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Allelopathic Potentials of Sorghum (*Sorghum bicolor* L.) Extract on Weeds and Performance of Maize (*Zea mays* L.) in Sudan Savanna.

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Abstract

Field trials were conducted at the Research Farm of Bayero University Kano and that of Audu Bako College of Agriculture Danbatta Kano state during 2018 raining season. The study evaluates the allelopathic potentials of sorghum extract in biological control of weeds in maize production. Treatments consisted of young sorghum extract at 5 and 10 % (w/v), mature sorghum extract at 5 and 10 % (w/v), Metolachlor at 3.0 kg a.i ha^{-1}, Hoe weeding at 3 and 6 WAS, young extract at 5% (w/v) followed by Metolachlor at 3.0 kg a.i ha^{-1}, young extract at 10% (w/v) followed by Metolachlor at 3.0 kg a.i ha^{-1}, matured extract at 5% (w/v) followed by Metolachlor at 3.0 kg a.i ha^{-1}, mature extract at 10 % (w/v) followed by Metolachlor at 3.0 kg a.i ha^{-1}, Metolachlor at 3.0kg a.i ha^{-1} followed by supplementary hoe weeding 6 WAS and weedy check as control. The experiment was laid out in a Randomized Complete Block Design and replicated three (3) times. Results revealed that, Hoe weeding at 3 and 6 WAS significantly produced lower weed cover score, weed density, weed dry weight, higher weed control efficiency, 100-seed weight and grain yield than other weeds control treatments at both locations. Application of both sorghum extract at (5 and 10% w/v) reduces weed cover score, weed density, weed dry weight and increase weed control efficiency, 100-seed weight and grain yield were significantly higher and can be recommended for weed management in maize.

Keywords: *Allelopathic, Sorghum Extract, Weed and Maize.*

1. Introduction

With the burgeoning population of the world, achieving the food security has become a challenge to mankind; as a result only yield maximization is becoming the last word of modern agriculture. Although this approach is satisfying the food demand to almost a desirable extent, but is directly and indirectly causing negative impact on quality of the produce, environment and overall human health. This system is mostly based on the use of heavy doses of chemicals like fertilizers or pesticides to satisfy nutrient efficiency and to control pest attack respectively. The global concern about the adverse effects of extensive use of synthetic pesticides in controlling pests in agro ecosystems has necessitated the need for resolute efforts on encouraging alternatives to synthetic pesticides (Pretty, 2008). Herbicides account for 42 % of global pesticides' use (Bunch and, Lopez, 1999). Over 95 % of herbicides reach a destination other than their target species as they are sprayed or spread across agricultural fields (George, 2004). Therefore, recent emphases have been on biological weed control measures so as to reduce dependence on synthetic herbicides and finding alternative strategies for weed control in agro ecosystems (Farooq *et. al*., 2011). The use of aqueous extract of plants with allelopathic property is one of such strategies that can be explored for biological weed control in cropping systems. There had been studies on the potential of extract of allelopathic plants in biological weed control in some part of the world, however past studies in Nigeria have been limited to laboratory and non-field experiments. Sorghum allelopathy has successfully shown its ability to inhibit the weeds and enhanced the yields in crops such as wheat, maize and soya bean crops (Cheema, 1998 and Khaliq *et al.,* 1999). Sorghum allelochemicals are species specific and concentration dependent in their effects (Cheema & Ahmad, 1992). Similarly, Cheema *et al.* (1999) revealed that two foliar sprays of sorgaab 10% during 30 and 40 days after sowing increased wheat grain yield by 21%, while at 5% during 30 and 40 DAS increased the yield in the range of 7to 16%, the overall weed density and biomass were reduced by 22 and 46%, respectively. Aqueous of sorghum crop residues has been used as alternative way for weed control in wheat (Ahmed *et al*., 2000).
Low maize yield in Nigeria is due to the fact that maize production in Nigeria, as in many other sub- Saharan countries is faced by many constraints which mainly include low soil fertility, pest and disease infestation and unavailability of improved germplasm. Corn is sensitive to weeds especially in early growth stages of production (Cheema *et al.,* 1999). It

has been established that use of synthetic organic pesticides, particularly the chlorinated hydrocarbons lead to serious environmental pollution (water, air and soil), affecting human health and causing death of non-target organisms (animals, plants, and fish) (Biswas *et al.*, 2014).

The over use of pesticides causes environmental and health problem have been the matter of concern for both scientists and public in recent years. Continuous use of heavy doses of chemicals is encouraging resistance development in different pests including weeds and also endangering the ecosystem. In this context, the resistance development among weeds to herbicides is of great concern. According to Stephenson, (2000), most agricultural systems collectively use three million tones of herbicides per year. The use of herbicides causes another problem, that of the selective growth of weeds and Resistance to specific synthetic herbicides is increasing dramatically in the last two decades leading to lowering the land values resulting farmers to run out of weed-controlling chemicals (Garko *et al.*, 2020).

Recommended control methods to reduce weeds in maize include application of nitrogen fertilizer to hasten the growth of the crop, chemical stimulants to abort seed germination, hoeing, hand pulling and herbicidal application. Most of those methods are effective but are labour intensive, causes environmental and health problem or expensive to average farmers and most farmers have not accepted those methods due to technological and socio economic reasons (Lagoke *et al*., 1994). Resistance to specific synthetic herbicides is increasing dramatically in the last two decades leading to lowering the land values resulting farmers to run out of weed-controlling chemicals. It has become a worldwide problem, now it is imperative to look into other ways to control weeds in cropping systems by using more environmentally friendly methods like plant extract thereby minimizing or avoiding the frequent use of herbicides. In this regard allelopathic effect of different plants is drawing attention of many researchers in the recent past. The study therefore focused on theallelopathic potential of Sorghum residue in biological control of weeds in maize cropping system which are environments friendly. This will eliminate the problem of herbicide resistant weeds. Therefore, the aim of this study is to determine the efficacy of allelopathic extracts of sorghum in the control of weeds, growth and yield in maize.

2. Materials and Methods

2.1 Study area

The experiment was conducted at during 2017 rainy season at two locations Teaching and Research Farm of Bayero University Kano (Lat 11^{o} 58$'$N and Long 8^{o} 33$'$E and 475m above sea level), and at Danbatta (Lat 12^{o} 43$'$N and long 8^{o} 61$'$E and 421m above sea level) all in the Sudan savanna zone of Nigeria.

2.2 Treatments and experimental design

The treatments consisted of Young sorghum extract at 5 and 10% (w/v), and a mature sorghum extract at 5 and 10% (w/v), Metolachlor at 3.0 kg a.i ha^{-1}, Hoe weeding at 3 and 6 WAS, Metolachlor at 3.0 kg a.i ha^{-1}follwoed by young sorghum extract at 5% (w/v), Metolachlor at 3.0 kg a.i ha^{-1}followed by young sorghum extract at 10% (w/v), Metolachlor at 3.0 kg a.i ha^{-1}followed by mature sorghum extract at 5% (w/v), Metolachlor at 3.0 kg a.i ha^{-1}followed by mature sorghum extract at 10% (w/v) Metolachlor at 3.0 kg a.i ha^{-1}followed by hoe weeding at 6 WAS and Weedy check as a control.

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three (3) replications. Gross plot size was 3m x 3m (9m²) consisting four rows of 0.75m apart and 3m long while the net plot size was 1.5m x 3m (4.5m²). A spaced 0.5m and 1m was left between plots and replications respectively. Concentrations (5 and 10% w/v) of the aqueous extract and Metolachlor at 3.0 kg a.i ha^{-1} were sprayed immediately after planting and at 3 and 6 WAS using Knapsack sprayer as indicated in the treatment combinations while weedy check plot was left untreated.

2.3 Preparation of aqueous extract of sorghum

Aqueous extract of sorghum residue was prepared according to Hussain and Gadoon, (1981). Young and mature whole Sorghum plant stalk was collected from farmers before and after harvesting. These were air dried for 7 days. The dried Sorghum plant residues were chopped into pieces with fodder cutter. The chopped plant materials was air dried at room temperature to a constant weight, milled with A2 grinder into fine powder and sieved through 10 mm sieve. The powder was soaked in the ratio of 1000g to 10litre of distilled water to obtained 10% (w/v) concentration. The water extract was obtained by filtering the mixture through four layers of Muslin cloth. This was diluted by adding distilled water to make 5% (w/v) concentrations.

2.4 Field operations

Maize seeds were sown at three seeds per hole and spacing of 75 x 25cm Inter and Intra row spacing respectively. Thinning was carried after the crop germinate and leaving one plant per stand. Fertilizer was applied at the rate of 120kg N, 60kg

P_2O_5, and 60kg K_2O per hectare at 2 WAS and the second half of N was applied at 6 WAS using urea (46% N) at maturity, harvesting was done when the cobs reached physiological maturity. It was carried out from two inner rows in each plot.

2.5 Data collection

Data were collected from all the plants/plots for weed density, weed cover score, weed dry weight, weed control efficiency, growth and yield parameters. Weed density was determined by counting the number of all weed specie within the quadrants in each plot using the following equation.

$$\text{Weed density} = \frac{\text{Total number of individual species in all quadrant}}{\text{total number of quadrant usde}}$$

Weed cover score where scored according to the scale used by Komboik *et al.* (2003) 0= no weed, 1 = moderately weedy, 2 = very weedy and 4 = highly weedy. Weed control efficiency was calculated on population/density per unit area as described by Mani *et al.* (1973) using the following relation.

$$\text{WCE (\%)} = \frac{\text{WDC} - \text{WDT}}{\text{WDC}} \times 100$$

Where: - WDC = Weed density (number / m²) in control plot
WDT = Weed density (number / m²) in treated plot

Data on growth and yield parameters were also collected on Number of leaves were counted at 6 and 9 WAS and Plant height at 6 and 9 WAS, Cob length and Cob weight, 100 seed weight and grain yield kg/ha were assessed after harvest.

2.6 Data Analysis

Data generated were subjected to statistical analysis of variance (ANOVA) as described by Snedecor and Cochran (1994) and differences between treatment means were separated using Newman-Keuls-test (SNK) at 5% level of probability using Gen-stat (17^{th} edition).

3 Results and Discursions

3.1 Physical and chemical properties of the soil.

The results of the soil analysis from the two locations are presented in Table 1. The results revealed that, soil textural class was sandy loamy at BUK and sandy at Danbatta. The soil had pH in water (6.07) which is a neutral stage at BUK and (6.20) for Gurungawa, the soil had 3.12 organic carbons for BUK and 2.28 gkg^{-1} for Danbatta. Total nitrogen content was observed to 2.64 at BUK and 1.89 gkg^{-1} for Danbatta. The available phosphorus content was 12.10 in BUK and 13.71 mgkg^{-1} for Danbatta. The exchangeable cations (Ca, Mg, K and Na) were 4.54, 0.65, 0.10 and 0.32 cmol (+) kg^{-1} at BUK while 3.10, 0.34, 0.31 and 0.1 cmol (+) kg^{-1} at Danbatta all in 2017 rainy season, whereas the CEC of the soil analysis was 7.31 at BUK and 5.17 cmol (+) kg^{-1} at Danbatta (Table 1).

3.2 Weed characters.

The effects of sorghum extract on weed cover score, weed density weed dry weight and weed control efficiency is presented in Table 2. Sorghum extract has significant effects on all parameters evaluated in both locations with exception of weed dry weight at BUK. The control plot resulted in highest mean values of all parameters evaluated, except weed control efficiency which significantly resulted in lower mean values in control plots. The highest values observed with those parameters in weedy check (control) plot in both location is as results of continuous weed seed germination, uninterrupted growth and production which enable the weeds utilized the more environmental resources at the expense of the maize (Table 2). This is in line with findings of the results of this study also agrees with the findings of (Ajayi *el al.*, 2017) which they reported decrease in weed density, weed cover score, weed dry weight and higher control efficiency for the hand weeding, herbicides and 10 and 20% (w/v) concentration of sorghum extracts when applied in cowpea plant.

Highest reduction in weed cover score, weed dry weight, weed density and higher control efficiency were recorded by the hoe weeding at 3 and 6 WAS and Metolachlor at 3.0kg a.i ha^{-1} treatments could be due to effective weed control which drastically reduced the levels of weed infestation in those plots (Table 2). This results was in line with the findings of Bhatti

et al. (2000) who reported that hand weeding gave maximum reduction (78%) in total weed density followed by the application of sorgaab which reduced weed density by 63%. In another related development Ajayi *et al*. (2017) reported that, 70 to 75% reduction in weed density and weed dry weight is with the aqueous extract of sorghum and 1/3 dose of Atrazine. This supported the finding of Garko *et al.* (2020) that, two hoe weeding at 3 and 6WAS or Application of 3Maizeforce at 2.5 kg a.i. ha-1 followed by Bentazone at 2.5 kg a.i. ha^{-1}, significantly revealed higher crop resistance with medium persistence of the weeds which indicate broad spectrum effect in controlling weeds in maize.
Hoe weeding at 3 and 6 WAS and Metolachlor at 3.0 a.i ha^{-1} treatments consistently recorded highest reduction in weed cover score, weed dry weight, weed density and higher weed control efficiency, young and mature sorghum extracts treatments were also effective in the controlling weeds in both locations better than the control plots. This could be as results of the allelopathic properties of the sorghum extracts which inhibits weed growth and development. This obtained from this study corroborated with the findings of Ahmad *et al. (*2000) who reported that foliar spraying of sorghum water extract reduced total weed density by about 34 to 57% and total weed biomass by 13 to 54% in maize fields. The results of this study also agrees with the earlier findings of Nimbal *et al*. (1996) reported that sorgoleone acts as a photosystem II inhibitor due to it structural similarity to plastoquinon. However, there was no significant difference on most of those parameters evaluated on both or between matured and young sorghum extracts. This is indicated that the concentrations used were too small to produces significant differences between each other. Cheema & Ahmad, (1992) pointed out that sorghum allelochemicals are species specific and concentration dependent in their effects. In a contrary development Cheema *et al.* (1999) revealed that two foliar sprays of sorgaab 10% during 30 and 40 days after sowing increased wheat grain yield by 21%, while at 5% during 30 and 40 DAS the yield increase range between 7 to 16%, the overall weed density and biomass were reduced by 22 and 46%, respectively. Aqueous of sorghum crop residues has been used as alternative way for weed control in wheat (Ahmed *et al*., 2000).

3.3 Plant growth and development.

The effect of sorghum extracts on Plant height and number of leaves per plant at 6 and 9 WAS is presented in Table 3. Sorghum extracts significantly affected plant height and number of leaves per plants in both locations. The results showed that, there was significant different among treatment evaluated across all sampling stages except on number of leaves at 6 WAS at Danbatta which resulted in non significant effect. The untreated control had the shorter plants and lowest number of leaves per plant as compared with the other treatment in all significant stages. Hoe weeding at 3 and 6 WAS recorded the tallest plant and more number of leaves that were statistically similar with some other weed control methods while control plots resulted in shortest and fewer plants across all sampling stages. This could be due to timely control of weeds by weeding at regular intervals, which resulted in reduced weeds germination and growth hence increase growth of maize. The superiority of manual hoe weeding could be attributed to its effect on improving soil texture conservation and improving the physical nature of the soil as indicated in the soil of the experimental site above (Table 1). Sorghum extract regardless of the age and concentration of the extract also recorded significantly higher or moderate growth parameters than the weedy check control and this may be due to the ability allelopathic effects of the extract to suppress the growth of the weeds by inhibition of photosynthetic ability of the weeds. The result of this study also agrees with the findings of Ajayi *et al.* (2017) which they reported increase in growth parameters of cowpea for the hand weeding, herbicides and 10 and 20% (w/v) concentration of sorghum extracts when applied to cowpea plant.

3.4 Yield components and yield.

The effect of sorghum extract on cob length, cob weight, 100-sed weight and grain yield are presented in Table 4. The effect of all parameters evaluated is significantly different across all sampling stages and locations. Hoe weeding at 3 and 6 WAS recorded longer, heavier and more grain yields as compared with all other weed control treatments that were statistically similar in some of the parameters. The untreated control (weedy check) recorded statistically shorter, lighter cob and fewer grain yields than the other treatment. All sorghum extracts treatments with or without combination had statistically similar mean values across all sampling stages. The effect of sorghum extract on 100-seed weight and grain yield of maize at both locations indicate that hoe weeding as well as application of Metolachlor followed by supplementary hoe weeding recorded heavier seed weight and higher grain yield than the other treatments in both locations. The untreated control had lighter seed weight and lower grain yield than the other treatments in both locations. All sorghum extract single or in combination with synthetic herbicide had statistically similar seed weight and grain yield.
Yield and yield characters of maize were all significant in both locations. Hoe weeding and Metolachlor at 3.0 a.i ha^{-1} treatments were significantly different in all the yield parameters measured in both BUK and Danbatta. Sorghum extracts treatments both young and mature extract regardless of the concentration also produces higher yield and yield components and this may be due to the presence of allelochemical in the extracts which suppress the weeds growth and developments. This makes environmental resources available to support the growth of maize instead of weeds hence higher yield. The

results of increase in yield under good weed management was in line with the findings of Cheema *et al*. (1997).whom they reported 14% more grain yield of wheat due to single spray of sorghum extracts at 30 DAS. Weedy check (control) plot had statistically yield components and yields. This may be due to reduced dry matter production as a result of competition between the crop and weeds which leads to inadequate translocation of metabolites to the sink. The increase in yield and yield characters of maize by sorghum extract and other weed control treatments may be due to fact that environmental resources are made available to be used by the crop instead of the competing weeds. Good performance of maize with sorghum extract indicated that the extract has no allelopathic effects on maize. This may probably be related the fact that both maize and sorghum belongs to the family of *Poaceae.*

4 Conclusions and Recommendation.

Based on the findings of this research, it is clear from the above findings that there is an immense prospect of allelopathic mechanism in sorghum extract. Rate higher than 5 and 10% (w/v) of sorghum extract can therefore be recommended for weed management in maize so as to reduce dependence on synthetic herbicides with its attendance environmental and health concerns.

Table 1: Physical and chemical Properties of the soil at Experimental sites (0-30cm) at BUK, Danbatta Locations 2017 Raining Seasons.

Soil Properties	BUK	DBT
Physical properties (gkg^{-1})		
Sand	719	782
Clay	120	98
Silt	161	120
Textural Class	Sandy loam	Sandy
Chemical properties of soil		
pH (H_2O)	6.07	6.20
Organic Carbon (gkg^{-1})	3.12	2.28
Total Nitrogen (gkg^{-1})	2.64	1.89
Available P ($mgkg^{-1}$)	12.10	13.71
Exchangeable base (cmol (+) kg^{-1})		
Ca	4.54	3.10
Mg	0.65	0.34
K	0.36	0.31
Na	0.32	0.11
CEC	7.31	5.17

Analysed in Laboratory of the Department of soil Science, Bayero University, Kano BUK = Bayero University Kano, DBT = Danbatta.

Table 2: Effect of Sorghum Extract on Weed Cover Score, Weed Control Efficiency (%), Weed Density and Weed Dry weight on Maize at BUK and Danbatta During 2017 Rainy Season.

Treatments	BUK				DBT			
	WCS	WCE	WD	WDW	WCS	WCE	WD	WDW
Young sorghum extract at	3.00b	53.21d	56.67b	539.9	3.00b	51.36d	64.00b	833.3b
Young sorghum extract at 10% (w/v)	3.00b	54.83d	53.00b	673.3	3.00b	51.93d	61.00b	826.7b
Mature sorghum extract at 5% (w/v)	3.00b	56.26d	53.44b	616.0	3.00b	54.33d	66.67b	785.0b
Mature sorghum extract at 10% (w/v)	3.00b	56.29d	54.67b	684.4	3.00b	53.18d	67.00b	802.0b
Metolachlor at 3.0 kg a.i ha^{-1}	2.00d	79.13b	29.33d	460.6	2.00d	79.16b	33.26d	358.0d
Hoe weeding at 3 and 6 WAS	1.00e	87.24a	12.33e	341.3	1.00e	86.99a	14.67e	223.8e
Young sorghum extract at 5% (w/v) fb Metolachlor at 3.0 kg a.i ha^{-1}	3.00b	53.21d	54.00b	661.0	3.00b	52.49d	67.00b	800.0b
Young sorghum extract at 10% (w/v) fb Metolachlor at 3.0 kg a.i ha^{-1}	3.00b	55.86d	53.33b	675.0	3.00b	51.77d	63.00b	811.0b
Matured sorghum extract at 5% (w/v) fb Metolachlor at 3.0 kg a.i ha^{-1}	3.00b	52.72d	56.42b	713.9	3.00b	51.98d	60.32b	809.0b
Matured sorghum extract at 10% (w/v) fb Metolachlor at 3.0 kg a.i ha^{-1}	3.00b	55.34d	55.67b	699.7	3.00b	50.79d	62.18b	826.7b
Metolachlor at 3.0 kg a.i ha^{-1}fb SHW at 6 WAS	2.33c	67.59c	40.33c	561.3	2.33c	69.95c	44.67c	506.0c
Weedy check control	4.00a	0.00e	133.6a	914.3	4.00a	0.00e	128.00a	1716.3a
SE$\pm$	0.136	1.925	3.36	234.4	0.136	2.514	3.515	38.28

Means followed by the same letter (s) in a column are not significantly different ($P \leq 0.05\%$) using Student Newman-Keuls Test (SNK), **= significant at 0.01%, NS = Not significant, WCS= Weed cover score WCE= Weed control efficiency, WD= Weed density, WDW= Weed dry weight, Fb = followed by.

Table 3: Effect of Sorghum Extract on Plant height and Number of leaves of Maize at BUK and Danbatta During 2017 Rainy Season.

Treatments	Plant Height (WAS)				Number of Leaves (WAS)			
	BUK		DBT		BUK		DBT	
	6	9	6	9	6	9	6	9
Young sorghum extract at	136.6a	171.7c	127.3b	164.3c	12.07a	14,27a	11.00	13.33ab
Young sorghum extract at 10% (w/v)	134.3a	173.7c	123.2b	163.1c	11.67a	14.07a	11.00	13.07ab
Mature sorghum extract at 5% (w/v)	135.3a	165.8c	127.0b	161.9c	11.53a	13.60a	10.80	13.20ab
Mature sorghum extract at 10% (w/v)	132.6a	170.2c	124.7b	161.8c	11.93a	13.87a	10.60	12.53ab
Metolachlor at 3.0 kg a.i ha^{-1}	132.0a	173.0c	127.3b	165.5c	12.00a	14.37a	10.53	13.27ab
Hoe weeding at 3 and 6 WAS	144.5a	207.5a	137.7a	189.3a	12.07a	14.67a	12.13	13.87a
Young sorghum extract at 5% (w/v) fb Metolachlor at 3.0 kg a.i ha^{-1}	138.3a	168.5c	129.7b	162.5c	11.67a	13.73a	11.33	12.87ab
Young sorghum extract at 10% (w/v) fb Metolachlor at 3.0 kg a.i ha^{-1}	134.7a	165.8c	126.3b	164.3c	11.93a	14.60a	10.67	12.93ab
Matured sorghum extract at 5% (w/v) fb Metolachlor at 3.0 kg a.i ha^{-1}	138.9a	171.6c	126.3b	162.8c	12.13a	14.40a	11.07	13.00ab
Matured sorghum extract at 10% (w/v) fb Metolachlor at 3.0 kg a.i ha^{-1}	131.1a	167.8c	123.3b	161.6c	11.80a	14.40a	11.67	13.20ab
Metolachlor at 3.0 kg a.i ha^{-1}fb SHW at 6 WAS	137.1a	190.4b	127.3b	174.1b	11.93a	14.47a	11.67	13.07ab
Weedy check control	106.7b	140.7c	106.0c	141.3d	10.33b	12.60b	10.33	12.03ab
SE$\pm$	4.09	4.72	3.48	2.62	0.278	0.309	0.579	0.477

Means followed by same letter (s) in a column are not significantly different ($P \leq 0.05\%$) using Student Newman-Keuls Test (SNK), WAS = Weeks after sowing, fb= followed by.

Table 4: Effect of Sorghum Extract on Cob length (cm), Cob weight (g), 100-seed weight and Grain yield of Maize at BUK and Danbatta During 2017 Rainy Season.

Treatments	BUK				DBT			
	CLH	CWT	HSW	GYL	CLH	CWT	HSD	GYL
Young sorghum extract at	17.50d	96.30c	17.12b	3.65c	16.90d	92.72c	16.95b	3.44c
Young sorghum extract at 10% (w/v)	18.20cd	101.52c	17.15b	3.64c	17.27d	93.74c	16.71b	3.45c
Mature sorghum extract at 5% (w/v)	17.57d	97.13c	17.03b	3.69c	17.17d	90.33c	17.11b	3.38c
Mature sorghum extract at 10% (w/v)	17.93cd	98.72c	17.26b	3.59c	16.93d	90.83c	16.90b	3.38c
Metolachlor at 3.0 kg a.i ha^{-1}	21.17b	108.00b	18.85a	4.11a	20.00b	104.93b	19.47a	3.86b
Hoe weeding at 3 and 6 WAS	22.74a	129.21a	19.45a	4.79a	21.70a	116.95a	19.30a	4.44a
Young sorghum extract at 5% (w/v) fb Metolachlor at 3.0 kg a.i ha^{-1}	18.17cd	100.03c	17.30b	3.53c	17.40d	91.64c	16.74b	3.28c
Young sorghum extract at 10% (w/v) fb Metolachlor at 3.0 kg a.i ha^{-1}	18.10cd	99.10c	16.91b	3.92bc	17.23d	91.31c	16.88b	3.37c
Matured sorghum extract at 5% (w/v) fb Metolachlor at 3.0 kg a.i ha^{-1}	17.43d	100.05c	17.63b	3.61c	16.93d	91.15c	16.57b	3.39c
Matured sorghum extract at 10% (w/v) fb Metolachlor at 3.0 kg a.i ha^{-1}	17.57d	99.63c	17.34b	3.62c	17.07d	92.29c	16.57b	3.42c
Metolachlor at 3.0 kg a.i ha^{-1}fb SHW at 6 WAS	18.77c	101.14c	17.45b	3.86bc	18.83c	93.72c	16.86b	3.71b
Weedy check control	14.27e	76.10d	14.25c	1.76d	13.73e	67.01d	13.34c	1.53d
SE$\pm$	0.295	1.903	0.433	0.129	0.424	2.276	0.362	0.077

Means followed by same letter (s) in a column are not significantly different ($P \leq 0.05\%$) using Student Newman-Keuls Test (SNK), CLH = Cob length, CWT = Cob Weight, HSD = 100-seed weight and GYL = Grain Yield.

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