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WEED SCIENCE

Monosodium Methanearsonate Influence on Broadleaf Weed Control with Selected Postemergence-Directed Cotton Herbicides

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INTERPRETIVE SUMMARY

Once a height differential between the crop and weeds has been established, growers routinely direct postemergence herbicides underneath cotton foliage. The organoarsenical herbicide, monosodium methanearsonate, is often applied with these herbicides to increase control of emerged broadleaf weeds, grasses, and yellow nutsedge. Improved efficacy by monosodium methanearsonate is species and herbicide dependent. Research conducted in Arkansas from 1989 through 1991 indicated that monosodium methanearsonate improved control of entireleaf morningglory, palmleaf morningglory, pitted morningglory, tall morningglory, and sicklepod when mixed with diuron, fluometuron, lactofen, or oxyfluorfen. Monosodium methanearsonate improved tall morningglory control by cyanazine but had no effect on entireleaf morningglory, palmleaf morningglory, or pitted morningglory control by this herbicide. Monosodium methanearsonate had little effect on hemp sesbania or velvetleaf control. These data suggest that monosodium methanearsonate is an important component in postemergence-directed treatments when *Ipomoea* spp. and sicklepod are present. Although concerns over the development of common cocklebur biotypes resistant to MSMA exist, herbicide options other than organoarsenicals are available to control these biotypes.

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Abbreviations: MSMA, monosodium methanearsonate.

ABSTRACT

Postemergence-directed herbicides are often applied with monosodium methanearsonate (MSMA) to increase control of emerged broadleaf weeds, grasses, and sedges in cotton (*Gossypium hirsutum* L.). Improved efficacy by MSMA is species and herbicide dependent, although this subject has not been fully investigated. Field experiments were conducted in Arkansas from 1989 through 1991 to determine the effect of MSMA on efficacy of cyanazine {2-[[4-chloro-6-(ethylamino)-1,3,5-triazin-2-yl]amino]-2-methylpropanenitrile}, diuron [*N*'-(3,4-dichlorophenyl)-*N*,*N*-dimethylurea], fluometuron {*N*,*N*-dimethyl-*N*'-[3-(trifluoromethyl)phenyl]urea}, lactofen {(±)-2-ethoxy-1-methyl-2-oxoethyl 5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoate}, and oxyfluorfen [2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl)benzene] applied to emerged broadleaf weeds. Cyanazine and MSMA were the most effective individual herbicides for controlling entireleaf morningglory (*Ipomoea hederacea* var. *integriuscula* Gray) and tall morningglory (*I. purpurea* L.). Cyanazine and lactofen controlled palmleaf morningglory (*I. wrightii* Gray) and pitted morningglory (*I. lacunosa* L.) more effectively than the other herbicides. Mixing herbicides with MSMA improved control of all morningglory species; however, MSMA did not improve hemp sesbania [*Sesbania exaltata* (Raf.) Rybd. ex A. W. Hill] or velvetleaf (*Abutilon theophrasti* Medikus) control. Oxyfluorfen, lactofen, and cyanazine were the most effective herbicides on hemp sesbania and velvetleaf. The MSMA was needed for acceptable sicklepod [*Senna obtusifolia* (L.) Irwin and Barneby] control.

Weed management systems in cotton often include a combination of soil-applied herbicides, timely applications of postemergence over-the-top herbicides, postemergence-directed herbicides, and cultivation (Buchanan, 1992; Culpepper and York, 1997; Rhodes et al., 1996; Ridgeway et al., 1984). Although pyrithiobac [2-chloro-(4,5-dimethoxy-2-pyrimidinyl-2-ylthio)benzoate], bromoxynil (3,5-dibromo-4-

hydroxybenzonitrile), and glyphosate [*N*-(phosponomethyl)glycine] can be applied postemergence over-the-top of cotton in certain situations, these herbicides generally need to be supplemented with standard postemergence-directed herbicides (Culpepper and York, 1997; Rhodes et al., 1996). Cotton producers often apply urea or triazine herbicides such as cyanazine, diuron, and fluometuron for contact and residual broadleaf weed control once cotton is tall enough for these herbicides to be directed underneath the foliage. Diphenylether herbicides such as lactofen and oxyfluorfen can also be directed underneath cotton.

Ipomoea spp. are found throughout the Cotton Belt (Dowler, 1995). Although not as widespread, velvetleaf is found in many cotton production regions, especially in the upper Mid-South. Hemp sesbania is found primarily in the Mid-South on alluvial clay soils. Although sicklepod is predominate in the southeastern and mid-Atlantic states, it also infests cotton grown in the Mid-South.

Cotton producers often apply MSMA with cyanazine, diuron, fluometuron, lactofen, or oxyfluorfen to improve control of common cocklebur (*Xanthium strumarium* L.), annual grasses, and yellow nutsedge (*Cyperus esculentus* L.). The effectiveness of MSMA in improving control of other weeds by these herbicides is not fully understood (Harvey et al., 1990; Savoy et al., 1993).

Biotypes of common cocklebur resistant to the organoarsenical herbicides MSMA and DSMA (disodium methanearsonate) have been reported in the Cotton Belt (Haigler et al., 1986; Kempen and Gossett, 1992; Nimbal et al., 1993). Reducing the amount of MSMA applied could decrease selection pressure and lessen the probability of developing resistance. Applying MSMA in combination with other herbicides may also reduce the probability of resistance evolution (Kempen and Gossett, 1992). Determining the influence of MSMA on efficacy of other postemergence-directed herbicides used in cotton would help determine the benefit of MSMA relative to concerns of resistance management. Therefore, research was conducted to determine the effect of MSMA on efficacy of postemergence-directed cotton herbicides applied to seven broadleaf weeds typically found in cotton fields.

MATERIALS AND METHODS

The experiment was conducted once in 1989, four times in 1990, and twice in 1991 on a Captina silt loam soil (fine-silty, mixed, mesic Typic Fragiudalts) at the Main Experiment Station located near Fayetteville, AR, or on a Zachary silt loam soil (fine-silty, mixed, thermic Typic Albaqualfs) at the Cotton Branch Station located near Marianna, AR. Seeds of entireleaf morningglory, palmleaf morningglory, pitted morningglory, tall morningglory, hemp sesbania, velvetleaf, and sicklepod were planted in rows spaced 20 cm apart in conventionally prepared seedbeds. Cyanazine, diuron, fluometuron, lactofen, and oxyfluorfen (hereafter referred to as postemergence-directed herbicides) at rates of 0.84, 0.38, 0.95, 0.24, and 0.28 kg a.i. ha^{-1}, respectively, were applied alone or with MSMA at 1.7 kg a.i. ha^{-1}. MSMA was also applied alone.

Herbicides were applied on a 2-m swath perpendicular to the weed rows 20 to 30 d after planting when weeds had two to six leaves using a CO_2-pressurized backpack sprayer calibrated to deliver 187 L ha^{-1}. A nonionic surfactant (X-77 Spreader, alkylarylpolyoxyethylene glycols, free fatty acids, isopropanol from Valent USA Corp.) at 0.25% (v/v) was included with all treatments. The formulation of MSMA did not contain surfactant. A nontreated check was included.

Visual estimates of weed control were recorded 21 d after herbicide application using a scale of 0 to 100% where 0 = no control and 100 = complete control. The experimental design was a strip plot with herbicide treatments replicated four times. Data were subjected to analysis of variance with basic partitioning for a two (MSMA rate) by five (postemergence-directed herbicides) factorial treatment arrangement for individual weed species. Pooled data are presented for each species. Means were separated using Fisher's protected LSD test at $P = 0.05$.

RESULTS AND DISCUSSION

Tall morningglory and entireleaf morningglory responded similarly to the treatments (Table 1). Cyanazine and MSMA were the most effective herbicides on both species. Compared with the postemergence-directed herbicides alone, MSMA increased control of tall morningglory and entireleaf

Table 1. Influence of MSMA on broadleaf weed control by selected postemergence-directed (POST-directed) herbicides.

POST directed		Morningglory species						
Herbicide	MSMA	Tall	Entireleaf	Palmleaf	Pitted	Hemp sesbania	Velvetleaf	Sicklepod
Cyan†	No	74b*	81a	85a	96a	96a	75abc	69ab
Cyan	Yes	100a	94a	94a	97a	92ab	78abc	92a
Diuron	No	22c	32b	48bc	48d	40e	63c	56bc
Diuron	Yes	98ab	83a	70ab	77abc	61cd	70bc	90a
Fluom	No	23c	43b	42c	52d	51de	33d	67abc
Fluom	Yes	91ab	72a	71ab	79abc	61cd	40d	93a
Lacto	No	40c	42b	67abc	70bcd	98a	85ab	37cd
Lacto	Yes	98a	92a	85a	86ab	99a	80abc	89a
Oxyfl	No	38c	41b	53bc	57cd	77bc	92a	31d
Oxyfl	Yes	99ab	92a	93a	88ab	86ab	88a	92a
None	Yes	90ab	75a	42c	51d	0f	4e	82ab

C Means within a species followed by the same letter are not different according to Fisher's protected LSD test at P = 0.05.
† Abbreviations: Cyan (cyanazine), Diuron (diuron), Fluom (fluometuron), Lacto (lactofen), Oxyfl (oxyfluorfen), and MSMA (monosodium methanearsonate) applied at 0.84, 0.38, 0.95, 0.24, 0.28, and 1.7 kg ha^{-1}.

morningglory by diuron, fluometuron, lactofen, or oxyfluorfen and increased control of tall morningglory by cyanazine. With both species, the herbicide combinations were no more effective than MSMA alone.

Cyanazine was the most effective herbicide on palmleaf morningglory and pitted morningglory although control by cyanazine was not substantially greater than control by lactofen (Table 1). Control by MSMA was similar to that by diuron, fluometuron, lactofen, and oxyfluorfen but less than control by cyanazine. MSMA was less effective on palmleaf morningglory and pitted morningglory than on tall morningglory and entireleaf morningglory. However, MSMA improved control of palmleaf morningglory by fluometuron and oxyfluorfen and pitted morningglory by diuron, fluometuron, and oxyfluorfen.

MSMA controlled hemp sesbania and velvetleaf 4% or less (Table 1). Additionally, MSMA did not affect hemp sesbania or velvetleaf control by cyanazine, fluometuron, lactofen, or oxyfluorfen. MSMA improved hemp sesbania control by diuron but had no effect on velvetleaf control.

Cyanazine and lactofen were the most effective herbicides on hemp sesbania (96–98%), followed by oxyfluorfen (77%) and diuron and fluometuron (40–51%) (Table 1). Cyanazine, lactofen, and oxyfluorfen controlled velvetleaf 75, 85, and 92%, respectively. Control by these herbicides exceeded that by fluometuron. Velvetleaf control by diuron was similar to that by cyanazine but less than control by lactofen or oxyfluorfen.

Sicklepod control by cyanazine, diuron, fluometuron, and MSMA was similar, ranging from 56 to 82% (Table 1). Oxyfluorfen and lactofen controlled sicklepod only 31 to 37%. Poor sicklepod control by lactofen has been reported previously (Brecke, 1996). When applied with MSMA, all postemergence-directed herbicides controlled sicklepod 89 to 93%. However, control by these herbicide combinations was no greater than control by MSMA alone. MSMA is needed for satisfactory sicklepod control in systems using pyrithiobac or bromoxynil (Brown et al., 1996).

Data from these experiments indicate that MSMA is a vital component in postemergence-directed herbicide sprays for morningglory and sicklepod. MSMA also controls yellow nutsedge, common cocklebur, and annual grasses, and it suppresses rhizomatous johnsongrass [*Sorghum halepense* (L.) Pers.] (Buchanan, 1992).

Although populations of organoarsenical-resistant common cocklebur exist, the risk of developing resistant populations from continued use of combinations of MSMA with other postemergence-directed herbicides most likely does not exceed the benefits gained from enhanced broadleaf weed control. MSMA is relatively inexpensive compared with many of the herbicides used for weed control in cotton. Additionally, federal registration of cyanazine may be lost due to concerns of negative environmental impact. Should federal registration of cyanazine be canceled, MSMA may play an even more important role in cotton weed management, especially as related to control of *Ipomoea* spp.

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