SECTION 9
WEED CONTROL

Dr. James Aitken
Section Chairman and Moderator

Soil Fumigation Alternatives to Eliminate Polyethylene Covers

W.A. Skroch, L.B. Gallitano and R.E. Wooten
North Carolina

Nature of Work: The use of soil fumigants is known to be an effective method of weed control and is often used by nursery operators for seedling and propagation beds. Methyl bromide is one of the most commonly used soil fumigants even though it is a restricted-use material that requires specialized handling and equipment to apply a polyethylene (plastic) cover. Methyl bromide is coming under increased scrutiny by the Environmental Protection Agency in an effort to reduce the use of environmentally harmful chemicals. As a result, alternative fumigants for weed control are needed that can replace methyl bromide and that can further reduce environmental concerns by eliminating the use of plastic.

The North Carolina Department of Transportation (NCDOT) uses fumigation extensively for weed control prior to planting wildflowers for the highway beautification program. The research reported here was conducted in conjunction with this program. Results are reported on the basis of weed control and wildflower establishment. A preliminary study was conducted in 1990 in which Basamid-Granular was evaluated as an alternative to methyl bromide. Results indicated that Basamid, when used with a plastic cover or with rolling to provide a sealed soil surface, was equally or more effective than methyl bromide. As a result of this work, an additional study was initiated with the following objectives: 1) to evaluate three alternative fumigants to methyl bromide that do not require polyethylene as a sealant, and 2) to evaluate a power roll seal method for soil sealing that can be used to replace polyethylene and improve the effectiveness of these three alternative fumigants.

The power roll seal method was developed in conjunction with the NCDOT. The basic applicator and roller were adapted from the Ro-To-Vate & Roll™ system from Northwest Tillers, Inc. The roller size and power were increased to expand the use from cultivated crops to rough highway roadsides. The roller on this equipment travels faster than the ground speed of the equipment which results in a slick soil surface where the roller travels. This slick surface reduces the surface cracks in the soil. This allows the fumigant to be held in the soil for a longer period of time, thereby increasing its effectiveness. The critical fumigation zone for maximum weed control is in the top one-half inch of soil. The roller applicator was evaluated to determine if its use might provide adequate soil sealing at the surface so plastic can be eliminated with some fumigants. Water can also be used as a surface sealant to enhance the roller method of sealing.

This study was initiated in the fall, 1991 to expand the fumigants being evaluated to include Vapam and Sectagon and to further evaluate Basamid and methyl bromide. This study was conducted at Research Unit 4, NCSU, Raleigh, NC. It was a randomized complete block design with eight treatments and four replications. Treatments were applied in the fall, 1991 and consisted of an untreated check, Basamid at 350 lb/A, Vapam and Sectagon at 75 gal/A each, and methyl bromide at 435 lb/A. Methyl bromide was sealed with plastic. Each of the other three fumigants was either sealed by mechanical rolling or mechanical rolling plus water.

Plots were row-seeded with wildflowers, by species. Treatments were evaluated by counting the number of flowers for each species in randomly chosen, three foot portion in each plot (row). Results are reported here for toadflax, catchfly, California poppy and corn poppy. Weed control was rated by counting the number of weeds in a 3’x1' section in each plot.

Results and Discussion: When compared to the check, methyl bromide and Basamid with rolling plus water provided highest weed control and the most flowers. Each treatment reduced the number of slender parsley-piert, corn speedwell and miscellaneous weed species as compared to the check. With Basamid, the number of flowers increased for cornpoppy and catchfly. With methyl bromide, the number increased for California and corn poppy.

In comparing methyl bromide to Basamid, no significant differences were detected overall for either weed control or flowering. However, there were more flowers in the Basamid plots. Basamid appears to be a good alternative to methyl bromide given the flowering and comparable weed control between the two treatments.

There were no increases in flower number and weed control was not as effective with the remaining five treatments. However, there was a decrease in the number of corn poppy flowers with Sectagon plus rolling. Basamid plus rolling and Sectagon with rolling plus water controlled slender parsley-piert and other miscellaneous species. The remaining treatments, Vapam with rolling, Vapam with rolling plus water, and Sectagon with rolling controlled only slender parsley-piert.

Significance to Industry: Overall, Basamid with rolling plus water is as effective as methyl bromide for weed control. A soil bioassay to determine if the fumigant has dissipated is recommended since this material can remain in the soil for extended periods under cool, wet conditions. However, Basamid with rolling plus water appears to be promising for effective, temporary weed control without the use of polyethylene covers.

Herbicide Phytotoxicity on Bulbs and Bedding Plants

W.A. Skroch and R.E. Wooten
North Carolina

Nature of Work: Two studies were conducted to determine phytotoxicity of eight herbicides when used for weed control in spring flowering bulbs and annual bedding plants. Both studies were randomized complete block designs with four replications and a total of nine treatments, including an untreated check. The studies were conducted at Research Unit 4, NCSU, Raleigh, NC. Herbicides were applied at the following rates: Pennant 4.0 lb/A, Derby 5.0 lb/A, Stakeout 1.5 lb/A, Gallery 0.75 and 1.0 lb/A, Snapshot 3.0 lb/A, Dacthal 12.0 lb/A and Pre-M/Pendulum 4.0 lb/A.

The following three species of spring flowering bulbs were included in the study: *Allium sphaerocephalon, Ornathogalum umbellatum* and *Narcissus sp.* Bulbs were planted in October, 1990 in a prepared field bed of clay loam amended with pine bark. Treatments were applied in November, 1990; May, August and November, 1991; and April, 1992. Weed control ratings were taken in June, 1991 for crabgrass and yellow nutsedge. Bulb injury ratings were taken in the spring of 1991 and 1992 to determine whether treatments affect flowering date. Flowering dates are given as Julian dates.

Five species of annual bedding plants were evaluated in the summer of 1990 and 1991. This study included: petunia, snapdragon, celosia, marigold and portulaca.

Planting dates were May 21, 1990 and April 29, 1991. Treatments were applied within four days of planting. Injury and/or weed control ratings were taken on June 14 and August 2, 1990 and June 4, 1991.

Results and Discussion: The spring flowering bulb study was rated for control of crabgrass and yellow nutsedge in 1991. Gallery at 0.75 lb/A was the only treatment that did not control crabgrass. The remaining treatments controlled crabgrass, with greater than 80% control for Pennant, Derby, Stakeout, Snapshot and Pre-M/Pendulum. Control of yellow nutsedge was not significant except with Pennant and Dacthal.

Time of flowering for *Allium* was affected in 1991 with Stakeout, Gallery (both rates), Snapshot, Dacthal and Prowl. Fifty percent of the bulbs in the check flowered on Julian day 151 while in the above treatments they flowered two days earlier. In 1992, *Allium* treated with Pennant flowered on day 126 as opposed to day 168 for the check. In 1992, *Narcissus* flowered 1-2 days earlier with every treatment.

In general, these treatments appear to be effective for weed control in spring flowering bulbs. Bulbs will be lifted and sized in the summer of 1992 to determine if timing of flowering is correlated with bulb size.

No injury was observed for the five species of annual bedding plants over the two year period with Pennant, Derby, Stakeout and Dacthal. However, at the August, 1990 rating, hop clover and other broadleaf weeds were not controlled by Dacthal.

Injury seen with the remaining treatments was not consistent from year to year. Injury was observed for the following treatment-species combinations: Pre-M/Pendulum- petunia, marigold and portulaca, Snapshot- celosia, Gallery (1.0 lb/A) - marigold, Gallery (0.75 lb/A) - portulaca. Most treatments effectively controlled crabgrass in both years. In 1991, yellow nutsedge was controlled with Pennant, Derby, Stakeout and Gallery at 1.0 lb/A.

Significance to Industry: Large expanses of spring flowering bulbs and annual bedding plants are commonly used in landscape plantings. Weed control is a major task in the maintenance of these areas over the summer growing season. Data presented here can be used by maintenance personnel in planning effective weed control programs.

Xanthomonas Control of Annual Bluegrass (Poa annua var. annua L. Timm)

Kathie E. Kalmowitz and Thomas J. Monaco , North Carolina
Paul Zorner, California

Nature of Work: Annual bluegrass (Poa annua L.) is a widely distributed and opportunistic grass that is considered a weed in most situations. It is closely related to commercially important Kentucky bluegrass cultivars (Poa pratensis) and rough bluegrass (Poa trivalis). This species common name, annual bluegrass, is considered confusing because there are both annual, bunch types (P. annua var. annua L. Timm), prostrate, creeping perennials [P. annua var. reptans (Hauskins) Timm] or mixtures of highly adaptive biotypes. The annual biotype is frequently found in dry, less managed areas; predominance of the perennial biotype thrives in wet (or frequently irrigated), highly maintained habitats (1,8).

The annual biotypes are characterized as prolific seed producers with prolonged germination when moisture is sufficient for survival and temperatures are not too high. Throughout the south, annual bluegrass germination extends from late August to March. Several preemergence herbicides will provide control of annual bluegrass; however, proper timing of application with germination can be difficult on golf courses or in managed landscape areas. Restrictions are specified due to plant sensitivities or overseeding requirements in turf (4,7). There is potential for biocontrol agents to be reliable alternatives to chemical controls or as a component of an integrated pest management program (IPM). Presently, biological control using plant pathogens is possible for a few weeds. These organisms have shown high specificity to the target weeds and have proven to be commercially acceptable bioherbicides (2).

In 1984 the Plant Diagnostic Laboratory of Michigan State University isolated a pathogenic bacterium (Xanthomonas campestris pathovar) from annual bluegrass biotypes (5). Mycogen Corporation of San Diego, California is developing this organism as a biocontrol agent for annual bluegrass (3,6).

Experiments were conducted at the Southeastern Plant Environment Laboratories at North Carolina State University in 1990 and 1991 to study the effects of temperature and inoculation concentration on the biological activity of Xanthomonas campestris (referred to as MSU450) on annual bluegrass (Poa annua var. annua L. Timm)

Germination and seedling establishment of annual bluegrass [seeded at a density of 200 seeds/7.5 cm (3 in) pots] were conducted at 22 C/18 C (72/64 F) short day photoperiod for 21 days. All plants were gradually acclimated to final chamber temperature for 6 days prior to inoculation. Temperature regimes included constant temperatures of 8 C (46 F), 14 C (57 F), 20 C (68 F), 26 C (79 F), and 32 C (90 F) with a 12 hr photoperiod. MSU450 concentrations were 10^9, 10^7, 10^5, and 10^3 cfu/ml (colony forming units per ml). A control of sterile distilled water was included. All treatments were applied at 1 ml per pot of annual bluegrass with a compressed air-atomizer and plants were cut to 3 cm (1.25 in) above the soil following application. The experiments were a split-plot design with chamber temperature as main plot, inoculum concentrations as subplots, and the entire experiment was repeated over time. Five replications (two pots/application) of each inoculum concentrations were used in each chamber.

Evaluations of MSU450 control of annual bluegrass were taken at 6,12, 18 and 21 days after treatment (DAT). Parameters measured included disease severity (scale of O = healthy to 5 = plant death), incidence of disease (% infection of tissue), color (scale of O = healthy green to 5 = necrotic), and weed control (0% = no control to 100% = plant death). At 21 DAT fresh and dry weights were taken.

Results and Discussion: Significant interactions of temperatures and inoculum rates were observed. Acceptable control of annual bluegrass was achieved at 10^9 cfu/ml by Day 12 at 26 C (79%) and 32 C (89%). By Day 21 levels of control had increased to 83% at 20 C, to 92% at 26 C, and to 98% at 32 C for the high rate of the MSU450. No inoculum concentration of MSU450 at the lower temperatures of 8 C and 14 C controlled annual bluegrass by Day 21. The 10^9 inoculum concentration and 26 C (79 F) temperature were shown to be optimum conditions for the bacteria-plant interaction. Fresh weights were a good measure of MSU450 effectiveness for control of annual bluegrass. These data showed that disease and weed control measurements provided similar evaluations for the biological activity of MSU450 as a control agent for annual bluegrass.

In a related study conducted in 1991 under similar experimental conditions showed annual bluegrass was controlled to 85% with the high rate of MSU450 (10^9) when plants inoculated and grown for 24 days at 8 C (46 F) and 14 C (57 F) were gradually exposed to increasing temperatures up to 26 C (79 F). This demonstrated that plants inoculated at lower temperatures become infected and the biological can provide control when temperatures become optimum.

Significance to the Industry: The use of the biological control agent Xanthomonas campestris pathovar MSU450 could augment control strategies or provide an alternative to chemicals for weed control of annual bluegrass under some management situations.

Literature Cited

1. Beard, J.B. et al. 1978. Annual bluegrass (Poa annua L..) description, adaptation, culture and control. Research Report 352, Michigan State University.

2. Charudattan, R. and H. L. Walker 1982. Biological Control of Weeds with Plant Pathogens. John Wiley & sons, NY pp 283.

3. Crowley, H. 1992. Control of annual bluegrass (Poa annua var. annua) in southern turf with the biological Xanthomonas campestris pv poannua. Proc. So. Weed Sci. Soc. 45:127.

4. Lewis, W.M. 1992. Chemical weed control in lawns and turf in 1992 North Carolina Agriculture Chemicals Manual, North Carolina State University publication. pp 270-273.

5. Roberts, D. L. et al. 1985. Occurrence of bacterial wilt on Poa annua and other turfgrasses. Phytopath. 75:1289.

6. Savage, S. D. 1991. Development of strain of Xanthomonas campestris as a bacterial biocontrol agent for annual bluegrass (Poa annua) in amenity turf. Weed Sci. Soc. of Amer. Abstr.31 :41 .

7. Skroch, W.A. et al. 1992. Weed control suggestions for christmas trees, woody ornamentals, and flowers. North Carolina Agriculture Extension Bulletin AG-427, pp 71.

8. Warwick, S.I. 1979. The Biology of Canadian Weeds. No 37 -Poa annua L. Can. J. Plant Sci. 59:1053-1066.

Weed Control Costs Using Methyl Bromide and Herbicides for Southern Pine Nurseries

David B. South
Alabama

Nature of Work: Weed management is potentially one of the most expensive steps in the production of tree seedlings. In the past, cost of handweeding could exceed 25% of the total production costs (2). Nursery managers employing efficient weed management systems can reduce the handweeding cost to less than 1% of production costs and the total cost of weed management to less than 8%.

Prior to 1947, southern pine nurseries were weeded almost entirely by hand or in combination with mechanical cultivation (4). Weed populations were high and the time required to handweed often exceeded 1,000 hr/Acre/yr. During the 1950's, methyl bromide was tested at several nurseries and at nurseries with high weed populations, fumigation reduced handweeding times by 50 to 66% (3).

By 1975, 77% of the pine nursery managers in the southern United States had adopted the system of fumigating with methyl bromide. Nurseries operated by state and federal governments tended to fumigate less frequently and averaged 220 weeding hr/A. Industry nurseries fumigated more frequently and averaged 74 weeding hr/A.

Weed control techniques have improved since 1975 and effective herbicides such as Goal (oxyfluorfen) and Poast (sethoxydim) are now being used. To document the changes in weed management practices, a questionnaire was sent to nursery managers in 1988. A total of 39 nurseries responded to the questionnaire. Four nurseries did not keep a record of handweeding times and therefore are not included in table 1. Some nurseries did not report the cost of methyl bromide fumigation and therefore a cost of $1000/A was assumed. Cost of a herbicide application (one tractor-trip) was assumed to be $5/A. Cost of Goal and Poast varied slightly by nursery.

Results and Discussion: All nurseries surveyed were using methyl bromide fumigation in combination with the herbicide Goal. Many nurseries were also using Poast to control grasses. Fall fumigation was used by 13 nurseries, and spring fumigation was used at 10 nurseries. Some nurseries (16) fumigate both in the fall and in the spring. The median handweeding time was 10 hr/A/yr. Only four nurseries reported handweeding times greater than 35 hr/A/yr. The nursery with 100 hr/A/yr produces mainly 2-

0 white pine and uses only two applications of Goal per crop. The nursery with 77 hr/A/yr had a high population of sicklepod, morningglory and nutsedge.

Production costs vary among nurseries but the selling cost of 1-0 loblolly pine in 1987 was approximately $28 per thousand plantable seedlings. Methyl bromide is often used to control various nursery pests including disease, insects, and nematodes. Although fumigation costs may be greater than $1,100/A, the increase in plantable seedlings will often be greater than 40,000/A. As a result, the crop value per acre usually increases after fumigating with methyl bromide.

The number of herbicide applications per crop usually exceeds 10 per year (Table 1). Frequent postemergence applications of 0.125 lb ai/A rates of Goal have proven more effective than two or three applications at 0.5 lb ai/A (1). Weed control is improved even though the total amount of herbicide used per crop is not increased. Nurseries that apply only 2 applications of Goal per crop are likely to have high handweeding costs.

Significance to Industry: When methyl bromide is used in combination with effective herbicides like Goal and Poast, the total cost of weed management is often less than 8% of the selling price. Handweeding times per acre are usually less than 35 hr/yr.

Literature Cited

1. Blake, J.I. and D.B. South. 1987. Weekly herbicide applications prove beneficial in forest nurseries. Ala. Agric. Exp. Sta., Highlights of Agric. Res. 34(2):12.

2. Boyer, J.N. and D.B. South. 1984. Forest nursery practices in the South. South. J. Appl. For. 8:67-75.

3. South, D.B. and D.H. Gjerstad. 1980. Nursery weed control with herbicides or fumigation - an economic evaluation. South. J. Appl. For. 8:67-75.

4. Wakeley, P.C. 1954. Planting the southern pines. USDA Forest Service Agric. Mongr. 18. 133 p.

Table 1. Weeding times, fumigation and herbicide costs at southern pine seedbeds in 1987.

State	Handweeding/A time	Handweeding/A cost	Fumigation cost	Fumigation area treated	Fumigation rate	Herbicides Goal	Herbicides Poast	Herbicides tractor trips	Approximate cost for weed management	
	hr/yr	$	$/A	%	lb/A	-$/A/yr-		#/yr	$/A/yr	$/1,000*
Methyl bromide with 2% chloropicrin										
NC	4	21	660	62	380	19	15	8	504	0.69
SC	6	48	800	100	375	70	30	17	1033	1.55
NC	6	30	700	84	320	32	15	9	710	1.10
GA	7	34	1000	100	400	38	0	6	1102	1.72
AL	8	75	1000	2	400	64	76	9	280	0.50
AL	8	64	920	100	350	58	30	14	1142	2.37
AL	10	90	900	100	350	61	30	11	1136	1.70
AR	10	35	1000	49	350	58	25	17	693	0.50
FL	10	80	1000	65	425	64	40	17	919	1.45
AL	12	89	900	69	325	49	30	10	1118	1.80
FL	15	90	1200	40	350	64	15	10	699	0.83
TX	19	90	980	45	400	66	30	21	732	1.56
LA	20	67	900	70	350	52	0	11	804	1.63
FL	24	163	1100	0	400	64	20	17	332	0.47
TX	25	116	1000	80	350	75	20	17	1096	1.10
GA	26	145	1060	31	400	46	30	12	610	0.73
MS	30	104	600	16	400	72	20	17	394	0.50
MS	32	121	1000	70	400	35	20	13	941	1.48
NC	51	300	545	100	350	43	46	13	999	1.53
AL	77	347	1000	65	450	75	30	17	1537	2.08
Methyl bromide with 33% chloropicrin										
MS	0	0	1050	100	400	81	25	16	1236	3.91
AL	2	9	1100	100	400	60	0	8	1209	2.18
GA**	4	14	889	9	400	46	81	19	316	0.56
VA	4	22	1000	39	350	64	0	13	541	0.70
AL	7	56	950	16	350	17	16	4	261	0.47
GA	8	27	889	58	400	52	60	15	730	1.58
VA	8	40	925	56	350	64	25	15	722	0.91
LA	8	40	1090	72	375	64	45	8	974	1.76
GA	10	75	850	100	275	46	20	11	976	1.63
TX	13	113	1000	58	350	75	20	17	863	1.10
AL	21	193	1000	100	350	23	15	5	1256	1.62
GA	22	172	950	58	350	49	25	11	852	1.36
GA***	30	10	889	100	400	61	10	17	1055	1.76
GA	37	222	900	25	350	43	0	9	535	0.65
VA	100	500	1000	53	350	19	15	4	1084	2.05

* Cost per thousand plantable seedlings produced

** This nursery used 93 liters/ha/application of mineral spirits (15% aromatic). A total of 2,044 liters ($0.25/l) were used at this nursery in 1987.

*** This nursery used 122 liters/ha/application of mineral spirits. A total of 7,570 liters ($0.20/1) were used at this nursery in 1987.

Combination of Fabrics and Films with Organic and Inorganic Mulches for Landscape Weed Control

Jeffrey F. Derr and Bonnie Lee Appleton
Virginia

Nature of Work: The use of a landscape fabric is one method of weed suppression in commercial and residential landscape plantings. Variable weed control has been reported for landscape fabrics, depending upon the fabric used, and the type and depth of mulch placed above the material (1, 2, 3, 4, 5). The specific mulch type used above a fabric could impact resulting weed control due to effects on soil moisture and temperature, the mulch's ability to serve as a growing medium, and other factors. The objectives of this research was to compare the use of organic versus inorganic mulches above landscape fabrics.

The experimental design was a six by six factorial arranged in a randomized complete block with four replications. The six ground cover treatments were: bare ground (no fabric), solid black plastic, Dalen's Weed-X, DeWitt Pro-5 Weed Barrier, a white spun-bonded fabric, and a blue nonwoven fabric. The six mulch treatments were: shredded pine bark, herbicide-treated shredded pine bark (Surflan 3 lb ai/A), pine bark nuggets, white marble rock, large particle volcanic rock, and small particle volvanic rock. Mulches were applied to a uniform two inch depth.

Results and Discussion: A) <u>Landscape fabric results averaged over mulches</u>
At 3 weeks after initiation, all fabric treatments and black plastic had less bermudagrass than bare ground. Bermudagrass cover increased in all plots by 9 weeks after initiation, with bare ground still containing greater amounts than the fabric or film treatments. Bermudagrass and yellow nutsedge, however, were present in all treatments. The greatest suppression of yellow nutsedge occurred with black plastic, followed by Weed-X. Significantly more yellow nutsedge was observed in the Pro-5 Weed Barrier, white spun-bonded, and blue nonwoven fabric than either black plastic or Weed-X. Very few annual grasses were found in the black plastic, Weed-X and blue nonwoven treatments at 9 weeks after initiation. Pro-5 Weed Barrier and the white spun-bonded fabrics were intermediate in annual grass cover between bare ground and the black plastic, Weed-X and blue nonwoven treatments.

By 7 months after study initiation, common chickweed and henbit were present in all treatments, although only small amounts were present in the black plastic plots. Slightly higher amounts of these two weeds were present in the Weed-X and Pro-5 Weed Barrier plots. Of the fabrics, the white and the blue ones had the greatest ground cover of these two weeds. Bare ground had approximately three times the ground cover by common chickweed and henbit than the white or blue fabrics. Fabrics were better at suppressing common chickweed and henbit, two winter annuals, than wild garlic, a perennial. Black plastic had the lowest density of wild garlic, with the highest density found in the bare ground treatment. When compared to the bare ground treatment, the following reductions in total weed weight were noted: black plastic 98%, Weed-X 96%, Pro-5 Weed Barrier 96%, the white spun-bonded 84%, and the blue nonwoven fabric 76% weed suppression.

B) Mulches averaged over landscape fabrics
At three weeks after study initiation, similar amounts of bermudagrass was observed in the shredded pine bark, herbicide-treated shredded pine bark, and the small volcanic rock treatments. Slightly less bermudagrass was found in the pine bark nuggets, white marble, and large particle volcanic rock. By 9 weeks after initiation, all differences in bermudagrass cover had disappeared, as roughly the same amount of bermudagrass was found in all mulch treatments. Lower ground cover by yellow nutsedge was observed in the white marble treatment compared to shredded pine bark at 3 weeks. Little difference was seen among the other fabrics, which were intermediate between white marble and shredded pine bark. At 9 weeks, lower amounts of yellow nutsedge was present in the white marble and large volcanic rock than the other treatments. Significantly less annual grasses were seen in the herbicide-treated pine bark and in the small volcanic rock than in shredded pine bark at 9 weeks. Pine bark nuggets and white marble were intermediate in annual grasses cover among the mulch treatments.

The lowest amount of common chickweed and henbit was found in the shredded pine bark, herbicide-treated shredded pine bark, and small volcanic rock than the three other mulches, although differences were not dramatic among the mulch treatments. Little difference in wild garlic cover was observed among the the various mulches. Total weed weight 7 months after initiation was lowest in the herbicide-treated pine bark, with the greatest amount present in the pine bark nuggets and the white marble treatments.

Significance to the Industry: Perennial weeds such as yellow nutsedge and bermudagrass will not be totally controlled by landscape fabrics, although these weeds may be suppressed. Fabrics differ in the ability to suppress weeds, although none used in this study were as effective as solid black plastic. Although the choice of mulch above a landscape fabric may not have a large impact on perennial weed control, use of a rock mulch may give greater suppression of certain annual weeds than shredded pine bark. Use of a landscape fabric below either organic or inorganic mulch generally improves weed control. In this study, use of the preemergence herbicide Surflan improved annual weed control with pine bark mulch. Other herbicides could potentially be utilized with fabrics and mulches to improve overall weed control.

Literature Cited

1. Appleton, B., J. Derr, and S. French. 1991. Evaluation of landscape fabrics with organic vs inorganic mulches. Proc. SNA Res. Conf. 36:317-319.

2. Appleton, B.L. and J.F. Derr. 1990. Growth and root penetration by large crabgrass and bermudagrass through mulch and fabric barriers. J. Environ. Hort. 8(4):197-199.

3. Billeaud, L. A. annd J. M. Zajicek. 1989. Influence of mulches on weed control, soil pH, soil nitrogen content, and growth of Ligustrum laponicum. J. Environ. Hort. 7(4):155-157.

4. Derr, J.F. and B.L. Appleton. 1989. Weed control with landscape fabrics. J. Environ. Hort. 7(4):129-133.

5. Martin, C.A., H.G. Ponder, and C.H. Gilliam. 1991. Evaluation of landscape fabrics in suppressing growth of weed species. J. Environ. Hort. 9(1):38-40.

Split Application of Herbicides for Weed Control in Woody Nursery Plants

Robert E. McNiel and Leslie A. Weston
Kentucky

Nature of Work: Research was conducted to evaluate the efficacy of standard and newly released herbicides(Table 1) for preemergence weed control in nursery crops. The evaluation was conducted for a total of three years (1989 - 1991) with herbicide applications performed annually in May and November. Newly released herbicides for evaluation include Pennant and Derby (Ciba Geigy, Inc.), Snapshot and Gallery (Dow-ELANCO, Inc.), Goal (Rohm and Haas, Inc.) and Stakeout (Monsanto, Inc.). In addition to these materials, other treatments included the industry standards Surflan, Princep and Kerb.

During April 1989, plots measuring 1800 sq. ft. were planted with ten tree and shrub species, using three plants of each species per plot. Each treatment was replicated three times. Herbicide application occurred on the following dates: In 1989 on May 2 and 4, and November 26; In 1990 on May 25 and November 2; In 1991 on May 2 and 3, and November 13. Method of application was with a rotary granular spreader or a backpack sprayer calibrated to 26 gallons per acre using 8004 nozzles at 28 lbs. psi at the boom. Weed control ratings were performed at four week intervals in spring and summer 1989,1990,1991 and 1992. All treatments(Table 1) included:

Taxus cuspidata 'Densa', *Viburnum lantana* 'Mohican', *Juniperus chinensis* 'Pfitzeriana', *Thuja occidentalis* 'Techny', and *Picea abies.* In addition, treatments 1-6 included: *Pyrus calleryana* 'Aristocrat', *Fraxinus americana* 'Autumn Purple', *Acer saccharum* and Tilia *cordata.* Treatments 7-9 included: *Syringa vulgaris, Quercus rubra, Crataegus viridis* 'Winter King', and *Gleditsia triacanthos* 'Shademaster'. Treatments 10-14 included *Syringa vulgaris, Quercus rubra, Acer rubrum* and *Gleditsia triacanthos* Skyline'.

Results and Discussion: The final visual weed control ratings, conducted upon a percentage basis from 0 to 100, were obtained six months after fall 1991 application, in May 1992. Seven weed species (bindweed, carpetweed, grasses, horseweed, lambsquarter, smartweed, and yellow nutsedge) were rated for control. These selected results from 1992 are presented in Table 2.

Lambsquarter was acceptably controlled by all herbicides except Kerb. Grasses were acceptably controlled by all treatments except Derby IX and Gallery. Carpetweed was acceptably controlled by all treatments except Derby IX, Goal IX, Kerb, and Princep-Surflan. Complete control of ragweed occurred with Gallery, Goal 2X, Snapshot 80DF, Snapshot G, and Stakeout 2X. Complete control of horseweed occurred with Gallery, Snapshot 80DF, Snapshot G, and Stakeout 2X. Smartweed was controlled acceptably by Gallery, Goal 2X, Pennant 2X, Snapshot 80DF, Snapshot G, Stakeout IX, and Stakeout 2X. Bindweed was acceptably controlled by Snapshot G and Stakeout 2X. Yellow nutsedge was controlled by Derby 2X, Pennant IX, Pennant 2X and Stakeout 2X. For overall control over a range of weed species and types, two treatments(Snapshot 80DF and Stakeout 2X) rated above the others and have shown the greatest residual effect over the three year time period. Others showing acceptable overall control of early summer weeds from a fall application included: Goal 2X, Snapshot G, and Stakeout IX. Less residual effect was evident over the three years with the granular form of Snapshot, the lower use rate of Stakeout and the Goal treatments. Snapshot is currently labelled for use for a wide selection of ornamental species and generally provides an excellent and cost effective means of full-season weed control. Stakeout is currently labelled only in turf but remains under consideration for development in nursery production systems. Goal is currently labelled only for use in conifers.

Table 1. Herbicide Applications and Manufacturers

TREATMENTS	CHEMICAL	RATE (lbs/A)	MANUFACTURERS
1. PRINCEP (4L) + SURFLAN (75W)	simazine + oryzalin	1 + 3	Ciba-Geigy Coop. + Dow-Elanco Co.
2. PENNANT (7.8L)	metolachlor	3	Ciba-Geigy Coop.
3. PENNANT (7.8L)	metolachlor	6	Ciba-Geigy Coop.
4. SURFLAN (75W)	oryzalin	4	Dow-Elanco Co.
5. DERBY (5G)	4% metolachlor, 1% simazine	40	Ciba-Geigy Coop.
6. DERBY (5G)	4% metolachlor, 1% simazine	80	Ciba-Geigy Coop.
7. SNAPSHOT (80DF)	isoxaben 20%, oryzalin 60%	3.75	Dow-Elanco Co.
8. SNAPSHOT (2.5G)	isoxaben 0.5%, trifuralin 2%	150	Dow-Elanco Co.
9. GALLERY (75DF)	isoxaben	1.0	Dow-Elanco Co.
10. STAKEOUT (1G)	MON 15159	100	Monsanto Co.
11. STAKEOUT (1G)	MON 15159	200	Monsanto Co.
12. KERB (50WP)	pronamide	4	Rohm and Haas Co.
13. GOAL (1.6E)	oxyfluorfen	1	Rohm and Haas Co.
14. GOAL (1.6E)	oxyfluorfen	2	Rohm and Haas Co.
15. UNWEEDED CHECK			

TABLE 2. HERBICIDE TREATMENTS AND WEED CONTROL RATINGS, MAY/1992

TREATMENT	YELLOW NUTSEDGE	BINDWEED	SMARTWEED	HORSEWEED	RAGWEED	LAMBSQUARTER	CARPETWEED	GRASSES	OVERALL
1. PRINCEP + SURFLAN	10 de	0 e	64 abc	63 abc	91 abcd	99 a	67 ab	98 a	62 de
2. PENNANT 1X	100 a	75 abcd	23 cd	53 bc	42 e	81 a	90 a	94 a	70 cde
3. PENNANT 2X	100 a	93 abc	97 a	78 abc	57 de	98 a	97 a	98 a	88 abc
4. SURFLAN	27 cde	40 abcde	67 abc	92 ab	62 cde	98 a	99 a	92 a	72 bcd
5. DERBY 1X	67 abc	37 bcde	48 bc	62 abc	63 bcde	97 a	62 ab	37 b	59 de
6. DERBY 2X	100 a	32 cde	77 ab	98 ab	97 abc	100 a	100 a	89 a	86 abc
7. SNAPSHOT 80DF	92 ab	93 abc	100 a	100 a	100 a	100 a	100 a	98 a	98 a
8. SNAPSHOT G	50 bcd	99 a	95 a	100 a	100 a	100 a	100 a	100 a	93 ab
9. GALLERY	93 ab	65 abcd	98 a	100 a	100 a	100 a	100 a	23 bc	85 abc
10. STAKEOUT 1X	90 ab	70 abcd	99 a	96 ab	98 ab	100 a	100 a	99 a	94 ab
11. STAKEOUT 2X	100 a	100 a	100 a	100 a	100 a	93 a	100 a	100 a	99 a
12. KERB	13 de	65 abcd	80 ab	32 cd	40 e	37 b	47 b	77 a	49 e
13. GOAL 1X	0 e	25 de	70 ab	60 abc	97 abc	95 a	85 ab	99 a	66 cde
14. GOAL 2X	63 abc	97 ab	100 a	93 ab	100 a	100 a	100 a	98 a	94 ab
15. CONTROL	0 e	0 e	0 d	0 d	0 f	0 c	0 c	0 c	0 f
SIGNIFICANCE	**	**	**	**	**	**	**	**	**
LSD 0.05	48.20	61.37	44.15	45.51	35.01	22.47	39.95	30.87	22.39