Weed Control

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Evaluation of Pendimethalin + Dimethenamid-P for Relative Safety and Efficacy Compared to Four Commercial Granular Herbicides

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Significance to Industry: Dimethenamid-P + pendimethalin (BAS 659) was very effective in controlling spotted spurge, large crabgrass and eclipta, and also effective at the higher tested rates in controlling parthenium weed, an increasingly problematic glyphosate (Roundup®) tolerant weed. Control of both spotted spurge and parthenium weed using BAS 659 was better than the equivalent rate of pendimethalin applied alone (Pendulum), indicating that the dimethenamid-P in BAS 659 was providing significant control of these weeds. Dimethenamid-P has a different mode of action than the most commonly used preemergence nursery herbicides and, therefore, could be used as an aid to reduce the development of weed herbicide resistance. In addition, the combination of dimethenamid-P + pendimethalin was safe, at what will likely be labeled use rates, on the three ornamental crops on which it was tested.

Nature of Work: Weed control in nurseries is a continuing problem. This is partly because the selection of preemergence herbicides labeled and safe to use on ornamentals is limited, especially as relates to available modes of action. A small number of preemergence herbicides are typically used repeatedly, causing shifts in weed populations toward weeds that those herbicides do not control well (tolerant weeds). In addition, this practice can lead to selection for herbicide resistance. Also, new weeds are introduced into the industry on a regular basis from contaminated seed, liners and plants, as well as other sources. Therefore, when a new active ingredient becomes available for trialing, it is important to test its efficacy against both hard to control and "new" weeds. Phytotoxicity testing is also important since it helps the herbicide companies determine whether their products have a fit in the ornamental industry. BAS 659 (BASF Corp., Research Triangle Park, NC) is an experimental granular herbicide containing 1% pendimethalin + 0.75% dimethenamid-P (a group 15 herbicide). BAS 659 will be marketed as FreeHand™.

Parthenium weed (*Parthenium hysterophorus* L.), perhaps the most troublesome and noxious weed in both urban and rural India (2) and a weed of national significance in Australia (1), has been detected in almost half of the states in the U.S. (4). This aggressive weed is allelopathic, can displace native plants and reduce biodiversity, is poisonous and can taint meat and milk of animals that eat it, and causes allergic reactions in animals including humans (3). Eclipta [*Eclipta prostrata* (L.) L.] and spurge (*Chamaesyce* spp.) are frequently listed as some of the toughest weeds to control in nurseries (Society of American Florists, unpublished).

On 28 May 2007, 1½"-cell liners of crape myrtle (*Lagerstroemia indica* 'Patriot'), lilyturf (*Liriope gigantea* 'Merton Jacobs') and plumbago (*Plumbago auriculata* 'Imperial Blue') were transplanted into 6½" nursery containers. Pots were filled with a potting mix composed of pine bark:"peat":sand (6:4:1 by vol) amended with 5 lbs/yd^3 of dolomite and 0.5 lbs/yd^3 of a micronutrient plus magnesium supplement (STEP Hi-Mag, Scotts, Marysville, OH). The "peat" component was composed of equal parts composted municipal yard waste, composted hardwood bark and Florida sedge peat. There were two containers of each crop in each plot and the pots were placed on black polypropylene ground cloth in full sun and watered using overhead irrigation. Initial plant height (ht), width at widest point (wd1), and the perpendicular width (wd2) measurements were made on 30 May. Additional pots containing the same growing medium were used to evaluate treatment efficacy for controlling one grass [large crabgrass, *Digitaria sanguinalis* (L.) Scop.] and three broadleaf weeds [eclipta; spotted spurge, *Chamaesyce maculata* (L.) Small; parthenium weed]. Weed seeds were sown into pots on 31 May. Each plot had two pots of each of the four weed species, each pot sown with 20 seeds.

Fourteen containers (two for each of the three crops and two for each of the four weeds) were placed in each 3' by 4' plot. Each plot was either left untreated (control) or was treated with one of five herbicides—BAS 659 1.75 G (1% pendimethalin + 0.75% dimethenamid-P) or BroadStar™ 0.25G (Valent USA) or Pendulum™ 2G (BASF Corp.) or OH2® 3G (The Scotts Co.) or Snapshot™ 2.5TG (Dow AgroSciences). BAS 659 was applied at three rates (Table 1). Herbicides were hand broadcast under calm wind conditions on 1 June when all plant foliage was dry. After herbicide, application the plots were irrigated with ½" of water. Herbicides were reapplied in the same manner on 27 July after the weeds had been harvested and the pots reseeded with another 20 seeds each. Treatments were replicated four times and the design was a randomized complete block.

Periodically throughout the experiment, data were collected regarding acute phytotoxicity (estimated visually as a percentage from 0–100% where 0 = no injury and 100 = plant dead) and chronic phytotoxicity (using differences in plant growth as determined using plant top growth indexes (PTGI) calculated using the formula—PTGI = height × ((wd1 + wd2) ÷ 2). Weed seedling counts were made up to 28 days after the herbicide treatments were applied and successful germination percentages were then calculated. Weed control percentages were based on differences between visual estimates of weed coverage in herbicide-treated pots compared to the untreated control pots. The values for the two pots of each weed in each treatment and replication were averaged prior to statistical analysis. Prior to the second herbicide application, the aboveground parts of the weeds were cut from the containers, placed in paper bags, dried at 131°F for 5 days and then weighed. Weed top dry weights were also determined at experiment termination.

Data were analyzed by analysis of variance and means separations were by Duncan's new multiple range test at $P \leq 0.05$ (SAS, SAS Institute, Cary, NC). Percent values were square root or arcsin-square-root transformed, as needed, prior to analysis.

Results and Discussion: *Acute phytotoxicity*. After the initial treatments, very minor phytotoxicity was observed on crape myrtle in the BroadStar (4 and 7 days after initial treatment [DAIT]) and OH2 (4 DAIT) plots. After the second treatment, only BroadStar caused visible damage with low average damage ratings (0.8 to 6.7). By 77 days after the second treatments (DAST), no damage was visible in any plot. Not surprising for lilyturf, the products containing group 14 herbicides (PPO inhibitors) caused significant damage. The damage from BroadStar and OH2 was apparent 4 to 7 DAIT and consisted of leaf chlorosis occurring near the base of the leaves. Damage was still visible at 77 DAST. The highest rate of BAS 659 caused minor damage (averaging 3.1 to 5.5) after the second application. Interestingly, the damage did not appear until 42 DAST. None of the other treatments caused significant phytotoxicity. As expected, plumbago was the most herbicide sensitive crop and was severely damaged by BroadStar. The medium BAS 659 rate and OH2 treatments were moderately phytotoxic (averaging 7.3 to 17.2), but the plants had grown out of the symptoms by the end of the trial. The high rate of BAS 659 was somewhat more damaging (averaging 8.5 to 34.4) than those treatments, but the plants also outgrew the injury by 77 DAST. *Chronic phytotoxicity*. Herbicide treatments had no effect on changes in plant top growth indexes (PTGI) for crape myrtle or liriope; however, growth of the sensitive indicator crop plumbago was reduced in the plots initially treated with BroadStar and the highest rate of BAS 659. By 56 DAST, PTGI increases for plumbago were not different from the control for any of the treatments except BroadStar. Some of the plumbago plants were killed by the BroadStar treatment. The BAS 659 rate effect on plumbago PTGI increase was inversely linear.

Weed Control – germination and seedling survival. At 28 DAIT, spotted spurge control ranged from 83 (Pendulum and low BAS 659) to 100% (all the other treatments). At 28 DAST, control was 95% or higher for all treatments. Control of large crabgrass was 100% for all treatments at all dates. Eclipta seed germination was very low but by 28 DAST was enough for treatment comparison. Successful seedling survival was not reduced using OH2 and was reduced by 72 and 81%, respectively, by Snapshot and Pendulum. Control was 100% with BroadStar and all rates of BAS 659. For parthenium weed at 28 DAIT, successful seedling establishment was reduced by all treatments except the low and middle rates of BAS 659. OH2 and Snapshot provided 100% control. At 28 DAST, all treatments except Pendulum provided very good to excellent (88 to 98%) parthenium control. *Weed control – coverage and dry weights.* Spotted spurge was well controlled by all herbicide treatments; however by 56 DAST, Pendulum was less effective (based on coverage) than the others with the exception of Snapshot (Table 1). Large crabgrass control was 100% for all treatments. Eclipta was not controlled by OH2 and poorly suppressed by Snapshot but the other treatments provided control with BroadStar and all rates of BAS 659 giving excellent control. Parthenium weed control was rate related for BAS 659 with only the highest rate providing significant control after the first sowing and the middle and high rates providing good to excellent suppression after the second application. Pendulum was not effective, indicating that it was the dimethenamid-P in BAS 659 that was controlling parthenium weed. Control at 56 DAIT/DAST ranged from 71.5 to 100% for BroadStar, OH2 and Snapshot.

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Table 1. Weed control, based on visual estimates of weed coverage of the medium surface, and weed dry weights.

		spotted spurge		large crabgrass		eclipta		parthenium weed	
		Weed control (%)							
Treatments	Application rate (lb a.i. /A)	56 DAIT[z]	56 DAST[y]	56 DAIT[z]	56 DAST[y]	56 DAIT[z]	56 DAST[y]	56 DAIT[z]	56 DAST[y]
Untreated control	—	0.0 b[x]	0.0 c	0.0 b	0.0 b	—[w]	0.0 b	0.0 c	0.0 c
BAS 659 1.75G	1.75	100.0 a	97.7 a	100.0 a	100.0 a	—	95.6 a	9.0 bc	61.3 b
BAS 659 1.75G	2.63	100.0 a	99.8 a	100.0 a	100.0 a	—	90.3 a	25.0 bc	81.6 ab
BAS 659 1.75G	3.50	100.0 a	99.4 a	100.0 a	100.0 a	—	98.3 a	76.7 ab	95.0 a
BroadStar 0.25G	0.375	100.0 a	100.0 a	100.0 a	100.0 a	—	99.8 a	71.5 ab	100.0 a
OH2 3G	3.00	100.0 a	100.0 a	100.0 a	100.0 a	—	1.1 b	100.0 a	88.5 a
Pendulum 2.0G	2.00	88.9 a	75.9 b	100.0 a	100.0 a	—	75.7 a	30.9 abc	8.7 c
Snapshot 2.5G	5.00	100.0 a	91.1 ab	100.0 a	100.0 a	—	45.0 ab	100.0 a	84.4 ab
		Dry weed weight (g)							
		56 DAIT[z]	74 DAST[y]	56 DAIT[z]	74 DAST[y]	56 DAIT[z]	74 DAST[y]	56 DAIT[z]	74 DAST[y]
Untreated control	—	3.8 b[x]	7.31 b	12.4 b	17.6 b	0.0 a	2.69 ab	5.1 c	19.5 b
BAS 659 1.75G	1.75	0.0 a	0.38 a	0.0 a	0.0 a	0.0 a	0.55 ab	2.6 b	7.9 a
BAS 659 1.75G	2.63	0.0 a	0.01 a	0.0 a	0.0 a	0.0 a	0.87 ab	2.6 b	3.3 a
BAS 659 1.75G	3.50	0.0 a	0.02 a	0.0 a	0.0 a	0.0 a	0.22 ab	0.2 a	1.4 a
BroadStar 0.25G	0.375	0.0 a	0.00 a	0.0 a	0.0 a	0.0 a	0.003 a	0.6 ab	0.0 a
OH2 3G	3.00	0.0 a	0.00 a	0.0 a	0.0 a	0.3 a	3.90 c	0.0 a	3.5 a
Pendulum 2.0G	2.00	0.4 a	1.52 a	0.0 a	0.0 a	0.3 a	1.58 abc	1.3 ab	17.2 b
Snapshot 2.5G	5.00	0.0 a	0.49 a	0.0 a	0.0 a	0.0 a	2.67 bc	0.0 a	1.7 a

[z] DAIT = days after initial herbicide treatments.
[y] DAST = days after second herbicide treatments.
[x] Means separation within columns and category by Duncan's new multiple range test at $P \leq 0.05$.
[w] There was inadequate eclipta seed germination for statistical analysis.