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Determination of microbial population and physicochemical components of atrazine treated soil

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ABSTRACT

This study determines the microbial population and physicochemical components of soil treated with atrazine. The uncultivated soil samples were treated with the recommended, high and low doses respectively of atrazine. Isolation and identification of the soil microbes as well as the determination of the physicochemical components (soil pH, organic carbon and organic matter) were carried out using standard procedures. The results of the study indicated that, the soil microbes eg *Staphylococcus* sp., *Micrococcus* sp., *Streptococcus* sp., *Pseudomonas* sp., *E coli, Actinomycetes bovis, A. Israeli, Streptomycetes* sp., *A. Israeli Streptomycetes* sp., *Aspergillus fumigatus, Aspergillus flavus, Aspergillus niger, Asidia corymbifera,* and *Rhizopus stolonifer* were all found present. Also Samples A, B and C analyzed before atrazine application showed a variation in their microbial population with the soil sample A significantly (P>0.05) having the highest microbial composition, whereas the physicochemical parameters of the soils such as the pH, organic carbon and matter were not significantly (P>0.05) different.

The microbial as well as the physicochemical components of the atrazine treated soils were mostly at the 2nd week after application significantly (P>0.05) recorded the highest population/composition. Atrazine, although, it could be transformed from one form to another by soil microbes such as fungi, is clearly a useful chemical for checking the level of soil microbial population and its effects on soil microbial population and physicochemical components depended on the concentration used and duration of application. Thus, the concentration and duration of atrazine application should, therefore, be based on what the targets are.

Key words: microbial, physicochemical, atrazine

1.0 INTRODUCTION

The global aim for sustainable agricultural systems involves optimizing agricultural resources to satisfy human needs and at the same time maintaining the quality of the environment and sustaining natural resources. In achieving this optimization, the soil microbial community composition is of great importance, because they play a crucial role in carbon flow, nutrient cycling and litter decomposition, which in turn affect soil fertility and plant growth (Chauhan *et al*., 2006; Tripathi *et al.,* 2006; Pandey *et al*., 2007), and hence occupy a unique position in biological cycles in terrestrial habitat. The soil microbial population is considered as active nutrient pool to plants and plays an important role in nutrient cycling and decomposition in ecosystem (De-Lorenzo *et al*., 2001). A healthy population of soil microorganisms can stabilize the ecological system in soil (Chauhan *et al*., 2006) due to their ability to regenerate nutrients to support plant growth. Any change in their population and activity may affect nutrient cycling as well as availability of nutrients, which is indirectly

affect productivity and other soil functions (Wang *et al*., 2008).

During the past four decades, a large number of herbicides have been introduced as pre or post-emergent weed killers in many countries of the world. In Nigeria, herbicides have since been effectively used to control weeds in agricultural systems (Adenikinju and Folarin, 1976). As farmers continue to realize the usefulness of herbicides, larger quantities were applied to the soil. But the fate of these compounds in the soil is becoming increasingly important since they could be leached down in which case groundwater is contaminated or if immobile, they would persist on the top soil (Ayansina *et al*., 2003). These herbicides could then accumulate to toxic levels in the soil and become harmful to microorganisms, plants, wildlife and man (Amakiri, 1982). Atrazine is a widely used s-triazine herbicide. It is used as pre-emergence herbicide in the control of broadleaf and grassy weeds in a variety of commercial crop as well as roadside and fallow fields (Munier-Lamy *et al.,* 2002). Early studies on the environmental fate of atrazine have shown that it is transformed slowly by fungi (Kaufman and Kearney, 1970).

In Adamawa State and its environs, atrazine [2chloro-4-ethylamino-6-isopropylamino-s-triazine] is among the best herbicides of choice by farmers for suppressing and killing of new emergent weeds. However, there is little or no information on the effect of this herbicide on the soil's microbial population and physicochemical components in these areas. Therefore, this study was aimed at evaluating the effect of this (atrazine) herbicide on the soil's microbial population and physicochemical components.

2.0 MATERIALS AND METHODS

2.1 Study area

The study was carried out at Modibbo Adama University of Technology Yola, in the Department of Plant Science Botanical garden, Girei Local Government Area of Adamawa state, Nigeria.

2.2 Experimental design

Completely randomized block design (CRBD) was used to design the experimental field. For each treatment, there was one block which was replicated three times.

2.3 Preparation of herbicides

The atrazine used was purchased from Jimeta Modern Market Yola, Adamawa State of Nigeria from the recommended dealer of the herbicides. The preparation/concentrations of the atrazine for application were prepared according to the manufacturer's recommendations. One and half and doubles of the recommended concentration for each of the herbicides was prepared as a little modification for application. Each of the concentrations has three replications.

2.4 Soil treatment

Treatment of the soil was carried out at the rates of 3 L/ha (at 150 ml in 10 L sprayer) as adopted by Stanley *et al*. (2013). The application of the herbicide was done at two weeks interval over a period of eight weeks. The control blocks were not applied any of the herbicides.

2.5 Sample collection

The top soil samples were collected at the depths of up to 0-1 cm, 1-3 cm, and 5 cm respectively from each block of the field during each collection. It was then put into a sterilized polythene bags and were taken to the Laboratory for Isolation. The soil samples were then made free of large stones and plant debris using 2.0 mm mesh sieve and stored at 4^0C. The collection was done at two weeks interval for a period of eight weeks.

2.6 Isolation of Microorganisms

2.6.1 Isolation of Bacteria

Isolation of bacteria was performed by making serial dilution of the taken samples and the dilution that was used for studies were 10^{-2} and 10^{-4}. The dilution was spread in freshly prepared Nutrient agar medium plates. The media was weighed out and prepared according to the manufacture's specification, with respect to the given instructions and directions. The inoculated plates were then incubated at 37^{0}C for 24 – 48 hrs after cooling.

After the incubation period, the pure cultures was obtained based on the color of colony and the pure cultures of the bacterial isolates was subjected to various morphological and characterization tests to determine the identity of the bacteria isolates with reference to Bergey's Manual of Determinative Bacteriology as described by Cheesbrough (2006). The morphological and Identification tests were performed by Grams Staining in identification of the microorganisms.

2.6.2 Isolation of fungi

The isolation of Fungi was performed by making Pour plate method using Potato Dextrose Agar (PDA.) medium plates. The media was weighed at 39g/L of distilled water and prepared according to the manufacture's specification, with respect to the given instructions and directions. The plates were then incubated at room temperature for 5 days. After incubation period, the pure cultures were obtained and the fungi were identified (firstly by staining a pinch of the pure culture placed on a slide with lacto-phenol stain and secondly, observing it under the microscope using 10X and 40X objective lens) through its micro and macro morphological structures (Guy, 2006).

2.6.3 Actinomycetes

About 2.0ml, 5.0ml, 15ml of glycerol yeast agar and 1.0g of potassium hydrogen phosphate (K_2HPO_4) were used for the isolation of actinomycetes and after incubation period of 7-14 days. The isolates were characterized based on colony.

2.7 Determination of soil pH

The pH of soil sample was determined using pH meter 3150 Jenway model according to the method described by Onyeike and Osuji (2003).

2.8 Determination of organic matter and organic carbon

Organic carbon and organic matter in the soil was determined using Walkly and Black (1934) method.

3.0 RESULTS

3.1 Microorganism Population and Physicochemical Components of Soil before Treatment

Table 1 revealed that, soil sample A significantly had the highest bacterial, fungal and actinomycetes populations (4.20, 5 and 3.48 x 10^4cfu/mg respectively) compared to those of soil samples B and C. However, in terms of physicochemical components, all the soil samples A, B and C were not significantly different (P>0.05) in their pH, organic carbon and organic matter components (Table 1).

The bacterial populations of the three soil samples (A, B and C) showed a comparable bacterial populations with that of the soil sample A significantly having the highest (P>0.05) population, but was not significantly different (P>0.05) from that of sample C. The fungal populations of soil samples B and C were not significantly different having the lowest (P>0.05) to that of soil sample A which was significantly the highest (P>0.05) in the fungal population. Also, the actinomycetes population of the soil sample B and C were significantly the

lowest (P>0.05) to the highest of soil sample A. In terms of the pH, organic carbon and organic matter, all the soil samples were not significantly different (P>0.05) (Table 1).

3.2 Effect of Atrazine Treatments on Fungal Count at 2 – 8 Weeks after Application. (WAA)

The application of atrazine doses showed that the most effective action was recorded at 2nd and 6th weeks after application with 4.00 and 4.00 x 10^4cfu/mg respectively The control at 2nd and 6th weeks after application recorded its highest action on the soil fungal count with 5.00 and 5.00 x 10^4cfu/mg respectively (Table 2).

3.3 Effect of Atrazine Treatments on Soil Bacterial Population at 2 –8 Weeks after Application. (WAA)

The highest action of atrazine application was recorded at the 4th and 8th week with 47.00, 24.00 and 30.70 x10^4cfu/mg respectively. The control, however, was at 2nd and 6th WAA recorded the highest action with 35.00 and 35.00 x10^4cfu/mg respectively (Table 3).

3.4 The Effect of Atrazine Treatments on Actinomycetes population at 2 – 8 Weeks after Application (WAA)

The application of atrazine doses at the 2nd and 4th weeks recorded the highest effect with 2.50, 4.50 and 9.80 x10^8cfu/mg respectively. The control, however, showed the highest effect only at 6nd and 8 WAA(Table 4).

3.5 The Effect of Atrazine Treatments on Soil Organic carbon at 2 – 8 weeks After Application (WAA)

In Table 5, the application of atrazine doses recorded the most effective action on the soil organic carbon only at the 4th WAA with 1.07, 1.15 and 1.41 % respectively. The control, on the other hand, recorded the most effective action at the 6th and 8th WAA (Table 5).

4.8 The Effect of Atrazine Treatments on Soil Organic Matter at 2 – 8 Weeks after Application. (WAA)

The application of atrazine doses showed that the most effective action was at 4th WAA with 1.84, 1.98 and 2.43 % respectively, but was not significantly different (P>0.05) to those at the other WAA for low and recommended doses of the atrazine. The control, however, was only effective on the soil organic matter at the 8th WAA (Table 6).

4.9 The Effect of Atrazine Treatments on Soil pH at 2nd - 8th Week after Application. (WAA)

The application of atrazine doses was at the 2nd and 6th WAA recorded the most effective

Table 1.1: Fungi, Bacteria and actinomycetes isolated from atrazine treated soils

Week Interval	Soil samples	Fungi identified	Bacteria identified	Actinomycetes identified
2nd WAA	ALD	*Aspergillus fumigatus*	*Pseudomonas* sp.*	*Actinomycetes Israeli*
	ARD	*A. flavus*	*Escherichia coli**	*Streptomycetes* sp.*
	AHD	*Asidia corymbifera*	*Pseudomonas* sp.*	*A. bovis*
	CON	*A. fumgatus* *A. flavus*	*Micrococcus* sp.	*Streptomycetes* sp.*
4th WAA	ALD	*A. flavus*	*Bacillus* sp.	*A. bovis*
	ARD	*A. niger*	*E. coli**	*A. Israeli*
	AHD	*Rhizopus Stalonifer*	*Pseudomonas* sp.*	*Streptomycetes* sp.*
	CON	*A. niger* *A. corymbifera* *A. fumgatus*	*E. coli**	*A. bovis*
6th WAA	ALD	*A. niger*	*Staphylococcus* sp.	*A. bovis*
	ARD	*A. flavus*	*Pseudomonas* sp.*	*Streptomycetes* sp.*

	AHD	*R. stalonifer*	*E. coli**	*A. Israelis*
	CON	*A. niger*	*Bacillus* sp.	*Streptomycetes* sp.*
		A. flavus		
		R. stalonifer		
		A. corymbifera		
		A. fumgatus		
8th WAA	ALD	*R. stalonifer*	*Bacillus* sp.	*A. bovis*
	ARD	*A. flavus*	*Pseudomonas* sp.*	*Streptomycetes* sp.*
	AHD	*A. niger*	*Bacillus* sp.	*A. Israelis*
	CON	*R. stalonifer*	*E. coli**	*A. bovis*
		A. flavus		
		A. niger		
		A. corymbifera		
		A. fumgatus		

Key: * Common bacteria and actinomycetes identified from atrazine treated and untreated soil samples; WAA: Week After Application**; ALD:** Atrazine low dose; **ARD:** Atrazine recommended dose; **AHD:** Atrazine higher dose; **WAA**= Week After Application; **CON:** Control (untreated soil)

Table 2: Microorganism Population and Physicochemical Components of the Soil Before Treatment

Sample	Microorganism population and physicochemical components of soil before treatment					
	Bacteria (10^4cfu/mg)	Fungal (10^4cfu/mg)	Actinomycetes (10^8cfu/mg)	pH	Organic carbon (%)	Organic matter (%)
Sample A	4.20^{a}	5.00^{a}	3.48^{a}	7.52^{a}	1.95^{a}	2.69^{a}
Sample B	3.49^{ab}	4.00^{b}	2.49^{b}	7.55^{a}	1.43^{a}	2.43^{a}
Sample C	3.30^{a}	4.00^{b}	2.78^{ab}	7.30^{a}	1.42^{a}	2.44^{a}
SEM	0.27	0.32	0.29	0.08	0.18	0.08

Key: Means with the same superscript(s) along the column are not significantly different at P>0.05. **SEM:** Standard Error of Mean

Table 3: Effect of Atrazine Treatments on Soil Fungal Count at 2 – 8 Weeks after Application (WAA).

Weeks	Atrazine treated soil (10^4cfu/mg)			
	ALD	ARD	AHD	CON
2nd WAA	4.00^{a}	4.00^{a}	3.00^{a}	2.00^{b}

4th WAA	3.00 [ac]	2.00 [bc]	1.00 [bc]	3.00 [b]
6th WAA	4.00 [a]	2.00 [bc]	3.00 [ac]	5.00 [a]
8th WAA	2.00 [bc]	3.00 [ac]	3.00 [ad]	5.00 [a]
SEM	0.48	0.48	0.50	0.19

Key: Means with the same superscript(s) along the column are not significantly different at P>0.05.

SEM: Standard Error of Mean; **ALD:** Atrazine low dose; **ARD:** Atrazine recommended dose; **AHD:** Atrazine higher dose; **WAA**= Week After Application; **CON:** Control (untreated soil)

Table 4: Effect of Atrazine Treatments on Soil Bacterial Population at 2 – 8 Weeks after Application (WAA)

	Atrazine treated soil (10^4cfu/mg)			
Weeks	ALD	ARD	AHD	CON
2nd WAA	34.00 [b]	19.40 [c]	12.30 [c]	35.00 [a]
4th WAA	14.30 [d]	24.00 [ab]	30.70 [a]	16.40 [b]
6th WAA	28.70 [c]	26.60 [a]	25.10 [b]	35.00 [a]
8th WAA	47.00 [a]	22.00 [b]	24.10 [b]	9.50 [c]
SEM	0.68	0.15	0.39	1.71

Key: Means with the same superscript(s) along the column are not significantly different at P>0.05.

SEM: Standard Error of Mean; **ALD:** Atrazine low dose; **ARD:** Atrazine recommended dose; **AHD:** Atrazine higher dose; **WAA**= Week After Application; **CON:** Control (untreated soil)

Table 5: The Effect of Atrazine Treatments on Actinomycetes population at 2 – 8 weeks of Application (WAA)

	Atrazine treated soil (10^8cfu/mg)			
Weeks	ALD	ARD	AHD	CON
2nd WAA	2.50[a]	4.50[a]	2.70[b]	3.48[a]
4th WAA	1.19[c]	3.90[b]	9.80[a]	0.15[c]
6th WAA	0.64[d]	0.29[d]	0.69[c]	2.39[b]
8th WAA	1.59[b]	0.57[c]	0.13[d]	2.76[b]
SEM	1.19	0.58	1.94	0.42

Key: Means with the same superscript(s) along the column are not significantly different at P>0.05.

SEM: Standard Error of Mean; **ALD:** Atrazine low dose; **ARD:** Atrazine recommended dose; **AHD:** Atrazine higher dose; **WAA**= Week After Application; **CON:** Control (untreated soil)

Table 6: The Effect of Atrazine Treatments on Soil Organic carbon at 2 – 8 weeks After Application (WAA)

	Atrazine treated soil (%)			
Weeks	ALD	ARD	AHD	CON
2nd WAA	0.87[c]	0.72[d]	0.41[c]	0.95[c]
4th WAA	1.07[a]	1.15[a]	1.41[a]	1.07[b]
6th WAA	0.42[d]	0.99[c]	1.18[b]	1.42[a]
8th WAA	1.01[b]	1.07[b]	1.08[b]	1.43[a]
SEM	0.15	0.09	0.21	0.12

Key: Means with the same superscript(s) along the column are not significantly different at P>0.05.

SEM: Standard Error of Mean; **ALD:** Atrazine low dose; **ARD:** Atrazine recommended dose; **AHD:** Atrazine higher dose; **WAA**= Week After Application; **CON:** Control (untreated soil)

Table 7: The Effect of Atrazine Treatments on Soil Organic Matter at 2 – 8 Weeks After Application (WAA)

	Atrazine treated soil (%)			
Weeks	ALD	ARD	AHD	CON
2nd WAA	1.50[a]	1.32[a]	0.71[d]	1.63[d]
4th WAA	1.84[a]	1.98[a]	2.43[a]	2.33[c]
6th WAA	1.75[a]	2.02[a]	1.74[c]	2.44[b]
8th WAA	1.77[a]	1.84[a]	1.86[b]	2.46[a]
SEM	0.08	0.16	0.36	0.20

Key: Means with the same superscript(s) along the column are not significantly different at P>0.05.

SEM: Standard Error of Mean; **ALD:** Atrazine low dose; **ARD:** Atrazine recommended dose; **AHD:** Atrazine higher dose; **WAA**= Week After Application; **CON:** Control (untreated soil)

Table 8: The Effect of Atrazine Treatments on Soil pH at 2nd - 8th Week after Application. (WAA)

	Atrazine treated soil			
Weeks	ALD	ARD	AHD	CON
2nd WAA	7.49[a]	7.50[a]	7.30[a]	7.52[a]
4th WAA	6.82[c]	6.83[ac]	6.81[ac]	6.83[ac]
6th WAA	7.07[b]	7.50[a]	6.02[b]	6.55[bc]
8th WAA	6.64[d]	6.49[bc]	6.51[bc]	6.74[bc]
SEM	0.18	0.25	0.27	0.21

Key: Means with the same superscript(s) along the column are not significantly different at P>0.05.

SEM: Standard Error of Mean; **ALD:** Atrazine low dose; **ARD:** Atrazine recommended dose; **AHD:** Atrazine higher dose; **WAA**= Week After Application; **CON:** Control (untreated soil)

4.0 DISCUSSION

In this study, determination of fungal species in atrazine untreated (control) soil sample presents fungal species such as *A. fumigatus, A. flavus, A. niger, A. corymbifera* and *R. Stolonifer* with *A. flavus* being the most common fungal species. The occurrence of *A. flavus* more than other fungal species could be attributed to the fungus being well adapted to soil environment than the other fungal species or probably the health status of the soil. This result was supported by the findings of Ayansina and Oso (2006) who reported the presence of fungi such as *A. niger, A. flavus, A. ochracuis, Rhizoctonia* sp., *Fusarium* sp., *Trichoderma* sp. and *Penicillium* sp. with *A. flavus* and *A. niger* being the common fungal species isolated. However, the fungal species isolated in their studies differ greatly with the ones isolated in this study. This could be due to the nature and type of soil assessed, environmental conditions as reported by Zain *et al*. (2013) to be one of the factors affecting soil microbes as well as the health status of the soil. On the other hand, fungal species such as *A. fumigatus, A. flavus* and *A. corymbifera* were found present in the atrazine treated soils. This was also supported by the findings of Ayansina and Oso (2006) who reported the presence of *A. niger, A. flavus* and *Penicillium* sp. in their herbicides treated soil. However, their findings differ slightly in some of the fungal species identified probably as a result of the differences in the type of agrochemicals, concentrations, mode of applications, environmental conditions and herbicides combination used as reported by Subhani *et al.* (2000) and Zain *et al.* (2013). Also,

apparent from the determination of the type of fungal species present in the untreated (control) soil of this study was the fact that fungal species such as *A. niger* and *R. Stolonifer* were not present. This could be that the chemicals used had fungicidal effect thus, killing some of the fungi present before the application of chemicals because of their inability to resist their effect.

The results of the identification of the bacterial species and actinomycetes present in the treated and control (untreated) soil samples showed that, bacteria such as *Staphylococcus* sp., *Bacillus* sp., *Streptococcus* sp., *Pseudomonas* sp., *E. coli* and *Micrococcus* sp. were present in both the treated and control (untreated) soil samples with *Pseudomonas* sp. and *Escherichia coli* being the most common ones identified in the soil samples whereas actinomycetes such as *Actinomycetes bovis*, *Actinomycetes israelis, Streptomycetes* sp. were identified with *Streptomycetes* sp. being the most common one. These fungi, bacteria and actinomycetes species identified, differ across the number of weeks after application of the treatments probably as a result of the effect of the chemicals on them. This was so because herbicides could adversely affect soil microbes depending upon the application rate/dose and the type of herbicide used (Wilkinson and Lucas, 1969; Ayansina and Oso, 2006; Sebiomo *et al.,* 2011). The bacterial species identified in the treated and control soil samples of this study were similarly reported by Stanley *et al.* (2013) in the control and atrazine treated soils. However, some of the bacterial species identified in this study such as *Staphylococcus* sp., *Streptococcus* sp., and *E. coli* were not reported in their findings probably as a result of the differences in concentration used, period of application and collection of samples for determination and the depth at which the soil samples were collected.

The results of the determination of microbial populations and physicochemical components of soil before treatment indicated a statistical comparability of bacterial populations of samples A, B and C. This might be due to lack of much variation in the environmental conditions and the physicochemical components of the untreated soil as seen in the results of the analysis. However, the fungal population of soil samples B and C were significantly the lowest to that of the soil sample A which was significantly the highest in fungal population. Also, the actinomycetes population of the soil sample B was significantly the lowest to the highest in soil sample A. Jeffrey *et al.* (2007) reported a high significant number of actinomycetes (1.57×10^3) isolated from soils planted with ornamental plants which was very much lower than the one obtained in this study ($2.49\text{-}3.48 \times 10^8$ cfu/mg). The reason could be as a result of the differences in media, which influence the growth rate of the microorganisms and also the environment of the soil such as the humidity and pH which were noted to influence the microorganisms' growth rate (Athalye *et al*., 1981; Oskay, 2004). In terms of the pH, organic carbon and organic matter, all the soil samples were not significantly different. This could be associated to the prevailing environmental factors affecting the soil samples and the type of farming activities around the areas where the soil samples were obtained.

The effect of atrazine treatments on soil fungal count indicated a decrease in count of the fungi from the 2nd to 8th week after application of the herbicides. Similar report was given by Baboo *et al.* (2013) who reported a decrease in the fungal count of the soil treated with butachlor, and pyrazosulfuron with passage of time that is from 7th to 28th day after treatment. The decrease of the fungal count observed in this study could be due to the adverse effect of

the herbicides on the fungal component of the soil. This was attested by the fungal count of the control as the fungal count in 6nd week was the same as that of the 8th week.

Bacterial population was low for most of the atrazine doses at the 2nd WAA, but increased at other weeks. Ayansina and Oso (2006) discovered that higher concentrations of herbicide treatments resulted in much lower microbial counts when compared to soils treated with recommended doses. This study agrees with the above statement because the recommended and high doses of the atrazine resulted in much lower bacterial counts when compared with the control and low dose of the herbicides. The effect of the herbicides on the bacterial population increases with the passage of time from the 2nd to 8th WAA. This contradicts the result of Stanley *et al.* (2013) who reported high bacteria count/population at the 2nd WAA of herbicides. This could be due to the fact that the bacteria were unable to temporarily mineralize and made use of the herbicides as energy.

Actinomycetes population decreases from 2nd to 8th weeks after application of atrazine low, recommended doses as well as the control. This could be influenced by the factors such as temperature, pH, organic carbon content, aeration and moisture content of the soils as reported by Arifuzzaman *et al.* (2010). However, for atrazine high dose, its effect increased the population of actinomycetes at 4th and 6th WAA respectively. Similar result was published by Baboo *et al.* (2013) who reported a significant increase in actinomycetes population from 7th to 28th day as a result of herbicide application.

Variation in the effect of atrazine treated soils on organic carbon content was observed with respect to the doses of the herbicides and the weeks after application.

Similar event was observed for the effect of atrazine on the soil organic matter content as well as pH of the soils. This could be due to vigorous microbial activities in the soil (Greaves *et al.,* 1976).

5.0 CONCLUSION

Soil treatment with different doses of atrazine at different week after application (WAA) affects soil microbial populations as well as the physicochemical components of the soil. Therefore, the effects of atrazine on soil microbial population and physicochemical components depended on the concentration used and duration of application. It also determines the type of microbes present in the soil by getting rid of those that cannot withstand its effects, thus allowing only the resistible ones.

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