($p > 0.05$) between the four different treatments in terms of plant height (cm), leaf length (cm), number of leaves and leaf length (D). However, there is a significant different ($P < 0.05$) in the 25 days after treatment and significant value for 50 days after treatment ($P < 0.05$) between the treatments. Pre-emergence herbicide application for treatment 1 (diuron) is the most effective herbicide for weed control as compared to treatment 2. Moreover, at 25 and 50 days after treatment, the data showed that there were no weed populations emerged with T1 (diuron) treatment at the planting site. This study will help researchers and farmers to choose the method of pre-emergence herbicide as a weed control in the pineapple plantation.

Keywords: pineapple, pre-emergence, herbicide, competition, weed control

Penilaian Pelbagai Racun Pra-Kemunculan Herbiside untuk Penanaman Nanas *(Ananas comosus)* Peringkat Awal.

ABSTRAK

Kehadiran rumpai melambatkan pertumbuhan pokok nanas (Ananas comosus) dan menjejaskan kualiti buah. Ini kerana tumbuhan nanas dan rumpai bersaing untuk mendapatkan cahaya matahari, air, dan nutrien yang mencukupi dalam tanah untuk proses fotosintesis dan respirasi tumbuhan. Kajian ini bertujuan untuk menyiasat kesan dua jenis aplikasi racun herba pra-kemunculan yang berbeza terhadap peringkat pertumbuhan vegetatif awal nanas. Varieti nanas MD2 telah digunakan untuk kajian ini. Tiga rawatan berbeza telah dijalankan: racun herba pra-kemunculan tidak dirawat (kawalan) dan dirawat (diuron dan atrazine). Pertumbuhan vegetatif nanas diukur dengan ketinggian tumbuhan (cm), panjang daun (cm) (daun tengah terpanjang), bilangan daun dan lebar daun (cm). Percubaan lapangan telah dijalankan pada peringkat awal penanaman nanas. Populasi rumpai (m^2) diukur dalam tempoh 25 hari dan 50 hari selepas penyemburan racun herba yang berbeza Keputusan menunjukkan tidak terdapat perbezaan yang signifikan ($p > 0.05$) antara empat perlakuan berbeza dari segi ketinggian tumbuhan (cm), panjang daun (cm).), bilangan daun dan panjang daun (D). Walau bagaimanapun, terdapat perbezaan yang signifikan ($P < 0.05$) dalam tempoh 25 hari selepas rawatan dan nilai signifikan selama 50 hari selepas rawatan ($P < 0.05$) antara rawatan. Aplikasi racun herba pra-kemunculan untuk rawatan 1 (diuron) adalah racun herba yang paling berkesan untuk kawalan rumpai berbanding rawatan 2. Selain itu, pada 25 dan 50 hari selepas rawatan, data menunjukkan bahawa tiada populasi rumpai muncul dengan T1 (diuron) rawatan di tapak penanaman. Kajian ini akan membantu penyelidik dan petani untuk memilih kaedah racun herba pra-kemunculan sebagai kawalan rumpai di ladang nanas.
Kata kunci: nanas, pra-kemunculan, racun herba, persaingan, kawalan rumpai

Kata kunci: nanas, racun herba, pra-kemunculan, persaingan, dan kawalan rumpai

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α	Alpha
%	Percentage
°	Degree

CHAPTER 1

INTRODUCTION

1.1 Research Background

According to the Malaysian Department of Agriculture (DOA), pineapple is grown on an area of about 10,847 hectares in Malaysia, with an estimated production of 272,570 metric tonnes in 2015 (DOA, 2016). The export of pineapple from Malaysia is expected to increase from 350,000 MT (metric tonnes) in 2013 to 700,000 MT in 2020 (Tong et al., 2020). Malaysia is in fourth place in South Asia after Filipina, Thailand, and Indonesia for exporting pineapple fruit around the world including Singapore, China, Japan, and Saudi Arabia. Johor is the largest producer of the pineapple crop in Malaysia by contributing 54% (16 000 ha). The other states that contribute to the pineapple production in Malaysia are Kelantan, Terengganu, Pahang, and Perak (Nik Rozana et al. ,2017). The growth of pineapple crops takes a long time compared to the planting of other crops. The minimum period of plant growth starting from the beginning takes 18 months to produce first fruiting (Bartholomew et al., 2002).

The presence of weed will slow down the growth of pineapple trees or will affect the quality of fruit. This is because pineapple plants and weeds will compete to get enough sunlight, water, and nutrients inside the soil for the process photosynthesis and plant respiration (Tadesse et al., 2007). The stage of weeding involves four stage development starting from seedling process, vegetative, seed production and ending with maturity stage (Buhler, 2004). The application of the control method for the different stages of weed growth throughout the planting cycle of pineapple can be done by weed controlled methods such as chemical control, cultural cultivation, and mechanical control. Chemical control includes herbicide and culture control including crop rotation. Mechanical control will involve the tillage (De Matos et al., 2009).

The application of the herbicide can be applied In two ways: pre-emergence herbicide application and post emergence herbicide application. Pre-emergence herbicides are usually sprayed on the soil surface after sowing but before the weeds emerge. It usually needs to rain a week after the herbicide is applied for the pesticide to get into the soil. This application can control the weeds prematurely and avoid the competing main crop with weeds. Subsequently, post-emergence application can be performed after the weed has grown. There are two types of this application: systemic application and contact application. Systemic application can be sprayed on the weed, where the herbicide is absorbed by the root and the leaf. This type of application is best suited for perennial weeds as it covers all parts of the plant. Contact application is suitable for the control of annual weeds. In this application, parts of the weed, such as leaves and stems, are touched (Buhler, 2004).

There are many types of herbicides used depending on the type of weed. Most of the conventional plantation will require herbicide treatment that is crucial to eliminate competition to the main plants as it will affect its growth performance. This method is also a method that gives fast results compared to other control methods (Metcalfe3et hl., 2018). Kusumayuni3et hl., (2021) in studying the use of herbicide Diuron (N-(3,4-dichlorophenyl)-N,N-dimethyl urea) to control weeds (*Eleusine indica*). The duration of use of diuron on *Eleusine indica* weeds were identified to either affect the environment or can eliminate weeds in the long run. The diuron herbicide was sprayed in pre-emergence. After 20 days of treatment of *Eleusine indica* weed, analysis was made for either diuron-resistance or diuron-sensitive.

1.2 Problem Statement

In Malaysia the production level for pineapple has achieved the self-sufficiency level (SSL). Singapore and Hong Kong are the countries that import the production of pineapple from Malaysia (Arshad & Ismail, 2020). Weed is one of the limitations that farmer must overcome in the pineapple production. The presence of weed will have caused the reduce of sources of nutrient, light, mineral and carbon dioxide. This may be affecting the growth of pineapple and qualities of fruit (Agril, 2014). The most common method for weed control in pineapple is by using silver shine plastic that covers the planting bed throughout. The use of silver shine to cover the bed has been able to reduce much of the weeding problem in pineapple farm. Nevertheless, occasionally some weed plant emerged at the same planting hole together with the pineapple plant. When this happen, it is very difficult to remove the weed plant without distributing the pineapple (Martini et al., 2019).

One of the most effective weed controls, is to apply pre-emergence herbicide. Used of herbicide will give the benefit to the farmers in terms of a more modern method and reduce the cost (Chauhan et al., 2017). However, the continued use of herbicides will result in environmental pollution, weed resistance, and shifts in the spectrum of weed flora (Duary, 2008; Johnson et al., 2009). The dosage of the herbicide is very important to prevent this problem from occurring. So, farmers should follow the correct method of use in front of the herbicide bottle (Siebeneichler & Tocantins, 2019). Each type of herbicide classification has an overlap and this true especially when assignments are made according to type of use and mode of action. The two major classifications are inorganic and organic herbicide. For pre-emergence application is suitable for grassy weeds and broadleaf weeds (Kamal-Uddin et al., 2009).

In addition, farmers also faced the problem of choosing the suitable herbicide on the market nowadays. Knowing the suitable mode of action and type of active ingredients of herbicides are very important to ensure that it is suitable or not with the situation of weed growth around the main crop (Thorp & Tian, 2004). The most common type of active ingredient herbicides used in pineapple crop to control weed are diuron and atrazine. Both herbicides can control grassy weed and broadleaf weed. However, diuron also can inhibit photosynthesis and can make plant tissues die and the leaf of weed turn to yellow (Webber, 2012). A study was done to investigate the effectiveness of weeding using herbicide (diuron: mix fluazifop-p-butyl and atrazine S-metolachlor) and manual weeding using hoe. The study was conducted in Brazil from December 2008 to November 2009 and the average stem diameter and average D-leaf measurement was recorded to study the effect of herbicide application to plant growth. The study identified that the herbicide application did not affect the fruit and plant growth (Maia et al., 2012).

1.3 Hypothesis

H0: There is no significant differences between the treated pineapple (with herbicide) and untreated sample (without herbicide) at the early growth stage.

H1: There is a significant difference between the treated pineapple (with herbicide) and untreated sample (without herbicide) at the early growth stage.

H0: There is no significant difference between the population of weed (m^2) growth around pineapple crop after 25 days and 50 days of spraying different herbicides.

H1: There is a significant difference between the population of weed (m^2) around pineapple crop after 25 days and 50 days of spraying different herbicides.

1.4 Scope of study

The study was conducted using three planting beds, each with the size of 30 cm x 60 cm x 90 cm. Each planting was utilized for different applications of two different herbicides and a negative control with no herbicide application. For the treated planting bed, the herbicide was applied following the product instructions before planting. The focus of the study is to test the efficiency of two different herbicides at controlling weed growth and to test the effect of the herbicide on pineapple plant growth. For this the vegetative growth of the pineapple grown in two treated planting beds and one untreated planting bed were monitored through the measurement of plant height (cm), D leaf length (cm) (longest central leaf), number of leaves, and leaf width (cm). For the herbicide efficiency on controlling weed the weed population that grows on the planting bed were recorded 25 days and 50 days after applied herbicide. The study area at Universiti Malaysia Kelantan, Jeli Campus.

1.5 Significant of study

The purpose of our studies is to observe the effect of herbicide to the pineapple growth at early stage. The importance of weeding in early season planting it will avoid the competition between plant and weed. This will help farmers in producing pineapples in short period time. In turn this will contribute plant growth well by getting enough nutrients to every part of vegetative growth stage (Thorp & Tian, 2004).

The result of the experiment can then be used to improve the current crop planning for pineapple which is with the current practice exclude the use of herbicide and rely solely on the silver shine. This study will ensure that farmers to easy adopt the method of herbicide application and type which better to use for the weed controlled. This new information is important to update the previous schedule of herbicide application to be more specific by classifying the different types of herbicides according to the reaction to the weed killing. So, farmer can harvest the pineapple fruit within a specified time frame (18 month) (Syahidah et al., 2021).

1.6 Objective

I. To determine the effect of two different types of pre-emergence herbicide application to the early vegetative growth stage of pineapple.

II. To identify the weed population growth after applied pre-emergence herbicide on pineapple planting bed.

CHAPTER 2

LITERATURE REVIEW

2.1 History of pineapple

The scientific name of pineapple is *Ananas comosus.* This pineapple fruit was classified from the Bromeliaceae order. The subfamilies of this fruit are pitcarnoiodea, tillandsiodeae and bromelioideae (Alfonso Parra-Coronado, 2015). The most spread variety is Smooth Cayenne (Cayena lisa), which was first introduced in Europe from French Guyana. Pineapple production is concentrated in the tropical regions of the world. It is grown in over 82 countries with over 2.1 million acres under the fruit (Hossain, 2016). The flesh is pale yellow to yellow, and the sugar and acidity of the fruit are high. It has a large hard fruit and is adapted to a Ginaca machine that peels its fruit. The most common varieties planted in Malaysia 'Moris', 'N36', 'Sarawak', 'Gandul', 'Yankee', 'Josapine', 'Maspine', and most recently 'MD2' (Lasekan, 2018).

2.1.1 Parts of pineapple

The reproduction for the plant pineapple are tops, slips, suckers, and even butt (figure 2.1). The length of steam is 25-50 cm and wide between 5-8cm. Stem of the pineapple contains the nodes and internodes. The slip development will start after 1 week of flowering. The slip is allocated under the fruit. Texture of the leaves is waxy and arranged. The adult plant bears between 70 until 80 leaves per plant. The position of the leave is from center to the outside. The youngest is located in the center and the older leaves at the outside. The color of the leaves change color based on its age, with old leaves colors dark green and the young leaves has bright green color. The arrangement of flower pineapple in spiral. There are 5 types of pineapple parts that can be used for planting. The parts involved are crown, slip, aerial sucker, ground sucker and stumps. The vegetative growth of pineapple are usually from crown, suckers, and stump bits (Maria Glorialis Lolo, 2017).

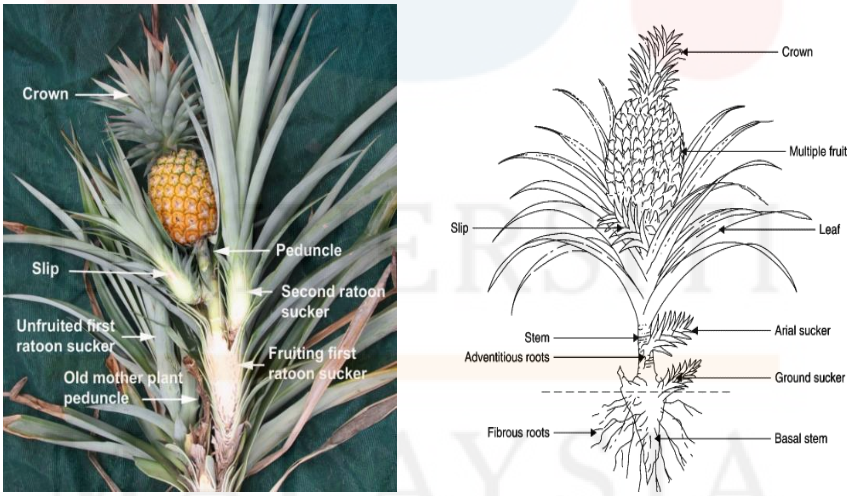

Figure 2.1: label and name the part in the pineapple plant (Sources: Krauss, 2009)

2.1.2 The growth development pineapple plant

There are six stages that involve the pineapple growth life cycle from planting until harvest (figure 2.2). In China, planting involves crown, slip, hapa and rotoon. The entire vegetative growth phase lasts at least 12 months. The reproductive stage involved are leaf development, sucker formation, pseudo stem development, and leaf development of the sucker. Among the processes that occur in pineapple development are planting, flowering, and harvesting. These three processes take 15 months about 1 year 3 months. Starting from the planting process until flowering it takes 10 months. After flowering induction, flowering takes 5 months for fruit production until harvesting (Wei, 2016).

Figure 2.2: the development of pineapple started from day 1 until day 901 (September 2013 until March 2015) (Sources: Wei, 2016).

2.1.3 Climate and soil suitability

Pineapples grow best with an average temperature of 24 - 30 ˚C. Relative humidity is 70 - 95%. The height of the pineapple tree has an important effect on the taste of the fruit. If the height of the trees exceeds 1,800 mm, they become sour and acidic. The fruit grown in the shade is fresher and less yellow, but low in sugar and of poor quality (Sherman & Brye, 2019). For the cultivation of pineapple trees, the best soil for pineapple culture is a well-drained sandy loam and has a high content of organic matter and must be easy to dry at a depth of at least 60 cm. Suitable soil pH = 4.5 - 5.5. In Malaysia, 97% of the pineapple cultivation area is on peat soil (Ramadhani & Nuraini, 2018).

Irrigation is important after planting unless it is done during the rainy season (Assumi & Jha, 2021). After establishment, irrigation is only necessary when there is a prolonged dry period. Sprinkler or drip irrigation is recommended, and flood irrigation should be avoided (Neri et al., 2021). Pineapples can survive in drought condition but are not resistant to waterlogging. Soil is considered waterlogged when it is almost submerged for a large part of the time, so that its air phase is limited, and anaerobic conditions are present. Pineapples usually need about 2.5 cm of water per week, through a raining or manual watering (Smith, 2016).

2.2 Weed

Weed is any plant growing where it is not wanted. In addition, the presence of weeds at each planting boundary will affect crop yields. Some weeds will produce toxins that will inhibit vegetative growth. The example weed that usually found or familiar such as tall fescue, creeping bent grassbermudagrass, poannua and so on (Strik & Vance, 2017). Weed will involve in four developing stages. Started from seedling, the production of small new trees emerges from the ground. The second stage is the weed will form roots, stems, and leaves. After that, it will move to the seeding phase in which the plant will produce seeds and flowers. The fourth phase is the maturity phase; the weed half of the tree will wither or dry out because this stage the weed will slow down the weed development. This cycle or process weed developing is depending on how long the weed will complete the stage of developing (Aiyelaagbe et al., 2012).

2.2.1 Type of weed

Weed species occur within three botanical group which are annual, biennials and perenials. Many weeds produce large numbers of seeds. Weed seeds can grow after being turbid for a significant period of time. They can also survive in weather conditions that exceed high or low temperatures. Weed seeds will spread widely through the wind and will cause an increase in weed in the surrounding area. To control weed, it is very good if it is controlled before the seed stage (Somerville et al., 2017).

Annuals species complete their life cycle from seed within one year. All stage of weed developing were occur in the annual and lastly die within one year. Winter annuals typically germinate in late summer or early fall in following summer (example some genotypes annual bluegrass, chickweed and henbit). Summer annuals germinate in spring and usually die with the first hard frost in fall (knotweed, spurge and crabgrass) (Kamal-Uddin et al., 2009).

Biennial weeds are those weeds that live for more than one year but not more than 2 years. In the first year, the biennials will form leaves and store food. The next stage is the seedling stage and bears fruit in the second year. This biennial easily found around farms, meadows and old uncut fences (Balch et al., 2013).

Perennials weeds live for more than two years and perhaps indefinitely. Simple perennials such as danndelions and plantains are propagated by seed but several organs may produce new plants. This perennial weed is one type of grass that is difficult to control because it spread underground. Although the main crop are removed above the soil surface but this perennial weed can not stop the spread of weed (Balch et al., 2013).

2.2.2 Type of control weed managment

2.2.2.1 Manual and mechanical control

Manual and mechanical control is the use of pulling and uprooting weeds by hand. This method is effective on shrubby plants. The weeds are easily controlled because they are uprooted to the roots. This method is only effective on small weed populations and not in areas with high weed growth such as shrubs. The advantages of this method include minimization of soil damage and low cost (Tu & Randall, 2003).

Manual control usually involves pulling out the weeds by hand, while mechanical control involves pulling them out with tools. Hand pulling or used hoe is the old method that used in the weed control. When pulling out by hand, the weed is pulled out with a glove. This is a very effective way to pull out the remaining root fragments and the potential for regrowth of the weed. This method is ineffective for deep and simple weed roots. The hand-pull method has also proven effective in controlling weed such as *Centaurea spp.* (thistles), *Melitolus officinals* (white and yellow clover), and *Lythrum salicaria* (goose cinquefoil) (Strik & Vance, 2017).

Tillage can be applied to the row of plants (intra-row weeding), the strips between the rows (inter-row weeding), or the entire area (whole crop weeding) (Vanhala et al. 2004). Mechanical control involves removing the weeds with tools. There are many tools that can be used, such as root tools, cultivation between the rows, claw hoes, harrows, and rotary hoes.

2.2.2.2 Cultural Weed Control

Cultural weed control refers to any technique that aims to manage agricultural conditions so that weeds are less likely to establish and/or increase in number. Examples of commonly used cultural weed control include crop rotation, avoiding excessive grazing, using well-adapted competitive livestock species, and maintaining good soil fertility (J. et al., 2012). Rotational and forward planning is also important in weed control. The basic principle of the prevention concept is to create a constantly changing environment in which no single weed species can adapt and become dominant and unmanageable. In practice, this means a crop rotation as varied and long as possible, in harmony with the farming system and preventing weeds from returning their seeds to the soil seed banks (Kleemann & Abdulai, 2013).

2.2.2.3 Biological Weed Control

Biological weed control is the use of natural enemy targets to reduce the density of a particular weed to an acceptable level. The goal of biological weed control is not eradication, but simply the reduction of weed populations to low economic levels. For permanently successful biological weed control, a small number of weed hosts must always be available to ensure the survival of natural enemies (Day & Witt, 2019). The aim of a biological weed control program is to introduce natural enemies (insects, mites, or diseases) that reduce the weed density to a tolerable level and reduce the impact of the weeds. Bioagents such as insects, pathogens, etc. and other animals are used to control weeds. Insects and pathogens attack weeds and either reduce growth or kill them (Harker & O'Donovan, 2013). Biological weed control is the targeted use of natural enemies to reduce the density of certain weeds to an acceptable level. The aim of biological weed control is not eradication, but merely the reduction of weed populations to an economically low level. For permanently successful biological weed control, a small number of weed hosts must always be present to ensure the survival of natural enemies (Oerke et al., 2010).

2.2.2.4 Chemical Weed Control

Chemical weed control uses chemicals called herbicides to kill or inhibit the growth of certain plants. Chemical weed control is an option of integrated weed management, which refers to the integrated use of cultural, manual, mechanical and chemical control methods. When applying herbicides, selectivity, dose, timing and method of application are of almost importance before applying them to a crop (Marble et al., 2015).

2.3 Herbicide

Herbicides are chemicals that kill plants to prevent them from growing. The mode of action for each herbicide are varied depending on the type of weed it is targeting. Selective herbicides control specific weed species, while leaving the desired crop relatively unharmed. Non-selective herbicides is somestimes called total weed killers in commercial products can be used to clear waste ground, industrial and construction sites, railyas and railway embankments as they kill all plant materials with which they come into contact. Selective herbicide can kill only target weeeds in farm. It is normally sprayed on top of the crop where it kills only target weeds leaving on crop healthy (Siebeneichler & Tocantins, 2019).

Herbicides are the most effective single agents for weed control when used judiciously and according to prescribed guidelines. They have the highest consumption, production and market share of all pesticides worldwide. Herbicides, especially those used pre-emergence, control weeds at the beginning of germination and then prove more effective than many other methods of weed control. Herbicides can control weeds whose morphology is similar to that of cultivated plants, such as *Phalaris minor*, *Avena* *fatualludoviciana*, *Lolium temulentum* and so on. Most herbicides prove to be more economical than mechanical and manual methods, especially where the cost of manual labour is higher. Herbicides are proving to the most important means of weed control with minimal or no tillage. The use of herbicides can also reduce the number of weeds during tillage, saving labour and energy (Barker & Prostak, 2008).

2.3.1 Active ingredient: diuron

Diuron is a white, oderless solid. Internasional Union of Pure and Applied Chemistry (IUPAC) name of diuron is 1-(3,4-dicholorphenyl)-3,3-dimethylurea. Available in various formulations such as wettable powders, granules, drainable dry products, granules, suspended liquid concentrates and water soluble mixtures. The most common formulation of diuron in wettable powder (Barker & Prostak, 2008). Diuron application is used before herbicide application and after emergence to control grasses and broadleaf weeds. The main danger is to the climate. It should be acted upon quickly to limit its spread in the climate (Pesce et al., 2006). It can cause disease by inhalation, absorption through the skin and additionally by ingestion. It is used as a herbicide. The mode of action of diurones is to act as photosynthesis inhibitors. Diurones act by stopping the process of photosynthesis of weeds and inhibiting their ability to convert light into chemical energy (Castillo et al., 2006).

2.3.2 Active ingredient: atrazine

Atrazine can be used during pre-emergence herbicide. Atrazine is an agricultural herbicide commonly used by farmers to control broadleaf weeds and grasses that affect the growth of maize, sorghum, sugarcane and other crops. The IUPAC name for the atrazine is 6-chloro-4-N-ethyl-2-Npropan-2-yl-1,3,5-trazine-2,4-diamine (Haynes et al., 2000). Atrazine is classified in the triazine group. The herbicide has been banned in the European Union since 2004. Like other triazine herbicides, atrazine works by restricting plastoquinone - a protein in photosystem II that living things need (Safety et al., 2010). Plant death is caused by starvation and oxidative damage caused by damage in the electron transport process. Oxidative damage is accelerated at high light levels. Individual European countries banned atrazine as early as 1991, but in the United States 80 million pounds of the product are used each year (Oliveira et al., 2015).

2.4 Pre-emergence herbicide

Pre-emergence herbicide is applied to target emergence weed species. Pre-germination herbicide is effective against weed seeds before they germinate. Species date of application depends on when the weeds germinate. The chemical can be applied several weeks before weeds germinate. These categories of herbicide are the preferred to control annual grasses weeds. It is usually been appied to the soil underlying the grass shoots where they are absorbed by roots or immature organs of germinating seeds. This also will prevents germination and may damage young or recently transplanted plants. This also may persist in enviorment (Somerville et al., 2017). Pre-emergent herbicides do not control perennial weeds emerging from vegetative structures. Pre-emergent herbicides do not kill the seeds. Pre-emergent herbicides also do not prevent seed germination. They only kill seedlings at the time they germinate (Jinks et al., 2006).

Pre-emergence herbicides should be applied and activated before weed seeds germinate, either annual or perennial. Pre-emergence herbicides form a thin barrier below the soil surface. When pre-emergence herbicides are applied, new weed seedlings emerge in the treated zone, take up the herbicide and then die. Pre-emergence herbicide control is designed to prevent current weeds from growing through the herbicide-treated zone (Berhan et al., 2021). Weeds that appeared before application or activation have not been affected by pre-herbicides because their primary growth points have not been treated. Pre-herbicides are permanently relatively immobile and do not evaporate into the soil. However, if left on the soil surface for a long time without water activation, these herbicides can evaporate or destroy photos (Cont, 2018).

2.5 Post – emergence

Post emergence herbicide is applied after emergence of weed. This post-emergence herbicide is preferred to control broadleaf herbicides. Usually applied to the foliage where they are absorbed by the leaves. Post-emergent herbicides are applied directly to the emerging weeds and are usually more effective against seedlings (De Matos et al., 2009). Plants have two growth stages: the vegetative stage is more easily killed if it grows and reproduces quickly. Post-emergent herbicides usually need to be applied several times to achieve adequate control. They can be applied as foliar or root herbicides, selectively or non-selectively, for control or systemically (Liu & Acín-díaz, 1992).

Post-germination is effective against weeds that have already germinated. Post-emergent herbicides are best used in early spring to kill the weeds as soon as they come out of the ground. When applied at the right time, herbicides kill all types of weeds. These include annual and perennial weeds, grassy and broadleaf weeds. The main difference between post-emergence and pre-emergence weed control applications is that the product is applied post-emergence. This application of used post-emergence only on the sport that weed has (Lin & Rahman, 2010).

2.5.1 Systemic

Systemic application is translocated to growing stems and roots. This application is suitable for the perennial weeds. Timing and growth cycle are importance because the element can pass through natural roots grafts. Systemically, it is taken up by certain roots, leaves or plant parts and translocated to all parts of the plant. Systemic herbicides are transported extensively in the vascular system of a plant from the uptake points (leaf or root) to the site of action (Caudle, 2015). Systemic herbicides (figure 2.3) are transported throughout the vascular system along with the nutrients, water and organic matter required for plant growth. Systemic herbicides require days to weeks for complete control (the herbicide must penetrate the entire plant (Kraehmer et al., 2014). Systemic herbicides are more effective than contact herbicides on perennial weeds. Examples of systemic herbicides Glyphosate and glufosinate for non-selective weed control 2,4-D, mecoprop and dicamba for broadleaf weed control. Atrazine and simazine for control of annual ryegrass and broadleaf weeds (Mcafee et al., 2007).

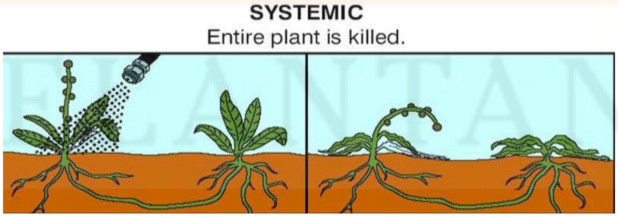

Figure 2.3: The systemic post emergence herbicide

2.5.2 Contract

Contact herbicides, also known as nontranslocated herbicides, do not move within the plant but kill plant tissue simply by contact. A contact herbicide kills the parts of the plant that come into contact with it (figure 2.4). Herbicides can be classified according to their mode of action, e.g. as growth regulators that interfere with normal metabolism or destroy the cell membrane (Rana, 2020). Contact application will killed weed by sprayed tissues. Contact herbicides do not move in plant. This type contact herbicide will be effective against annual broadleaves. Contact herbicides only kill the part of the green tissue that is touched (Madsen et al., 2014). Therefore, uniform spray coverage and particle size are essential for adequate control (the entire plant must be sprayed). Contact herbicides do not kill perennial underground structures such as rhizomes, tubers and bulbs (Gunsolus et al., 1999).

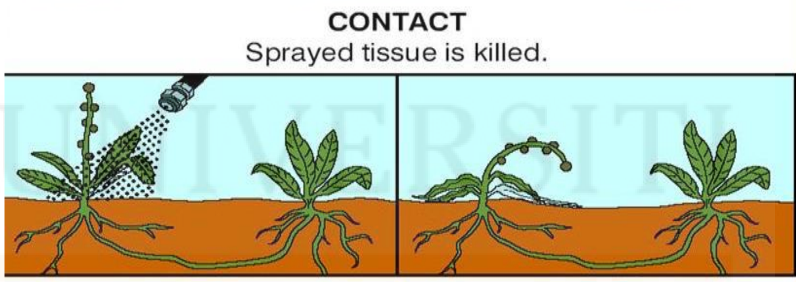

Figure 2.4: The contact post emergence herbicide

CHAPTER 3

MATERIAL AND METHOD

3.1 Materials

The pineapple sucker was obtained from local pineapple in Jeli, Kelantan. The pineapple varieties MD2 were used in these studies. Each bed planting consists of 6 plants. A total of 18 suckers were used for 3-bed planting.

3.2 Preparation of site planting

The experiment was conducted in three different planting beds at the same site. Each bed is for the two treatments of herbicide and one untreated control. The plant for each bed, 18 suckers were planted following the planting distance of 30cm x 60cm x 90cm. The site was plowed, and the planting beds were prepared manually using a hoe.

3.3 Herbicide calculation

This study is about the evaluation the effects of 3 different treatment through the vegetative growth of pineapple plant. There are three different treatments herbicide were used include treatment 0 (control), treatment 1 (diuron) and treatment 2 (atrazine). Commercial pesticides are given based on the rates of application. Normally the rates are available on commercial packages in either gram or liter/ hectare (table 3.1). Based on these rates and by applying at the different sizes of areas, the amount of product needed to be calculated. That information will be inserted in this formula and lastly get quantities herbicide needs to cover based on area planting (ft^2). If not familiar with those feet square unit, it can be converted to the other unit that is usually used.

Table 3.1: the type of pre-emergence used in this project

Trade name	**Chemical / active ingredient**	**Dose (per unit area)**	**Dose (per 1 L)**
Rezim 90WG	Atrazine	10L water = 50g herbicide 1hectare = 2.2kg	1L water = 3.8g herbicide
ANCOM DIURON 80	Diuron	10L water = 38g herbicide 1 hectare = 1700g	1L water = 5g herbicide

Calculation:

a. Herbicide:

Diuron:

10-liter water = 50g herbicide
1 hectare = 2.2kg

Atrazine:
10-liter water = 38g herbicide
1 hectare = 1700g
Volume spray per hectare = 450 liter

b. Quantities(g) herbicide need cover based on volume of sprayer:

Diuron:
10-liter water = 50g herbicide
1 liter water = 5 g herbicide

Atrazine:
10-liter water = 38g
1 liter water = 3.8 g

3.4 Measurement of physical properties of pineapple vegetative growth

The vegetative growth of the pineapple were measured by plant height (cm), D leaf length (cm) (longest central leaf), number of leaves, and leaf width (cm). All boundaries were estimated utilizing a measuring tape (Jalil, 2021). Data of vegetative growth stage were collected over 6 weeks (42 days), starting before herbicide spraying (week 0) until after herbicide spraying (week 5). The D leaf is characterized as the most as of late mature leaf with greatest physiological action. D leaves were examined during vegetative development as it were (Rajan, 2018). The minimum height is measured from the base of the stem to the longest leaf. These physical properties will be measured every week before and after spray herbicide. All the data were collected in 7 weeks (50days) after planting.

3.5 Measure the population of weed(m^2) around pineapple crop after 25 days and 50 days of spraying different herbicides.

The quadrant method to be used is either triangular or rectangular to calculate the weed crop. The size of the quadrant will rely upon the thickness of the weeds. In each crop planting area, place 50-100 or more 100 cm^2 boxes for each crop. All weeds were collected from each square independently (Irwin & Craig, 2016).

$$\text{Density} = \frac{\text{Total number of individuals of a species in all quadrants (plant)}}{\text{Total number of quadrant studies } (m^2)}$$

$$\text{Frequency (\%)} = \frac{\text{Total number of individuals of a species in all quadrants occurred}}{\text{Total number of quadrant studies}} \times 100$$

3.6 Measure dry weight of weed in three bed planting after 25 days and 50 days applied herbicide.

The weeds were removed from the soil and washed off any loose soil that is sticking around the weeds. Weed placed in three plastic zip lock bags and label planting bed 1, planting bed 2, and planting bed 3. Then plants were dried overnight in an oven at low heat (100 ° f). The plant is allowed to cool in a dry environment (ziplock bags prevent moisture) - in a humid environment the plant tissue will absorb water. When the plant has cooled, weigh it on the milligram scale, as dried plants do not weigh very much. Weight of dry was recorded.

3.7 Statistical analysis

The observation was done weekly, and data based on the observation of vegetative stage were recorded after 6 weeks (46 days). Several data were collected in this experiment which were plant height (cm), D leaf length (cm) (longest central leaf), number of leaves, leaf width (cm) weed population and dry weed. The collected data was analysed using the one-way ANOVA procedure. The result can be used to determine whether the hypothesis can be accepted or not.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Comparison the increment of vegetative growth stage between treated and untreated application of pre-emergence herbicide.

Three different treatments were applied in this study, namely T0 (control), T1 (atrazine) and T2 (diuron). As initially planned, there was six pineapple suckers planted for each treatment. However, in the middle of the experiment half of the suckers were affected with Bacterial Heart Rot disease and the plant died gradually. Hence, only three survived samples were chosen randomly for each treatment. Then, each increment of vegetative growth stage by week were calculated to get the statistical analysis. The increase in vegetative growth of 3 replicates of each treatment was analyzed from week 0 (before treatment) to week 5 (after treatment). When evaluating the area of the planting bed, it was found that the soil on the planting bed was uneven or slightly sloping. However, the areas of treatment 0 and treatment 1 are shadier than the planting area of treatment 2. These factors may have influenced the result of the experiment.

Figure 4.1 shows the graph of increment of plant height (cm) in three different treatments. The height growth of this pineapple plant was recorded for 6 weeks. In the graph of figure 4.1, shown the increment of plant height in T1 and T2 are higher than T0. The plant height growth of the pineapple plant in T2 (diuron) was higher than the growth plant height in T1 (atrazine). Means with the same letter ([a]) at every error bar on the bar chart below (figure 4.1) did not significantly different by Tukey's test ($\alpha=0.05$). There has no significant effect ($p > 0.05$) between increment of plant height with control, T1 and T2. According to (Maia, Maia, Lima, et al., 2012) the use of herbicides of the diuron, fluazifop- p-butyl and atrazine + S-metolachlor was evaluated on pineapple trees of the cultivar 'Perola'. The herbicide is applied was found no effect on the yield and quality of the pineapple. The morphology of the pineapple is between 1-2 m in both height and width. The form of the plant is spiral along the growth of the leaves (Australian Government, 2008). Phosphorus deficiency, along with other environmental factors such as light, carbon dioxide diffusion, etc., is one of the causes of the plants' limited height growth. However, phosphorus does not influence the physico-chemical properties of the pineapple fruits (Valleser, 2019).

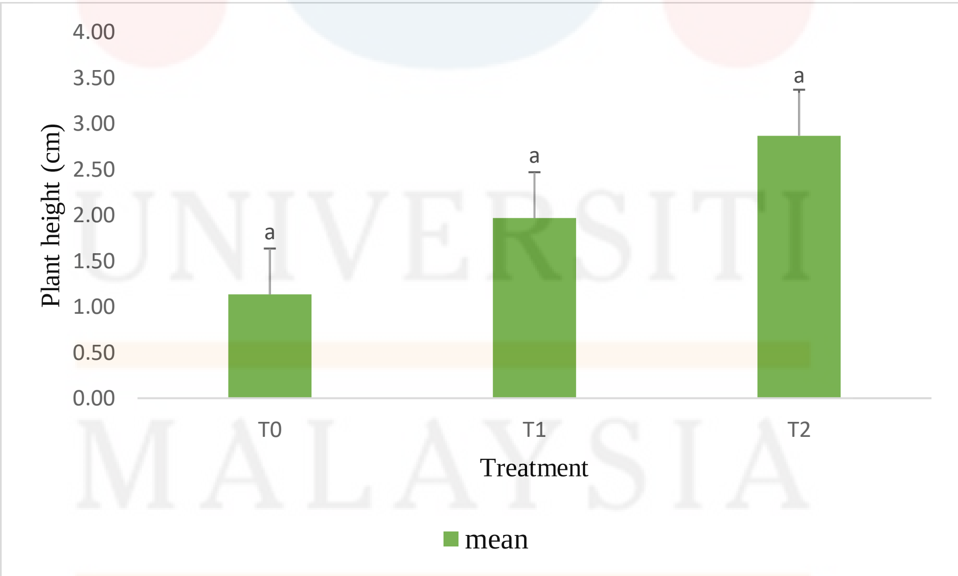

Figure 4.1: The increment of plant height (cm) in untreated and treated herbicide in 6 weeks after planting pineapple.

Figure 4.2 shows the comparison of D-leaf length growth for the control and uncontrol treatments after plant emergence. The graph below shows the different increases in D - leaf length of pineapple six weeks after planting. T2 (atrazine) has a greater number of increases in D-leaf length than T0 (control), and the smallest increase in T1 (diuron). So, no significant different ($P > 0.05$) between treatment and d leaf length (cm). The leaf is the main place for photosynthesis and the main source of photoassimilates for the other parts of the plant. The photosynthetic soil area increases due to the development of the leaf area, which also leads to an additional accumulation of dry mass in the plant. Therefore, the leaf area D (cm^2) of the pineapple flower 'Perola' was transplanted to the pineapple flower from the same period (Dos Santos et al., 2018).

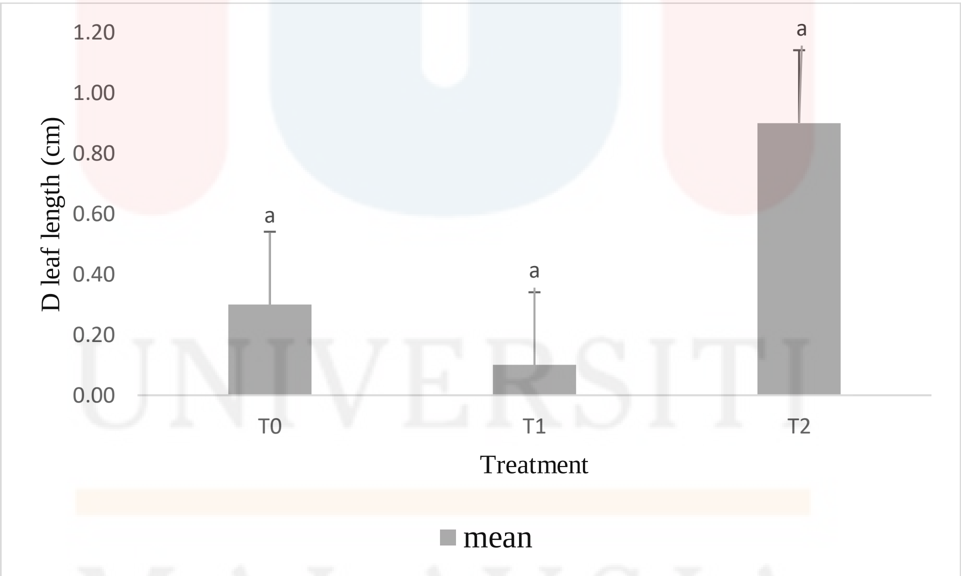

Figure 4.2: The increment of D leaf length (cm) in untreated and treated herbicide in 6 weeks after planting pineapple.

In addition, the increase of leaf number in figure 4.3 showed that T1 (diuron) and T2 (atrazine) had the same value in 6 weeks. The increase in the number of leaves was higher than in T0 (control) on average. The average increase in leaves for T1 and T2 ranged from 2.33 leaves in 6 weeks, while treatment 0 was 1.00. There have no significant different ($p > 0.05$) between number of leaves with T0, T1 and T2. At the point when pruned leaves or those having over half green region were counted, contrasts were not significant different as occurred with plant spread. Pruning medicines didn't contrast among them (Jordán-Molero, 1969). Information on "D" leaf showed critical contrasts in weight yet not long, width or thickness. D-leaf part such a prolonged duration represents a phototropic response related to the optimization of photosynthetic performance (Takemiya et al., 2005).

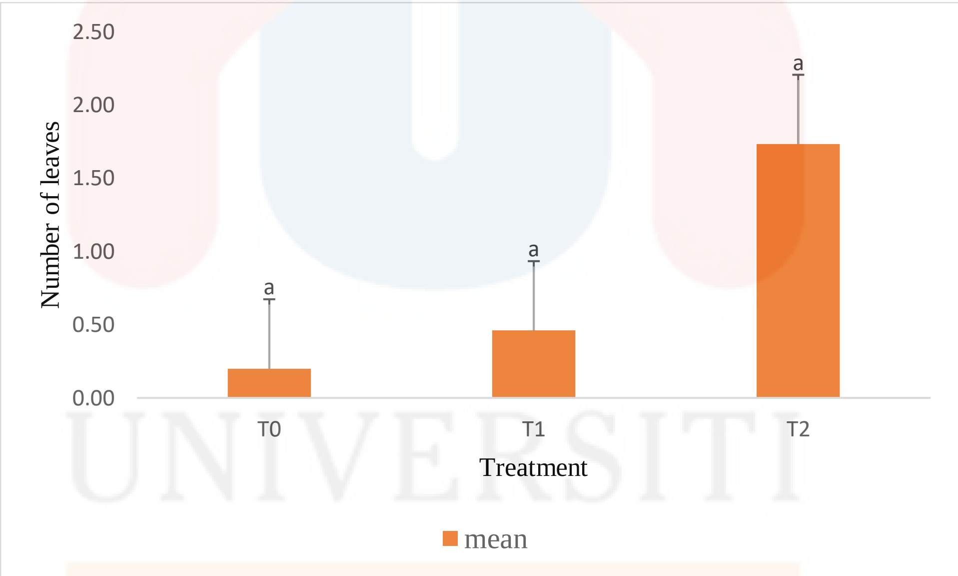

Figure 4.3: The increment of number of leaves in untreated and treated herbicide in 6 weeks after planting pineapple.

The D-leaf was selected from the pineapple leaves, which were less old than the other leaves and the most active in terms of their physiological growth during the growing season. The increase in length D leaf width was calculated (figure 4.4) and divided into two main groups, the control group, and the treatment group. There have no significant different ($p > 0.05$) between D leaf width with treatments and control herbicide. According to Catunda et all. (2005), the growth of the pineapple cultivar 'Perola' showed no difference in the increase of D leaves when the herbicide amicarbazone was applied. When treated with an herbicide mixture of diuron and paraquat, damage due to symptoms of Phytotoxin was observed on the pineapple trees already on the first day. This resulted in the pineapple tree being severely damaged and dying 30 days after treatment. Maia, Maia, e Lima, et al., (2012) stated that the effect of the herbicide mixture (atrazine + S-metolachlor) on the late growth of pineapple was not disturbed.

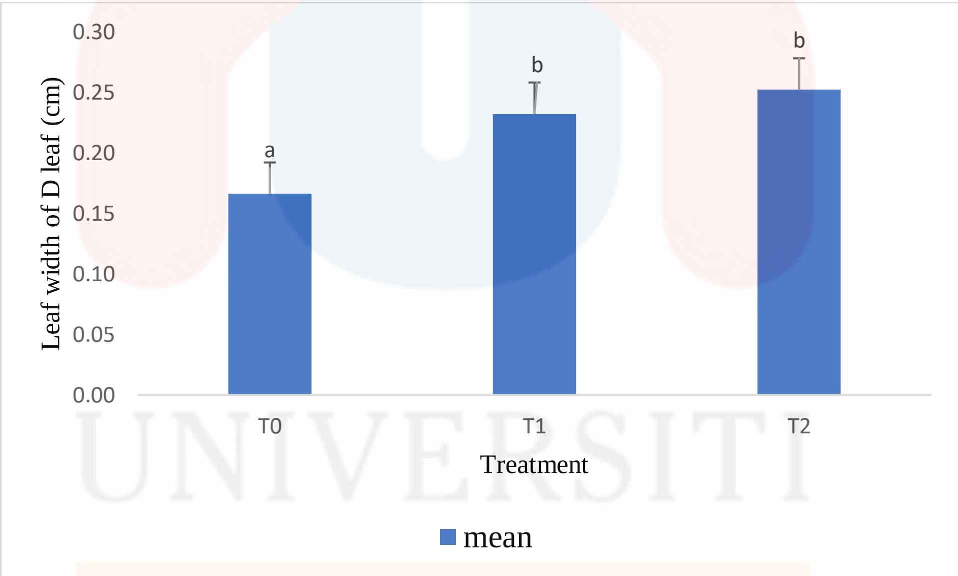

Figure 4.4: The increment of leaf width of D leaf (cm) untreated and treated herbicide in 6 weeks after planting pineapple.

As shown in Table 4.1, there no significant differences ($p > 0.05$) between the three different treatments in terms of plant height, D leaf length (cm), number of leaves and D leaf length. Data represent the mean ± standard error (SEM) of the increment vegetative growth parameter with three different treatments. According to (Assignee & Monte, 2016), the leaves of the plants grown under better shade conditions at 0.50 m, 0.75 m and 1.0 m intervals were significantly ($P < 0.05$) longer than the leaves of the plants grown under much less light (01.25 m interval) or in daylight (pineapple monoculture). The results are consistent with those of Mahmoud et al. (2015) and Arvin et al. (2008), who observed that the membrane stability index (MSI) decreased with increasing stress conditions, such as the harmfulness of herbicides.

Table 4.1: (Mean ± SEM) of the three different treatments on vegetative growth stage of pineapple.

Parameter	**Treatment**			**P-value**
	T0	**T1**	**T2**	
Plant height (cm)	1.134 ± 0.456^{a}	1.967 ± 0.359^{a}	2.868 ± 0.737^{a}	0.100
D leaf length (cm)	0.300 ± 0.227^{a}	0.100 ± 0.100^{a}	0.900 ± 0.488^{a}	0.214
Number of leaves	0.200 ± 0.134^{a}	0.466 ± 0.310^{a}	1.732 ± 1.184^{a}	0.315
Leaf width of D leaf (cm)	0.166 ± 0.110^{a}	0.232 ± 0.064^{b}	0.252 ± 0.174^{b}	0.131

SEM, Standard error of mean. Means with the same letter at every column did not significantly different by Tukey's test (α=0.05).
T0 = Control
T1 = Diuron
T2 = Atrazine

4.2 Weed population

The herbicides used for treatment are T1 (atrazine) and T2 (diuron). These two active ingredients are used specifically for pre-emergence herbicides. The formulation of atrazine is a pellet and that of diuron is a wettable powder. Pellet is one of the dry formulation and wettable powder is liquid formulation. The active ingredient wettable powder made up with small-grained carrier, e.g. clay, to obtain the form of particles in suspension in the water (Tu & Randall, 2003). After pre-emergence herbicide application, weed population was recorded 25 days and 50 days after treatment. Figure 4.5 shows the data of weed density. Based on the graph below error bar in the graph shown same value a. So, there have significant different ($p < 0.05$) of the weed density in 25 days after treatment. The result shows that 25 days after treatment, the weed population is only present in the control treatment compared to treatment 1 (atrazine) and treatment 2 (diuron). The weed density was divided into two types, namely grasses and sedges and broadleaf weeds. The graph below (Figure 4.5) shows that the number of grasses and sedges is the highest compared to the number of broadleaf weeds.

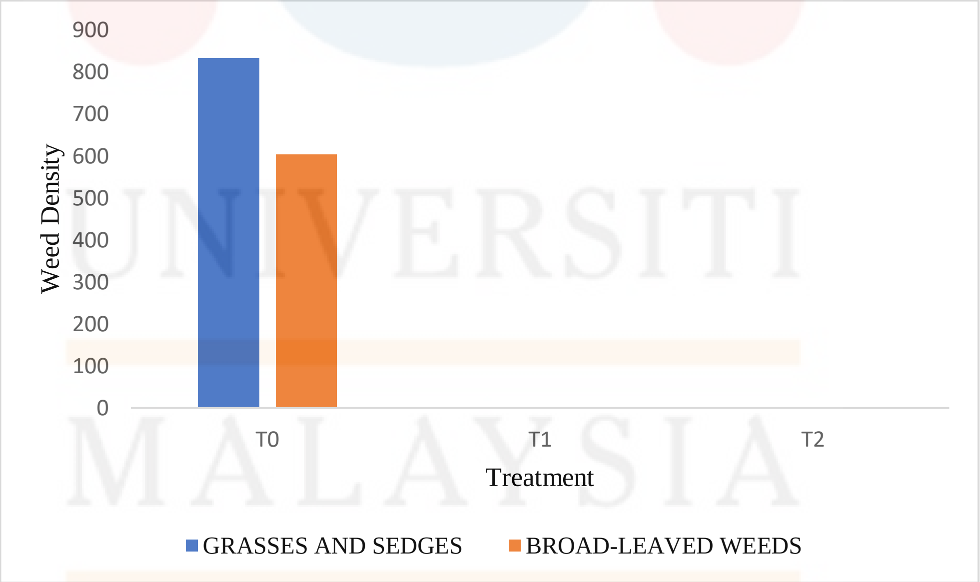

Figure 4.5: The graph of weed density of grasses and sedges, and broad leaf weed after 25 days of treatment.

In addition, Figure 4.6 showed the weed density of weed population growth in the treated and untreated herbicides. The graph below shows the differences in the growth of grasses and broadleaf plants. After 50 treatment days, weed population growth was shown in treatment 0 (control) and treatment 2 (atrazine), while treatment 1 (diuron) still showed no weed growth. The type of weed growth in the control treatment shows that grasses and rushes have the highest number compared to broadleaf plants. In treatment 2 (atrazine), the graph shows the opposite result of the control treatment in terms of growth of grass and rush populations and broadleaf plants.

The toxic effect of diuron on plant photosynthesis is well known and although the toxic effect of diuron on the biochemical pathways of photosynthesis has been studied in detail for over 30 years (Van Rensen, 1989). Atrazine has both a post-emergence and a pre-emergence effect when it enters the soil by direct contact or by being washed off the grass leaves. When applied as a pre-emergence herbicide, it can control annual grasses such as field bindweed, goosefoot, jungle weed, touch-me-not, crabgrass, etc. However, as a post-emergence herbicide, atrazine can control broadleaf weeds such as plantain, carpet flower, eclipta, lacecap, purslane, etc. (Mcafee et al., 2007).

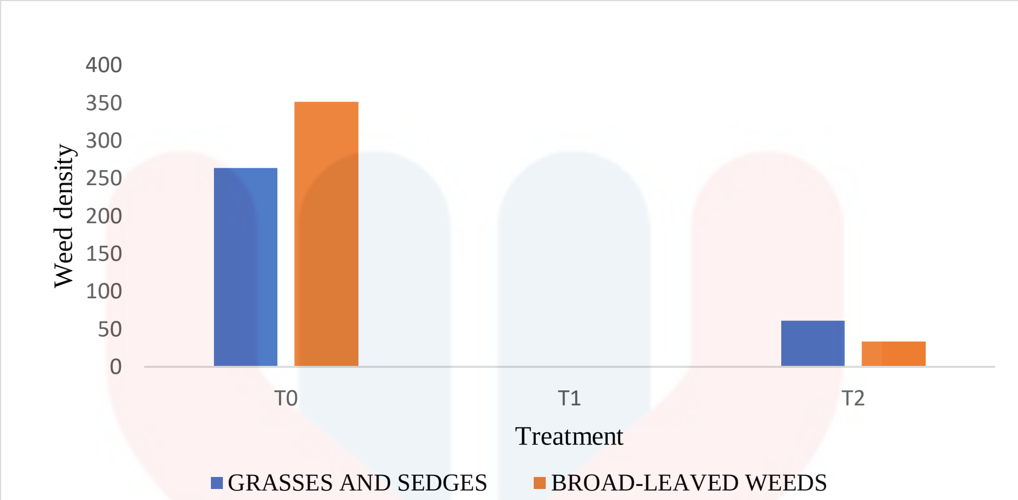

Figure 4.6: the graph of weed density of grasses and sedges, and broad leaf weed after 50 days of treatment.

In this study, shown in table 4.2, there is significant ($P < 0.05$) weed population at 25 days after treatment and no significant value at 50 days after treatment ($P < 0.05$). Data represent mean ± standard error (SEM) of weed density. The control treatment (0.5 ± 0.10^b) has the better mean compare uncontrolled treatment T2 (0.20 ± 0.28^a). The fact that some herbicides are able to promote plant development while others do not refute the hypothesis that hormesis is a general pressure response (Stebbing, 1998; Calabrese and Baldwin, 2001).

Table 4.2: (Mean ± SEM) of weed density(g) that observe after 25 day applied treatment and 50 day applied treatment in untreated and treated herbicide.

	Treatment			**P-value**
	T0	**T1**	**T2**	
25 DAT	0.5 ± 0.26^b	0.00 ± 0.00^a	0.00 ± 0.00^a	0.00711

50 DAT	0.5 ± 0.10^{b}	0.00 ± 0.00^{a}	0.20 ± 0.28^{a}	0.00714

SEM, Standard error of mean. Means with the different letter at every column did significantly different by Tukey's test (α=0.05).
T0 = Control
T1 = Diuron
T2 = Atrazine

4.3 Disease (heart and root rot pineapple)

At the second week after planting, one of the pineapple trees in the first replicate (T1R6) fell. In this same situation was present in week 4 after planting in the control treatment when 3 (T0R2, T0R3 and TOR5) out of 6 trees in the sample also fell in T0. Later, in week 6, the same situation was also observed when treatment 2 (T2R3) was repeated. Finally, Figure 4.7 shows the disease that leads to the death of the pineapple plant. The name of this symptom is heart rot. Pineapple heart rot is caused by the parasite Phytophthora. The first symptom occurs when the pineapple falls (Figure 4.8(a)) when the pineapple becomes infected. This symptom leads to soft rooting of the basal white leaf tissue (Figure 4.8 (c)). Infected leaves can be pulled off the plant immediately (Figure 4.8 (b)), and if the disease progresses accordingly, the plants will bite the dust (Green et al., 2015). Due to the low rate of decomposition of pineapple roots, the side effects become noticeable via the soil only after a delay. The side effects of root rot are more noticeable via the soil than those of heart rot, which occurs mainly in the first few months after planting. Heart rot is in most cases an enlargement of the root rot, with P. cinnamomi climbing up the stem to the top. This contrasts with heart rot caused by Phytophthora nicotianae, where infestation mainly occurs via the leaf bases (Rohrbach and Schmitt 1994).

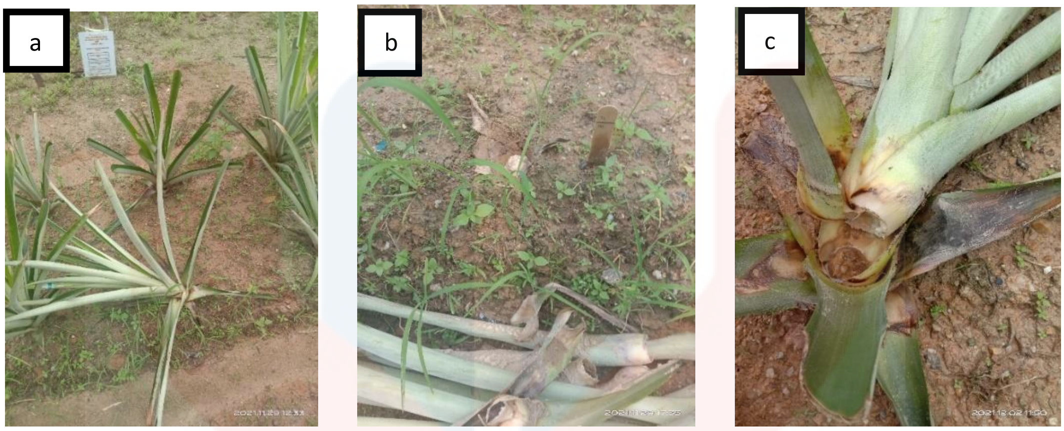

Figure 4.7 : Heart rot disease that infection of pineapple plant

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Based on this study, there is no significant difference ($p > 0.05$) between plant height, D–leaf length, number of leaves and D-leaf width as compared to untreated and treated pre-emergence herbicides treatments. The increase in vegetative growth stage in the T0 (control) is the lowest compared T1 (diuron) and T2 (atrazine). In this study, the pre-emergence herbicide T1 is the most effective herbicide for weed control. In addition, data at 25 and 50 days after treatment showed that no weed populations emergence in T1 (diuron). The increase in vegetative growth not only affects weed emergence, but also disease infection (heart rot). This is also one of the factors that do not indicate the exact number of vegetative growth parts of the pineapple plant. This study will help researchers and farmers to choose the method of pre-emergence weed control, especially in Malaysia, by providing additional data and information. For more accurate and reliable results, this study requires further research.

5.2 Recommendation

Further research is needed to improve and update new information on the benefits, effectiveness and drawbacks of pre-emergence herbicide use to increase production on pineapple farms. This will avoid the use of highly concentrated herbicides for weed control. Selecting the active ingredient of other pre-emergence herbicides can also provide new information that others are better for weed control and do not harm nature. However, this effect of herbicides on the vegetative growth stage of pineapple should be studied with a large sample to obtain more accurate results in the future. Considering the type of weed control in the collection and a large sample size could therefore allow more accuracy and variation in the effectiveness of pre-emergence for weed control in pineapple plantations.

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APPENDIX A

A.1 Preparing bed planting

A.2 Measure planting distance

A.3 30cm X 60cm X 90cm

A.4 Plant material

A.5 Pineapple planting

A.6 Herbicide hand sprayer

A.7 Collect weed

A.8 Dry weed in oven

A.9 Weed after dry

APPENDIX B

B.1 Plant Height

Table B (1.2) Means plant height with the different letter at every column did significantly different by Tukey's test (α=0.05).

Plant_Height			
	Treatment	N	Subset for alpha = 0.05
			1
Tukey HSD[a]	T0	5	1.1340
	T1	5	1.9660
	T2	5	2.8680
	Sig.		.100
Means for groups in homogeneous subsets are displayed.			
a. Uses Harmonic Mean Sample Size = 5.000.			

Table B (1.2) ANOVA disruptive plant height with the different letter at every column did significantly different by test (α=0.05).

Descriptive				
Plant Height				
	N	Mean	Std. Deviation	Std. Error
T0	5	1.1340	1.01916	.45578
T1	5	1.9660	.80326	.35923
T2	5	2.8680	1.64852	.73724
Total	15	1.9893	1.33970	.34591

B.2 D Leaf Length

Table B (2.1) Means D Leaf Length with the different letter at every column did significantly different by Tukey's test (α=0.05).

D_Leaf_Lenght			
	Treatment	N	Subset for alpha = 0.05
			1
Tukey HSD[a]	T1	5	.1000
	T0	5	.3000
	T2	5	.9000
	Sig.		.214
Means for groups in homogeneous subsets are displayed.			
a. Uses Harmonic Mean Sample Size = 5.000.			

Table B (2.2) ANOVA disruptive D leaf length with the different letter at every column did significantly different by test (α=0.05).

Descriptive				
D Leaf Length				
	N	Mean	Std. Deviation	Std. Error
T0	5	.3000	.50690	.22669
T1	5	.1000	.22361	.10000
T2	5	.9000	1.09176	.48825
Total	15	.4333	.74301	.19184

B.3 Number of leaves

Table B (3.1) Means number of leaves with the different letter at every column did significantly different by Tukey's test (α=0.05).

Number_leaf			
	Treatment	N	Subset for alpha = 0.05
			1
Tukey HSD[a]	T0	5	.2000
	T1	5	.4660
	T2	5	1.7320
	Sig.		.315

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 5.000.

Table B (3.2) ANOVA disruptive Number of leaf with the different letter at every column did significantly different by test (α=0.05).

Descriptive				
Number Leaf				
	N	Mean	Std. Deviation	Std. Error
T0	5	.2000	.29908	.13375
T1	5	.4660	.69299	.30991
T2	5	1.7320	2.64936	1.18483
Total	15	.7993	1.62692	.42007

B.4 Leaf width of D leaf

Table B (4.1) Means leaf width of D leaf with the different letter at every column did significantly different by Tukey's test (α=0.05).

	Treatment	N	Subset for alpha = 0.05	
			1	2
Tukey HSD[a]	T0	6	5.3000	
	T1	6	5.5233	5.5233
	T2	6		6.0500
	Sig.		.663	.131
Means for groups in homogeneous subsets are displayed.				
a. Uses Harmonic Mean Sample Size = 6.000.				

Table B (4.2) ANOVA disruptive leaf width of D leaf with the different letter at every column did significantly different by test (α=0.05).

Descriptive				
Leaf width of Leaf	N	Mean	Std. Deviation	Std. Error

T0	6	5.3000	.30186	.12323
T1	6	5.5233	.41913	.17111
T2	6	6.0500	.56370	.23013
Total	18	5.6244	.52593	.12396

B.5 Data of weed population

Day after spraying (day)	Day after spraying (DAS)	Herbicide	Grasses and sedges	Broad-leaved weeds	Quadrant				Total (n)
					1	2	3	4	
25	25	without treatment (t0)	667	483	257	312	334	247	1150
		Diuron (t1)	0	0	0	0	0	0	0
		Atrazine (t2)	0	0	0	0	0	0	0
50	50	without treatment (t0)	211	281	123	91	151	148	491
		Diuron (t1)	0	0	0	0	0	0	0
		Atrazine (t2)	49	27	19	17	15	25	76