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Effect of Atrazine on Germination and Growth Performance of Water Yam (*Dioscorea alata*)

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Authors' contributions

This work was carried out in collaboration between all authors. Author OSO designed the study and wrote the protocol. Author AOS wrote the first draft of the manuscript, managed the literature searches. Author FAA did the analyses of the data and the conclusion. All authors read and approved the final manuscript.

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ABSTRACT

Effect of rates of application of atrazine on germination and growth performance of water yam minisetts was investigated at Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria. The treatments in the field experiment were four (4) rates of atrazine i.e 100%, 50%, 25%, and 0% of the recommended dosage rate of 2.5 kg active ingredient/ha or 5litres/ha. A plot to which no herbicides was applied served as the control (0%). The experiment was arranged in a randomized complete block design with three replications. Result showed that though yam minisetts emergence was not hampered by the rates of application of atrazine, the growth parameters of the yam minisetts were significantly (p= 0.05) affected at early stage. Yam minisetts vine length and vine thickness were significantly (p=0.05) higher at 50% treatments compared to other treatments and control. Rates of application of atrazine however, did not affect the number of leaves of yam minisetts. The rates of application of atrazine did not significantly (p=0.05) affect the

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yield parameters of yam minisetts, though the heaviest weight was produced under 25% treatments. Similarly, the rates of application of atrazine were similar in their effect on weed control and were better than the control.

Keywords: Yam minisetts; atrazine; dosage.

1. INTRODUCTION

Yams, (*Dioscorea spp.*)*,* are important tuber crop and staple food for millions of people in many tropical and subtropical countries. It has become a cash crop in countries along the coast of West Africa [1]. They produce edible starchy storage tubers, which are of cultural, economic, and nutritional importance in the tropical and subtropical regions of the world [2]. Generally, yam tubers are boiled, roasted, baked, or fried. However, in some regions, the tubers are boiled and then pounded to glutinous dough called "fufu" (in Yoruba language). Cooked yam tubers or their products are usually eaten in association with protein-rich sauces. It has also gained importance in pharmaceutical industries [3]. Nigeria accounts for about 70% of the world's production of yam, generating a global output of over 33 million metric tons [4]. *D, alata* is popular and prevalent in Abakaliki agro ecological zone of Ebonyi State, Nigeria where it is called "Mbala or Nvula" (Igbo names).

Traditionally, water yams are propagated vegetatively by means of tuber. Whole tuber called "seed" yam from l00 g to 1500 g are used as planting materials. Alternatively, larger tubers are often cut into approximately 200 g pieces and used to establish the new crops [5,6]. A major constraint to yam production however, is the availability of the planting material. Since the tuber for which the crop is grown is equally needed as planting material, it becomes difficult to get enough material for planting since this constitute a competitive use for the tuber.

Furthermore, the conventional seed yam and or yam sett are usually very big thereby consuming a greater percentage of the total yam produced. The practical implication is that the seed represent the highest cost items, accounting for as much as 50 percent of operating expenses [7] while planting material makes up 35 percent and 54 percent of the total cost of production [8].

The National Root Crop Research Institute in Nigeria developed a system termed the "minisett" technique which aims at overcoming the seed yam problem. A "minisett" is defined as set less than one quarter of the minimum size (l00 g) of yam sett often planted [6]. The technique involves cutting the selected "mother seed" yam into pieces 20 g to 25 g each, treating them in a fungicides or insecticides suspension and sprouting them in nursery beds or polyethylene bags. After three to four weeks, the sprouted minisetts are transplanted into the main fields [9].

Generally, weed constitute a major hindrance to crop production especially in the tropics due to factors ranging from weather condition (torrential rain and adequate insolation), farming system and illiteracy which does not allow for maximum employment of chemical weed control [10]. The debilitation effect of weeds is a function of weed type, crop type, season of the year amongst others. In yam production, yam is mostly susceptible to weed infestation during the early growth during which time the canopy is not formed yet thereby allowing for ample space for the weed to develop. Thus, any practice that will allow prompt germination and rapid canopy formation will go a long way to checking the weed menace in yam production. A common practice in the tropics is the use of big size yamsetts or seedyams. This technique relies on the fact that since the young yam plant relies on the stored nourishment in the planting material at the early age, the size of the planting material, therefore is of great significance for a proper and a more competitive development of the yam seedling during the early growth stage through timely and adequate canopy formation which reduce weed seedlings recruitment and development.

From the foregoing, it could be inferred that weeds and weed control is a major constraint to yam minisett production. The tiny nature of the emerging vines due to the size of the planting material delays canopy formation thereby yielding more space for weed emergence, development and competition. Similarly the fragility of the vines makes the use of manual weeding, using hand hoeing, a delicate activity aside labour intensiveness, time constraint and cost of labour.

Thus, a more effective and less cumbersome weeding using the herbicide becomes more appealing. The use of chemical weeding has remained very popular in crop production due effectiveness, timeliness, reduce labour and reduce cost. The practice has also been reputed to be desirable due to reduced erosion arising from reduced soil tillage [11,12]. It is in the light of this that this experiment was designed to evaluate the effect of atrazine, a popular pre-emergence herbicide, on the germination and growth performance of water yam minisett. Atrazine used to prevent pre- and postemergence broadleaf and grassy weeds in crops such as sorghum, maize, sugarcane, lupins, pine, and eucalypt plantations, and triazine-tolerant canola [13].

[14], stated that in the United States as of 2014, atrazine was the second-most widely used herbicide after glyphosate, with 76 million pounds of it applied each year [15,16]. Atrazine continues to be one of the most widely used herbicides in Australian agriculture, [13].

The result of this experiment is expected to enhance the success of rapid yam minisetts production.

2. MATERIALS AND METHODS

Field experiment was carried out at Ladoke Akintola University of Technology, Teaching and Research Farm, Ogbomoso, during the rainy seasons of 2011 and 2012. The raining season, which is between April and October, is characterized by maximum rainfall distribution in southern part, due to the influence of the south westerly monsoon wind on the atmosphere. The dry season covers between November and March and is characterized by hot weather. The soil of the experimental plot was sandy loam and slightly acidic (Table 1).

The common weeds on the experimental plot include: - *Tithonia diversifolia, Argeratum conyzoides, Digitaria horizonntalis,* and *Tridax procumbens.* The predominant weed species were *Tithonia diversifolia and Digitaria horizonntalis* (50% and 35% respectively). The experiments were laid out in a randomized complete block design, with three replicates. The minisetts, 25g each, were treated with wood ash and cut, the surfaces were allowed to dry for 24hrs before planting. The minisetts were planted in situ at 6 plants per bed at a spacing of 0.5 m by 0.5 m. The bed was dimensioned 2 m x 2 m. Grass mulch was applied on planting spots to conserve moisture and prevent excessive sunlight. Four rates of application were tested in the experiment namely; atrazine 100%, atrazine 50%, atrazine 25% and control treatment to which no herbicide was applied. Atrazine was applied to rain moistened soil using a knapsack sprayer model Cp3, which delivers at a rates of 2001/ha. To achieve the 100%, 50%, 25% of dosage rates of herbicides, 250 ml, 125 ml and 62.5 ml of the herbicides were dissolved each in 10 litres of water. Stakes were provided for plant stands and the growing young vines were trained as soon they are long enough using threads. Data were collected on growth and yield parameters of water yam. Weed population density was estimated from 3 randomly placed 0.25 m^2 quadrat, while the wet weight of weeds harvested from the quadrats were measured on a sensitive scale. Mean data collected over the two years were subjected to analysis of variance (ANOVA) while the means were separated by Duncan's Multiple Range Test (DMRT) at 5% probability level.

Table 1. Pre-cropping soil analysis of the experimental site

	Year 2011	Year 2012
pH (H_2O)	6.0	6.3
Organic C (%)	1.9	1.6
Total N	0.26	0.18
Available P (ppm)	4.93	5.98
Exchangeable K (Meg/100 g)	0.42	0.38
Sand (%)	87	88
Silt (%)	9	10
Clay (%)	4	2
Textural class	Sandy loam	Sandy loam

3. RESULTS AND DISCUSSION

Effect of rates of application of atrazine on germination of yam minisetts is presented in the Table 2. There were no significant (p=0.05) differences among the treatments and the control at 3 weeks after planting (WAP). Atrazine did not have any effect on the germination of yam minisetts as both the atrazine treated and the untreated minisetts germinated at the same rate. At 6WAP, there were no significant differences on germination rate between atrazine 50%, Atrazine 25% and control. These were however significantly (p=0.05) higher than those of Atrazine 100%.

Table 2. Effect of rates of application of atrazine on germination of yam minisetts

Treatment	% germination	
	3 WAP	6 WAP
Atrazine l00%	16.7a	55.6b
Atrazine 50%	27.7a	77.8a
Atrazine 25%	33.3a	72.2a
Control	33.4a	77.8a

Mean followed by the same superscript along the column are not significantly different (p=0.05) by Duncan's Multiple Range Test (DMRT).
WAP: Weeks after planting

Effect of rates of application of atrazine on growth parameters of yam minisetts is presented in Table 3. There were no significant (p=0.05) effect of rates of application of atrazine on yam minisetts growth parameters across the period of data collection.

Similarly, application rates of atrazine did not have significant (p=0.05) effect on tuber yield of yam minisetts (Table 4). However, the heaviest tuber (1.3 kg) was produced under 25% treatment (1.30 kg) followed by the control (1.0 kg). The smallest tuber (0.87 kg) was produced by the 100% treatment.

The weed control effectiveness of the rates of application as measured by weed density and biomass is presented in Table 5. All the rates were superior to the control in effectiveness (p= 0.05). There were no significant difference (p= 0.05) between the rates in effectiveness. This result confirms the efficiency of the herbicide as indicated by the producers. Atrazine had been indicated for the control of broad leaves and some grass weeds when applied pre-emergently on at early weed emergence.

The result from this experiment indicated that atrazine can safely be used for weed control in yam minisett production. The experimented rates did not have any significant (p= 0.05) negative effects on both the growth and tuber yield of water yam compared to the control (Table 7), which confirmed yam's tolerance to timely application of the herbicides. Thus, it could be safely recommended that the lowest rates (25%) be adopted for weed control in yam minisett production more so, when there were no significant (p= 0.05) difference between the weed control efficiencies of the rates (table 6). As such, it is implied that only 25% of the recommended dose will be required. Similar finding had been reported by [17]. In addition, since atrazine had been listed as one of the most persistent herbicides [18], an effective reduced dosage rate will help mitigate the problem of persistence of the herbicides in addition to added economic gains. Furthermore, since the use of herbicides does not involve using equipment like hoes and cutlasses that can easily injure or destroy the tender and fragile yam minisetts vines, the choice of this method of weed control aside reducing labour, drudgery and cost will guarantee safety of the yam minisett vines.

Table 3. Effect of rates of application of atrazine on vine length of yam minisetts

Treatment	Vine length (cm)			
	6 WAP	8 WAP	10 WAP	12 WAP
Atrazine 100%	33. 1b	86.0a	122.6ab	147.0a
Atrazine 50%	58.1a.	98.0a	I41.4a	144.4a
Atrazine 25%	54.4a	71.4a	80.7b	135.9a
Control	46.8a	96.2a	124.6ab	126.4a

Mean followed by the same superscript along the column are not significantly different (p=0.05) by DMRT

Table 4. Effect of rates of application of atrazine on vine thickness of yam minisetts

Treatment	Vine thickness (cm)			
	6 WAP	8 WAP	10 WAP	12 WAP
Atrazine 100%	0.5a	0.5a	0.5a	0.6ab
Atrazine 50%	0.6a	0.5a	0.6a	0.7a
Atrazine 25%	0.5a	0.5a	0.5a	0.6ab
Control	0.5a	0.5a	0.5a	0.5b

Mean followed by the same superscript along the column are not significantly different (p= 0.05) by DMRT

Table 5. Effect of rates of application of atrazine on number of leaves of yam minisetts

Treatment	Number of leaves			
	6 WAP	8 WAP	10 WAP	12 WAP
Atrazine 100%	8.4a	24.0a	33.8a	49.0a
Atrazine 50%	11.8a	32.2a	37.5a	49,0a
Atrazine 25%	11. 8a	27.7a	32.7a	48.8a
Control	10.0a	24.7a	30.2a	52.2a

Mean followed by the same superscript along the column are not significantly different (p=0.05) by DMRT

Table 6. Effect of rates of application of atrazine on weed density and weed biomass of yam minisetts

Treatment	Weed density unit/25 m^2	Weed biomass g/25 cm^2
	8 WAP	8 WAP
Atrazine 100%	10.3b	28.3b
Atrazine 50%	14.4b	33.3b
Atrazine 25%	15.0a	32.3b
Control	28.9a	79.7a

Mean followed by the same superscript along the column are not significantly different (p=0.05) by DMRT.
WAP: Weeks after planting

Table 7. Effect of rates of application of Atrazine on the yield parameters of yam minisetts

Treatment	Yield parameters		
	Tuber weight (kg)	Tuber length (cm)	Tuber diameter (cm)
Atrazine 100%	0.87a	21.20a	9.50a
Atrazine 50%	0.99a	24.90a	8.90a
Atrazine 25%	1.30a	24.90a	10.30a
Control	1.00a	25.30a	9.70a

Mean followed by the same superscript along the column are not significantly (p=0.05) different by DMRT

4. CONCLUSION

This experiment has shown that atrazine at the rates used in this experiment is adequate for use in the rapid multiplication of water yam tubers through minisetts. Though yam performance under the herbicides was not significantly different from those produced under hand hoe weeding, however considering the fragility of the minisett vines, the relative ease of spraying, timeliness coupled with the difficulty of the experienced in securing labour for farm operations especially hoeing, this result is a positive way to enhancing yam production through the use of minisett technology. Furthermore, for economic and environmental concern, it is recommended that 25% of the recommended dosage rate of atrazine should be used for weed control in yam minisetts production.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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