Weed Science, 50:386–391. 2002

Effects of MT-101 and NOP on germination and seedling growth of hemp sesbania and rice

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The effects of MT-101 and its herbicidally active form, NOP, on the germination and seedling growth of hemp sesbania and rice were investigated. MT-101 decreased the germination of hemp sesbania by 57 and 90% at 0.05 and 0.5 mM, respectively, 1 d after treatment (DAT) in petri dishes. The germination, however, recovered such that there was no significant difference between treatments 4 to 6 DAT. NOP completely inhibited the germination of hemp sesbania at both 0.05 and 0.5 mM 1 DAT. However, germination also similarly recovered, and there was no difference between treatments 4 to 6 DAT. Neither MT-101 nor NOP decreased the germination of rice 3 to 6 DAT. In greenhouse trials preemergence (PRE) application of MT-101 at 2.25 kg ai ha^{-1} decreased the density (number of plants pot^{-1}), plant height, and dry weight of hemp sesbania by 85, 67, and 91%, respectively. When applied postemergence (POST), MT-101 at 2.25 kg ha^{-1} decreased the density, plant height, and dry weight by a maximum of 58, 61, and 82%, respectively, indicating that MT-101 may have greater activity when applied PRE. NOP had greater activity than MT-101 on hemp sesbania. NOP at 2.25 kg ai ha^{-1} decreased the density, plant height, and dry weight of hemp sesbania 99, 78, and 97%, respectively, with PRE application. A POST application of NOP at 2.25 kg ha^{-1} decreased the dry weight of hemp sesbania 91 to 94%. A PRE application of NOP at 2.25 kg ha^{-1} decreased the dry weight of rice by 58%. Rice was not affected by POST applications of MT-101 but was affected slightly by NOP. These results suggest that MT-101 is a possible weed control agent in rice.

Nomenclature: MT-101, (naproanilide—common name approved by the Japanese Ministry for Agriculture, Forestry and Fisheries), 2-(2-naphthyloxy)propionanilide; NOP, 2-(2-naphthyloxy) propionic acid; hemp sesbania, *Sesbania exaltata* (Raf.) Rydb. ex A. W. Hill SEBEX; rice, *Oryza sativa* L. 'Lemont'; cotton, *Gossypium hirsutum* L. 'Deltapine 5415'.

Key words: Herbicidal efficacy, crop injury, dry weight, density, plant height.

MT-101 is a selective herbicide (Anonymous 2000) that controls annual and perennial broadleaf weeds, such as monochoria [*Monochoria vaginalis* (Burm. f.) Kunth] var. *plantaginea* Solms-Laub. and *Sagittaria pygmaea* Miq., in transplanted rice in Japan (Oyamada et al. 1986a). It is usually applied to flooded paddy fields as a granular formulation (Hirase and Kishi 1997). The recommended application rate is 2 to 3 kg ai ha^{-1} and is effective both preemergence (PRE) (Hirase et al. 1999) and postemergence (POST) (Hirase and Kishi 1997). It has auxin-like activity (Takasawa et al. 1975) and reportedly affects tuberization and RNA synthesis (Kobayashi and Ichinose 1985; Kobayashi et al. 1983) of *Cyperus serotinus* Rottb. and *Eleocharis kuroguwai* Ohwi.

MT-101 has no herbicidal activity, but one of its metabolites, NOP, is highly phytotoxic (Takasawa et al. 1982) (see Figure 1 for chemical structure of MT-101 and NOP). In fact, MT-101 is hydrolyzed to NOP by soil microorganisms (Hirase et al. 1999; Oyamada and Kuwatsuka 1990; Tanaka et al. 1991) and several plants (Oyamada and Kuwatsuka 1982; Oyamada et al. 1985, 1986a, 1986c). The formation of NOP from MT-101 by leaf disks of *S. pygmaea* was considered to be an enzymatic reaction because heat treatment and trichloroacetic acid inhibited NOP formation (Oyamada et al. 1986b). MT-101 is also hydrolyzed to NOP in aqueous solution in sunlight (Oyamada and Kuwatsuka 1986). MT-101 applied into paddy water as a granular formulation may be transformed to NOP in soil, flooded water, or plants to exhibit auxin activity.

Rice is tolerant to MT-101 (Oyamada et al. 1985). The tolerance may be caused by differential uptake of MT-101 and NOP. *Sagittaria pygmaea* absorbed twice as much MT-101 and its metabolites as did rice seedlings, and *S. pygmaea* accumulated larger amounts of MT-101 and NOP than did rice seedlings (Oyamada et al. 1985). There was a close correlation between susceptibility to the herbicide and concentrations of MT-101 and NOP in tissues of rice and susceptible weeds (Oyamada et al. 1986a).

Hemp sesbania is an annual legume that grows 3 m tall. It is found throughout the southern United States (Lorenzi and Jeffery 1987) and is considered to be one of the most common and troublesome weeds in two of the 13 southern states (Webster 2000). Hemp sesbania reduced rice grain yield more than did the other broadleaf weeds in density experiments (Smith 1988). In rice this weed can be controlled by several herbicides, such as acifluorfen, quinclorac, propanil, triclopyr, and 2,4-D (Akkari et al. 1982; Anonymous 1999; Smith 1982; Street and Mueller 1993). Phenoxy herbicides control hemp sesbania but may cause injury in rice if applied after the late tillering to early jointing stages (Smith et al. 1977). Moreover, neither 2,4-D nor triclopyr offers residual weed control in rice (Street and Mueller 1993). Aerial application of 2,4-D has been used for

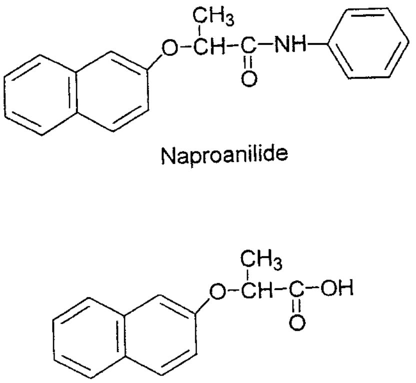

FIGURE 1. Chemical structure of MT-101 (naproanilide) and NOP.

broadleaf weed control in rice but has been severely restricted because of drift and phytotoxicity on cotton (Street and Mueller 1993).

We explored the possibility of using MT-101 as a herbicide to control hemp sesbania in direct-seeded rice. This study examined the effects of MT-101 and NOP on germination and seedling growth of hemp sesbania and rice, and their phytotoxicity on cotton because of the potential for injury from drift.

Materials and Methods

Germination Test

MT-101 and NOP[1] were dissolved in dimethyl sulfoxide (DMSO) and added to deionized water to obtain final concentrations of 0.05 and 0.5 mM herbicide and 0.5% DMSO (v/v). Seeds of hemp sesbania and rice were placed on one layer of Whatman filter paper[2] in a petri dish (60 mm in diameter and 15 mm deep). Two milliliters of MT-101 or NOP solution was added to each dish. Deionized water containing 0.5% DMSO (v/v) served as a control. Twenty-five hemp sesbania and 15 rice seeds were placed in each dish. Different numbers of rice and hemp sesbania seeds were used based on weight. This allowed for approximately the same weight of seeds per petri dish for the two species. The petri dishes were wrapped with aluminum foil to keep seeds in the dark and were placed in a thermostatically controlled incubator at 24 C. Seeds that germinated were counted and removed from the dishes 1, 2, 3, 4, and 6 d after treatment (DAT). The germination criterion was 2-mm radicle emergence for hemp sesbania (Johnston et al. 1979) and 1-mm coleoptile emergence for rice. Different radicle and coleoptile lengths were used for the two species to insure that the radicle and coleoptile had fully emerged from the seeds.

Greenhouse Experiments

Twenty-five seeds of hemp sesbania or rice were planted in 10-cm plastic pots containing soil. The soil was a Bosket sandy loam (fine-loamy, mixed, thermic Mollic Hapludalfs: 43% sand, 48% silt, 9% clay, 1.51% organic matter, pH 5.4). No commercial fertilizer was added. The compounds were applied PRE, POST-1 (hemp sesbania, cotyledon; rice, one leaf), and POST-2 (hemp sesbania, two true leaves; rice, two leaves). Plants of hemp sesbania were thinned to 18 plants pot^{-1} for POST-1 and 12 plants pot^{-1} for POST-2, 1 d before application. Rice was not thinned. The reason for the various densities was to insure proper herbicide coverage with the POST treatments. The application rates of both compounds were 0.25, 0.75, 2.25, and 6.75 kg ha^{-1} for each of the three application timings. In each application compounds were dissolved in a solution consisting of water–acetone (20:80, v/v) containing 0.1% Triton X-100.[3] Seedlings treated with this solution without MT-101 or NOP served as controls for each application time. No appreciable effect of this solution was observed on the parameters obtained in this study. The solutions were applied with a manually pressurized hand sprayer[4] fitted with an 8004 nozzle and pressurized to 30 psi on the boom; spray volume was 500 L ha^{-1}. The greenhouse temperature varied between 25 and 33 C, and natural light was supplemented by sodium vapor lamps to provide a 14-h photoperiod. Pots were watered on the soil surface as needed. Two weeks after application, the densities (number of plants pot^{-1}) and heights of the surviving plants were recorded. For the plant height evaluation, 10 plants in each pot were selected at random and measured, and if the density was less than 10 plants pot^{-1}, the heights of all the plants were measured. Then, plants were harvested by clipping at the soil surface, dried in the same greenhouse for 2 wk, and the dry weight per pot determined.

To examine the phytotoxicity of MT-101 and NOP on cotton, seeds were sown in 10-cm plastic pots containing a Bosket sandy loam soil and Jiffy-mix Plus[5] (1:1, v/v). At the two-leaf stage, plants were treated with MT-101 and NOP and maintained in the greenhouse as described earlier. The dosage of these compounds was 0, 0.025, 0.075, 0.225, and 0.675 kg ha^{-1}. Plant injury was estimated visually 3, 7, and 14 DAT using a 0 to 100% scale with 0 representing no injury and 100 representing complete kill. Injury was defined as symptoms similar to those attributed to auxin herbicides, such as malformation and growth reduction.

Data Analysis

The experimental design for the germination test and greenhouse trials was a randomized complete block with three to four replications. Each experiment was repeated. No interaction was observed in the germination experiments and greenhouse trial runs, therefore data were combined over time. There was an interaction for herbicide treatment and rate for the germination test and cotton tolerance experiment, and an interaction for herbicide treatment, application timing, and rate for the greenhouse experiments. Therefore, these data are presented separately. Data were subjected to regression analysis to obtain linear and nonlinear equations (Table 1).

Results and Discussion

Germination Test

Germination of untreated hemp sesbania began 1 DAT and reached a maximum that was greater than 70% 3 DAT. MT-101 decreased germination of hemp sesbania by 57 and 90% at 0.05 and 0.5 mM, respectively, 1 DAT (Figure 2). However, there were no differences in germination between

TABLE 1. Regression equations and correlation coefficients (r^2) for naproanilide and NOP.

Figure	Compound	Plant species	Concentration (mM)/application timing/DAT[a]	Regression equation[b]	r^2
2	Naproanilide	Hemp sesbania	0.05	$y = -3.45x^2 + 35.3x + 12.5$	0.99
2	Naproanilide	Hemp sesbania	0.5	$y = -6.09x^2 + 59.0x + 37.8$	0.96
2	Naproanilide	Rice	0.05	$y = 1.76x + 92.6$	0.92
2	Naproanilide	Rice	0.5	$y = -1.05x + 101.4$	0.19
2	NOP	Hemp sesbania	0.05	$y = -8.39x^2 + 73.9x - 53.1$	0.86
2	NOP	Hemp sesbania	0.5	$y = -5.23x^2 + 56.2x - 57.2$	0.96
2	NOP	Rice	0.05	$y = -4.56x^2 + 42.9x + 3.95$	0.81
2	NOP	Rice	0.5	$y = -4.63x^2 + 43.8x + 1.46$	0.91
3	Naproanilide	Hemp sesbania	PRE	$y = -15.9 \ln(x) + 35.2$	0.94
3	Naproanilide	Hemp sesbania	POST-1	$y = -22.7 \ln(x) + 66.1$	0.95
3	Naproanilide	Hemp sesbania	POST-2	$y = -22.6 \ln(x) + 65.0$	1.0
3	Naproanilide	Rice	PRE	$y = -4.48 \ln(x) + 99.7$	0.78
3	Naproanilide	Rice	POST-1	$y = -1.93 \ln(x) + 107.4$	0.21
3	Naproanilide	Rice	POST-2	$y = -4.69 \ln(x) + 96.7$	0.82
3	NOP	Hemp sesbania	PRE	$y = -10.5 \ln(x) + 14.6$	0.83
3	NOP	Hemp sesbania	POST-1	$y = -28.3 \ln(x) + 52.1$	0.93
3	NOP	Hemp sesbania	POST-2	$y = -32.2 \ln(x) + 55.4$	0.98
3	NOP	Rice	PRE	$y = -10.6 \ln(x) + 78.8$	0.95
3	NOP	Rice	POST-1	$y = -1.27 \ln(x) + 101.2$	0.38
3	NOP	Rice	POST2	$y = 1.82 \ln(x) + 95.2$	0.62
4	Naproanilide	Hemp sesbania	PRE	$y = -1.35 \ln(x) + 35.6$	0.16
4	Naproanilide	Hemp sesbania	POST-1	$y = -8.27 \ln(x) + 47.6$	0.87
4	Naproanilide	Hemp sesbania	POST-2	$y = 1.73 \ln(x) + 61.6$	0.97
4	Naproanilide	Rice	PRE	$y = -3.43 \ln(x) + 86.6$	0.98
4	Naproanilide	Rice	POST-1	$y = -0.06 \ln(x) + 101.4$	0.0003
4	Naproanilide	Rice	POST-2	$y = -3.31 \ln(x) + 99.9$	0.63
4	NOP	Hemp sesbania	PRE	$y = -4.69 \ln(x) + 21.4$	0.31
4	NOP	Hemp sesbania	POST-1	$y = -11.9 \ln(x) + 36.3$	0.99
4	NOP	Hemp sesbania	POST-2	$y = -6.91 \ln(x) + 52.6$	0.91
4	NOP	Rice	PRE	$y = -11.3 \ln(x) + 62.2$	0.94
4	NOP	Rice	POST-1	$y = 3.90 \ln(x) + 88.3$	0.71
4	NOP	Rice	POST-2	$y = -1.29 \ln(x) + 94.9$	0.27
5	Naproanilide	Hemp sesbania	PRE	$y = -4.88 \ln(x) + 12.1$	0.86
5	Naproanilide	Hemp sesbania	POST-1	$y = -18.1 \ln(x) + 38.8$	0.97
5	Naproanilide	Hemp sesbania	POST-2	$y = -10.1 \ln(x) + 34.2$	1.0
5	Naproanilide	Rice	PRE	$y = -5.64 \ln(x) + 92.3$	0.65
5	Naproanilide	Rice	POST-1	$y = -0.75 \ln(x) + 103.0$	0.02
5	Naproanilide	Rice	POST-2	$y = -7.66 \ln(x) + 107.8$	0.70
5	NOP	Hemp sesbania	PRE	$y = -3.11 \ln(x) + 4.96$	0.73
5	NOP	Hemp sesbania	POST-1	$y = -20.5 \ln(x) + 33.5$	0.93
5	NOP	Hemp sesbania	POST-2	$y = -16.4 \ln(x) + 26.8$	0.95
5	NOP	Rice	PRE	$y = -10.5 \ln(x) + 50.5$	0.97
5	NOP	Rice	POST-1	$y = 5.40 \ln(x) + 88.5$	0.51
5	NOP	Rice	POST-2	$y = -3.19 \ln(x) + 94.5$	0.09
6	Naproanilide	Cotton	3	$y = 19.4x^2 + 4.42x + 0.16$	1.0
6	Naproanilide	Cotton	7	$y = 18.3x^2 + 9.99x - 0.09$	1.0
6	Naproanilide	Cotton	14	$y = -12.5x^2 + 33.8x - 1.09$	1.0
6	NOP	Cotton	3	$y = -11.8x^2 + 20.8x + 0.31$	0.95
6	NOP	Cotton	7	$y = -9.50x^2 + 24.5x + 0.09$	0.98
6	NOP	Cotton	14	$y = -36.9x^2 + 48.4x - 0.88$	1.0

[a] Abbreviations: DAT, days after treatment; POST, postemergence; PRE, preemergence.

[b] In Figure 2 x is DAT, and y is the germination (% of control). In Figure 3 x is the rate (kg ha^{-1}), and y is the density (% of control). In Figure 4 x is the rate (kg ha^{-1}), and y is the plant height (% of control). In Figure 5 x is the rate (kg ha^{-1}), and y is the dry weight (% of control). In Figure 6 x is the rate (kg ha^{-1}), and y is % injury.

samples receiving MT-101 and the controls by 4 DAT. Germination of untreated rice began 2 DAT and increased until 4 DAT, when at least 89% germination of the control was achieved. MT-101 had no effect on the germination of rice through the experiment.

NOP completely inhibited hemp sesbania germination at both 0.05 and 0.5 mM 1 DAT, but as with MT-101, no difference occurred between NOP and the control by 4 DAT. NOP reduced rice germination by 32% 2 DAT at both 0.05 and 0.5 mM. However, germination recovered, and there was no significant difference between the treatments and control 3 DAT. Hemp sesbania seeds can ger-

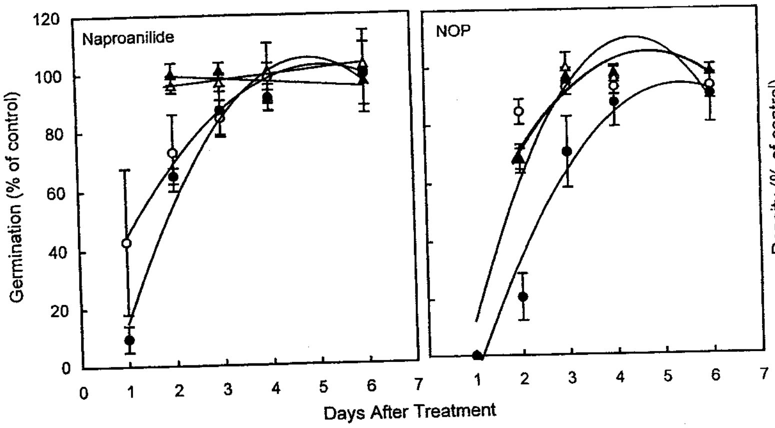

FIGURE 2. Effect of MT-101 (naproanilide) and NOP on hemp sesbania and rice germination. ○, hemp sesbania 0.05 mM; ●, hemp sesbania 0.5 mM; △, rice 0.05 mM; ▲, rice 0.5 mM. Vertical bars represent standard errors. Regression equations are presented in Table 1.

minate over a broad temperature range, under a low osmotic potential (−8 bars) and at soil depths up to 12 cm (Johnston et al. 1979). These properties may confer competitive advantages to the weed over crops. In this experiment MT-101 and NOP retarded hemp sesbania germination by only 2 to 3 d. This delay in germination may be insufficient to provide rice with a competitive advantage over hemp sesbania at the early stages of growth.

Effect on Growth of Hemp Sesbania and Rice

MT-101 and NOP reduced hemp sesbania density (number of plants pot^{-1}) compared with the untreated control, depending on the application rate (Figure 3). The density of untreated hemp sesbania for PRE, POST-1, and POST-2 was 21.3 ± 1.7, 19.3 ± 3.3, and 12.3 ± 0.5 plants pot^{-1}, respectively. MT-101 applied PRE at 2.25 and 6.75 kg ha^{-1} decreased the density by at least 85%. When MT-101 was applied POST, the decrease in density was only 77 to 78% at 6.75 kg ha^{-1}. These results indicate that MT-101 was more efficacious on hemp sesbania when applied PRE.

The effect of NOP on hemp sesbania density was greater than that of MT-101. Applied PRE, NOP reduced plant density 99 and 100% at 2.25 and 6.75 kg ha^{-1}, respectively. Density reductions were 79 to 86% and 95 to 100% at 2.25 and 6.75 kg ha^{-1}, respectively, applied POST. This result was expected in that NOP is the active form of MT-101 (Takasawa et al. 1982). MT-101 must be transformed to NOP before exhibiting herbicidal activity on hemp sesbania.

PRE and POST applications of MT-101 affected the density of rice considerably less than that of hemp sesbania. The density of untreated rice for PRE, POST-1, and POST-2 was 22.0 ± 1.4, 21.7 ± 1.2, and 22.7 ± 0.5 plants pot^{-1}, respectively. Density reduction was less than 10% with most MT-101 treatments. NOP did not decrease rice density after POST application but decreased it 23 to 41% when applied PRE at 2.25 to 6.75 kg ha^{-1}. With regard to density reduction, rice is apparently more tolerant than hemp sesbania to MT-101 and NOP, particularly with POST application. Density is thought to be an important factor for competition between weeds and crops (VanDevender et al. 1997). Competition from 1.35 to 5.4 hemp sesbania plants m^{-2} reduced yields in rice, and yields decreased as the duration of competition increased (Smith 1968).

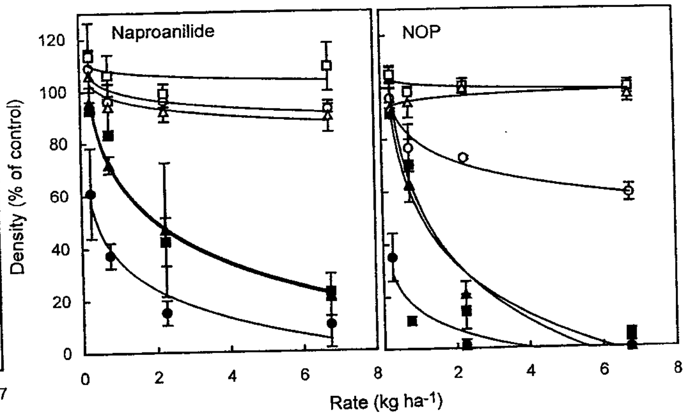

FIGURE 3. Effect of MT-101 (naproanilide) and NOP on hemp sesbania and rice density. Compounds applied POST-1 to hemp sesbania at the cotyledon stage and to rice at the one-leaf growth stage, and POST-2 to hemp sesbania and rice at the two-leaf growth stage. Hemp sesbania: ●, PRE; ■, POST-1; ▲, POST-2. Rice: ○, PRE; □, POST-1; △, POST-2. POST, postemergence; PRE, preemergence. Vertical bars represent standard errors. Regression equations are presented in Table 1.

Plant heights of untreated hemp sesbania after PRE, POST-1, and POST-2 applications were 13.5 ± 0.6, 19.1 ± 0.4, and 17.1 ± 0.4 cm, respectively, and those of untreated rice for PRE, POST-1, and POST-2 were 18.1 ± 0.6, 23.8 ± 0.6, and 26.3 ± 0.7 cm, respectively. Plant height reduction of hemp sesbania with MT-101 applied PRE or POST ranged from 35 to 69% at 0.25 to 6.75 kg ha^{-1} (Figure 4). Generally, the reductions were larger with PRE than with POST applications. Between the two POST treatments, MT-101 was more efficacious when applied at POST-1 than at POST-2. Similar results were obtained in NOP treatments. The decrease in height of surviving hemp sesbania seedlings was 36 to 86%, depending on the application rate. PRE applications were generally more effective than POST treatments. MT-101 and NOP had no effect on the height of surviving rice with POST treatments. On the other hand, MT-101 reduced height by as much as

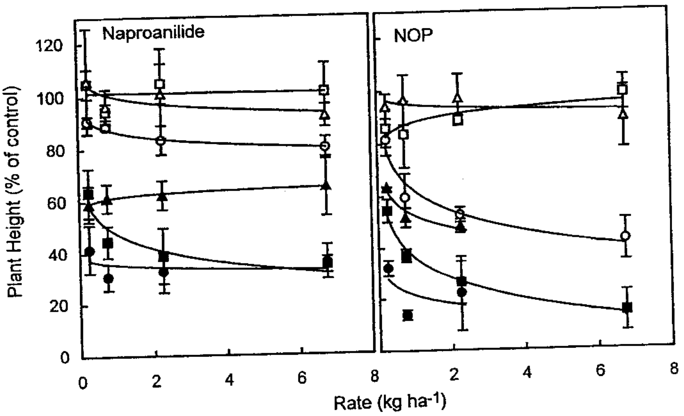

FIGURE 4. Effect of MT-101 (naproanilide) and NOP on height of surviving hemp sesbania and rice. Compounds applied POST-1 to hemp sesbania at the cotyledon stage and to rice at the one-leaf growth stage, and POST-2 to hemp sesbania and rice at the two-leaf growth stage. Hemp sesbania: ●, PRE; ■, POST-1; ▲, POST-2. Rice: ○, PRE; □, POST-1; △, POST-2. POST, postemergence; PRE, preemergence. Vertical bars represent standard errors. Regression equations are presented in Table 1.

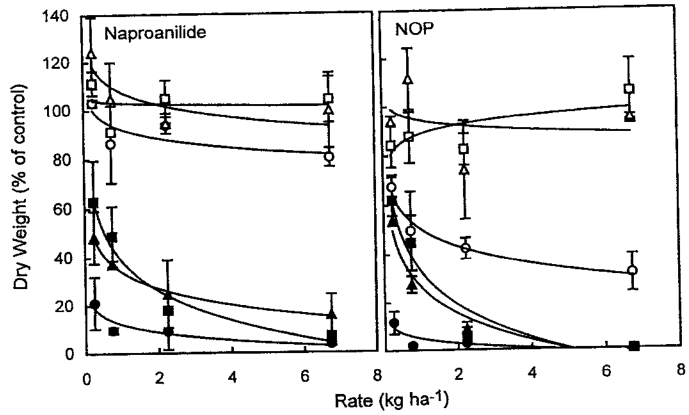

FIGURE 5. Effect of MT-101 (naproanilide) and NOP on hemp sesbania and rice dry weight. Compounds applied POST-1 to hemp sesbania at the cotyledon stage and to rice at the one-leaf growth stage, and POST-2 to hemp sesbania and rice at the two-leaf growth stage. Hemp sesbania: ●, PRE; ■, POST-1; ▲, POST-2. Rice: ○, PRE; □, POST-1; △, POST-2. POST, postemergence; PRE, preemergence. Vertical bars represent standard errors. Regression equations are presented in Table 1.

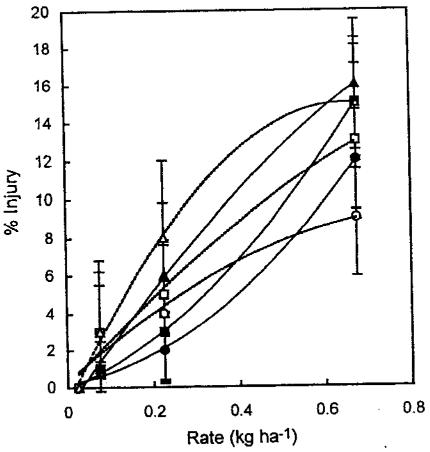

FIGURE 6. Injury from MT-101 (naproanilide) and NOP in cotton. Compounds were applied at the two-leaf stage. MT-101 treatments: ●, 3 DAT; ■, 7 DAT; ▲, 14 DAT. NOP treatments: ○, 3 DAT; □, 7 DAT; △, 14 DAT. DAT, days after treatment. Vertical bars represent standard errors. Regression equations are presented in Table 1.

20%, depending on the PRE application rate. Height reduction of surviving rice by NOP PRE application from 0.75 to 6.75 kg ha^{-1} was 40 to 57%. These results indicate that MT-101 and NOP were more efficacious for height reduction in hemp sesbania than in rice.

Plant height may be an important factor in the competition between hemp sesbania and rice. MT-101 treatment increased the difference in height between the two species. For example, in the POST-1 treatment the average heights of untreated hemp sesbania and rice were 19.1 and 23.8 cm, respectively. The height of surviving hemp sesbania was 12.1, 8.5, 7.4, and 6.7 cm at 0.25, 0.75, 2.25, and 6.75 kg ha^{-1}, respectively. The height of rice was 25.0, 22.5, 25.0, and 24.1 cm, respectively, at the same rates. Thus, MT-101 treatment might benefit rice relative to hemp sesbania in their mutual competition for light. Hemp sesbania, which grew much taller than northern jointvetch (*Aeschynomene virginica* L.), was more competitive to rice than northern jointvetch because of the shading of rice (Smith 1968).

The dry weight of untreated hemp sesbania for PRE, POST-1, and POST-2 was 0.44 ± 0.03, 0.74 ± 0.09, and 0.58 ± 0.08 g pot^{-1} and that of untreated rice for PRE, POST-1, and POST-2 was 0.18 ± 0.03, 0.41 ± 0.03, and 0.46 ± 0.03 g pot^{-1}. The effect of MT-101 and NOP on dry weight was examined, and a similar tendency to that of density was observed. Generally, hemp sesbania dry weight was dependent on application rate (Figure 5). PRE applications were more efficacious than POST. MT-101 reduced dry weight of hemp sesbania more than 90% at 6.75 kg ha^{-1} applied PRE and from 75 to 93% at 2.25 and 6.75 kg ha^{-1} with POST application. NOP decreased hemp sesbania dry weight 97% at 0.75 kg ha^{-1} and 100% at 6.75 kg ha^{-1} with PRE and 91 and 100% at 2.25 and 6.75 kg ha^{-1}, respectively, with POST application. The difference in efficacy between PRE and POST applications might be partly the result of the higher sensitivity of hemp sesbania to NOP during emergence than at the cotyledon or two-leaf stage. MT-101 did not affect the dry weight of rice between 0.25 and 2.25 kg ha^{-1} with PRE application. The reduction in rice dry weight with NOP PRE treatment ranged from 32 to 68%. POST applications of MT-101 did not affect rice dry weight significantly. These results indicate that rice injury from MT-101 applied POST is slight. However, NOP appears to be phytotoxic to rice, and injury from PRE application is high.

Effect on Cotton

Injury by MT-101 and NOP in cotton was examined because auxin-type herbicides applied aerially to rice injure cotton by drift (Street and Mueller 1993). Knowledge of the potential injury by these compounds in cotton is an important market concern in the United States. In this experiment the rate of both compounds was 1/10 of that used in the tests described previously in order to approximate phytotoxicity from drift. Neither MT-101 nor NOP injured cotton at 0.025 kg ha^{-1} POST 3 to 14 DAT, but they caused 1 to 16% injury at 0.075 to 0.675 kg ha^{-1}, depending on the rate (Figure 6). Generally, there were no differences in injury between MT-101 and NOP, and we conclude that both compounds are potentially phytotoxic to cotton.

In conclusion, MT-101 and NOP reduced the growth of hemp sesbania when 0.25 to 6.75 kg ha^{-1} was applied PRE or POST, and herbicide efficacy was higher PRE than POST. MT-101 had no effect on rice with POST applications but had a slight influence on rice growth PRE. NOP applied PRE had a significant effect on rice growth and only a slight effect when applied POST. MT-101 may be an effective weed control agent for hemp sesbania in rice. The potential for drift injury on neighboring cotton is low but present.

Sources of Materials

[1] MT-101 and NOP, Mitsui Chemicals, Inc., 1144 Togo, Mobara-shi, Chiba 297-0017, Japan.

[2] Whatman #1, Fisher Scientific, 711 Forbes Avenue, Pittsburgh, PA 15219.

[3] Triton X-100, Sigma Chemical Co., P.O. Box 952968, St. Louis, MO 63195.

[4] Hand sprayer, H. D. Hudson Manufacturing Co., 500 N. Michigan Avenue, Chicago, IL 60611-3748.

[5] Jiffy-mix Plus, Canadian Sphagnum Peat and Vermiculite, Jiffy Products of America, Inc., 1119 Lyon Road, Batavia, IL 60510-4303.

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Received December 5, 2000, and approved November 17, 2001.