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# Effects of Some Formulations of Chlorsulfuron, On *Striga* Control and Sorghum Yield

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***Abstract:*** **This experiment was carried out in *Striga*-sick plots, in two locations under rain fed condition at the Demonstration farm of the Faculty of Agricultural Science, Gedarif University, in Northern region of the Gedarif and under irrigation at Gezira Agricultural Research Station Farm, to evaluate the activity and selectivity of post-emergence application of three chlorsulfuron formulations (Boudakiller 75 WG, Slean 75WG, Mickleen 75 WDG and Glean 75DF), each at 1g a.i./fed, on *Striga* control and sorghum yield. The tested herbicides gave an excellent control to the *Striga* (more than 90%) under both irrigation and rainfed conditions. Directed spraying of the tested products showed no visible phytotoxicity symptoms on sorghum plants. All chlorsulfuron formulation significantly reduced *Striga* infestation and improved sorghum growth and yield under both irrigation and rainfed conditions.**

***Keywords:*** ***Striga*, Hemi-Parasite, Chlorsulfuron, Tubercle, Residue, Counterpart.**

## I. INTRODUCTION

The genus *Striga* includes several parasitic weeds that attack and parasitize many members of the Poaceae and leguminaceae world-wide (Nelson, 1958; Witt & weber, 1975; Eplee, 1981; Musselman, 1982)[1],[2],[3],[4]. Their effects are severe, and complete loss of harvest in not uncommon in heavily infested areas (Parker, 1991)[5]. *Striga Hermonthica* is a serious parasitic weed on cereals in the tropics and subtropics. In Sudan *S. hermonthica* is a major biological constraint to the production of the staple crops of the majority, mainly sorghum and pearl millet. The parasite also attacks maize, sugarcane and rice.

*Striga* species are obligate parasite draws water and its nutritional needs from the host root system. During its under ground stages *Striga* is a hemi-parasite, therefore, once *Striga* seeds germinate, a xylem connection with the roots of the host plant must be established within few days in order to survive (Bouwmeester *et al.*, 2003; Shen *et al.*, 2006)[6],[7]. Once a successful connection with host plant established, *Striga* then develops tubercles for several weeks before emergence of aboveground shoots.

Prodigious seed production, the subterranean nature of the early stages of parasitism and the complex nature of the host parasite relationship make *Striga* a difficult weed to control. *Striga* control by conventional methods is not effective because the parasite makes most of its damage to the host crop before emergence, time consuming and could not be done timely and frequently. Chemical control of *Striga* is an alternative, easy, effective and non costive method that could be used in an integrated *Striga* management approach to reduce damage inflicted by the parasite. Chlorsulfuron in form of Glean reduce damage caused by *Striga* and effectively control the parasite. However, presence of the herbicide from more than one source of production will enhance availability and reduce the cost of control. This study was set to assess the activity and selectivity of three new chlorsulfuron formulations for *Striga* control in sorghum fields.

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## II. MATERIALS AND METHODS

The experiment was sown in *Striga*-sick plots under rainfed condition in the demonstration farm of Gedarif University (DFGU) in northern Gedarif, Sudan (Latitude N 14°.33˜, Longitude E 35°.36˜, and Elevation 540 m above sea level) and under irrigation in Gezira Research Station Farm (GRSF) in wad medani, Sudan (Latitude N 14°.24˜, and longitude E 33°.29˜). Sorghum cultivar "Arfaa Gadamak-8" was sown on last week of July 2011 at both sites. The crop was sown on rows 80 cm apart and 20 cm space between holes, the plants thinned to 2plant/hole three weeks after crop emergence. Other cultural practices adopted as recommended by Agricultural Research Corporation (ARC), Sudan, for sorghum production. Treatments include the herbicides Chlorsulfuron in different formulations namely Boudakiller 75WG (manufactured by Chemax International, India and introduced to Sudan by Astral Trading Co Ltd, Khartoum), Slean 75%WG (manufactured by Sino Agrochemical Industry Ltd, China and introduced to Sudan by Star Chemical Co Ltd, Khartoum), Mickleen 75%WDG (manufactured by Jiangsu Pesticide Co Ltd, and introduced to Sudan by Sabico Investment Co Ltd, Khartoum) and Glean 75DF (counterpart) each at 1g a.i./fed subsequent to urea at 40 kg/fed and three controls for comparison namely; only urea fertilization at 40 kg/fed, urea fertilization at 40 kg/fed plus frequent *Striga* hand pulling and untreated control. Urea was applied at sowing whereas the herbicides were applied 4 weeks after sowing as directed spray between sorghum rows at spray volume of 105 - 130 L/fed. The treatments were arranged in Randomized Complete Block Design (RCBD) with 4 replications. Data collected include *Striga* count 60 days after sowing (DAS) and at crop harvest, sorghum stand and grain yield. Data was analyzed by analysis of variance and Ducan's Multipe Range test was used for mean separation.

Residue analysis was carried out using standard method for extraction and clean-up of the samples. Residues were examined by Thin-layer Chromatography (TLC).

## III. RESULTS AND DISCUSSION

***Effects on Striga:*** At Gezira, The chlorsulfuron formulations Boudakiller 75WG, Slean 75%WG, Mickleen 75%WDG and the counterpart Glean 75 DF each at 1g a.i./fed significantly reduced *Striga* emergence by more than 95%, in comparison with urea applied control two months after sorghum emergence. Prior Harvest the Tested Chemicals achieved also significant reduction in *Striga* population in comparison with urea applied control by more than 96.

In comparison with untreated control the tested herbicide and their counterpart (Glean) also significantly reduced *Striga* count by more than 96%, 60 days after sorghum plants emergence and at harvest (Table 1). Differences between chlorsulfuron formulations on *Striga* population, 60 days after crop emergence and at harvest were, however, not significant (Table 1).

At Gedarif site, The chlorsulfuron formulations Boudakiller 75WG, Slean 75%WG, Mickleen 75%WDG and the counterpart Glean 75 DF, each at 1g a.i./fed, resulted in 93%, 98%,92% and 74% *Striga* control, 60 days after sorghum sowing, respectively. The tested chemicals reduced *Striga* count at harvest by 95%, 92%, 87% and 41%, respectively, (Table 2). At Gedarif site, the new formulations of chlorsulfuron gave results in *Striga* control better than the counterpart clean.

It is obviously that, the tested chlorsulfuron formulations Boudakiller 75WG, Slean 75%WG, Mickleen 75%WDG and the counterpart Glean 75 DF, achieved excellent *Striga* control under irrigation and rainfed conditions. This could be attributed to the mode of action of chlorsulfuron one of amino acid inhibitors belongs to sulfonylurea's group the mode of action in this group is the tendency of poorly developing roots and the secondary roots are shortened. The non-significant differences between the formulations on *Striga* will have a positive impact on the use of chlorsulfuron to compact the effects of *Striga* by increasing its availability to farmers from different sources and will also have an impact of reducing the herbicide prices and hence the cost of *Striga* management.

***Effect on crop:*** At Gezira, the *Striga* infestation resulted in more than 43% reduction in sorghum grain yield (Table 3). Sorghum plants population was 47.5 to 54.6 (000) plant/fed. The imposed treatments displayed no significant effects on sorghum stand (Table 3). The tested chlorsulfuron formulations significantly increased sorghum grain yield in comparison with both urea only and the untreated control by >151% and >191%, respectively (Table 3). Sorghum grain yield produced by the tested chlorsulfuron formulations was not significantly different from the counterpart herbicide, Glean.

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At Gedarif, the sorghum plants population was 47.5 to 54.6 (000) plant/fed. Due to extremely low and irritable rainfalls at northern Gedarif sorghum yield was extremely low. However, the tested chlorsulfuron formulations resulted in similar grain yield as the counterpart, Glean (Table 4).

No visible phytotoxicity symptoms on sorghum plants were noticed after chemicals application, in both locations. The high yield in chlorsulfuron treatments will mainly be the result of reducing damaged caused to sorghum by *Striga* and efficient use of the crop the added nitrogen fertilizer. Moreover, availability of the herbicide from different sources will reduce the cost of the production via reducing herbicide cost and will leads to increased revenue for the farmer.

**Residue analysis:** The $R_f$ value of chlorsulfuron standard was 0.7, the minimum detectable quantity was 0.09 µg and the recovery of the method was 85%. No residues of chlorsulfuron were detected in treated and control samples of sorghum seeds. The maximum residue limit for chlorsulfuron in sorghum is 0.3 µg/g (ppm). According to the results obtained, the use of Boudakiller, Slean and Mickleen (chlorsulfuron) on sorghum at the recommended dose constitutes no risk to human.

## IV. CONCLUSIONS

In conclusions the herbicides, Boudakiller, Slean, and Mickleen resulted in *Striga* control similar to that achieved by the counterpart, Glean. Boudakiller, Slean and Mickleen outyielded the untreated control and resulted in grain yield comparable to that obtained by the counterpart, Glean. These were no negative effects on sorghum plant as a result of the directed application of the chemical. No residues of chlorsulfuron formulations were detected in sorghum seeds at harvest.

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## APPENDIX - A

**Table 1: Effects of chlorsulfuron formulations on *Striga* control at Gezira**

| Treatments | Herbicide rate g(a.i./fed) | *Striga* count 60 DAS (plant/$m^2$) | *Striga* count At harvest (plant/$m^2$) |
|---|---|---|---|
| Boudakiller | 1.0 | 1.001c | 0.751b |
| Slean | 1.0 | 0.251c | 0.251b |
| Mickleen | 1.0 | 0.001c | 0.001b |
| Glean | 1.0 | 0.001c | 0.001b |
| Urea only | - | 20.75b | 24.25a |
| Untreated | - | 28.75a | 21.25a |
| SE ± | | 2.1218 | 2.5005 |
| CV% | | 50.2 | 64.5 |

DAS= days after sowing

In each column values followed by the same letter(s) are not significantly different according to DMRT at $p \leq 0.05$

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**Table 2: Effects of chlorsulfuron formulations on *Striga* control at Gedarif**

| Treatments | Herbicide rate g(a.i./fed) | *Striga* count 60 DAS (plant/$m^2$) | *Striga* count At harvest (plant/$m^2$) |
|---|---|---|---|
| Boudakiller | 1.0 | 2.25c | 1.00b |
| Slean | 1.0 | 0.75c | 1.50b |
| Mickleen | 1.0 | 2.75c | 3.25b |
| Glean | 1.0 | 8.75bc | 11.50ab |
| Urea only | | 21.75ab | 10.00ab |
| Untreated | | 33.25a | 19.25a |
| SE ± | | 4.8 | 3.8 |
| CV% | | 53.51 | 51.76 |

DAS= days after sowing

In each column values followed by the same letter(s) are not significantly different according to DMRT at p≤0.05

**Table 3: Effects of chlorsulfuron formulations on crop stand and sorghum grain yield at Gezira**

| Treatments | Herbicide rate g(a.i./fed) | Number of plant/fed (000) | Sorghum grain yield (kg/fed) |
|---|---|---|---|
| Boudakiller | 1.0 | 47.78 | 1107a |
| Slean | 1.0 | 51.98 | 1263a |
| Mickleen | 1.0 | 54.60 | 1111a |
| Glean | 1.0 | 48.56 | 1080a |
| Urea only | | 52.24 | 832b |
| Hand pulling | | 50.40 | 1155a |
| Untreated | | 47.52 | 658b |
| SE ± | | $4.2^{ns}$ | 80.6 |
| CV% | | 16.6 | 15.7 |

DAS= days after sowing

$^{ns}$ = non significant effects

In each column values followed by the same letter(s) are not significantly different according to DMRT at p≤0.05

**Table 4: Effects of chlorsulfuron formulations on crop stand and sorghum grain yield at Gedarif**

| Treatments | Herbicide rate g(a.i./fed) | Number of plant/fed (000) | Sorghum grain yield (kg/fed) |
|---|---|---|---|
| Boudakiller | 1.0 | 49.35a | 166.4a |
| Slean | 1.0 | 37.35d | 86.15ab |
| Mickleen | 1.0 | 43.05b | 169a |
| Glean | 1.0 | 40.95c | 149ab |
| Urea only | - | 39.90c | 70b |
| Hand pulling | - | 43.05b | 67b |
| Untreated | - | 48.30a | 100ab |
| SE ± | - | 5.2 | 29.0 |
| CV% | | 14.53 | 50.13 |

DAS= days after sowing

In each column values followed by the same letter(s) are not significantly different according to DMRT at p≤0.05