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Effects of Organic Matter and Atrazine (2-Chloro, 4-Isoproylamino, 6-Ethylamino-1,3, 5-s-triazine) on the Relative Tolerance of Sorghum (*Sorghum bicolor* L. *Moench)* and Millet (*Pennisetum typhoides* L.) in Digil-Mubi, Adamawa State, Nigeria

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ABSTRACT

This research, the effects of organic matter and atrazine (2-Chloro, 4-Isoproylamino, 6-Ethylamino-1,35-s-Triazine) on the relative tolerance of sorghum (*Sorghum bicolor* L. *Moench)* and millet (*Pennisetum typhoides* L.) was conducted in Farm and skills acquisition center Digil -Mubi, to determine the effects of organic matter and atrazine (2-Chloro, 4-Isoproylamino, 6-Ethylamino-1,35-s-Triazine) on the relative tolerance of sorghum (*Sorghum bicolor* L. *Moench)* and millet (*Pennisetum typhoides* L.) in the area. Seeds of sorghum and millet were obtained from the open market in Mubi. Randomized Complete block design (RCBD) was used in factorial arrangement, where rates of atrazine and organic matter were factorized; using sixteen treatments replicated three times. The field trials were conducted during the 2017 cropping season at Digil - Mubi, Mubi Local Government, Adamawa state, Nigeria. Located in the Northern Guinea Savannah of Nigeria. Digil - Mubi is situated between latitude 10^0 10'' and 10^0 30'' North of the Equator and between longitude 13^0 10 and 13^0 30'' E of the Greenwich meridian and at an altitude of 696 m above mean sea level (MSL). The research was implemented in polythene bags of soil under conditions of a screenhouse in a completely randomized design in factorial arrangement of organic matter and atrazine treatments at 5×3 with three replicates, corresponding to five dose of atrazine: 0; 0.5; 1.5; 2.5 and 4.0 kg i.a. ha^{-1}, applied in three stages of growth of sorghum and millet (two, four and eight expanded leaves). The levels of Phytotoxicity was evaluated at 7; 14 and 21 days after application on plant height, dry weight and mass of spike.The atrazine effectiveness and tolerance was ranked as E = effective; G = good; F = fair; P = poor and N = none or no effect while tolerance was ranked: 1 = minimal risk; 2 = crop injury under (applied good and bad weather conditions; 3 = mild crop injury; 4 = severe crop injury and 5 = very severe crop injury. The major symptoms of phytotoxicity observed were reduction in the number of tillers, from applications made in the early stages of culture and intensified with increasing dose of atrazine. With respect to the mass of spike, doses below 1.5 kg ha^{-1} of atrazine showed greater flexibility and tolerance in the application stage and can be used safely in-view of the management of weeds. In terms of ranking, 1 = minimal risk gave results as the control plots. The recommended ranking in terms of tolerance of atrazine to sorghum and millet in the study area is 2 and 3 under good weather observed conditions before application with proper rates and doses of between 0.5 – 1.5 i.a/ ha^{-1} for effective results.

Keywords: atrazine, phytotoxicity, sorghum, millet and tolerance.

INTRODUCTION

Atrazine, a triazine compound that have gained major recognition in agriculture and non-agricultural system is an important group of herbicides that are design to kill or suppress unwanted plant populations by their toxic or deleterious effects. Atrazine is widely used for selective and non-selective weed control. It can be phytotoxic to some plants or crops when improperly used. However, when used properly it will lead to better and most economical crop production, (Das, 2011).

Atrazine is primarily a soil applied herbicide, it is taken up by plants through roots. This ability to be taken up through the root system is beneficial for the control of weeds that emerge after the date of application. In years of reduced temperature and moisture, atrazine can persist into the following growing seasons (Hall *et al*., 1998, Hill *et al*., 1999). This prolonged persistence can potentially injure sensitive crops grown in rotation.

Agricultural soil is the final destination of large number of herbicides, either when they are applied directly to the soil or on the shoot of the plants (Walker, 1987). When the herbicides reach the soil, they interact with the environment. Their fate is governed by three general types of processes: physical (sorption-desorption, volatilization, leaching by water erosion and transported along the ground by wind and water); chemical (photodecomposition, sorption, chemical reaction with the soil constituents) and biological (represented by the microbial decomposition of the molecules and removal of the soil by plants) Harper, 1994; Hanson *et al.*, (2004).

All these processes are also described by Briggs (1984), Walker (1983), Hill *et al.*, (1998), Walker and Allen (1984). Their description relates to the chemical and physical properties of soils and climatic conditions particularly temperature and moisture, and soil characteristics (texture, content and nature of soil colloids, P^H , temperature and organic matter content), as they relate to herbicides. The chemical of each herbicide in turn, is a function of its solubility, polarity, volatilization, molecular structure and molecular ionization. On the other hand, several external factors may play an important role in herbicides-soil interaction, such as rate and application method of herbicide, formulation and soil microbial community.

Interaction of herbicide with soil and environment factors determines its immediate phytotoxicity and hence its persistence and behavior in the soil as well as herbicide suitability or otherwise in a particular soil and cropping situation (Rao 2000; Das 2011).

It has been reported that, atrazine causes several abnormalities in wide range of crops when treated with these group of herbicides. Injury symptoms begin with interveinal chlorosis of leaves and yellowing of their margins. These are followed by further chlorosis and necrosis. Older leaves are more damaged than the new growth. Browning of leaf tips can occur while root growth is not affected, however atrazine does not affect seed germination (Rao, 2000). Knowledge of the different soil and environmental factors affecting the fate of atrazine is essential if it is to be used safely and effectively.

Sorghum and millet are cultivated extensively in northern Nigeria because they require little input such as fertilizer and withstand the weather conditions of the zone and therefore easy to produce. However, in other crops, weeds constitute a problem in their production by competing with the crops and reducing yield significantly. Getting manual on weed control is difficult and time consuming coupled with the literacy level of the farmers in the zone. If large area is to be cultivated with sorghum and millet, chemical weed control must be employed as herbicides which are more effective in controlling weeds. Atrazine has been found to be tolerated by sorghum and millet when used at moderate rates. However, atrazine can be phytotoxic depending on the rate applied and organic matter present in the soil. In the Northern Nigeria, little study has been carried on the influence of organic matter on atrazine phytotoxicity to Sorghum and millet. Hence, the study determines the effect of various rates of organic matter on atrazine phytotoxicity to sorghum and millet and also determined the relative tolerance of sorghum and millet to atrazine as influenced by various rates of organic matter.

Organic matter (OM) has a strong influence on atrazine phytotoxicity. Soil organic matter therefore, determines the rate at which atrazine should be applied.

Mode of Action of Atrazine

Atrazine is one of the most important herbicides frequently use. The herbicides interfere with photosynthesis and inhibit starch and sucrose formation in leaves, oxygen release and carbon dioxide utilization in plants. Thus the photochemical activity of the chloroplast is adversely affected which leads to the death of treated plants (Singh *et al.*, 2003; Robert *et al.*, 2003).

Factors affecting herbicide performance: One of the properties of atrazine herbicide is soil residual activity that can result in weed control throughout the growing season. However, these characteristics can also cause crop damage and economic loss due to phytotoxic effect on sensitive crops (Tomalin, 1994). The degree to which herbicide can cause damage is influenced by the soil properties (Spark *et al.*, 2002).

Soil properties: the soil properties the influence herbicide performance are broadly categorized into chemical, physical and microbial. Soil texture and organic matter content along with P^H have a large impact on the fate and toxicity of herbicide in the soil. The importance of soil properties in persistence and phytotoxicity is also dependent upon the nature of the herbicide applied (Celis *et al*., 1997).

Impact of soil properties on herbicide performance: herbicides applied to the soil are subjected to physical, chemical and biological processes that affect their movement through soil and their potential to cause crop damage (Radosvich *et al.*, 1997). Several soil properties affect herbicides performance, some of which are soil texture, clay colloids, organic matter, soil P^H, soil moisture and temperature.

Soil texture: soil texture, is the physical property of soil that relates to the relative amount of sand, silt and clay in the soil and has the impact on herbicide performance (Delvin *et al.*, 1992). Sandy soil is soil consisting of more than 70% of sand separate and tends to have irregular shape, greater pore space, lower power of water retention, maximum leaching, less adsorption surface and coarse particles (Singh *et al.*, 2003). Das (2011) also reported that, herbicides tend to leach more easily in coarse texture soils, therefore, may cause phytotoxicity even though the dose of the herbicide is less. Clay consist of 40% or more of clay particles and are less porous, more sticky, have high water retention capacity, possesses cohesive and adhesive properties, larger amount of surface area with many sites (Singh *et al.*, 2003 and Vincil, 2002). Clay particles are very fine compared to sand. Soils with higher clay content were found to increase adsorption of atrazine herbicides (Das, 2011). Rao (2000) reported that, herbicide underwent, greater hydrolysis breakdown in sandy loam soil compared to clay loam soils, resulting in ore of the chemical being present in the soil solution.

Clay colloids: clay colloids, which has high adsorptive capacity, refers to the microscopic (0.001 – 1.0mm in diameter) inorganic and organic particles in the soils. These particles have an extremely large surface area in proportion to a given volume (Miller *et al.*, 2004). Clay particles have negative charges and hence can attract to their surfaces positive ions (cations). Adsorption is closely associated with inorganic and organic colloids of the soil. Inorganic colloids are principally clay (Barriuso *et al*., 1992). According to Rao (2000), there are three major groups of clay: montmorillonite, illite and kaolinite. Montmorillonite is expanding lattice clay providing both internal and external adsorptive surfaces. It has three layers with one layer of aluminum oxide laying between two layers of silicon oxide (Pierzynski *et al.*, 2000). Illite is also a three layered clay, but it lacks the expanding lattice characteristics which makes it less adsorptive of herbicide molecule than montmorillonite clay (Madhun *et al.*, 1990). Baham and Sposito (1994) reported that, kaolinite is only two layered clay with alternate layers of aluminum and silicon oxide. There are few residual charges in kaolinite clay, making it the least adsorptive of the three clays. However, Rao (2000), reported that, kaolinite do not have one hydroxyl surface which makes it adsorb some organic chemicals more strongly than the other clays.

Montmorillonite clay have a high cation exchange capacity (CEC) (80-150milliequivalent/100gram) and high surface area (600-800mg). it has therefore a high capacity for adsorption. Vermiculite also has a high cation exchange capacity 100-150milliequivalent/10gram) and a high surface area (600-800mg), Pierzynski *et al.*, (2000). Ros, (2000) observed that, illite and kaolinite clay which have low cation exchange capacity (10-40 and 3-15 milliequivalent/10gram) and low surface area (65-100 and 7-30mg) do have a large adsorptive capacity as montmorillonite. Montmorillonite adsorbs considerably more of various herbicides than do illite and kaolinite.

Organic matter: Spark *et al.*, (2002) observed that, the universal soil colloid that influences adsorption and hence the behavior of herbicide is organic matter. Organic matter plays an important role in the chemistry of soil; it covers the pores created by roots or pseudo fauna action by stabilizing the soil structure. Organic matter affects the water flow into the pores (capillary porosity), in fact, the coexistence of hydrophilic and hydrophobic properties in the same structure makes organic matter a material which is able to retain moisture or to repel the water by decreasing its flow along the pores. Moreover, organic matter forms macroscopic aggregates (cements) with inorganic species and can also interact with agrochemical by H-bonding (Tipping, 19980). Organic matter which has higher surface area usually dominates over clay in respect od adsorption (Kaiser and Zech, 1997). Yuan *et al.*, (2007) observed that, organic matter has a variable effect on the phytotoxicity of herbicides. This suggests that, the influence of organic matter on the phytotoxicity of herbicide in soil varies according to crop species.

Rao(2000), stated that, the higher the organic matter content, the greater is the adsorption of herbicide and therefore, less herbicide will be available to plant for uptake which may lead to reduced herbicidal activity, thereby warranting an increase in the rate of herbicide application. Seol and Lee (2000), observed that, medium and fine textured soils with an organic matter content of more than 3% have greater potential to bind or hold herbicide resulting into subsequent crop injury. However, coarse to medium textured soils with a lower organic content (less the 3 percent) are less likely to retain herbicide and to have carry over problems. Under the right circumstances, however, herbicide carry over can occur in any type of soil.

Soil $P^{H.}$: Soil P^H is the potential P^H of the soil solution. the water and other elements that exist in a free state around the soil particles affects how much herbicide is available for plant uptake and quickly the herbicide is degraded by the chemical processes known as hydrolysis (Hess, 1993). Basically, the P^H is related to the number of hydrogen ions in the water solution. the more the hydrogen ions, the more acid the solution becomes (Rao, 2000). As hydrogen ions decreases, the hydroxyl ions increases, making the solution more basic. A P^H of 7 has an equal number of hydrogen and hydroxyl ions and it is considered neutral (Hall, *et al*., 1999). Hydrogen ions have a positive electrical charged soil and organic matter particles. The more free site clay and organic matter particles have on them, the more hydrogen and other ions that can bind to these particles. These binding sites also called exchanging sites indicates the cation exchange of the soil. Thus, soil with greater cation exchange capacity have more exchange sites. Also the more exchange sites of a soil has, the more hydrogen ions that can be held to the soil for eventual release into the soil solution (Gunsolus and Curran, 1999; Miller and Westra, 2004).

The P^H of the environment where the herbicide is found influences he herbicide whether the herbicide is in neutral, anionic or cationic state. Miano *et al*., (2003) observed that, at P^H greater than 6, atrazine herbicide tend to be found in anionic form. This results in atrazine been move in soil solution, and more available to plants and therefore more phytotoxic. However, its degradation increases, thus reducing persistence. Bresnahan *et al*., (2000) observed that, atrazine was more tightly adsorbed and persisted longer as soil P^H decreased. However, Beckie and Mckercher (1989) reported the opposite with atrazine herbicide which persisted longer in soils with higher P^H.

Soil moisture: soil applied herbicides can be only effective if moisture is applied to the soil through irrigation and rainfall (Boesten *et al.*, 1991). Water is a very polar molecule and is strongly adsorbed by mineral colloids. The moisture content of a soil system has a considerable effect on both the degree of adsorption and the phytotoxicity of herbicide present in the aqueous phase. When a herbicide is applied to the soil, it is partitioned into adsorption and solution phase (Bollag and Liu, 1990). The amount of herbicide present in solution depends on the solubility of the herbicide in water and amount adsorbed by the soil colloids (Carabias et al., 2000). Rao (2000), observed that, the effect of soil water content on herbicide concentration in soil solution was dependent on the magnitude of the herbicide adsorption. As the moisture content increases, the number of water molecules increases resulting in reduced adsorption of organic molecules such as atrazine, leading to increase herbicide phytotoxicity under most circumstances.

Most herbicides have lower phytotoxicity at lower soil moisture contents. At low moisture level, the number of water molecules presents to compete for adsorption sites is relatively small, therefore herbicide molecules may be able to compete more favorably for the available sites (Boesten, *et al.*, 1991).

Temperature: temperature has significant effect on soil applied herbicide, because of its effect on transport coefficient and herbicide solubility (Hall *et al*., 1999). Kaiser and Zeck, (1997) observed that, increasing ambient temperature increased the rate of vaporization from moist soil than from dry soil. Atrazine, a herbicide having very low vapor pressure, may also volatilize if exposed to high temperature. Temperature can indirectly affect herbicide performance through its effect on plant growth. Germination, growth rate, leaf area, leaf shape and cuticle development can influence the amount of herbicide that penetrates and retained by the plant. However, certain herbicides can cause crop damage when applied at low temperatures, as crop is unable to mobilize the herbicide as quickly as usual (Madhum *et al*., 1990).

MATERIALS AND METHOD

This research, the effects of organic matter and atrazine (2-Chloro, 4-Isoproylamino, 6-Ethylamino-1,35-s-Triazine) on the relative tolerance of sorghum (*Sorghum bicolor* L. *Moench)* and millet (*Pennisetum typhoides* L.) was conducted in Farm and skills acquisition center Digil- Mubi, to determine the effects of organic matter and atrazine (2-Chloro, 4-Isoproylamino, 6-Ethylamino-1,35-s-Triazine) on the relative tolerance of sorghum (*Sorghum bicolor* L. *Moench)* and millet (*Pennisetum typhoides* L.) in the area. Seeds of sorghum and millet were obtained from the open market in Mubi. Complete block randomized design (CBRD) was used in factorial arrangement, where rates of atrazine and organic matter factorized, using sixteen treatments replicated three times . The field trials were conducted during the 2017 and 2018 cropping seasons at Digil-Mubi, Mubi Local Government, Adamawa state, Nigeria. Located in the Northern Guinea Savannah of Nigeria, Digil-Mubi is situated between latitude 10^0 10'' and 10^0 30'' North of the Equator and between longitude 13^0 10 and 13^0 30'' E of the Greenwich meridian and at an altitude of 696 m above mean sea level (MSL). The annual mean rainfall of the study area is 900mm, and a minimum temperature of 18^{o}C during harmattan period and 40^{o}C as maximum.

Experimental procedure:

Crop variety: Sorghum and millet were obtained from the open Mubi market and sown at 3-5 seed per stand at depth of approximately 3cm.and later thinned to two per stand.at a row spacing of 15-23cm for millet and 24-30cm row spacing for sorghum and 35cm between rows. Cow dung was collected from the Teaching and research farm of Faculty of Agriculture, Adamawa State University Mubi and at the paddock in the surrounding Digil – Mubi Farm and skills acquisition center. Atrazine was purchased in Mubi market. Various rates of organic matter and atrazine was applied on the treatments

Seed sowing fertilizer application: Seeds were sown at the rate of 3.5 seeds per hole for both sorghum and millet at a row spacing of 24-30cm and 15-23cm and 35cm between rows respectively. Cow dung was applied at the rate of … and the seedlings were thinned to two per stand after three weeks of emergence.

Treatments:

Samples collected:

Cow dung: Cow dung was collected from the Teaching and research farm of Faculty of Agriculture, Adamawa State University Mubi and at the paddock in the surrounding Digil – Mubi Farm and skills acquisition center.

Herbicide: Atrazine was purchased from the open market at a dealer's shop in Mubi, Adamawa State, Nigeria.

Seed source: Seeds were purchased in Mubi open market from local seed sellers after thorough observation and selection.

Soil sampling: Top soil (0 – 15cm depth) sample were collected from the experimental site with no prior pesticide treatment. The soil sample was sieved through a 2.0mm mesh size where stones and plant debris were removed.

Soil analysis: A composite soil sample was obtained using auger and subjected to Laboratory soil test where its physiochemical properties determined.

Organic carbon, Particle size and P^H: organic carbon was determined by wet oxidation method according to Walkley and Black, 1934, while particle size distribution was determined by hydrometer method (Day,1965). The soil P^H was determined at 1:2 soil to water susupension using glass electrode and P^H meter.

Data collected:

Day to emergence: The number of days to the time of when the tip of the sorghum and millet was first noticed above the soil surface.

Plant height: the heights of the plants were measured using meter rule from the base of the plants to the last flag leaf at 3, 6 and 9 weeks after sowing.

Herbicide injury: herbicide injury score was taken after emergence at 6 weeks after sowing using a scale 0 – 5. A scale of 0 indicates that, the plants were healthy as the control, while scale of 5 indicates the plants were seriously injured and may not survived.

Number of plants per sample: the number of plant on the sample area were collected.

Number of leaves per plant: After sowing, at 3 and 6 weeks, active photosynthesized leaves per plant were taken.

Crop growth rate: the crop growth rate was measured using the dry matter produced per unit time. The crop rate was taken as follows:

$$CRG = \frac{W2 - W1}{t2 - t1}$$

Where W_1 and W_2 are plant dry matter in gram at time t_1 and t_2 in weeks.

Total dry matter: The total dry matter per treatment was taken to the laboratory at 8 weeks after sowing and oven dried at 100^0C until constant weight was reached.

Data analysis: Data collected were subjected to the analysis of variance (ANOVA) as described by Snedecor and Cochran (1967). The significant differences among the means were compared using Duncan Multiple Range Test (DMRT) (Duncan. 1955).

RESULTS AND DISCUSSION

Atrazine was applied on sorghum and millet during three leaf stage before 30cm in height on the three replicates at the dose of 0; 0.5; 1.5; and 4.0 i.a,/$ha^{-1.}$ These was applied at three stages of growth, 3, 6 and 9WAS.

Herbicide injury: The test was implemented in pots of soil under conditions of a screenhouse in a completely randomized design in factorial arrangement of organic matter and atrazine treatments at 5×3 with three replicates, corresponding to five dose of atrazine: 0; 0.5; 1.5; 2.5 and 4.0 kg i.a. ha^{-1}, applied in three stages of growth of sorghum and millet (two, four and eight expanded leave). The level of phytotoxicity was evaluated at 7; 14 and 21 days after application, plant height, dry weight and mass of spike. The major symptoms of phytotoxicity observed were reduction the number of tillers from applications made in the early stages of culture and intensified with increasing dose of atrazine. With respect to the mass of spike, doses below 1.5 kg ha^{-1} of atrazine showed greater flexibility in the application stage and can be used safely view the management of weeds

Crop growth rate: The crop growth rate was not affected at tolerance levels 0; 0.5; and 1.5kg i.a/ha^{-1}, but symptoms of phytotoxicity was observed at level 2.5kg i.a/ha^{-1} with reduction in the number of tillers and leaves chlorosis.

Table 1: Weeds, Sorghum and Millet response to atrazine.

	Weeds response			Sorghum response			Millet response		
	7DAS	21DAS	35DAS	7DAS	21DAS	35DAS	7DAS	21DAS	35DAS
EPOST	E	F	P	E	F	P	E	F	P
POST	E	F	P	E	F	P	E	F	P

Key: EPOST = Early postemergence; POST = Postemergence: after the crops and the weeds have emerged; DAS = Days after sowing, E = Efficient; G = Good; F = Fair; P = Poor; N = No effect.

There was excellent control of small-seed annual broadleaves. Good control of large-seeded annual broad leaves and fair control on annual grasses. Risk of injury was greatest on light low organic matter under wet conditions. Atrazine response was active during the first week of seeds emergence on the Sorghum and Millet as can be seen on Table 1. Late application has little or no effect on the crops and weeds in the study area at both early postemergence and postemergence applications. The result is in line with the work of Mike Moeching (2010) on weed control in Sorghum.

Table 2: Tolerance of Sorghum and millet to different levels of atrazine

	Sorghum tolerance				Millet tolerance			
	0kg/ha^{-1} i.a.	0.5 kg/ha^{-1} i.a.	1.5 kg/ha^{-1} i.a.	4.0 kg/ha^{-1} i.a.	0kg/ha^{-1} i.a.	0.5 kg/ha^{-1} i.a.	1.5 kg/ha^{-1} i.a.	4.0 kg/ha^{-1} i.a.
EPOST	1	1	3	5	1	1	1	5
POST	1	1	2	3	1	1	2	3

Key: EPOST = Early postemergence; POST = Postemergence: after the crops and the weeds have emerged; DAS = Days after sowing, 1 = Minimal risk on crop injury as in control; 2 = Crop injury under unfavorable condition (wet and hot humidity); 3 = Mild crop injury, 4 = Severe crop injury; 5 = Very severe crop injury.

Atrazine was applied as pre-emergent herbicides after planting prior to crop or weed emergence using dosages at the low 0.5kgi.a/ha^{-1} and high (4.0kg i.a/ha^{-1}) on the research for sorghum and millet. 0kg i.a/ha^{-1} gave no effect on the crops, the results are similar to the control treatment. There was minimal effect in terms of injury to the crops at the rate of 0.5kg i.a/ha^{-1} , however, at 1.5kg i.a/ha^{-1} sorghum recorded mild injury with crop injury after rains during application, while at the same rate millet minimal risk during early postemergence as can be seen on Table 2. Both crops had severe injury at the rate of 4.0kg i.a/ha^{-1}. The research is in line with the work of O'Neall, (1993) on a Research Farm in Lafayette, Indiana and Dan, H. de A. *et al*. (2011).

SUMMARY AND CONCLUSION

Weather condition was observed to influence atrazine effectiveness and weed control. Weed control was observed to be better and effective during favorable weather conditions when applied as against under por and unfavorable weather conditions. There was minimal risk on crop injury of atrazine on sorghum and millet at tolerance level 1, but with mild and very severe crop injuries at levels 3 and 5. Postemergence and emergence response were effective during the first week of sowing and poor 3WAS.

The atrazine effectiveness and tolerance was ranked as E = effective; G = good; F = fair; P = poor and N = none or no effect while tolerance was ranked: 1 = minimal risk; 2 = crop injury under (applied good and bad weather conditions; 3 = mild crop injury; 4 = severe crop injury and 5 = very severe crop injury.The major symptoms of phytotoxicity observed was reduction in the number of tillers. from applications made in the early stages of culture and intensified with increasing dose of atrazine. With respect to the mass of spike, doses below 1.5 kg ha^{-1} of atrazine showed greater flexibility and tolerance in the application stage and can be used safely in-view of the management of weeds. In terms of ranking 1 = minimal risk gave results as the control plots. The recommended ranking in terms of tolerance of atrazine to sorghum and millet in the study area is 2 and 3 under good weather observation before application with proper rates and doses of between of 0.5 – 1.5 i.a/ ha^{-1} for effective results. Future research should explore the use of pre-emergent herbicides that contain crop safeness and the use of post-emergence directed sprays of grass killing herbicides. The goal is a safe weed management system that controls problem weeds without crop injury to crops.

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