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Research Article

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Effect of Different Doses of Glufosinate-Ammonium 88% (Expert 88wdg) For Controlling Weed in Citrus Orchard

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Abstract

A field trial was conducted at the Fruit Research Farm of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, during the period from January to July 2020 to find out the optimum dose of herbicide to control weed in the citrus field. Five treatments i.e. T1: spraying of expert 88 WDG @ 2.5 g/litre of water, T2: spraying of expert 88 WDG @ 3.0 g/litre of water, T3: spraying of expert 88 WDG @ 3.5 g/litre of water, T4: Two hand weeding at 25& 50 DAE (Days After Establishment) and T5: no spray (Control) was included in this study. Number of weed/m2 and weed control efficiency (WCE) was influenced by different treatments. Maximum (123 and 200) weeds/m2 was recorded in control plot at 25 & 50 DAE, respectively and minimum 27 weeds/m^2 were recorded in T4 followed by T3 treatment (31 weeds/m^2) respectively. The highest weed control efficiency 81.43% and 88.10% was found in T3 treatment at 25 DAE followed by T4 treatment (80.95% and 86.47%) in field-1 and field-2. The results revealed that spraying of herbicide (Expert 88 WDG @ 3.5 g/litre of water) was most effective in controlling weeds up to 25-35 days of herbicide spraying. The herbicide action was shown quickly after spraying one day.

1. Introduction

Citrus, the genus *Citrus L.* of the family Rutaceae, subfamily Aurantioideae (Wu, G. A. et al., 2018). Citrus fruit production of Bangladesh increased from 18,712 tonnes in 1972 to 164,008 tonnes in 2021 growing at an average annual rate of 5.52% [1]. Weeds in citrus orchards are a major problem in cultivation, since weeds compete with the main tree unit for water, nutrients and also interfere with cultural practice [2]. Weeds live at different phenological stages and at the same time and space with the crop throughout its cycle and these crops have a smaller number of herbicides and control opportunities compared with the annual crops (Rodrigo Martinelli, 2022).

Weed causes problems of Citrus orchards in early of growth period, and chemical herbicides are used against it that is accompanied with environmental pollutions [3]. The weeds in Citrus orchards decrease available water and nutrients of soil. They also may be host of a variety of pests, diseases, and even funguses [4]. Meanwhile,

weed species compete with citrus trees in many ways and with varying intensities; management of more competitive weeds such as *Conyza canadensis, Conyza bonariensis, Sorghum helepense, Cyperus spp.,* and *Vicia sativa* should be prioritized. While some weeds (e.g., *Tribulus terrestris, Xanthium spinosum, Cirsium vulgare and Helminthotheca echioides*) may have low competitive effects on citrus trees, they can hinder labor operations and may also rank high for active management. Mechanical mowing is generally more expensive than tillage and can throw seed under the tree canopy, increasing weed pressure next to the tree trunk. The presence of weeds in a citrus grove can also affect insect populations. Weeds growing around tree trunks may also create a favorable environment for pathogens that infect the trunk and roots (Futch and Singh, 2010). Herbicides can provide effective control of most weeds in a citrus orchard, facilitating irrigation and other cultural operations. However, certain problems are associated with total reliance on herbicides. In orchards planted on slopes, complete weed control creates bare orchard floors that are prone to soil erosion. If a particular herbicide is used repeatedly, species that are not susceptible to the herbicide may thrive and become dominant. In addition, repeated use of the same herbicide may lead to the development of herbicide resistance.

The mode of action of glufosinate has been very controversial for almost 30 years since its first introduction in 1993. Furthermore, environmental conditions can strongly affect glufosinate performance in the field, and only a few weed species have evolved glufosinate resistance in the world [5] . Glufosinate ammonium is one of the most widely used post emergence and broad-spectrum herbicides, controlling weeds in a huge variety of crops worldwide. It is effective against a broad range of weeds, eliminating the need to apply several herbicides to control different weeds in a given crop (Molefe B. P., 2015) and unique mode of action makes it ideal to be used in rotation with other herbicides to mitigate weed resistance. Glufosinate is a nonselective, POST-applied herbicide that offers broad-spectrum weed control (Duenk et al., 2023). Driven by an immense accumulation of reactive oxygen species, glufosinate-induced phytotoxicity is rapid, causing cell death shortly after application [6]. Only six weed species have evolved resistance to glufosinate, despite commercialization for almost 30 year (Heap, 2022). Weed control efficacy with glufosinate is influenced by weed species, weed height at application, time of day at application, weather, adjuvant, and glufosinate application rate (Coetzer et al. 2002; Steckel *et al*. 1997). Therefore, an attempt has been needed to explore the effective rate of the weedicide active ingredients (a.i.) for its commercialization in Bangladesh. Hence, the experiment has been undertaken to find out the effective dose of herbicide for weed management in citrus orchards in the central region of Bangladesh.

2. Materials and Methods

The Experiment was carried out at the Fruit Research Field, Pomology Division, Horticulture Research Centre of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during July 2018 to June 2019 and July 2019 to June 2020 in two subsequent years. The location of the experimental site was about 35 km North of Dhaka city with 24.00 N latitude and 95.250 E longitude [7] . The altitude of the location is 8.5 m from mean sea level (Anon., 1995). The soil was silty clay loam with PH 6.3 belonging to agro Ecological Zone 28. The treatments were T1: spraying of expert 88 WDG @ 2.5 g/litre of water, T2: spraying of expert 88 WDG @ 3.0 g/litre of water, T3: spraying of expert 88 WDG @ 3.5 g/litre of water, T4: Two hand weeding at 25& 50 DAE (Days After Establishment) and T5: no spray (Control). The trial was set up in a randomized complete block design with three replications. The unit plot size was 4 m x 4 m. The fertilizers were applied as basal doses cowdung 20 kg, TSP 300 g and 250 g Muriate of potash per pit. One kg urea per plant were applied at four split doses starts from March - June –October-December months. Grafts of *Citrus lemon* and *Citrus aurentifolia* were planted on 22 October 2014. Herbicide spray was done on 4th May 2018. Weed samples were collected using 1m × 1m quadrate, from randomly selected one places of each plot at 25 days interval in two times. Number and dry weight of weeds were recorded. Weed control efficiency (WCE) was calculated according to Varshney (1999) using following formula: WCE (%) = $(A- B) / A \times 100$ where A = Dry weight of weeds in no weeding plots and B = Dry weight of weeds in treated plots. Data were recorded and analyzed statistically.

3. Results and Discussion

The weed species, number of weeds/m^2, density of weeds (%) and weed control efficiency (WCE) of Expert 88wdg have been presented in Tables 1 and 2. The results showed that weed species, number of weed/m2, weed density (%) and WCE was affected by different doses of herbicide applications. It was observed that Mutha (*Cyperus rotundus*), Helencha (*Enhydra fluetuans*), Shama (*Echinochloa crusgalli*), Kanaibashi (*Commelina bengalensis*) and Durba (*Cynodon dactylon*) were the common weeds in the citrus field [8]. partially agreed with this finding where they identified *Cyperus rotundus* (Nut sedge), *Cynodon dactylon* (Bermuda grass), *Chinopodium album* (Lamb's squarters), *Amaranthus spp* (Pig weed) and *Parthanium hyterophorus* (Carrot grass).

Treat ment	Weed species		At 25 DAE		At 50 DAE	
	Local name	Scientific name	Weed/m²	Weed density (%)	Weed/m²	Weed density (%)
	Mutha	Cyperus rotundus	10	25.64	68	44.16
	Kanaibashi	Commelina bengalensis	7	17.95	20	12.99
	Gaicha	*Paspalum distichum L.*	8	20.51	24	15.58
	Chapra	Eleusine indica	0	0.00	7	4.55
T1	Ulu	Imperata cylindrical	9	23.08	17	11.04
	Helencha	Enhydra fluctuans	5	12.82	18	11.69
		Total	**39**	**100**	**154**	**100**
	Mutha	Cyperus rotundus	8	22.86	43	37.72
	Kanaibashi	Commelina bengalensis	6	17.14	17	14.91
	Gaicha	*Paspalum distichum L.*	7	20.00	20	17.54
T2	Chapra	Eleusine indica	0	0.00	5	4.39
	Ulu	Imperata cylindrical	6	17.14	11	9.65
	Helencha	Enhydra fluctuans	5	14.29	10	8.77
	Shaknotey	Amaranthus iridus	3	8.57	8	7.02
		Total	**35**	**100**	**114**	**100**
	Mutha	Cyperus rotundus	8	25.81	35	35.71
	Kanaibashi	Commelina bengalensis	4	12.90	15	15.31
	Gaicha	*Paspalum distichum L.*	6	19.35	18	18.37
T3	Chapra	Eleusine indica	0	0.00	5	5.10
	Ulu	Imperata cylindrical	5	16.13	10	10.20
	Helencha	Enhydra fluctuans	5	16.13	7	7.14
	Shaknotey	Amaranthus iridus	3	9.68	8	8.16
		Total	**31**	**100**	**98**	**100**
	Mutha	Cyperus rotundus	7	25.93	33	34.38
	Kanaibashi	Commelina bengalensis	4	18.52	13	13.54
	Gaicha	*Paspalum distichum L.*	6	18.52	15	15.63
T4	Chapra	Eleusine indica	0	0.00	7	7.29
	Ulu	Imperata cylindrical	5	18.52	9	9.38
	Helencha	Enhydra fluctuans	5	18.52	7	7.29
	Shaknotey	Amaranthus iridus	0	0.00	12	12.50
		Total	**27**	**100**	**96**	**100**
	Mutha	Cyperus rotundus	45	36.59	74	37.00
	Kanaibashi	Commelina bengalensis	15	12.20	24	12.00
	Gaicha	*Paspalum distichum L.*	22	17.89	35	17.50
T5	Chapra	Eleusine indica	12	9.76	18	9.00
	Ulu	Imperata cylindrical	14	11.38	20	10.00
	Helencha	Enhydra fluctuans	7	5.69	15	7.50
	Shaknotey	Amaranthus iridus	8	6.50	14	7.00
		Total	**123**	**100**	**200**	**100**

Where: T_1: spraying of expert 88 WDG @ 2.5 g/litre of water, T_2: spraying of expert 88 WDG @ 3.0 g/litre of water, T_3: spraying of expert 88 WDG @ 3.5 g/litre of water, T_4: Two hand weeding at 25& 50 DAE (Days After Establishment) and T_5: no spray (Control).

Table 1: Effect of Weed Management Methods on Weed Species, Weed Number/m2 and Weed Density Over Time During the Summer Season of 2020

Among the weed species Mutha (*Cyperus rotundus*), Gaicha (*Paspalum distichum L.*) are the dominant weed. The highest weed infestation was recorded in control plot at 25 and 50 days 123 and 200 weeds/m2 respectively (Table-1). The lowest infestation (27 and 96 weeds/m2) was recorded in T4 treatment followed by T3 treatment (31 and 98 weeds/m^2). The weed control efficiency influenced by different weed management methods. Takano H. K. and. Dayan F. E., (2020) opinted that additional studies need to optimize the synergistic effect on different weed species and crops. Likewise, glufosinate resistance mechanisms require further investigation as the current understanding is not clearformost resistant populations. The dry weight of the weed population was maximum 285 g and 470 g at 25 DAE and 50 DAE in control treatment and it was minimum in T3 treatment 114 g and 187 g respectively. resulted significantly lower dry weight of weeds (168.31 kg ha-1) was found under treatment W4 (W4: Pendimethalin @ 1.0 kg ha-1 as PE + Quizalofop - P - ethyl @ 0.04 kg ha-1 at 20 DAS + HW and IC at 40 DAS). Moreover, the present study exerted the highest weed control efficiency 81.43% and 60.21% in T3 treatment at 25 DAE and 50 DAE followed by T4 treatment (80.95% and 57.45%) in field-1 and (86.47% and 55.32%) field-2 respectively. (Table-2 & 3) [9].

Treatment	Dry wt g/m^2		Weed control efficiency (%)	
	25 DAE	50 DAE	25 DAE	50 DAE
T1	152	280	63.33	40.43
T2	120	220	78.57	53.19
T3	114	187	81.43	60.21
T4	115	200	80.95	57.45
T5 control	285	470	0	0
Mean	157.20	271.40	60.85	42.25
Standard dev	65.41	104.28	31.14	22.19
Range	114-285	187-470	0-81.43	0-60.21

Where: T_1: spraying of expert 88 WDG @ 2.5 g/litre of water, T_2: spraying of expert 88 WDG @ 3.0 g/litre of water, T_3: spraying of expert 88 WDG @ 3.5 g/litre of water, T_4: Two hand weeding at 25& 50 DAE (Days After Establishment) and T_5: no spray (Control).

Table 2: Effect of Weed Management Practices on Weed Dry Weight and Weed Control Efficiency Over Time (Field 1)

Treatment	Dry wt g/m^2		Weed control efficiency (%)	
	25 DAE	50 DAE	25 DAE	50 DAE
T1	168	312	63.81	31.43
T2	128	245	82.86	46.15
T3	115	190	88.10	61.29
T4	110	210	86.47	55.32
T5 control	302	455	0	0
Mean	164.6	282.4	64.248	38.838
Standard dev	71.65361	95.7551	33.27804	21.87456
Range	110-302	190-455	0-88.10	0-61.29

Where: T_1: spraying of expert 88 WDG @ 2.5 g/litre of water, T_2: spraying of expert 88 WDG @ 3.0 g/litre of water, T_3: spraying of expert 88 WDG @ 3.5 g/litre of water, T_4: Two hand weeding at 25& 50 DAE (Days After Establishment) and T_5: no spray (Control).

Table 2: Effect of Weed Management Practices on Weed Dry Weight and Weed Control Efficiency Over Time (Field 2)

The result showed that the weed control efficiency was noted lower in T1 treatment (63.33 and 63.81%) in field-1 and field-2 at 25 DAE compare to other treatments. Moreover, the efficiency becomes retired after 50 DAE in all of treatments. It was also observed that within 6-8 hours action of herbicide (weed mortality) was appeared on weed.

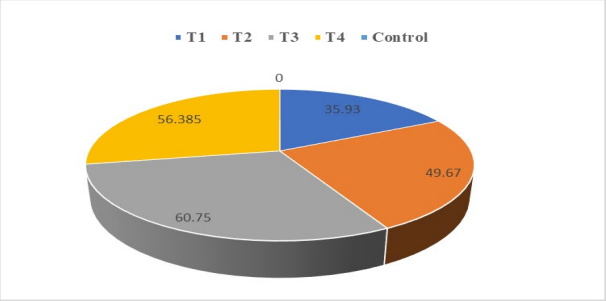

Figure 1: Percent Weed Control Efficiency at 25 Days After Emergence.

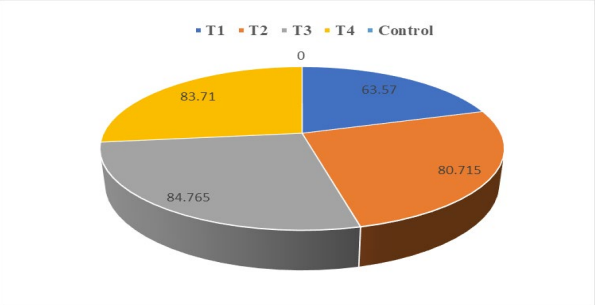

Figure 2: Percent Weed Control Efficiency at 50 Days After Emergence.

also recorded maximum weed control efficiency (75.33%) in treatment W4 and found most effective in controlling the weeds. They prescribed this might be due to effective weed control achieved under efficient method of weed management in terms of lower weed population per unit area and less availability of underground (nutrient and moisture) and above ground resources (light) to weeds due to more competitive and smothering effect of crop, resulting lower biomass of weeds and higher weed control efficiency. Almost similar results were also reported by Banga et al., (2004) at Hisar (Haryana); Sarkar et al., (2005) at West Bangal; Adhikari and Ghosh (2014) at West Bangal and at Jammu (J & K) [10].

4. Correlation

In the light of weed density, a strong significant correlation was noticed between Helencha and Mutha. In contrast, a negative correlation was found between Helencha and other weeds. Likewise, other weeds had a strong but negative correlation was presented with Mutha but showed exclusively positive correlation with Ulu. On the other hand, Kanabashi, Gaicha and Chapra had revealed non-significant correlation (In Figure 1).

According to Figure 2, based on weed density a highly significant correlation was presented between Chapra and Mutha. On the contrary, solely negative but significant correlation was disclosed between Helencha and Chapra. However, ULu, kanaibashi, Gaicha and other weeds unveiled non-significant correlation.

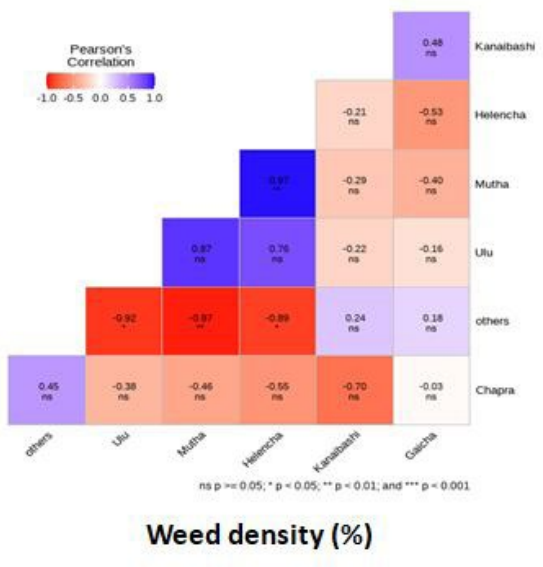

Figure 1. Density of Different Weed Species at 25 Days After Emergence/Weedicide Spray

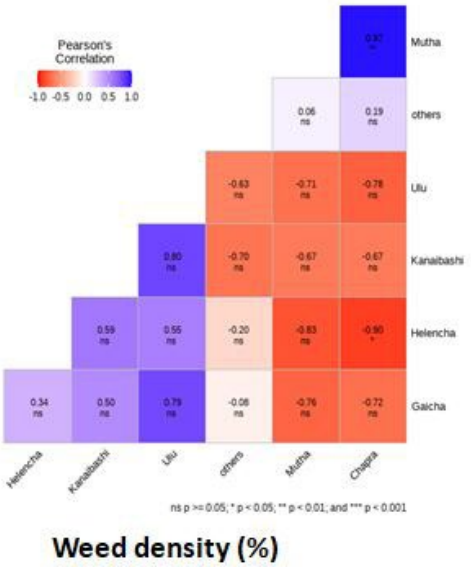

Figure 2. Density of Different Weed Species at 50 Days After Emergence/Weedicide Spray

5. Conclusion

The result revealed that spraying of herbicide Expert 88WDG (88% Glufosinate - Ammonium) @ 3.5 g/ litre of water formulation was found most effective to control weeds for citrus production upto 25-35 days after herbicide spraying. **Weed density (%)**

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Conflict of Interest

The authors declare no conflict of interest.

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