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Herbicidal Efficacy of atrazine for Weed Control in Maize (*Zea mays* L.)

Khogali I. Idris[1], Dafalla A. Dawoud[2] and Hassan A. Mubark[2]

1. Agricultural Research Corporation, Shambat Research Station
2. Agricultural Research Corporation, Gezira Research Station.

Corresponding Author:khogaliarc@yahoo.com
Article history: Received:December 2014
Accepted: October 2015

Abstract: A field trial was conducted at Gezira Research Station Farm, duringseasons 2010/2011 and 2011/2012, to evaluate activity and selectivity of the pre-emergence herbicide atrazine (Oxatryne 500SC) for weed control in maize. The herbicide was tested at 0.357, 0.476, 0.595 and 0.714 kg a.i ha^{-1}. The most prevailing weed species were False amaranth {(*Digera muricata* (L.) Mart}., Blue morning glory (*Ipomoea* spp.), Cattail grass (*Seteria pallide-fusca*)and *Ocimum basilicum* . The herbicide displayed very good to excellent control of broadleaved weeds (73- 98%) . However, its activity against grassy weeds was poor to moderate (4- 56% control). All herbicide treatments were highly selective to the crop.Yield reductions as a result of unrestricted weed growth were 81 and 74 %, in the first and second seasons, respectively. In both seasons, the herbicide at all rates tested, irrespective of supplementary hand weeding increased maize yield significantly compared to the untreated control.

Keywords: Weeds, atrazine, Maize, Yield

Introduction

Maize (*Zay mays* L.) is an important cereal crop worldwide. In Sudan the crop ranks fourth after sorghum, millet and wheat in both acreage and total production. However, the area under maize is steadily increasing over years. The crop is used as human food as well as an important ingredient in animal and poultry feed.

The average grain yield of the world is 7.47 ton per hectare, which is about 7 folds that of Sudan (Ali *et al*., 2012). This may be a result of several biotic and a biotic stresses. Weeds are one of the major constraints limiting maize production. Yield losses ranging from 46 to100% have been attributed to weed competition during the growth of crop. (Ishag, 1979; Spitters *et al*., 1998; Chikoye*et al*., 2000; and Mukhtar *et al*., 2007). The traditional method of weed control in Sudan is hand weeding. This method is effective, but slow, tedious, costly, time consuming and sometimes not feasible because of the unavailability of labour at the time of need. These limitations have generated a requirement for alternative control measures especially under large scale production. Chemical weed control or

use of herbicides is of great importance to eliminate early weed competition. A few herbicides are recommended for weed control in maize in Sudan.

Several research reports have indicated that many herbicides can be used effectively to control weeds in maize (Shakoor *et al*., 1986; Khan and Haq, 2003 and 2004; Nurse *et al,* 2007 and Fontem and Chikoye, 2012). However, little work on chemical weed control in maize has been done in the Sudan. Therefore, this study was set to evaluate the activity and selectivity of the pre-emergence herbicide atrazine (Oxatryne 500SC) for weed control in maize.

Materials and Methods

A field trial was conducted during growing seasons 2010/2011 and 2011/2012, at Gezira Research Station Farm. The soil is heavy cracking clays, non-saline, non- sodic of El Remeitab soil series of central Sudan vertisols (SMSS- USDA/SSA, 1982). The experimental sites were disc ploughed, harrowed and ridged and divided into subplots of 49.5 m^2 each. In both seasons, maize (cv. Mugtama 45) was planted on the third week of July. Seeds, at rate of 2 seeds/ hole, using inter and intra- ridge spacing of 80 and 20 cm, respectively. The crop was thinned to one plant/hole 10 days after sowing. Nitrogen fertilizer, in form of urea, was applied at 80 kg/fed immediately after thinning.The herbicideatrazine (Oxatryne 500SC) was tested at 0.357, 0.476, 0.595 and 0.714 kg ai ha^{-1}. Some of the herbicides treatments received a supplementary hand-weeding 4 weeks after sowing (WAS). Herbicide was applied as pre- emergence immediately after sowing using a knap-sack sprayer at a volume rate of 92 - 100 L/fed. Weeded and unweeded controls were included for comparison. In the weeded plots, weeds were hand removed at 15, 30 and 45 days after sowing, whereas the unweeded treatment was kept weedy for the whole growing season. Treatments were arranged in Randomized Complete Block Design with four replicates.

Visible injury ratings were based on scale of EWRS (1= 0% mortality and 9 = 100% mortality).The effects of herbicide on weeds was evaluated by counting total and individual weed species and percent ground covered by weeds in 6 fixed quadrates (25 x 40 cm) per plot at 4 and 8 weeks after sowing, hencefore, referred to as early and late season weeds, respectively. Percentage control of grassy and broad-leaved weeds was calculated relative to the unweeded treatment. At harvest, weed biomass was determined from an area of 1m² per plot. Plant population and yield of maize were recorded at the end of the season. Data were subjected to analysis of variance and Duncan's Multiple Range Test.

Results

Effects on weeds:

In season 2010/2011, the total number of weeds in the weedy check was 353 and 198 plants m^{-2} at 4 and 8 weeks after sowing, respectively. Of the total, 50 – 68% were broad leaved weeds and the rest were grassy weeds. The most dominant weed species were *Digera muricata, Seteria pallide-fusca, Corchorus spp.* and *Ipomoea* spp.

In 2011/2012, the total number of weeds in the weedy check was 83 and 130 plants m^{-2} early and late in the season, respectively. Broad leaved weeds represent65 – 83% of the total weed flora and the rest were grasses. The dominant weeds were *Ipomoea* spp., *Ocimum basilicum, Phyllanthus maderaspatensis* and *Seteria pallide-fusca.*

In both seasons, the herbicide atrazine at all rates, irrespective of supplementary weeding, effectively controlled broad leaved weeds (73 – 98% control). However, the herbicide displayed poor to moderate

activity (4- 56% control) against grassy weeds (Tables 1 and 2). The control of grassy weeds was improved when the herbicide treatments were followed by one supportive hand weeding 4 weeks after sowing.

At harvest, the herbicide at all rates significantly reduced weed air dry weight and the observed reductions were 34- 80% and 48- 97%, in the first and second seasons, respectively (Tables 1 and 2). It was clear that application of the herbicide at all rates tested reduced weed groud cover and weed growth compared to the weedy check .

Effects on crop:

In both seasons, all herbicide treatments showed no visual injury symptoms on the crop. The treated plants had vigorous growth indicating that the herbicide is selective for maize. Furthermore, none of the herbicide treatments had adverse effects on plant population (Tables 3 and 4).

Unrestricted weed growth accounted for 81 and 74% losses in maize grain yield as compared to the weeded control in seasons 2010/2011 and 2011/2012, respectively (Tables 3 and 4). Among all treatments the untreated control it produced the lowest grain yield.

In both seasons, all herbicide treatments, regardless of supplementary weeding, significantly increased maize grain yield in comparison to the weedy check (Tables 3 and 4).

Discussion

The results obtained from this study revealed that maize has high tolerance to the herbicide atrazine (Tables 3 and 4). In both seasons, the herbicide atrazine at all rates, irrespective of supplementary weeding, effectively controlled broad leaved weeds.Similar findings were obtained by Shakoor *et al.* (2001) and Khan *et al* (1991) who showed that the herbicide was highly effective against broad-leaved weeds in corn.However, the herbicide displayed poorto moderate activity against grassy weeds (Tables 1 and 2). Supplementary hand weeding 4 weeks after sowing improved control of grassy weeds .

As expected,weed airdry weight was higher in the unweeded control than in all other treatments in both seasons. The herbicide at all rates tested significantly reduced weed air dry weight in comparison to the untreated control. This reduction confirms that the herbicide control weeds better as previously reported in other studies (Shakoor *et al.* 2001 and Khan *et al*, 1991). It was clear that application of the herbicide at all rates tested reduced weed groud cover and reduced weed growth compared with the weedy check treatment. This was an indication of the ability of this herbicide treatment to ensure season long weed control.

Unrestricted weed growth accounted for 81 and 74% losses in maize grain yieldas compared to the weeded control. The untreated control produced the lowest grain yield compared to all other treatments. This reflects severe weed interference where weeds directly compete for water, nutrients and light because of the low competitive ability of maize during the early stages of it growth (Swanton and Weise, 1991). These findings are in conformity with those of (Ishag (1979), Spitters *et al*. (1998), Chikoye *et al* (2000) and Mukhtar *et al*. (2007). Whose study results showed that reductions in maize due to weeds ranging from 46 to 100%.

All herbicide treatments, regardless of supplementary weeding, significantly increased maize grain yield in comparison with the weedy check.These results are in agreement with other researchers, who have shown that chemical weed control may

improve maize yield(Shakoor *et a*l., 1986; Khan and Haq, 2004; Nurse *et al,* 2007 and Fontem and Chikoye, 2012). These results have shown that early removal of weeds by herbicides enables the crop to maximize the use of the available resources. Herbicide treatments with supplementary hand weeding gave grain yield comparable to the weeded control**.**

et al 1991; Shakoor *et al.* 2001; Khan

Conclusion

The effectiveness of the herbicide atrazine (Oxatryne 500SC) against broad- leaved weeds and its high selectivity in maize, make it a plausible candidate for weed control in maize. This issubstantiated by the adverse of weeds onmaize couple with scarcity of labor and its high cost.

Table 1: Effects of herbicide treatments on weed control, weed ground cover and air dry weight of weeds (Season, 2010/2011)

WAS= Weeks after sowing.

Treatment	***Herbicide rate (kg a.i ha^{-1})***	**Weed control(%)**				**Weed ground cover (%)**		Air dry weight of weeds (g m^{-2})
		Grasses		**Broadleaved**				
		4WAS	8WAS	4WAS	8WAS	4WAS	8WAS	
Atrazine	0.357	8	27	85	74	16	26	325.0 ^{bc}
Atrazine +	0.357	8	65	85	76	16	17	187.5 ^{cd}
Atrazine	0.476	7	31	85	79	18	28	362.5 ^{b}
Atrazine +	0.476	7	75	85	82	18	16	212.5^{bcd}
Atrazine	0.595	4	27	91	73	15	28	287.5 ^{bc}
Atrazine +	0.595	4	81	91	74	15	13	187.5 ^{cd}
Atrazine	0.714	16	49	90	86	14	19	250.0 ^{cd}
Atrazine +	0.714	16	80	90	75	14	13	112.5 ^{de}
Weeded control		100	100	100	100	-	-	0.000 ^{e}
Weedy control		0	0	0	0	31	54	550.0 ^{a}
SE ±								47.482

+ = Treatment with supplementary hand weeding at 4 Weeks after sowing.

Means within a column followed by the same letters (s) are not significantly different at $P \leq 0.05$ level according to the Duncan's Multiple Range Test.

Table 2: Effects of herbicide treatments on weed control, weed ground cover and air dry weight of weeds (Season, 2011/2012)

Treatment	Herbicide rate (kg a.i ha^{-1})	Weed control(%)				Weed ground cover (%)		Air dry weight of weeds (g m^{-2})
		Grasses		Broadleaved				
		4WAS	8WAS	4WAS	8WAS	4WAS	8WAS	
Atrazine	0.357	1	1	2	8		20	140.0 bc
Atrazine +	0.357	1	2	2	5		5	53.8 def
Atrazine	0.476	9		1	6		16	192.5 b
Atrazine +	0.476	9	3	1	6		5	45 def
Atrazine	0.595	2	2	4	2		15	147.5 bc
Atrazine +	0.595	2	7	4	6		3	11.3 f
Atrazine	0.714	6	4	8	2		12	130.0 bcd
Atrazine +	0.714	6	3	8	7		3	22.5 ef
Weeded control							-	-
Weedy control					30		60	367.5 a
SE ±								26.53

WAS= Weeks after sowing.

+ = Treatment with supplementary hand weeding at 4 Weeks after sowing.

Means within a column followed by the same letters (s) are not significantly different at $P \leq 0.05$ level according to the Duncan's Multiple Range Test.

Table 3: Effects of herbicide treatments on plant population and yield of maize (Season, 2010-2011)

Treatment	Herbicide rate (kg a.i ha^{-1})	Plant population (000 fed^{-1})	Grain yield (kg fed^{-1})
Atrazine	0.357	19.9 a	507 c
Atrazine +	0.357	19.2 a	935 ab
Atrazine	0.476	20.3 a	537 c
Atrazine +	0.476	20.2 a	646 bc
Atrazine	0.595	19.6 a	626 c
Atrazine +	0.595	20.3 a	994 a
Atrazine	0.714	15.9 ab	766 abc
Atrazine +	0.714	20.9 a	935 ab
Weeded control		20.4 a	803 abc
Weedy control		14. 3 b	155 d
SE±		1.611	93.57

+ = Treatment with supplementary hand weeding at 4 Weeks after sowing. Fed = 0.4 hectare.

Means within a column followed by the same letters (s) are not significantly different at $P \leq 0.05$ level according to the Duncan's Multiple Range Test.

Table 4: Effects of herbicide treatments on crop stand and yield of maize (Season, 2011-2012)

Treatment	Herbicide rate (kg a.i ha^{-1})	Plant population (000 fed^{-1})	Grain yield (kg fed^{-1})
Atrazine	0.357	19.5	657 d
Atrazine +	0.357	23.1	1155 a
Atrazine	0.476	24.0	708b cd
Atrazine +	0.476	19.7	1077 ab
Atrazine	0.595	26.8	725b cd
Atrazine +	0.595	23.7	1229 a
Atrazine	0.714	23.3	662 d
Atrazine +	0.714	23.7	1161 a
Weeded control		21.9	983 abcd
Weedy control		20.6	256 e
SE±		ns	118.2

+ = Treatment with supplementary hand weeding at 4 Weeks after sowing. Fed = 0.4 hectare.
ns= not sigficant
Means within a column followed by the same letters (s) are not significantly different at $P \leq 0.05$ level according to the Duncan's Range Test.

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فعالية مبيد الاترازين لمكافحة الحشائش في محصول الذرة الشامية *(Zea mays L.)*

خوجلي عزالدين ادريس[1]، دفع الله احمد داؤد [2] وحسن عبدالقادر مبارك[2]

1. هيئة البحوث الزراعية، محطة بحوث شمبات
2. هيئة البحوث الزراعية، محطة بحوث الجزيرة

المستخلص:

أجريت هذه التجربة بمحطة بحوث الجزيرة خلال موسمي 2011/2010 و2012/2011 م بهدف تقويم فعالية مبيد الاترازين لمكافحة الحشائش في محصول الذرة الشامية. أستخدم المبيد باربعة تراكيز هي 0.357 ، 0.476، 0.595 و0.714 كيلوجرام مادة فعالة للهكتار. وتمت إضافة المبيد قبل الانبثاق. أهم الحشائش السائدة في هذة التجربة هي لبلاب احمر، تبر، لصيق وريحان. أتضح من الدراسة ان معاملات المبيد ذات فعالية عالية في مكافحة الحشائش عريضة الأوراق (73–98%). بينما اعطي نفس المعاملات مكافحة ضعيفة الي متوسطة للحشائش ذات الاوراق الرفيعة (4–56%). أظهرت النتائج أن جميع معاملات المبيد ذات اختيارية عالية للمحصول. أتضح من الدراسة أن الضرر الذي تسببه الحشائش في الإنتاجية لمحصول الذرة الشامية قد بلغ 81 و74% في الموسمين علي التوالي. في الموسمين، معظم معاملات المبيد أدت الي زيادة معنوية في إنتاجية الذرة الشامية بغض النظر عن عدم وجود العزيق اليدوي المصاحب للمعاملات وذلك مقارنة بالشاهد غير المعشب.