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AEROLLER: HERBICIDES ROLLER MACHINE FOR AEROBIC RICE WEED CONTROL

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Graphical abstract

Abstract

As wet land rice, aerobic rice is also faced with the problem of weeds management. The absences of stagnant water facilitating more weed species to survive and compete with rice plants. Therefore, soil preparation is crucial for reduce weed problems in addition to manual control, which focuses on the rate of herbicides, the growth of rice plants, plant moisture and weed species. The risk of spray drift would be eliminated if herbicides were wiped on to weeds rather than sprayed. A machine designed to apply herbicides using rolling wipers were assessed for their ability to apply constant amounts of herbicide to treated surfaces. The machine designed by developed a structure consist of weed ball applicator, a hose connect to a 300 liter reservoir tank which attached to the transplanter prime mover. Weed ball applicator treated strips 15cm wide and having a roller 100 cm length. Adjustments to the flow rate as the reservoir can be made using a control valve at weed ball devices and control valve at the reservoir tank. AeRoller application used by wipe the herbicide onto weeds instead of spraying. The risk of damage to nearby non target plant would be almost eliminated and treatment under windy conditions would be possible by wiping herbicide on to weeds rather than spraying. A field evaluation of the Aeroller showed that it had good potential for the applications of herbicides for controlling weeds on aerobic rice farm. The use of this rollers device system saves chemicals, reduce labor, reduce pollution on the environment and reduce worker exposure to dangerous herbicides.

Keywords: Ae-Roller, wiping, roller device, herbicide, reduce pollution, save chemicals, DAS

1.0 INTRODUCTION

Staple food for more than half of the world population is coming from 90% of the rice area worldwide in Asia country. In the next 10 years global rice production needs to increase significantly to keep pace with demands of increasing populations. With limited scope for area expansion, rice productivity per unit area will have to be raised to meet the expected demand. However, farmers have to shift from manual transplanting of seedlings to direct-seeding in many Asian countries due to the increasing costs for labor and restricted supplies of irrigation water (Pandey and Velasco, 2005). There is a risk of greater crop yield losses due to weeds in direct-seeded rice than in transplanted rice because of simultaneous emergence of crops and weeds and the absence of standing water at the early stages of crop to suppress weed growth (Tuong *et al*., 2005 and Chauhan and Johnson, 2010). In order to save irrigation water due to flooded rice, aerobic rice was introduced with a direct seeding system in which dry

rice seeds are sown in dry or moist soil and irrigation is subsequently applied to keep the soil moist but not saturated.

MARDI is a pioneer in Aerobic rice studies in Malaysia. The studies have been on going in MARDI Seberang Perai (Penang, Malaysia) with almost 40 ha of aerobic rice research plot. Studies in Aerobic rice included seed production, weed control and low-yield due to weed issues. Critical periods for weed control to obtain 95% yield of the weed-free plots were estimated to be 13–75 days after sowing (DAS) in the dry season (Johnson *et al*., 2004). The information gained from such studies could be used as a guide to optimize weed management to avoid maximum competition between crops and weeds. Studies show that, for aerobic rice, Infestation or weed attack such as from Eleusine indica (*Gelang Sambau*), Digitaria Spp.(*cakar ayam*), Cyperus rotundus (*rumput halia hitam*), Cyperus iria (*rumput para*), and Mimosa invisa (*semalu besar*) depend on the area. If the infestation is high, herbicides control for pre emergence such as glyphosate is needed to be applying when land preparation is undergoing and follow by paraquat herbices 2 week after it before first rotor is done.The pre herbicides (pretilachor 3-7 DAS) and after emergence herbicide (propanil/benthiocarb 10-13 DAS) prior to or at the beginning of the critical period is very important to control weeds effectively.

Hand weeding is still been practicing in many Asian countries, however, labor shortage in rural areas is a constraint. Herbicides are expected therefore to be the main intervention against weeds in aerobic rice. According to Van Acker (1993), the intervals selected for weed selectivity, herbicide application timings should be based on critical weed control periods these are the intervals during which weeds have the greatest impact on crop growth and yield. If periods of weed infestation are extended losses and yield drop will be a major issue, and in these cases, late herbicide application will be wasteful. Increased herbicide in herbicide doses may be required to get good weed control, which increases costs and could result in crop phytotoxicity (Johnson *et al*., 2004).

Therefore a machine that wipes herbicides (AeRoller) by rolling the weeds on aerobic rice fields has been developed by Department of Engineering MARDI for accurate and efficient used. Application of this rollers device system saves chemicals, reduce labor, reduce pollution on the environment and reduce worker exposure to dangerous pesticides. The roller device is attached to transplanter prime mover and used gravity to flow the herbicides from the 300 L tank to the roller handle rod. Spraying is done on the route and the chemical flow can be control using a tap valve on the weed ball devices and the valve at the reservoir tank. Figure 1 and Figure 2 show the design concept and the experimental studies of the AeRoller.

2.0 MATERIAL AND METHOD

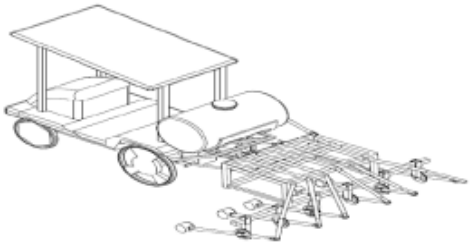
2.1 The Output of the AeRoller Machine

The output of solution from the AeRoller machine was measured by filling the tank with water then rolling it for 50 m across dry concrete at a constant speed of 1.2 m/sec. Application of solution was calculated by weighing the applicator before and after. The rate of application was compared when the tank were full 300 L for the AeRoller machine, and partially full 150 L or 75 L for quarterly full. All measurements were replicated 10 times.

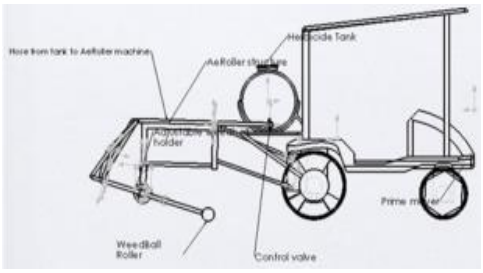
Figure 1 Output measurement of the AeRoller

2.2 Application to Weed on Aerobic Rice Plot

The adequacy of the AeRoller machine for applying selective herbicides to localised weedy areas in Aerobic Rice plot was tested by marking out line-transects within a weed infested area and applying several herbicide treatments (Table 1) along the lines. Herbicides tested were Propanil (Minconil), Benthiocarb (Satunil), Pyrazosulfuron ethyl (Basmin) and Bentazon (Basagran M60). Each treatment was applied to three different line transects, each 5.0 m long. The AeRoller applicator was run down one side of the line transect and back along the other side at 1.2 m/sec, doubling the width of the treated strip. A new foam ball was fitted to the applicator for each herbicide type to avoid contamination of treated areas by previous chemicals. Flow rate was restricted using the tap to 80 litres/ha, and application rates were determined using results from past research (Harrington and Zhang 1997). The herbicide treatments were compared to untreated line transects. The transects were scored on a regular basis over subsequent weeks to quantify damage to each of the individual weed species present.



(a)



(b)

Figure 2 a)Design of the AeRoller, b)Component and function of the AeRoller

3.0 RESULTS AND DISCUSSION

3.1 The Output of the AeRoller

Due to the shape of the ball on the AeRoller applicator, herbicide solution was only applied in a strip 15 cm wide, despite the ball being 20 cm in its original width. The amount of solution applied by the applicator was quite consistent when the solution was topped up to the same mark in the tank before each application. However, output dropped markedly as the reservoir emptied. When the reservoir was full, the output (mean value with standard error in parentheses) over 1ha was equivalent to (+ 96) litres/ha. When half full, output was (+ 60) litres/ha, a 37.5% decrease. When the tank contained only 100 L, application was equivalent to (+ 31.2) litres/ha, representing a 68% reduction in output. Partially closing the tap when the tank was full could give similar outputs to when the tap was fully open and the tank partially empty.

3.2 Application to Weed on Aerobic Rice Plot

From the experiment that has been done, The AeRoller appeared to apply the herbicides uniformly (Figure 3), as determined by the extent of damage to plant species along each line. The effect of the herbicides on the weeds present became easy to determine as weeks passed by.

All herbicide treatments controlled weed species present, namely Eleusine indica (Gelang Sambau), Digitaria Spp.(*cakar ayam*), Cyperus rotundus (*rumput halia hitam*), Cyperus iria (*rumput para*), and Mimosa invisa (*semalu besar*). Although Benthiocarb appears less effective in Table 1, it had a slower effect than other herbicides and did eventually give very good control of clover at both rates used.

Table 1 Herbicides effect from AeRoller machine on treated weeds as assessed by scoring (1=dead, 8= unaffected). Treatment 30 DAS on Aerobic rice plot. Result 4 weeks after treatment

	Rate	Health of plants		
Active ingredient (a.i)		**Digitaria Spp.(*cakar ayam*)**	**Cyperus rotundus (*rumput halia hitam*)**	**Cyperus iria (*rumput para*)**
Benthiocarb	6 l/ha	6.6	6.4	6.8
Propanil	2-4kg a.i./ha	5.0	4.8	5.1
Pyrazosulfuron Ethyl	0.012-0.02kg a.i./ha	3.3	4.3	4.7
2,4-D	0.5-1kg a.i./ha	3.7	2.8	3.0
Benzaton	90-120ml/18l water	1.5	1.9	1.3
Untreated		8	8	8

Figure 3 Field test of the AeRoller machine on weeds at Aerobic rice plot in MARDI Seberang Perai

3.3 Comparison Conventional Practice Versus AeRoller

For weed management, farmers using conventional practice which are knapsack spraying or hoeing. This method is drudgery and tedious. When applying

selective herbicides to aerobic rice field through conventional spraying equipment, there is often a risk that nearby desirable plants may be damaged by spray drift. Therefore, AeRoller applicator can be used for wiping chemical on to weeds instead of spraying (Table 2). By wiping herbicide on to weeds rather than spraying, the risk of damage to nearby non target plant would be almost eliminated and treatment under windy conditions would be possible. A machine that wipes herbicides (AeRoller) by rolls the weeds on aerobic rice fields has been developed by Department of Engineering Research MARDI for accurate and efficient used. Use of this rollers device system saves chemicals, reduce labor, reduce pollution on the environment and reduce worker exposure to dangerous pesticides. The roller device is attached to transplanter prime mover and used gravity to flow the herbicides from the 300 liter tank to the roller handle rod.It equipped with 6 roller rods and the distance of each of it can be adjust desirely.

Table 2 Comparison between conventional and AeRoller machine

Features	Conventional practices		AeRoller
Application	knapsack spray	Hoeing	AeRoller wipe
Weed control covers	1 row/person	1 row/person	6 row/person
Volume of herbicides usage/ha	320L/ha	Nil	96L/ha
Operator	Manual	Manual	AeRoller attach to prime mover
Operation time	4.7 hour/ha	16 hour/ha	2.5 hour/ha
Tank capacity	25 L	-	300L
Targeted area	Drift	Precise	Precise

4.0 CONCLUSION

AeRoller machine show good potential for applying selective herbicides to weeds in Aerobic rice area by minimize spray drift, but only if carefully calibrated so that output can be changed as the reservoir empties. If the taps are not adjusted as the reservoirs empty, there will either be too much herbicide applied when the reservoir is full or insufficient application when nearly empty. This constant need for adjustment of the tap does not make them easy to use. The Weed Ball applicator is better suited to treating Aerobic rice weeds as it can be lifted off the soil surface between each weed. With this machine, clearing the herbicides in the aerobic rice field not a waste because the rolling is done on the route and the chemical flow can be control using a tap in weed ball devices and valve at the reservoir tank. This system is very effective in terms of precision application and not harmful to workers and the environment. This machine is designed and developed with low maintenance cost and it is also easy to handle.

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