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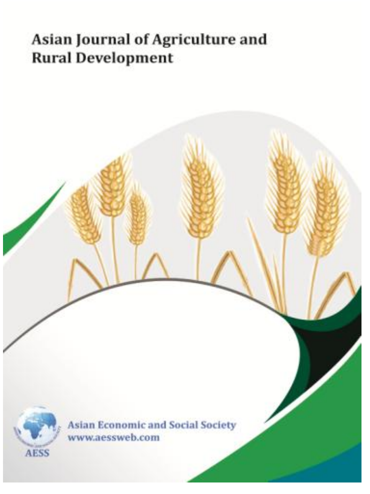

Effect of Two Formulations of Sufentrazone on Weed Control in Tobacco (*Nicotiana Tabacum L*)

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Abstract

Field studies were done to compare the weed control efficacy of a wettable granular formulation (Authority 75 WG) and a suspension concentrate formulation (Authority 48 SC) of the herbicide sulfentrazone. A 6 x 2 factorial experiment was laid out in a split plot design to evaluate the effect of the two herbicides on the weed control efficacy in tobacco. The first factor was herbicide which had 6 levels and the second factor was weeding which had 2 levels. One rate of the wettable granular formulation at 0.225 kg/ha, four different rates of the suspension concentrate formulation at 0.165, 185, 0.205 and 0.225 kg a.i. /ha and the untreated control were tested. These were split into two weeding levels (weedy and weed free). The weed free plots were weeded every other week for 12 weeks beginning two weeks after transplanting tobacco. The treatments were combined to give 6 treatments for each main plot. These were replicated four times. This work reported efficacy data from the weedy plots. Weed counts were measured at 4 and 8 weeks after transplanting (WAP) and weed dry-mass at 8WAP. Results show that both formulations at all tested rates poorly controlled broadleaf and grass weeds while nutsedge control was excellent**.** This study showed that the rates used were too low to effectively control grasses and broadleaved weeds while they were adequate for control of nutsedge. We therefore suggest that this material fills an important niche as a nutsedge material with post emergent nutsedge control. Further work should look at herbicide mixtures in order to improve grass and broadleaf control.

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Introduction

Tobacco (Nicotiana tabacum L) is an important crop that has a major contribution to the gross domestic product (GDP) and export revenue of all countries that grow it. Yields have been variable, depending on the implementation of good agronomic practices, an increased use of irrigation facilities and good management of pests, diseases and weeds (Stocks, 1994).

Tobacco yield loss due to poor weed management was estimated at 50% (Paunescu et al., 1992). Effective weed control is therefore important especially during the critical required weed free period, which is the first 4-6 weeks of the crop's production cycle. Chemical control is an effective strategy to achieve this (Chivinge, 1984).

Sulfentrazone is a herbicide widely used in the control of yellow nutsedge, broadleaf weeds and grasses in tobacco. In Zimbabwe it was first registered for use in tobacco in 1999 under the trade name Authority 75 WG, a wettable granular formulation (Mazarura, 1999). The herbicide was developed for use in tobacco and soya bean (*Glycine max* (L. Merr.). It belongs to the aryl triazolinone family and controls weeds by inhibiting protoporphyrinogen oxidase (PPO). The conversion of proto-porphyrinogen to protoporphyrin IX in the chlorophyll biosynthetic pathway is oxidized by PPO. Hence inhibition of this enzyme leads to the build up of this intermediate leading to cell perturbation and eventual plant death (Becerril & Duke, 1989a; Becerril & Duke, 1989b)

Susceptible weeds take up the herbicide as they emerge from the soil and die on exposure to sunlight. Sulfentrazone has excellent preemergent soil activity on yellow nutsegde and many other weeds like common lambsquarters (*Chenopodium album* L.) and the *Amaranthus* spp. which are important in tobacco production. The herbicide is also important in soya bean production. The herbicide has suppressive effects on grass weeds and can be used to manage ALS resistant biotypes (Hulting et al., 2001). Thus sulfentrazone has been applied as preemergence, early pre-plant or incorporated as a pre-plant application alone or in combination with other herbicides like Clomazone or chlorimuron (Hulting et al., 2001).

This work was motivated by a formulation change of the herbicide sulfentrazone from a wettable granular formulation (Authority 75®WG) to a suspension concentrate formulation (Authority 480® SC) in order to reduce the risk of phytotoxicity without reducing efficacy. Research done by Riggle and Penner (1990), suggested that a change in formulation can influence herbicide efficacy by modifying its biological activity, selectivity, mode of action and persistence. The suspension concentrate formulation is meant to address the problem of high phytotoxicity to tobacco, high residue build up in the soil and leaf as well as improve efficacy on broadleaf and grass weeds. The present studies therefore, sort to compare the two formulations of sulfentrazone with regards to weed control efficacy.

Materials and Methods

Site Description

This experiment was done on a sandy loam soil (72.8% sand, 8.8% silt and 18.4% clay) at Kutsaga Research Station (17^{O} 55` S, 31$^{O}$ 08`; Altitude 1480m, Average annual rainfall 882 mm), Zimbabwe from 2007 to 2008. The Station has light, well drained sandy soils of granite origin and resembles those found in most tobacco growing areas in Zimbabwe. The soils are very low organic content and have low water-holding capacity.

Land Preparation and Fertilization

The land was ploughed, disked and treated with a nematicide as per standard practice. The nematicide, ethyl di-bromide (EDB) was applied at 3l/ha. Tobacco was grown on ridges 0.2m high and 1.2m apart, while the plant to plant spacing on the row was 0.56m. The tobacco variety T66, a slow ripening cultivar with a yield potential of more than 3500kg/ha cured leaf, was used. The fertilizer applied was compound C (6N:18P:17K) at 700kg/ha.

Treatment Description, Design and Herbicide Application

The design was a split plot of four blocks. Two main plots (weeded and weedy) and six sub-plots (weed control rates) were used. The weedy plots were used for assessing weed control efficacy and that data is presented in this paper. Herbicide application was done by calibrated knapsack a day after transplanting the T66 variety. Weeding was done every fortnight for the weeded plots, starting two weeks after transplanting. The herbicide subplot rates were:

1. Untreated control
2. Sulfentrazone WG formulation at 0.225 kg a.i. /ha
3. Sulfentrazone SC formulation at 0.165 kg a.i. /ha
4. Sulfentrazone SC formulation at 0.185 kg a.i. /ha
5. Sulfentrazone SC formulation at 0.205 kg a.i. /ha
6. Sulfentrazone SC formulation at 0.225 kg a.i. /ha

Seven 0.3 x 0.3 m quadrants, randomly arranged to go across the width of two harvested rows were used for sampling. For each plot the middle furrow, the two sides and tops of the ridges were sampled. This was done at 3 randomly selected positions in each treatment subplot. The full plot for each treated measured 4.8 m x 17.92 m (i.e. 4 rows) while the assessed plot was 2.4 m x 16.80 m (i.e. 2 rows). Weed counts and dry mass were measured in the quadrants at 4 and 8 weeks after planting (WAP). Weeds, pulled with their roots were packed in pockets and oven dried for 28 hours at 85°C. Samples were removed from the oven and the dry weights were measured.

All data was subjected to ANOVA to test treatment effects. The data was analysed using Genstat Version 9.2. Mean separation was conducted using Fischer's Protected Least Significant Difference (LSD) test at 5%.

Results

Broadleaf Weed Counts

Various broad leaf weeds like upright starbur (*Acanthospermum hispidum*), pigweed (*Amarunthus hybridus*), mexican marigold (*Tagetes minuta*), mexican clover (*Richardia scabra*) and dwarf marigold (*Schkuhria pinnata*) were evident in the plots used for this trial.

At 4WAP all herbicide rates gave significantly ($P < 0.05$) better weed control than the untreated control (Table 1). All the rates of the SC formulation except the 0.185 kg/ha rate were as good as the standard WG formulation (Table 1). As expected, herbicides continued to perform better than the control even at 8 WAP. However, at this time all herbicide rates were the same ($P < 0.05$). However, in general broadleaf control was poor but better at 4WAP than at 8WAP.

Table 1: Mean Grass and Broadleaf Weed Counts at Four and Eight Weeks after Transplanting

	Broad leaf weeds		Grass Weeds	
Herbicide level kg/ha	**4WAP**	**8WAP**	**4WAP**	**8WAP**
0.00 (Untreated Control)	126.5	238.8	63.75	87.65
0.225(WG formulation)	43.4(65.3)[1]	179.2 (25.0)	52.00 (18.4)	70.10(20.0)
0.165(SC formulation)	61.85(50.7)	185.0 (22.5)	41.35 (35.1)	34.50 (60.6)
0.185(SC formulation)	72.15(42.6)	186.5 (21.9)	25.42 (60.1)	44.50 (49.2)
0.205(SC formulation)	54.5(56.5)	197.5 (17.3)	48.60 (23.8)	64.60 (26.3)
0.225(SC formulation)	60.75(51.6)	185.2 (22.4)	27.10 (57.5)	35.00 (60.1)
P value	*	*	*	*
$LSD_{0.05}$	28.85	20.2	21.8	32.06

* Denotes significant differences at $P<0.05$, WG-Wettable Granular, SC-Suspension Concentrate; [1] Brackets show % control relative to the untreated control

Grass Weeds Control

The plots showed infestation with rapoko grass (*Eleusine indica*), couch grass (*Cynodon dactylon*), foxtail species (*Setaria geniculata*), large crab grass (*Digitaria sanguinalis*), barnayard grass (*Echinochloa crus-galli*), among other grasses. Grass weed control at 4WAP was different ($P<0.05$) from the control only for the SC formulation at 0.165, 0.185, and 0.255 kg/ha but was poor. The SC formulation at 0.185 and 0.225 kg/ha gave better grass weed control at 4WAP than the standard WP formulation. A similar trend was apparent also at 8WAP with only herbicide treatments of the SC formulation at 0.165, 0.185 and 0.225 kg/ha giving superior ($P<0.05$) weed control than the control and the WP formulation and the SC formulation at 0.0205 kg/ha controlling grasses poorly (Table 1). Like in the case of broadleaved weeds, there was poor control of grass weeds.

Nutsedge Control

The plots were mainly infested with yellow nutsedge *(Cyperus esculentus).* At 4WAP all herbicide rates and formulations gave excellent ($P<0.05$) nutsedge control compared to the control (Table 2). The herbicides rates did not differ with regards to efficacy (Table 2). The control at 8WAP was the same as at 4WAP (Table 2). In general nutsedge control was very good (Table 2). Early post emergence nutsedge control was evident in all herbicide treatments regardless of dose and formulation.

Table 2: Mean Total Dry Yellow Nutsedge Weed Counts (/M²) at Six Rates of Sulfentrazone in Tobacco Cultivar T66 at 4 and 8WAP

	Yellow nutsedge counts		Total weed dry Mass (g/m²)
Herbicide level ka/ha	**4WAP**	**8WAP**	**8WAP**
0.00(Untreated Control)	59.25	74.5	126.75
0.225(WG formulation)	8.35(85.9)[1]	8.95 (88.0)	48.95 (61.4)
0.165(SC formulation)	7.10(88.0)	10.82 (85.5)	46.40 (63.4)
0.185(SC formulation)	8.75(85.2)	10.90 (85.4)	33.30 (73.7)
0.205(SC formulation)	8.75(85.2)	14.20 (80.9)	42.35 (66.6)
0.225(SC formulation)	11.60 (80.4)	13.00 (82.6)	23.50 (81.5)
P value	*	*	*
$LSD_{0.05}$	14.5	18.2	54.6

* denotes significant differences at $P<0.05$, WG-Wettable Granular, SC-Suspension Concentrate; [1] Brackets show % control relative to the untreated control.

Total Weed Dry Mass

The total weed dry mass was a composite measurement of all the weeds and showed the general trend which had been depicted by the weed counts. Herbicides showed significantly ($P<0.05$) lower mass than the untreated control. All rates and formulations did not differ from each other in terms of dry mass (Table 2). Overall, with regards to dry matter, weed control efficacy was satisfactory only with the SC formulation at 0.185 and 0.225 kg a.i. /ha.

Discussion

Broadleaf Weeds Control

The common broadleaf weeds encountered included upright statbur (*Acanthospermum hispidum),* Khakibos *(Tagetes minuta),* Wandering Jew *(Commelina benghalensis),* Mexican clover *(Richardia scabra),* Fat hen *(Chenopodium album),* Pig weed (*Amaranthus hybridus), Portulaca oleracea*, *Hibiscus museei,* and Black Jack (*Bidens pilosa),* Billygoat weed (*Ageratum conyzoides)* while the grasses included *Rottboliea conchichinensis*, *Setaria pumula*, and *Eleusine indica*. In essence, both broadleaf and grass weed control was unsatisfactory regardless of herbicide rate and formulation (Table 1). On average, at 4WAP, broad leaf control was about 53% while at 8WAP it was about 21% relative to the untreated control. In addition, increasing rates of sulfentrazone did not give increasing broadleaf control. Apart from the poor control, this data also suggest that sulfentrazone was not persistent in the case of broadleaf control and further, that a change in formulation did not improve efficacy.

Bailey et al. 2002 and Clewis et al. 2007 reported poor control of ragweed, a broadleaf weed. In similar work utilizing rates from 0.14 to 0.28 kg a.i. /ha Grey et al. 2009 reported excellent broadleaf control, again, at rates higher than those we used.

Grass Weeds Control

On average grass control at 4WAP was about 39% and virtually unchanged (43%) at 8WAP. Grass control was both persistent and poor. Good control of grasses reported by Bailey et al. 2002, was at rates much higher (0.28 kg a.i./ha) than those used in this work, implying perhaps that the reduced rates used in this work could have been well below the threshold for grass control. Indeed, Grey et al. 2009 reported that grass control increased with increasing rate from 0.14 to 0.28 kg a.i. /ha. Very poor control has been reported by Grichar et al. 2006, while Mazarura, 1999 also noted variable grass control in similar plots as those reported in the present study. Clewis et al. 2007 showed improved grass control only when sulfentrazone was mixed with other herbicides. Peedin (1996) also reported that sulfentrazone was relatively weak on several grass species.

Nutsedge Control

Control of nutsedge, primarily yellow nutsedge, since this was the only sedges observed in the plots, was excellent for all rates of sulfentrazone irrespective of formulation. This control was also persistent up to 8WAP. Grey et al. 2009 reported 83% yellow nutsedge control by rates ranging from as little as 0.112 to 0.28 kg a.i. /ha. Work by Grichar et al. 2006 showed that yellow nutsedge was dependent on both site and method of application, with pre-plant incorporation giving better control than pre-emergent applications. In addition, 0.11 kg a.i. /ha gave at least 93% control in one site while giving no better than 65% control in another site. Such site depended response, is however not uncommon as herbicide control depends on many factors which include, soil clay content, organic content, soil pH and other factors. Kopec and Gilbert (2001) also reported high levels of nutsedge control by sulfentrazone. Similar results were given by Mazarura, 1999.

Total Weed Dry Mass

Overall weed control with regards to total weed dry mass was satisfactory only with the SC formulation at 0.185 and 0.225 kg a.i. /ha. This observation shows, however, the overriding effect of the excellent yellow nutsedge control as reported by Mazarura, 1999, Kopec and Gilbert, 2001, and others.

Conclusions and Recommendations

These studies show that the two formulations had excellent nutsedge control at all the tested rates. However, grass and broadleaf control was very poor at the rates tested. It is thus apparent that, while the change in formulation did not compromise weed control, it also did not increase efficacy, effectively ruling out the possibility of using reduce rates. Further work must test possible herbicide mixtures in order to improve grass and broadleaf control. Regardless of the poor grass and broadleaf control, this herbicide targets a very important niche when one considers the importance of nutsedge in tobacco production in the country and indeed the region. Further, the ability by this herbicide to control nutsedge after emergent is a unique property that is not shared by many tobacco herbicides.

References

Bailey, W. A., Wilson, H. P. & Hines, T. E. (2002). Response of Potato (*Solanum tuberosum*) and Selected Weeds to Sulfentrazone 1. *Weed technology*, 16(3), 651–658.

Becerril, J. & Duke, S. O. (1989a). Acifluorfen effects on intermediates of chlorophyll synthesis in green cucumber cotyledon tissues. *Pesticide Biochemistry and Physiology*, 35(2), 119–126.

Becerril, J. M. & Duke, S. O. (1989b). Protoporphyrin IX Content Correlates with Activity of Photobleaching Herbicides. *Plant physiology*, 90(3), 1175–1181.

Camper, N. D. (1986). Research methods in weed science, 3rd ed. Southern Weed Science Society . pp 37

Chivinge, O. A. (1984). The role of herbicide technology in the small scale farms of Zimbabwe, *Zimbabwe Agricultural Journal* 81(3): 97-102

Clewis, S. B., Everman, W. J., Jordan, D. L. & Wilcut, J. W. (2007). Weed management in North Carolina peanuts (Arachis hypogaea) with S-metolachlor, diclosulam, flumioxazin, and sulfentrazone systems. *Weed Technology*, 21(3), 629–635.

Grey, T. L., Bridges, D. C. & Brecke, B. J. (2009). Response of Seven Peanut (*Arachis hypogaea*) Cultivars to Sulfentrazone1. Available at: http://www.wssajournals.org/perlserv/?request=get-abstract&doi=10.1614%2F0890-037X(2000)014%5B0051%3AROSPAH%5D2.0.CO%3B2 [Accessed December 21, 2012].

Grichar, W. J., Besler, B. A. & Dotray, P. A. (2006). Weed control and peanut (*Arachis* *hypogaea*) response to sulfentrazone. *Crop Protection*, 25(8), 753–757.

Hulting, A. G., Wax, L. M., Nelson, R. L. & Simmons, F. W. (2001). Soybean (*Glycine max*(L.) Merr.) cultivar tolerance to sulfentrazone. *Crop protection*, 20(8), 679–683.

Kopec, D. M. and Gilbert, J. J. (2001). Sulfentrazone effects on purple nutsedge. Turfgrass and ornamental research report. University of Arizona College. http://ag.arizona.edu/pubs/crops/az/1246

Mazarura U. (1999). A new herbicide for nutsedge and some broadleaf weeds, *Zimbabwe Tobacco,* 8, 41-43.

Paunescu, A. D., Cirnicia, M., Paunescu, M. and Udrescu, E. (1992). Chemical control of the weeds on the fields of Oriental type tobacco in Rumania, *CORESTA* publication p.136

Peedin, G. F. (1996). Flue-Cured Tobacco, North Carolina State University, Raleigh, USA. pp 17-23

Riggle B. D. and Penner, D. (1990). The use of controlled release technology for herbicides, *Reviews of Weed Science*, 5, 1-14.

Stocks, J. L. (1994). Flue-cured tobacco production in Zimbabwe, *CORESTA Zimbabwe*, pp. 205-209.