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EFFECT OF DICAMBA ON THE CONTROL OF *STRIGA HERMONTHICA* IN MAIZE IN WESTERN KENYA

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ABSTRACT

Dicamba (2-methoxy-3,6-dichlorobenzoic acid) has been shown to be effective in controlling *Striga asiatica* in maize in the USA. Experiments were therefore conducted from 1990 to 1992 to evaluate its effectiveness against *S. hermonthica* in Western Kenya. Dicamba was more effective when applied at the rate of 0.75 kg a.i. ha^{-1} compared to 0.50 kg a.i. ha^{-1}. Applying dicamba over the top of maize plants or post-directing it to the lower plant part did not significantly affect its effectiveness. Application at 30 days after planting was not as effective as delaying the application to 45 days after planting. Crop injury was observed early in a few cases, though the affected plants later recovered and yield was not affected. Dicamba was not persistent as *Striga* emerged later in the season. Although dicamba can provide some control early in the season, its low persistence implies that other control measures need to be integrated with it to avoid subsequent seed production by the *Striga* plants that germinate later in the season.

Key Words: **Dicamba, maize, *Striga hermonthica***

RÉSUMÉ

Le dicamba (acide 2-methoxy-3, 6-dichlorobenzoïque) a été montré d'être efficace pour le contrôle de *Striga asiatica* chez le maïs aux Etats-Unis. A ce sujet, des expériences ont été effectués entre 1990 et 1992 pour l'évaluation de son efficacité contre *S. hermonthica* au Kenya occidental. Une dose de 0.75 kg m.a. ha^{-1} était plus efficace qu'une dose de 0.55 kg m.a. ha^{-1}. L'application du dicamba sur la partie apicale de la plante ou la partie basale de la plante n'améliorait pas l'efficacité d'une façon significative. L'application 30 jours après plantation était moins efficace que de retarder l'application jusqu'à 45 jours après plantation. Dans quelque cas, des dégâts ont été observé sur la plante, ces plantes se rétablissaient et la productivité n'était pas affectée. Le dicamba n'était pas persistant si le *Striga* apparaissant plus tard dans la saison. Bien que le dicamba puisse offrir une protection au debut de la saison, la persistance limitée implique qu'il doit être combiné avec d'autres mesures de contrôle afin d'éviter la production de graines par les plantes atteintes par le *Striga*, qui germent plus tard dans la saison.

Mots Clés: **Dicamba, le maïs, *Striga hermonthica***

INTRODUCTION

Striga hermonthica (Del.) Benth. is an important weed of maize in western Kenya. It limits maize production in heavily infested areas (Ivens, 1967). *Striga* is difficult to control especially with existing crop production technology used by the small-scale farmers of eastern Africa. Much of the deleterious effects of *Striga* on the host crop is exerted before its emergence from the soil, making hand-weeding, the traditional form of weed control, ineffective.

One control option widely applied in the USA is the use of herbicides. Both pre- and post-emergence herbicides have been tested (Eplee and Norris, 1987); however, some of the herbicides do not act on *Striga* until it emerges and are therefore only effective in reducing seed multiplication.

Dicamba is one of the herbicides found to be effective against *S. asiatica* in the U.S.A. (Eplee and Norris, 1987). Langston *et al.* (1991) found that it provided good top kill as well as some degree of subterranean control for 3-8 weeks when applied post-emergence to *Sorghum bicolor*. However, it was not as effective when used in maize (*Zea mays*). Since it is applied post-emergence to maize, its effectiveness could be influenced by the time of application relative to the time of *Striga* attachment (Sand *et al.*, 1971) and the rate applied. At higher rates, it has been shown to cause toxicity and reduce root growth in maize (Hahn *et al.*, 1969).

Previous work has also shown that placement method of dicamba influences its effectiveness. Ransom *et al.* (1990) observed the superiority of control of *Striga asiatica* for the soil-applied and over-the-top (OTT) placement methods compared to the post-directed (PD) placement methods. Awad *et al.* (1991) found that the majority of dicamba absorbed by the foliage remained in sorghum or maize shoot, but some was translocated to the roots in sufficient quantity to kill attached *Striga* seedlings.

The objective of this research was to determine the effect of rate, time and placement method of dicamba on its effectiveness against *Striga hermonthica* in maize in Western Kenya.

MATERIALS AND METHODS

Field experiments were conducted at the Alupe Research sub-centre (Busia) (orthic Ferrasols; partly petro-feric phase; with orthic Acrisols) during the long and short rains of 1990. During the long rains of 1991, the National Sugar Research Centre (N.S.R.C)-Kibos (vetro-eutic Planosols) and a farmers' field at Bumala (Busia) (rhodic Ferrasols) were used as sites. In 1992—Kibos was used during the long rains while the Alupe site was used in both the long and the short rains.

The experiment in 1990 consisted of two rates (0.28 and 0.56 kg a.i. ha^{-1}) of dicamba (2-methoxy-3, 6-dichlorobenzoic acid), two application times (4 and 6 weeks after maize planting) and three placement methods (over-the-top; post-directed, and soil-applied) as a 2 x 2 x 3 complete factorial combination. In 1991 and 1992, the soil-applied placement method was deleted creating a 2 x 2 x 2 factorial design and the two rates were raised to 0.50 and 0.75 kg a.i. ha^{-1}. All the dicamba treatments were applied with a hand-pump backpack sprayer using a solution volume of 400 l ha^{-1}. The design was a randomized complete block with three replications. The treatments are shown in the Tables.

Plots at Kibos consisted of five rows while those at Alupe and Bumala consisted of six rows all of 5 m length. Hybrid maize (H512 during the long rains and H511 during the short rains) was hand-planted. A spacing of 75 cm x 50 cm was used resulting in a population of 53,000 plants ha^{-1}. At planting, furadan was applied in the maize planting holes. Fertilizer was applied at the rate of 40 kg N and P_2O_5 ha^{-1}. Dipterex was applied to control late stalkborer attack at about 4 weeks after planting.

Striga counts were taken from the centre rows of each plot, after the first emerged *Striga* was observed, and were continued at bi-weekly intervals until maize maturity. The counts were then converted to *Striga* density per square metre. Where the infestation was moderate, maize was harvested from the centre rows and grain yield determined and weight (ton ha^{-1}) adjusted to 15% moisture content.

The data were subjected to analysis of variance and significant interaction or main effect means were separated using the Least Significant Difference (L.S.D.) at $P \leq 0.05$.

RESULTS AND DISCUSSION

Field plots used for these experiments had a very high level of *S. hermonthica*. The severity of infestation, however, varied with site, season and year. This was expected as *Striga* seed conditioning is necessary before germination takes place, and conditioning depends on environmental conditions which change from season to season.

Striga density was significantly effected by the rate of dicamba applied (Tables 2,4,5 and 6) in all sites/years except two (Tables 1 and 3). In the site/years with significant differences, dicamba applied at the rate of 0.75 kg ha^{-1} was more effective than that applied at 0.50 kg ha^{-1}. Ransom *et al.* (1990) also observed greater effectiveness from their highest rate (for their experiments 0.50 kg ha^{-1} of dicamba).

To be effective, the time of dicamba application should coincide with the peak in *Striga* germination and attachment. This is especially important due to the fact that the chemical has low persistence in the soil and in the crop plant. In these experiments,

TABLE 1. Effect of rate, application time and placement method on *Striga* density at three counting dates and maize yield at Alupe, Kenya, 1990[a].

	Striga density (plants m^{-2})			
	count 1	count 2	count 3	Yield[b] (Ton ha^{-1})
Application rate (kg a.i. ha-1)				
0.28	7	19	27	1.12
0.56	10	23	33	1.10
Application time (plant height)				
55 cm	9	24	31	1.08
80 cm	8	19	29	1.14
Placement method				
OTT	6	18	29	0.91
PD	9	19	25	0.86
SA	10	27	35	1.57
Control	6	19	34	1.01
C.V.(%)	90	75	93	26.0

[a]Means followed by the same letter are not statistically different (P> 0.05);
OTT = Over-the-top; PD = Post-directed; SA = Soil-applied
[b]Maize grain yield results only for short rains of 1990.

TABLE 2. Effect of rate, application time and placement method on *Striga* density and maize yield at Kibos, Kenya, during the long rains of 1991[a].

	Striga density (plants m^{-2})				
	14 May	28 May	11 June	25 June	Yield (Ton ha^{-1})
Application rate (kg a.i. ha^{-1})					
0.50	17a	47a	53a	16	1.55
0.75	5b	17b	18b	7	2.15
Application time (plant height)					
4 WAP	6b	20	29	15	1.90
6 WAP	16a	23	19	8	1.80
Placement method					
OTT	8	24	25	15	1.86
PD	6	19	22	9	1.84
Control	48	88	41	13	1.12
C.V.(%)	90	75	93	26.0	34

[a]Means followed by the same letter are not statistically different (P> 0.05);
OTT = Over-the-top; PD = Post-directed; WAP= Weeks after planting.

TABLE 3. Effect of rate, application time and placement method of dicamba on *Striga* density at Bumala, Kenya, during the long rains of 1991[a].

	Striga density (plants m^{-2})		
	10 May	28 May	7 June
Application rate (kg a.i. ha^{-1})			
0.50	20	59	163
0.75	12	61	178
Application time			
4 WAP	25	67	219a
6 WAP	8	54	122b
Application method			
OTT	18	59	161
PD	15	62	180
Placement time x method			
4WAP OTT	27	65	182ab
4WAP PD	22	72	256a
6WAP OTT	9	56	140b
6WAP PD	7	51	104b
Control	23	88	194ab
C.V. (%)	75	93	26.0

[a]Means followed by the same letter are not statistically different (P> 0.05);
OTT = Over-the-top; PD = Post-directed; WAP = Weeks after planting.

dicamba applied at 6 WAP consistently reduced *Striga* density to a greater extent than applications at 4 WAP (Tables 2, 3, and 5). Where the reduction was not significant (Tables 1, 4, and 6), applications at 6 WAP were still slightly more effective. In earlier experiments with *S. asiatica* however, greater effectiveness of dicamba was observed when applied earlier in the season (Ransom *et al.*, 1990).

Dicamba can be translocated through the plant, besides its movement through the soil. Method of application could therefore have an effect on its efficiency in reducing *Striga* infestation. In all the sites/years, there was no significant effect of placement method on *Striga* density, although, applications over the top of the plant or post directed were slightly more effective than soil applications (Table 1). Hahn *et al.* (1969) and Ransom *et al.* (1990) observed greater control when dicamba was soil applied. Since crop injury due to dicamba is of major concern, OTT applications might be a problem for farmers, though very little injury was noted with the date of application and rates used in these experiments.

Although method of application did not significantly influence effectiveness of dicamba, there was a time by method interaction in some sites/years (Tables 3 and 4). There was no consistency in the interaction between the sites. In the case of Bumala (Table 3), the interaction was due to a significant decrease in *Striga* density when dicamba was post-directed at 6 weeks after planting (WAP) compared to post-directed at 4 WAP. This could have been due to inadequate rainfall to move the chemical down the soil profile at the 6 WAP application. At the Alupe site (Table 4), there was a greater reduction in *Striga* density from the OTT application at 6WAP than at 4 WAP. This was also reflected in a significantly higher grain yield with OTT at 6 WAP compared to the OTT at 4 WAP.

The results varied somewhat from season to season, indicating that the efficacy of dicamba is related to the prevalent environmental conditions. This is not surprising since the timing of *Striga* attachment is dependant on environmental factors. It does indicate, however, that the use of dicamba will be somewhat risky, and therefore a problem for the risk-adverse small-scale farmers of Africa. The lack of a consistent yield response to the application of dicamba is a further concern, since without a yield response there would be no

TABLE 4. Effect of rate and application time of dicamba on *Striga* density and maize yield at Alupe, Kenya, during the long rains of 1992.

	Striga density (plants m^{-2})			
	10 May	28 May	7 June	Yield (Ton ha^{-1})
Application rate (kg a.i. ha^{-1})				
0.50	24a	33a	33a	1.53
0.75	2b	11b	14b	1.58
Application time				
4 WAP	14	25	25	1.43
6 WAP	12	18	22	1.68
Application method				
OTT	15	24	25	1.44
PD	12	20	22	1.68
Placement time x method				
4WAP OTT	22a	33a	31	1.15b
4WAP PD	7b	18b	20	1.72a
6WAP OTT	8b	15b	19	1.72a
6WAP PD	16a	22ab	24	1.65a
Control	28	43	29	1.22
C.V.(%)	146	46	37	

Means followed by the same letter are not statistically different ($P > 0.05$);
OTT = Over-the-top; PD = Post-directed; WAP = Weeks after planting.

TABLE 5. Effect of rate, time and placement method of dicamba on *Striga* density and maize grain yield at Kibos, Kenya, during the long rains of 1992.

	Striga density (plants m^{-2})				
	6 May	20 May	3 June	17 June	Yield (Ton ha^{-1})
Application rate (kg a.i. ha^{-1})					
0.50	3	26a	61	56	2.73
0.75	1	14b	40	66	2.15
Application time					
4 WAP	3	25a	59	60	2.31
6 WAP	1	14b	42	62	2.58
Application method					
OTT	1	21	51	51	2.52
PD	2	19	50	71	2.37
Control	8	40	59	49	0.98
C.V. (%)	99	61	66	64	57

Means followed by the same letter are not statistically different ($P > 0.05$);
OTT = Over-the-top; PD = Post-directed; WAP = Weeks after planting.

incentive to invest in its use. Based on the information from these experiments, we would not recommend that dicamba be promoted as a viable *Striga* control option for the farmers in western Kenya.

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Table 6. Effect of rate, application time and placement method of dicamba on *Striga* density and yield at Alupe, Kenya, during the short rains of 1992.

	Striga density (plants m^{-2})			
	19 November	3 December	14 December	Yield (Ton ha^{-1})
Application rate (kg a.i. ha^{-1})				
0.50	06a	19a	21a	1.24
0.75	01b	07b	09b	1.24
Application time				
4 WAP	4	14	16	1.24
6 WAP	2	12	14	1.24
Application method				
OTT	3	12	14	1.08a
PD	4	14	16	1.40b
Control	4	9	9	1.22
C.V.(%)	99	49	51	30.0

Means followed by the same letter are not statistically different (P> 0.05);
OTT = Over-the-top; PD = Post-directed; WAP = Weeks after planting.

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