BAY NTN 6867 PERFORMANCE TEST FOR WEED CONTROL IN GRAIN SORGHUM (*Sorghum bicolor* Moench.)

by

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B.S., Horticulture, College of Agriculture
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A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

IN CROP PROTECTION

KANSAS STATE UNIVERSITY
Manhattan, Kansas

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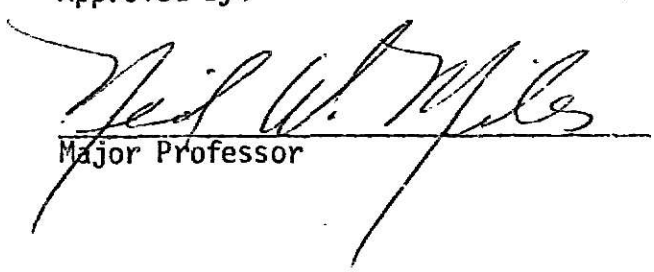
Approved by:



Major Professor

BAY NTN 6867 experimental herbicide is a product of Chemagro Division of Mobay Chemical Corp., P.O. Box 4913, Hawthorn Road, Kansas City, Missouri 64120.

The research summarized in the following report was conducted on land leased by Chemagro, and all pesticides and equipment used in the experiment were furnished by Chemagro.

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INTRODUCTION

Broadleaf and grassy weeds are a major limiting factor in grain sorghum (Sorghum bicolor Moench.) production. Several commercially available and practical herbicide materials control broadleafed weeds in grain sorghum, but the number of materials available for control of grassy weeds is limited.

Control of "grassy weeds" in grain sorghum is difficult, since both weeds controlled and crop protected are graminaceous. The basis for selectivity between closely related species of monocots is small in comparison to the basis of selectivity for controlling dicots in a monocot crop.

An experimental herbicide, BAY NTN 6867 (O-Methyl O-(4-methyl-2-nitrophenyl) (1-methylethyl) phosphoramidothioate), a product of Chemagro Division of Mobay Corp. shows promise for grassy weed control in grain sorghum. This report summarizes information on a sorghum weed control study evaluating BAY NTN 6867 for control of giant foxtail (Setaria faberii Herrm.), and suppression of populations of redroot pigweed (Amaranthus retroflexus L.) and smooth pigweed (Amaranthus hybridus L.) in grain sorghum.

METHODS AND MATERIALS

Design of experiment

Field plots were established in the spring of 1975 at the Carl Spray farm, Lawrence, Kansas. The plot site was 72m X 27.5m and individual plots were 9.75m X 3.05m (4 crop rows). A randomized block design and three replications were used (Figure 1).

On April 29, 1975, the site was fertilized at the rate of 157 kg/ha nitrogen (as 34% ammonium nitrate). The fertilizer was incorporated by discing twice with an offset disc, and harrowing to level the soil. No phosphorus or potassium fertilizers were added since the available phosphorus and potassium were greater than 200 lbs/A and 400 lbs/A, respectively. The soil was a silty clay loam, pH 6.8, and 2.5 percent organic matter.

Herbicide treatments

Three methods of herbicide application were employed: preplant incorporated (PPI), preemergence surface applied (PRE), and post-emergence (POST). All treatments were applied using a push type bicycle plot sprayer with a carbon dioxide propellant source. Applications were made at 45 psi. using Teejet 8004 spray tips. The sprayer was calibrated to apply 336.7 l/ha of liquid mixture. POST applications were made with X-77 spreadersticker added to sprayer tank at 20 ppm.

On May 20, 1975 all PPI treatments (Table 1) were applied and incorporated using an eight foot mounted tandem disc, set at 10 cm penetration depth for 5 cm incorporation.

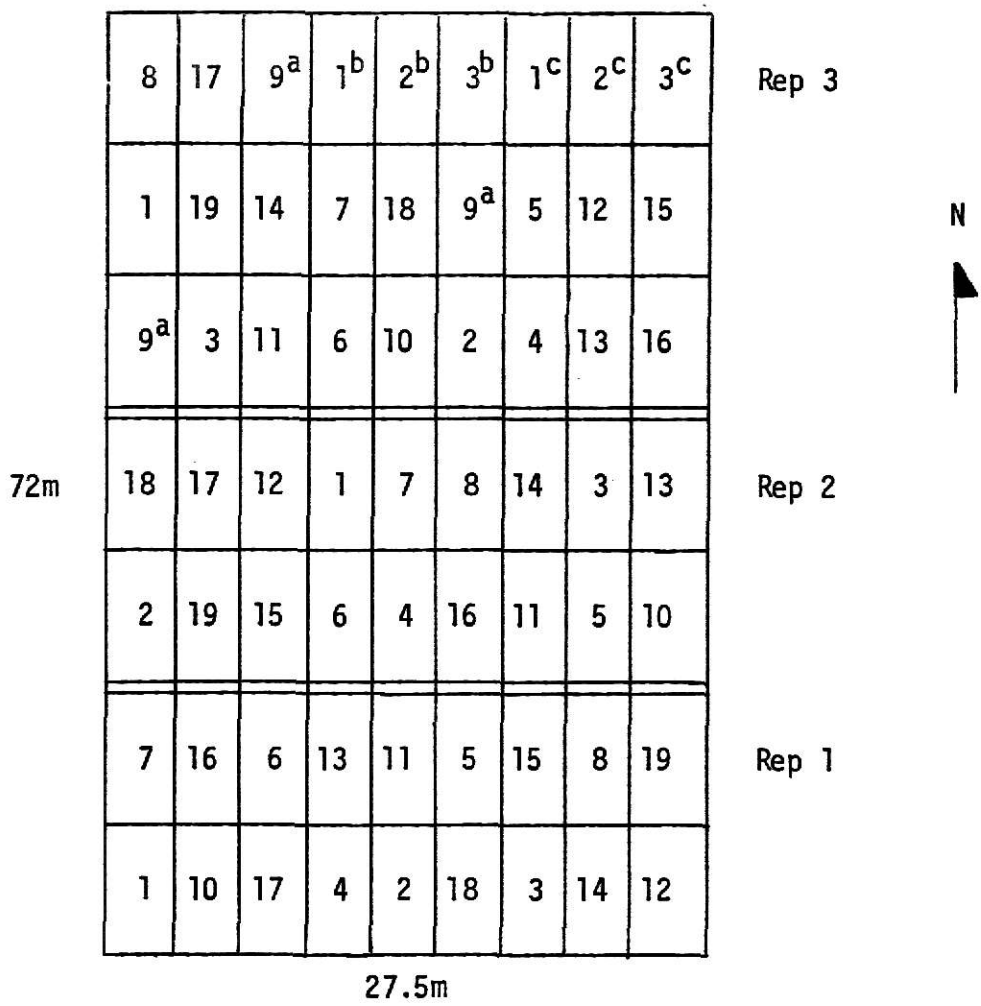

Figure 1. Experimental plot layout. Numbers in squares correspond with code numbers assigned to treatments described in Table 1.

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[a]Treatment 9 was inadvertently misplaced in the plot layout.

[b]Treatments 1, 2, and 3 are nonreplicated rates of 11.20, 13.44, and 17.92 kg/ha, respectively, of BAY NTN 6867 as a preemergence surface application for phytotoxicity study.

[c]Treatments 1, 2, and 3 are nonreplicated rates of 11.20, 13.44, and 17.92 kg/ha, respectively, of BAY NTN 6867 as a preplant incorporated application for phytotoxicity ratings.

Table 1. Chemical, method and rate of application of herbicide treatments.

Treatment number	Herbicide	Method of application	Rate kg/ha A.I.
1.	BAY NTN 6867*	Pre[1]	2.24
2.	BAY NTN 6867	Pre	3.36
3.	BAY NTN 6867	Pre	4.48
4.	BAY NTN 6867	Pre	6.72
5.	BAY NTN 6867	PPI[2]	2.24
6.	BAY NTN 6867	PPI	3.36
7.	BAY NTN 6867	PPI	4.48
8.	BAY NTN 6867	PPI	6.72
9.	BAY NTN 6867	Post[3]	2.24
10.	BAY NTN 6867	Post	3.36
11.	BAY NTN 6867	Post	4.48
12.	BAY NTN 6867	Post	6.72
13.	AAtrex**	Pre	1.80
14.	Weedy Check		
15.	Hand Weed Check		
16.	Ramrod Atrazine***	Pre	4.64
17.	BAY NTN 6867 + AAtrex	Pre-TM[4]	2.24 + 1.80
18.	BAY NTN 6867 + AAtrex	Pre-TM	3.36 + 1.80
19.	BAY NTN 6867 + AAtrex	Pre-TM	4.48 + 1.80

*BAY NTN 6867 is formulated as a 2.5 lb./gal. emulsifiable concentrate.

**AAtrex is a registered trademark of Ciba-Geigy Corp. for atrazine selective herbicide for grain sorghum. Formulation used was a 4 lb./gal. flowable.

***Ramrod/Atrazine is a registered trademark of the Ag Chemical Division of Monsanto Chemical Co. for package mix of Ramrod selective herbicide for grass control in certain crops, plus Atrazine for control of selected broadleaf weeds. Formulation used was a 65 percent wettable powder.

[1]Preemergence surface application of herbicide material.

[2]Preplant incorporation of herbicide.

[3]Postemergence application of herbicide.

[4]Materials applied as preemergence surface applied tank mix.

Following these treatments, Dekalb E-59 hybrid grain sorghum was planted at the rate of 6.67 kg/ha. Disyston 15G[1] insecticide was applied at planting time at 1.12 kg/ha in an 18 cm band over the row. All PRE applications were made immediately following planting (Table 1).

On June 12, 1975 the POST treatments were applied to the established stand of sorghum and existing weed populations (Table 1).

Parameters evaluated

Data were taken for crop plants per meter, crop stunting, percent early and late foxtail and pigweed control, and yield of grain in kilograms per hectare. All data were taken from the center two rows of individual plots.

Stand counts, taken June 30, 1975, were an average of plants per meter for three counts per plot.

Crop stunting was a combined rating for the degree of stunting which appeared in the plot and the percentage of plants which were stunted. Degree of stunting was an evaluation of plant height variation among plots from which six height categories were developed. The stunting index, 1 through 6, was transformed to a percentage figure and multiplied by the percentage of the plot affected. This value expressed the relative amount of stunting in the plot.

Ratings for early and late season foxtail and pigweed control were based on visual observations of percent control achieved. The early season rating was made on June 30, 1975 and late season rating on

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[1]Disyston is a registered trademark of Chemagro Division of Mobay Chemical Corp.

August 8, 1975. The two species of pigweed were combined into one control category.

Yield data were taken on all plots by hand harvesting grain panicles and threshing with a stationary plot thresher.

Statistical treatment

Analysis of variance was run on all data and means of the three replications recorded in tables. Significance was calculated at .05 level. Fisher's least significance difference test (LSD) was used to compare means.

RESULTS AND DISCUSSION

Replication effect

Replications effect, Table 2, was significant. Replication effect on weed control primarily was due to differences in weed population pressures.

Since stunting and stand were not significantly effected by replication, differences in weed control and yield in the experiment were a result of changes in weed pressure rather than differences in performance by the herbicides in the experiment at different locations within the plot site.

Table 2. Effect of replication on parameters used to evaluate selected herbicides in grain sorghum.

Replicate	Percent weed control						Crop[1] stunting	Crop stand plants/m	Crop yield kg/ha
	Foxtail			Pigweed					
	Early control %	Late control %	Seasonal average %	Early control %	Late control %	Seasonal average %			
1	70.0^{b}	72.2^{b}	71.1^{b}	79.2^{ab}	60.2^{b}	69.7^{b}	4.84	12.6	2791^{b}
2	80.0^{ab}	91.3^{a}	85.6^{a}	86.8^{a}	76.6^{a}	81.7^{a}	7.68	12.3	3567^{a}
3	90.6^{a}	82.5^{ab}	86.6^{a}	71.6^{b}	76.1^{a}	74.0^{b}	7.26	11.7	2529^{b}
LSD_{05}	15.4	12.2	11.5	8.9	10.0	7.0	N.S.	N.S.	764.7

[1] 0 = no stunting, 100 = extreme stunting (dead plant).

Means within a column with a letter in common are not significantly different at the 0.05 level.

Rate effect

Rate of BAY NTN 6867 had no effect on control of giant foxtail (Table 3). The control of pigweed was rate dependent. At 4.48 kg/ha, control was better than higher or lower rates, indicating a possible peak of activity. There was no difference between 3.36 and 6.72 kg/ha rates. The 2.24 kg/ha rate was least effective for pigweed control.

BAY NTN 6867 at 4.48 kg/ha was shown to significantly reduce the stand of plants per meter below that of 2.24 or 6.72 kg/ha. The yield of grain however does not show a corresponding decrease. This suggests that either the planting rate was too high and 1.91 plants per meter was not a significant stand loss in terms of yield, or the increase in total weed control offset the stand loss.

Table 3. Effect of application rate of BAY NTN 6867 on parameters used to evaluate selected herbicides in grain sorghum.

Rate kg/ha	Percent weed control						Crop[1] stunting	Crop stand plants/m	Crop yield kg/ha
	Foxtail			Pigweed					
	Early control %	Late control %	Seasonal average %	Early control %	Late control %	Seasonal average %			
2.24	71.0	68.1	69.5	64.4[b]	50.6[b]	57.5[c]	4.22	13.00[a]	2002
3.36	79.4	78.1	78.8	76.7[ab]	64.4[ab]	70.6[b]	8.44	11.33[ab]	2319
4.48	79.9	82.5	81.8	90.4[a]	74.9[a]	82.9[a]	11.55	10.44[b]	2959
6.72	72.8	80.3	76.6	76.6[ab]	63.7[ab]	69.6[b]	8.67	12.88[a]	2604
LSD_{05}	N.S.	N.S.	N.S.	14.3	16.2	10.6	N.S.	1.91	N.S.

[1] 0 = no stunting, 100 = extreme stunting (dead plants).

Means within a column with a letter in common are not significantly different at the 0.05 level.

Method of application

The method of application of BAY NTN 6867 had a significant effect on all data (Table 4).

Foxtail control was less where BAY NTN 6867 was applied POST rather than PRE or PPI. Pigweed control was best with POST and poorest with PPI. Since grassy weed control is of primary concern, PRE would be the better application method.

BAY NTN 6867 when applied as a PPI treatment was phytotoxic to the emergence of grain sorghum, showing a significantly greater stand loss than either the PRE or POST application. Crop stunting also was greatest where PPI method of application was employed. This combination of stand loss, crop stunting, and poorer weed control contributed to substantial yield reduction.

Plates 1 and 2 show the effect of the different method and rates of application of BAY NTN 6867 on the rooting characteristics of grain sorghum. Similar effects were noted on foxtail growing in the treated areas. This loss of root system contributed to lodging and loss of yield in POST treated plots located along the south edge of the site where plants faced the prevailing wind.

There were no significant differences in stunting or yield when the POST and PRE method of application were compared. It seems likely that under stress conditions a loss of yield would be experienced as a result of loss of root system experienced with POST method of application.

Table 4. Effect of application method of BAY NTN 6867 on parameters used for evaluation of selected herbicides in grain sorghum.

Method	Percent weed control						Crop[1] stunting	Crop stand plants/m	Crop yield kg/ha
	Foxtail			Pigweed					
	Early control %	Late control %	Seasonal average %	Early control %	Late control %	Seasonal average %			
PPI	91.5[a]	82.6[a]	87.0[a]	47.1[b]	25.8[c]	36.7[c]	22.88[a]	9.33[b]	842[b]
PRE	95.4[a]	90.1[a]	92.8[a]	85.8[a]	68.7[b]	77.3[b]	1.50[b]	12.75[a]	3333[a]
POST	40.4[b]	59.1[a]	50.2[b]	97.4[a]	95.6[a]	96.5[a]	.33[b]	13.67[a]	3238[a]
LSD_{05}	22.4	17.5	16.9	12.4	14.0	9.2	9.87	1.66	1050.2

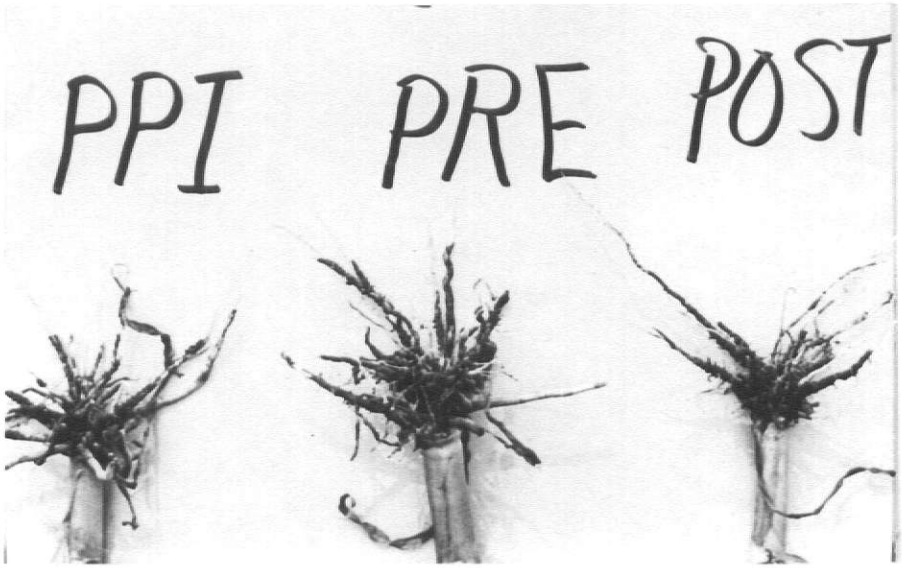
[1] 0 = no stunting, 100 = extreme stunting (dead plants).

Means within a column with a letter in common are not significantly different at the 0.05 level.

Plate 1. Effect of preplant incorporated (PPI), preemergence surface applied (PRE), and postemergence (POST) methods of application and rate of application of BAY NTN 6867 on root growth of grain sorghum.

Top: 2.24 kg/ha BAY NTN 6867

Bottom: 3.36 kg/ha BAY NTN 6867


PPI
PRE
POST

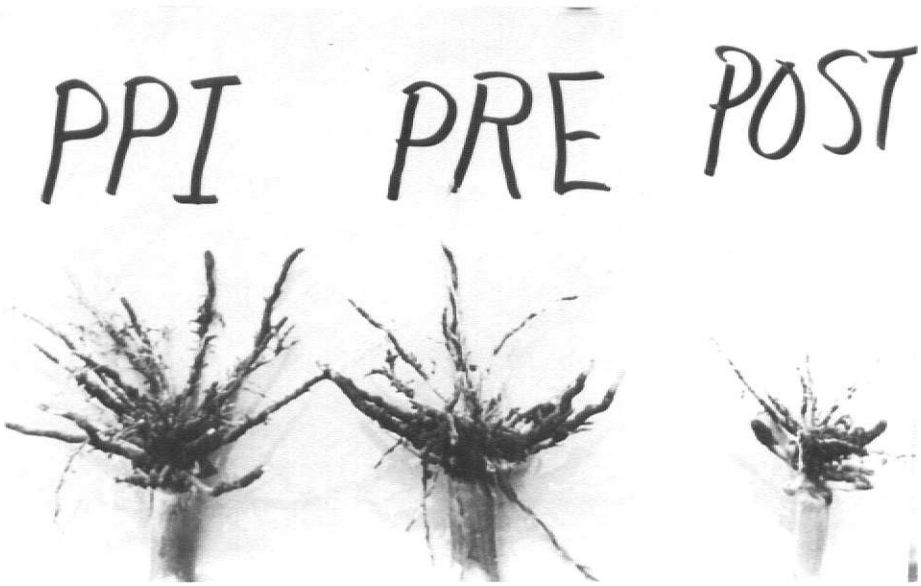
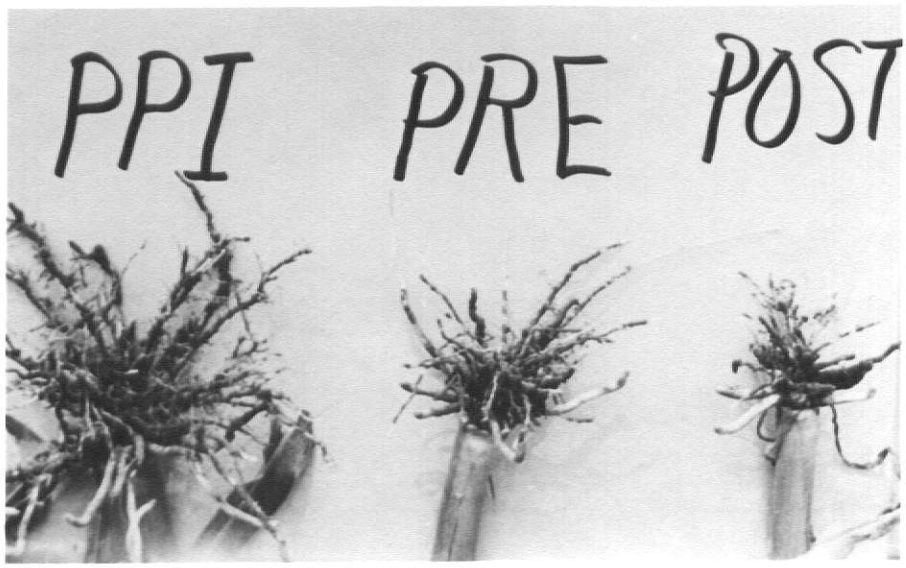
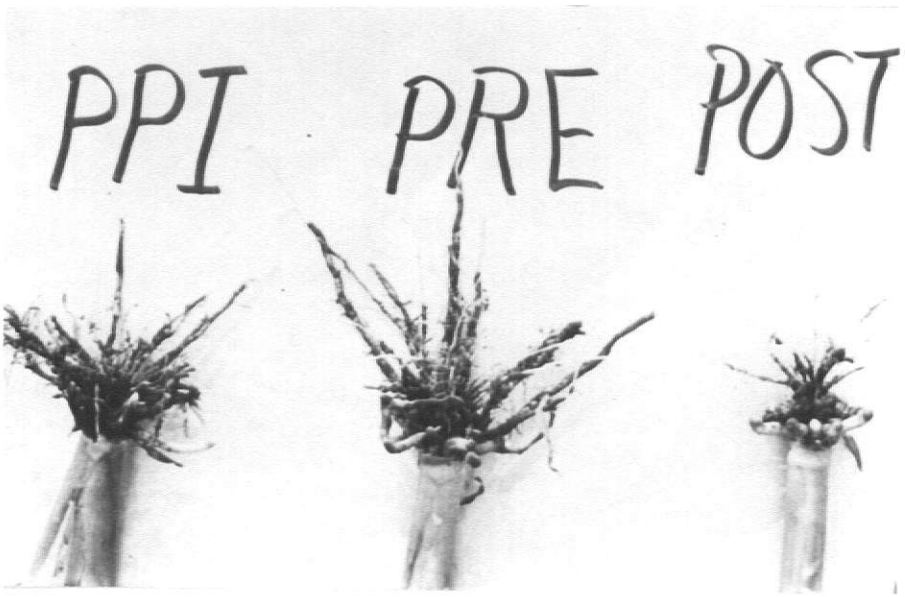

PPI
PRE
POST

Plate 1 (continued)

Top: 4.48 kg/ha BAY NTN 6867

Bottom: 6.72 kg/ha BAY NTN 6867


PPI
PRE
POST


PPI
PRE
POST

Comparison of BAY NTN 6867, standards, and appropriate checks

Results of BAY NTN 6867, alone and in combinations with AAtrex compared with the standard (Ramrod/Atrazine), and appropriate checks are presented in Table 5.

All chemical treatments and the hand weeded check gave significantly better results in all categories except crop stand than the weedy check.

BAY NTN 6867 alone at the 2.24 and 3.36 kg/ha rate showed significantly less late and seasonal pigweed control than either the hand weed or Ramrod/Atrazine plot.

BAY NTN 6867 (2.24 and 3.36 kg/ha) in combination with AAtrex (1.8 kg/ha) gave significantly less early season grass control than either the hand weeded check or Ramrod/Atrazine standard. In late season control only the lower rate showed significantly less foxtail control.

BAY NTN 6867, when used alone at 4.48 kg/ha or in combination with AAtrex, showed no significant differences in performance in any category from either the hand weeded check or the Ramrod/Atrazine standard.

The addition of AAtrex to BAY NTN 6867 did not produce significantly better control of foxtail than was obtained with BAY NTN 6867 alone. Pigweed control was improved significantly by the addition of AAtrex to the 2.24 and 3.36 kg/ha rates of BAY NTN 6867.

Table 5. Effect of BAY NTN 6867, alone and with AAtrex, as a herbicide for grain sorghum.[1]

Trt. no.	Herbicide	Application rate kg/ha	Percent weed control: Foxtail Early control %	Foxtail Late control %	Foxtail Seasonal average %	Pigweed Early control %	Pigweed Late control %	Pigweed Seasonal average %	Crop[2] stunting	Crop stand plants/m	Crop yield kg/ha
1.	BAY NTN 6867	2.24	95.0	86.3	90.7^{+}	80.0	60.0^{+*}	70.0^{+*}	0.0	13.30	2338*
2.	BAY NTN 6867	3.36	96.7	93.0	94.8	81.7	73.3^{+*}	77.5^{+*}	2.0	11.67	3495
3.	BAY NTN 6867	4.48	95.0	96.3	95.7	96.7	76.3	86.5	2.7	11.67	3738
13.	AAtrex	1.80	93.0^{+}	80.0^{+*}	86.7^{+*}	83.3	95.0	89.1	0.0	13.00	4606
14.	Weedy Check	0.00	00.0	38.3^{+*}	18.2^{+*}	00.0^{+*}	00.0^{+*}	00.0^{+*}	24.0^{+*}	14.67	856^{+*}
15.	Hand Weed Check	0.00	100.0	100.0	100.0	100.0	100.0	100.0	0.0	13.30	4167
16.	Ramrod/Atrazine	4.64	99.3	97.7	98.5	100.0	98.0	99.0	1.3	12.30	4931
17.	BAY NTN 6867 AAtrex	2.24 1.80	81.7^{+*}	93.0	87.3^{+*}	100.0	99.3	99.7	0.0	11.67	3947
18.	BAY NTN 6867 AAtrex	3.36 1.80	91.3^{+*}	97.7	94.5	100.0	99.3	99.7	0.0	12.00	4143
19.	BAY NTN 6867 AAtrex	4.48 1.80	95.0	97.7	96.3	100.0	99.3	99.7	1.3	12.30	3981
	LSD_{05}		7.0	15.2	8.8	20.8	24.6	17.3	11.3	N.S.	1858

[1] Only data for PRE method of application is presented to avoid interaction of method in making comparisons.

[2] 0 = no stunting, 100 = extreme stunting (dead plants).

$^{+}$Means different than hand weeded check.

*Means different than Ramrod/Atrazine.

CONCLUSIONS

BAY NTN 6867 (4.48 kg/ha) alone, BAY NTN 6867 (3.36 kg/ha) + AAtrex (1.8 kg/ha) or BAY NTN 6867 (4.48 kg/ha) + AAtrex (1.8 kg/ha), did not differ significantly in performance from Ramrod/Atrazine or the hand weeded check in any category of this experiment for weed control in grain sorghum.

Application rates of BAY NTN 6867 (2.24 to 6.72 kg/ha) did not significantly affect the percentage of foxtail controlled. This range of rates was insufficient to produce differences. Data indicate that a study using lower rates would be necessary to more thoroughly evaluate the activity spectrum of this herbicide.

The amount of pigweed control achieved is rate dependent within the same range. The best control was provided with 4.48 kg/ha.

BAY NTN 6867 is most effective in terms of weed control and yield when used as a preemergent surface applied herbicide. BAY NTN 6867 does not appear to be suitable as a PPI herbicide for grain sorghum. Contradictory evidence gathered in this experiment does not allow a clear conclusion concerning the postemergent use of this product. Yield and pigweed control were good, but foxtail and root pruning effects create some doubt about the feasibility of this type of application.

APPENDIX

Table 1. Precipitation received during weed control evaluation period.

Date		Amount in.
May	23	1.37
	26	.77
	27	.02
	28	.51
	29	.93
	30	.84
June	3	.75
	9	.93
	11	1.23
	17	.37
	21	.02
	22	.19
	23	.09
July	9	.06
	20	.36
	24	.01
August	8	--

Table 2. Climatic and soil moisture conditions at dates of herbicide application.

	Temperature degrees F	Wind MPH	Relative humidity %	Soil moisture
PPI + PRE	85	<5	60	excellent
POST*	75	<2	85	field capacity

*X-77 spreader sticker used to facilitate foliar application.

Table 3. Effect of high rates of application of BAY NTN 6867 on parameters used for evaluation of selected herbicides in grain sorghum.

Method of application	Rate kg/ha	Seasonal foxtail control %	Seasonal pigweed control %	Crop[1] stunting	Crop stand plants/m	Crop yield kg/ha
PRE	11.20	94.5	99.0	24.0	8.67	2639
PRE	13.44	99.5	100.0	36.0	10.30	1667
PRE	17.92	99.5	100.0	54.0	9.00	2292
PPI	11.20	90.0	75.0	40.0	2.67	903
PPI	13.44	95.0	85.0	60.0	1.67	625
PPI	17.92	99.0	95.0	60.0	0.33	69.4

[1] 0 = no stunting, 100 = extreme stunting (dead plants).

Data presented in Table 3 is for nonreplicated treatments at high rates.

ACKNOWLEDGMENTS

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BAY NTN 6867, an experimental chemical of Chemagro division, Mobay Chemical Corp., was tested in the summer of 1975 at Lawrence, Kansas as a herbicide for control of giant foxtail (Setaria faberii Herrm.), and redroot pigweed (Amaranthus retroflexus L.), and smooth pigweed (Amaranthus hybridus L.) in grain sorghum (Sorghum bicolor Moench.).

BAY NTN 6867 was used alone at rates 2.24 - 6.72 kg/ha and in combination with AAtrex in comparison with Ramrod/Atrazine and appropriate checks. The chemicals were applied by three methods: preplant incorporated, preemergence surface applied, and postemergence.

Data were taken for crop plants per meter, crop stunting, percent early and late weed control, and yield of grain per hectare.

The rate of application of BAY NTN 6867 did not significantly effect the percent of foxtail control achieved. The amount of pigweed control obtained was affected by the rate of application of BAY NTN 6867.

BAY NTN 6867 was phytotoxic to grain sorghum emergence when applied as a preplant incorporated herbicide. A corresponding yield reduction resulted.

Preemergence surface application, and postemergence application of BAY NTN 6867 produce the highest yield of grain. However postemergence application does not provide grass control equal to preemergence surface application.

Postemergence application has a root pruning effect on grain sorghum.

BAY NTN 6867 alone (4.48 kg/ha) and in combination with AAtrex (3.36 + 1.8 kg/ha) or (4.48 + 1.8 kg/ha) provide weed control and yields which are not significantly different from Ramrod/Atrazine or the hand weeded check.