Abstract. 2007 Report - Weed Research in Mint

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Statement of purpose. This research develops new knowledge on weed control methods in peppermint and spearmint, including information on the selectivity and efficacy of new herbicides and how to integrate these herbicides into weed management programs for mint.

Summary of objectives.

1. Identify and evaluate new herbicides for use in mint crops. Determine efficacy of herbicides applied in the fall, spring, and after first cutting but prior to mint regrowth.
2. Determine peppermint response and broadleaf weed control with low doses of mesotrione and mesotrione tank mixes and with bromoxynil and fluroxypyr premixes and bromoxynil plus MCPB tank mixes.
3. Evaluate newly planted peppermint response and weed control with white mustard seed meal and field pennycress seed meal.
4. Evaluate prickly lettuce and tall hedge mustard control with postemergence applied herbicides at three stages of growth.

Actions taken.

1. Herbicides including flucarbazone, asulam, amicarbazone, fomesafen, and pyrasulfotole were tested in peppermint and spearmint in field trials.
2. Field trials were conducted in peppermint with mesotrione applied alone or in tank mixes and with fluroxypyr or MCPB tank mixed with bromoxynil.
3. Field trials were conducted on response of weeds and newly planted peppermint to seed meals.
4. The response of prickly lettuce and tall hedge mustard to several herbicides applied postemergence at three growth stages was measured in container trials.

Results.

1. Amicarbazone, pyrasulfotole, asulam, controlled many broadleaf weeds in mint without reducing oil yields. Flumioxazin, sulfentrazone, and carfentrazone controlled pigweed in peppermint following the first harvest. Flucarbazone reduced mint oil yields when applied to dormant mint.
2. Low doses of mesotrione in combination with other broadleaf herbicides injured mint temporarily and controlled several broadleaf weeds. Bromoxynil reduced the activity of fluroxypyr on prickly lettuce, but improved common groundsel control.
3. Mustard seed meal applied at 1 ton/acre suppressed annual weeds for about 3 weeks in newly planted peppermint without injuring the mint.
4. Several preemergence applied herbicides and early postemergence applied herbicides controlled prickly lettuce and tall hedge mustard well.

2007 - Mint Weed Research Report

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Statement of Research. Weeds lower mint oil yield and quality and controlling weeds is a major production cost for growers. The goal of this research was to develop improved weed control methods in spearmint and peppermint and to identify promising new herbicides for use in mint production. Ongoing research will lead to development of new weed control techniques and contribute to the registration of new herbicides in mint that will improve weed control, decrease crop injury, decrease cost of production, decrease harm to the environment, and slow the development of herbicide resistant weeds. Few researchers in the United States conduct studies on weed control in spearmint and peppermint and this research will significantly add to the current body of knowledge on control of weeds in mint. This research has increased our knowledge of peppermint, spearmint, and weed response to various herbicides. The research identified several control options for broadleaf weed control in double cut mint that often escape current standard herbicide treatments.

Materials and Methods. Field trials were conducted at the Prosser Irrigated Agriculture Research and Extension Center (IAREC) on a Warden sandy loam soil (1% O.M., pH 7.9) (peppermint) or Warden silt loam soil (1.2% O.M., pH 6.6) (native spearmint) and were sprinkler irrigated.

Trials were randomized complete block (RCB) designs with treatments replicated 3 or 4 times. In most instances plot size was 10 by 20 feet. All herbicides were applied in 25 gpa water volume with a bike CO_2 sprayer equipped with six, 8002XR flat fan nozzles. In seed meal trials, plot size was 5 by 15 feet and treatments replicated four times.
In container trials, herbicides were applied with a bench single nozzle sprayer. Each treatment was replicated five or more times in a completely randomized design and each trial was repeated in time.

Peppermint and spearmint response to herbicides was visually estimated and recorded at various times throughout the growing season. Weed control was visually estimated in most trials when weed infestations were great enough and uniform enough to adequately evaluate. Weed density was also determined in some trials by counting weeds in a known area within each plot. In trials that mint hay and oil yield were determined, a 40 inch by 20-foot swath of mint was cut using a sickle bar mower. Mint fresh hay was weighed, and three 7 lb subsamples were taken from each plot and air dried in burlap bags. Oil was steam-distilled from air-dried hay using the standardized mini-stills at IAREC.

Research Project Goals and Objectives

1. Identify and evaluate new herbicides that control weeds selectively in spearmint and peppermint.
Three field trials were conducted on peppermint and two on native spearmint evaluating weed control and mint response to various herbicides.

2. Determine peppermint response and broadleaf weed control with low doses of mesotrione and mesotrione tank mixes and with bromoxynil and fluroxypyr premixes and bromoxynil plus MCPB tank mixes.
Weed control and peppermint response to low doses of mesotrione applied alone and in tank mixes were determined and fluroxypyr and MCPB were tested alone and in tank mixes with bromoxynil.

3. Evaluate newly planted peppermint response and weed control with white mustard seed meal and field pennycress seed meal.
Weed control with white mustard seed meal and field pennycress seed meal was evaluated in a field trial on newly planted peppermint.

4. Evaluate prickly lettuce and tall hedge mustard control with postemergence applied herbicides at three stages of growth.
Prickly lettuce control with several postemergence applied herbicides was evaluated in field containers.

Success Criteria and Timing. All trials were initiated and completed. Herbicide treatments and mint harvests were accomplished so that results were obtainable and relevant to the mint industry. Results and reports were completed according to MIRC and Washington Mint Commission deadlines.

Data Analysis. Data were statistically analyzed using analysis of variance procedures (ANOVA) and treatments means separated using Fisher's protected LSD or the Student-Newman-Keuls test at the 0.05 level.

Results and Discussion

1. Identify and evaluate new herbicides that control weeds selectively in spearmint and peppermint.

Trial 1. Weed control and peppermint response to Chateau (flumioxazin) applied December 20, 2006 and/or February 27, 2007 alone and in combination with Command (clomazone), Sinbar (terbacil), or Prowl H2O (pendimethalin) were measured. All treatments included Gramoxone at 0.38 lb ai/a for control of emerged winter annual weeds. Treatments were replicated three times in a RCB design. The study was conducted on a Warden sandy loam soil (1% O.M., pH 7.9) and was sprinkler irrigated with hand lines. The main weeds present were prickly lettuce and flixweed, with lesser amounts of tall hedge mustard.

Chateau alone or in tank mixes tended to stunt early spring mint growth, particularly with Chateau + Command compared to nontreated checks. Prickly lettuce and flixweed control was excellent with all Chateau treatments and timings (Table 1). There was no difference in prickly lettuce and flixweed control between the December and late February application dates. Tall hedge mustard was controlled well by all herbicide treatments in late March, but some plants regrew in several treatments. Plots treated with Chateau plus Sinbar (Dec., Feb., or Dec. + Feb.) and Chateau plus Command (Dec. + Feb.) were completely free of tall hedge mustard in late April.

Peppermint was harvested July 16, 2007 and averaged 75 lbs oil/acre and there was no yield differences among herbicide treated plots (Table1). Peppermint treated sequentially (Dec. + Feb.) with Chateau plus Sinbar averaged 92 lbs oil/acre. All but one herbicide treatment yielded greater oil than weedy checks, which averaged 41 lbs oil/acre.

<u>Trial 2.</u> Weed response and peppermint tolerance to Everest (flucarbazone) and Asulox (asulam) applied Feb. 28, 2007 to dormant mint or applied May 7, 2007 to emerged peppermint that was 4 to 6 inches tall were evaluated. Huskie [pyrasulfotole (3.3%) + bromoxynil (18.5%)] was also applied May 7, 2007. Pyrasulfotole is a new cereal herbicide which inhibits HPPD (4-hydroxyphenylpyruvate dioxygenase) and is being developed by Bayer. It is active against a broad spectrum of broad-leaved weeds. Asulox is an older herbicide registered in sugarcane for and controls several composite species, some grass species, and bracken fern. Treatments were replicated three times in a randomized complete block design. The study was conducted on a Warden sandy loam soil (1% O.M., pH 7.9) and was sprinkler irrigated with hand lines. The main weeds present were prickly lettuce and flixweed, with lesser amounts of tall hedge mustard.

Everest controlled flixweed well, but did not control prickly lettuce (Table 2). Everest applied to dormant peppermint in late February caused little or no injury but applied postemergence in early May injured peppermint excessively several weeks after application (Table 2). Asulox controlled common groundsel well, suppressed prickly lettuce, and did not control flixweed initially (Table 2). Control of prickly lettuce improved over time with Asulox, while control of flixweed declined. Asulox did not injure peppermint appreciably applied preemergence, postemergence, or preemergence plus postemergence at the rates tested. All treatments that included Gramoxone (paraquat) in February controlled prickly lettuce and flixweed best. Huskie applied early postemergence injured mint severely (83%), but mint slowly recovered over time and yielded more oil than weedy checks (Table 2).

Peppermint hay and oil yields were collected July 16, 2007. Hay and oil yield was variable and few significant differences were observed. Peppermint treated with Asulox treatments, Huskie applied postemergence, and Everest applied preemergence yielded similar amounts of oil ranging from 50 to 79 lbs oil/acre (Table 2). The two lowest yielding treatments were the weedy check (33 lbs oil/acre) and Everest applied preemergence (31 lbs oil/acre) (Table 2).

Trial 3. Broadleaf weeds emerging in double cut mint after the first harvest are sometimes difficult to control, especially with the loss of Tough (pyridate) herbicide. Peppermint tolerance and broadleaf weed response to reduced rates of Spartan (sulfentrazone), Chateau (flumioxazin), and Aim (carfentrazone) applied one week after peppermint harvest and prior to weed emergence was tested. Aim was also tested as an early postemergence treatment to both pigweed and peppermint, since it has limited soil residual activity. Spartan was applied at 0.063 and 0.125 lb ai/a, Chateau at 0.047 and 0.063 lb ai/a, and Aim at 0.015 and 0.028 lb ai/a on July 23, 2007. Aim was also applied 1 week later, July 31, after pigweed began to emerge. The study was conducted on a Warden sandy loam soil (1% O.M., pH 7.9) and was sprinkler irrigated with hand lines. Treatments were replicated three times in a randomized complete block design.

Peppermint regrowth was slightly stunted initially in August with the highest rate of Chateau applied preemergence and with Aim applied postemergence on July 31 (Table 3). Peppermint grew normally thereafter and no visual differences were obvious in September. Peppermint treated with the highest rate of Spartan tended to be slightly shorter in mid September. Redroot pigweed was controlled well in all treatments except the Aim applied July 23, prior to pigweed emergence (Table 3). Aim lacks soil residual and was only effective when applied after pigweed had emerged.

Hay and oil yields were determined on September 24, 2007. All treatments yielded similar amounts of hay and oil and averaged 44 lbs oil/acre (Table 3).

Trial 4. Several herbicides [flucarbazone (Everest), asulam (Asulox), amicarbazone, fomesafen (Reflex), and pyrasulfatole (Huskie)] were applied at several rates and application times for broadleaf weed control in native spearmint at the WSU-Roza site. Amicarbazone is a new herbicide for broadleaf weed control developed by Arysta LifeSciences that inhibits photosynthesis in susceptible species. Fomesafen is a protox inhibitor registered in soybeans for broadleaf weed control and similar in mode of action to Goal herbicide. The study was conducted on a Warden silt loam containing 1% O.M. and was sprinkler irrigated with hand lines. Dormant applications of paraquat (Gramoxone), Everest or Asulox were applied February 28, 2007. Postemergence applications of Everest, Asulox, amicarbazone, or Reflex were applied May 7, 2007 when spearmint ranged from 3 to 6 inches tall. Treatments were replicated three times in a RCB design.

Everest applied preemergence in late February caused very little visual injury to spearmint, but when applied postemergence in early May injured native spearmint (Table 4). Huskie or Reflex applied postemergence injured emerged native spearmint excessively in May. Reflex applied earlier to dormant spearmint in late February resulted in much less injury than when applied postemergence. Amicarbazone injured native spearmint at 4 DAT, but mint recovered soon after (Table 4). Everest controlled flixweed well, but did not control prickly lettuce (Table 5). Asulox did not injure spearmint appreciably applied preemergence, postemergence, or preemergence plus postemergence (Table 4). Asulox suppressed prickly lettuce, but did not control flixweed

(Table 5). All treatments that included Gramoxone (paraquat) in February controlled prickly lettuce and flixweed best (Table 5). Tall hedge mustard control was greatest in plots treated with Gramoxone in February followed by any of the following; high rate of Asulox, amicarbazone, Reflex, Everest, or Huskie (Table 5). Common lambsquarters control was excellent with Gramoxone in February followed by any of the following; high rate of Asulox, amicarbazone, Everest, or Huskie (Table 5).

Native spearmint hay and oil yields were collected in September 13, 2007. Yield was variable and not many significant differences among treatments were evident (Table 4). Weedy checks averaged the lowest oil yield at 22 lb oil/acre. Everest applied to dormant spearmint yielded only 27 lbs oil/acre. Although Reflex applied to dormant spearmint caused some slight early season injury, spearmint yielded relatively high at 61 lb oil/acre (Table 4).

Trial 5. Select Max, a new formulation of clethodim containing 1 lb ai/gal was introduced in 2006. The original Select formulation contains 2 lb ai/gal. A trial was conducted on native spearmint comparing the two formulations for annual grass weed control. Grass weeds were mainly barnyardgrass (80%) and green foxtail (20%). Three rates of each clethodim formulation were applied with ammonium sulfate at 2.5 lb ai/a. Select Max treatments included R-11 nonionic surfactant at 0.25% (v/v) and Select treatments included COC at 1% (v/v) spray solution. Treatments were applied when grass weeds averaged 6 to 8 inches tall on August 22, 2007 to native spearmint that had been harvested in late July. To determine speed of kill, the top portion of five grass weeds was gently pulled at two days after herbicide application and the base of the pulled leaf blade examined for brownish discoloration.

Two days after clethodim application, grass weeds in all treated plots exhibited 87% or more of the leaf bases browning when leaf blades where pulled gently on the top of each plant (Table 6). No differences in speed of death were observed among Select formulations or rates. All treatments controlled barnyardgrass and green foxtail similarly at 1, 2, and 4 weeks after application. Control was 99 to 100% at two weeks after treatment and 100% for all treatments at four weeks after treatment (Table 6). No mint injury was observed with any treatment.

2. Determine peppermint response and broadleaf weed control with low doses of mesotrione and mesotrione tank mixes and with bromoxynil and fluroxypyr premixes and bromoxynil plus MCPB tank mixes.

Previous Research. In 2004, low rates (0.016 - 0.032 Lb ai/a) of mesotrione (Callisto) applied POST alone and with bentazon (Basagran), bromoxynil (Buctril), and terbacil (Sinbar) were tested in native spearmint and peppermint. Treatments were applied to regrowth (about 4 inches tall) following the first cutting of native spearmint and peppermint. Initial mint injury from POST applied Callisto or Callisto tank mixes ranged from 25 to 70%, but mint recovered several weeks later. Both spearmint and peppermint were injured most by tank mixes of Callisto with Buctril. Oil yield of native spearmint treated with Callisto alone or in tank mixes with Basagran or Sinbar was greater than oil yield in plots where pigweed was not controlled. In 2005, mint injury with Callisto at 0.016 or 0.032 lb ai/a alone or in tank mixes was transient and by 4 WAT was very minor. Oil and hay yields were not obtained. In 2006, peppermint tolerance to POST applications of Callisto alone and in tank mixes were applied April when peppermint averaged 3 to 4 inches. Initial crop injury at 2 weeks after application was significant with all treatments except the lower rate of Callisto (0.016 lb ai/a) applied alone, which injured mint similar to Basagran. By June 6, 2006 all treatments had 10% or less crop injury as mint had recovered well. No mint injury or difference in peppermint bloom was evident just prior to harvest and no differences in peppermint hay or oil yield were observed among treatments.

In 2007, POST broadleaf weed control and peppermint injury were evaluated with several herbicides including low rates Callisto (mesotrione) alone and in tank mixes with Basagran (bentazon) and Sinbar (terbacil). Herbicides were applied April 6, 2007 when peppermint was 0.5 to 1 inch tall. The trial was conducted on a Warden sandy loam soil (1% O.M., pH 7.9) and sprinkler irrigated. The main weeds present were prickly lettuce and flixweed with lesser amounts of tall hedge mustard, common groundsel, western salsify, and marestail (*Conyza canadensis*). Starane (fluroxypyr) was tested at 0.13 and 0.19 lb ae/a with and without bromoxynil (premix of fluroxypyr and bromoxynil called Starane NXT). Thistrol (MCPB) and Thistrol plus Buctril (bromoxynil) were also included. All treatments were replicated three times in a RCB design.

Peppermint was injured for about 10 to 14 days after Callisto application (Table 7). Peppermint did not totally recover from Callisto treatments as seen in previous years, possibly because the mint was treated at an earlier stage of growth in the current study. Callisto tank mixes with Sinbar or Basagran injured mint similar to that with Callisto alone (Table 7). Callisto alone controlled flixweed well and controlled prickly lettuce about 90% or more (Table 8). Flixweed and prickly lettuce control was excellent with Callisto + Basagran or Callisto + Sinbar treatments. Basagran or Sinbar tank mixes with Callisto suppressed groundsel better than Callisto alone. All Callisto treatments suppressed a sparse population of tall hedge mustard well (80-95%) (data not shown) and suppressed salsify about 50% (Table 8).

Starane injured peppermint for several weeks after application (Table 7). Starane NXT caused less injury to peppermint than Starane. Starane suppressed prickly lettuce, but did not control flixweed or tall hedge mustard (Table 8). Starane NXT controlled prickly lettuce less than Starane, similar to results in the container trials. It appears that bromoxynil in the Starane NXT formulation antagonizes the activity of the fluroxypyr on several weeds and mint. Starane NXT controlled common groundsel better than Starane, probably due to bromoxynil in the formulation, which has good activity on groundsel.

Thistrol alone did not control any weeds well that were present in this trial. Buctril only partly suppressed prickly lettuce and flixweed, but controlled common groundsel well (Table 8). Bromoxynil tank mixed with Starane (Starane NXT) or Thistrol improved groundsel control.

All treatments containing bromoxynil significantly injured peppermint through late April (Table 7). Peppermint oil yield was lowest in weedy checks (26 lb oil/acre) and with treatments of Thistrol, Thistrol plus Buctril, and Buctril alone, likely due to the poor control of prickly lettuce and flixweed with these three treatments (Table 7). All other treatments injured peppermint initially, but controlled prickly lettuce and/or flixweed better and resulted in oil yields from 42 to 66 lbs oil/acre (Table 7).

After several four years of testing low rates of Callisto applied POST it appears the risk of crop injury may not be acceptable, although in all cases the crop regrew and yielded normal. Callisto applied POST at these low rates offers some interesting weed control benefits, but the manufacturer, Syngenta, has no intention to pursue this herbicide for registration in mint.

3. Evaluate newly planted peppermint response and weed control with white mustard seed meal and field pennycress seed meal.

Peppermint and weed response to white mustard (*Sinapis alba*) seed meal, Var. 'Ida Gold' and field pennycress (*Thlaspi arvense*) seed meal were evaluated. Field pennycress seed meal contains glucosinolates that predominately yield allyl isothiocyanate upon hydrolysis. This particular glucosinolate is relatively volatile and may be more effective in suppressing weeds when incorporated shallow in the soil. The main glucosinolate in white mustard seed meal is sinalbin which yields less volatile isothiocyanates and thiocyanate ion which is more water soluble. Therefore, white mustard seed meal was placed on the soil surface and sprinkler irrigated. Seed meal was cold pressed by McKay Seeds at Moses Lake and flakes were ground with a hammer mill to obtain more uniform granules.

Seed meals were applied evenly over plots measuring 5 by 10 feet. Field pennycress was applied April 11, 2007 prior to planting peppermint roots and rototilled in the top 3 inches of soil. Peppermint rhizomes/roots were planted 2 to 3 inches deep in two rows spaced 30 inches on a Warden sandy loam soil (1% O.M., pH 7.9) at WSU-IAREC April 12, 2007. Mustard seed meal was applied immediately after planting mint and left on the soil surface. Seed meals were applied at 0.5, 1, and 2 ton/acre. Plots were irrigated with 0.34 in. water the day of application and the following two days. Treatments were replicated four times in a RCB design. A nontreated weedy check and a terbacil (Sinbar) treated standard were included for comparison.

White mustard seed meal reduced broadleaf and grass weeds in late April (2 WAT) with the 1 and 2 ton/acre rate providing total weed control (Table 9). By May 9, 2007 (4 WAT) broadleaf and grass weed suppression with mustard meal was still evident, but new weeds had begun to emerge. On May 21 (5 ½ WAT), emerged weeds were smaller in the mustard meal treated plots compared to the nontreated checks and weed control ratings were significantly greater with mustard seed meal treatments compared to pennycress or nontreated checks (Table 9). No phytotoxicity (chlorotic leaves) was observed on peppermint plants.

Field pennycress seed meal applied at 0.5, 1, and 2 ton/a failed to reduce broadleaf or grass weed emergence consistently at any time (Table 9). No injury to peppermint was observed with field pennycress seed meal at any rate. Sinbar controlled nearly all weeds through the end of May.

These results were similar to a previous study on newly planted peppermint conducted in late summer of 2006, with the exception that white mustard initially injured peppermint slightly at the 2 ton/a rate in 2006. Field pennycress was not incorporated into the soil in 2006 and did not control weed emergence in either year. White mustard seed meal appears to several weeks of weed suppression in peppermint, but could be difficult and/or expensive to obtain and apply. Mustard seed meal is not currently registered for weed control on conventional or organic fields.

4. Evaluate prickly lettuce and tall hedge mustard control with several herbicides applied at different growth stages.

The response of tall hedge mustard and prickly lettuce to several herbicides applied preemergence (Sinbar, Karmex, Chateau, and Spartan) and postemergence (Starane, Buctril, Starane NXT, Gramoxone, Karmex + Gramoxone, Sinbar + Gramoxone, and Chateau + Gramoxone) were tested. Flixweed, tall hedge mustard and prickly lettuce seed collected from mint in the Columbia Basin were seeded in 2-gal containers filled with a 33% commercial potting soil and 66% silt loam soil mix. Twenty seed of flixweed or tall hedge mustard and 15 seed of prickly lettuce were planted per container in several trials initiated from January through March 2007.

Preemergence treatments were applied the day of seeding weeds. Containers were maintained in the greenhouse for preemergence trials. For postemergence herbicide trials, containers were initially placed in the greenhouse until weed seedling emergence and then placed outdoors so that plants would develop leaves and cuticles more similar to field grown plants. Postemergence trials included applications when prickly lettuce was 1, 2 to 3, and 3 to 4 inch diameter and when tall hedge mustard were 1 to 2 and 2 to 3 inch diameter. Herbicides were applied with a single nozzle bench sprayer delivering 25 gpa. Treatments were replicated 5 times in a completely randomized design.

Preemergence control of prickly lettuce, tall hedge mustard, and flixweed. All four preemergence treatments; Karmex (diuron) at 1 lb ai/a, Sinbar (terbacil) at 0.75 lb ai/a, Chateau (flumioxazin) at 0.13 lb ai/a, and Spartan (sulfentrazone) at 0.19 lb ai/a totally prevented establishment of prickly lettuce and tall hedge mustard for 4 or 5 WAT at which time the trials were terminated (Table 10).

Early postemergence control of prickly lettuce (1 in. stage). By Feb. 13 (2 WAT), 1-inch prickly lettuce was completely controlled by all POST treatments including Karmex + Gramoxone (1 + 0.5 lb ai/a), Sinbar + Gramoxone (0.75 + 0.5 lb ai/a), Chateau +

Gramoxone (0.125 + 0.5 lb ai/a), Gramoxone alone (0.5 lb ai/a), Starane (0.125 lb ae/a), Buctril (0.25 lb ai/a), and Starane NXT (0.292 lb ai/a) (Table 11).

Postemergence control of prickly lettuce (2 to 3 and 3 to 4 inch stage) and tall hedge mustard (1 to 2 and 2 to 3 inch stage). Control of 2 to 3 or 3 to 4 inch diameter prickly lettuce at 4 WAT was excellent with Karmex, Sinbar, or Chateau tank mixed with Gramoxone, Gramoxone alone, and Starane, all giving 93% or better control in the two trials (Table 11). Control of prickly lettuce was not consistent with Starane NXT, which contains bromoxynil, giving only 35% control in trial 1 and 95% control in trial 2. In field trials, Starane NXT controlled prickly lettuce poorly, suggesting that the bromoxynil in the premix may antagonize fluroxypyr activity on prickly lettuce. Buctril did not control prickly lettuce well when applied at these larger stages of growth.

Tall hedge mustard in the 1 to 2 or 2 to 3 inch stage was completely controlled by 4 WAT with Karmex + Gramoxone (1 + 0.5 lb ai/a) or Sinbar + Gramoxone (0.75 + 0.5 lb ai/a) in both trials (Table 12). Chateau + Gramoxone (0.13 + 0.5 lb ai/a) or Gramoxone (0.5 lb ai/a) alone controlled tall hedge mustard 77 to 93% at 4 WAT in the two trials. Starane (0.13 lb ae/a), Buctril (0.25 lb ai/a), and Starane NXT (0.29 lb ai/a) only partly suppressed tall hedge mustard in both trials (Table 12).

5. Rattail fescue response to two formulations of clethodim (Select and Select Max) and preemergence herbicides.

The response of rattail fescue to preemergence applied herbicides (Sinbar, Command, and Prowl H_2O) and to postemergence applied Select (clethodim) and Select Max was tested. Rattail fescue seed collected from mint in the Yakima valley were seeded in 2-gal pots filled with a 33% commercial potting soil and 66% silt loam soil mix. Twenty seed were planted per container on March 5, 2007 and an average of 17 plants emerged in each container in the nontreated checks. Preemergence treatments were applied the day of seeding with a bench sprayer delivering 25 gpa. Select treatments were applied April 17, 2007 when grass seedlings were 1.5 inch tall with 6 to 9 leaves per plant. Prior to postemergence herbicide applications, plants were thinned to 8 plants per pot. Select treatments included COC (crop oil concentrate) and UAN (urea ammonium nitrate) whereas Select Max treatments included R-11 nonionic surfactant and UAN. Treatments were replicated 5 times in a randomized complete block (RCB) design. Containers were watered by hand as needed.

Preemergence applied terbacil (Sinbar) at 0.5 lb ai/a and clomazone (Command) at 0.25 lb ai/a completely controlled rattail fescue for the duration of the trial. Pendimethalin (Prowl H2O) at 1 lb ai/a controlled rattail fescue 94% (Table 13).

Postemergence applied Select at 0.25 lb ai/a controlled rattail fescue seedlings 81% and Select Max at 0.24 lb ai/a controlled emerged rattail fescue 99% by 6 WAT (Table 13). Select Max at lower rates of 0.06 or 0.12 lb ai/a only slightly suppressed the growth of rattail fescue seedlings (Table 13). Several extra containers were treated with

Asulox at 2.5 lb ai/a and rattail fescue was dead in those containers by 4 WAT (data not shown).

Conclusions

Chateau applied alone and in combinations with other preemergence herbicides and Gramoxone controlled prickly lettuce and flixweed well with minimal injury to peppermint. Everest herbicide applied preemergence to dormant mint controlled mustard species well, but resulted in lower oil yields of both native spearmint and peppermint. Postemergence applications of Everest caused more visual mint injury than dormant applications, but resulted in greater oil yields. Asulox applied at two rates both preemergence and postemergence did not injure peppermint or native spearmint and controlled common groundsel, suppressed prickly lettuce, and did not control mustard species well. Huskie applied postemergence controlled broadleaf weeds well, but injured peppermint and native spearmint excessively. However, the mint recovered and yielded similar to mint treated with other standard herbicides. Amicarbazone applied postemergence to native spearmint controlled all broadleaf weeds well, injured spearmint initially, but the mint yielded similar to mint treated with other standard herbicides. Pigweed was controlled in second growth peppermint after the first cutting with relatively low rates of Chateau or Spartan applied prior to mint and weed emergence or with Aim applied soon after pigweed emergence. Select Max performed similar to Select on annual grass weeds with no injury to native spearmint. Low rates of Callisto applied early postemergence alone or in tank mixes with Sinbar or Basagran controlled broadleaf weeds well, but injured peppermint for about 1 month. Starane applied early postemergence controlled prickly lettuce well, but not flixweed. Bromoxynil tank mixed with Starane reduced prickly lettuce control, reduced peppermint injury, and improved common groundsel control. White mustard seed meal applied at 1 or 2 ton/acre to the soil surface reduced weeds in newly planted peppermint and may be useful in organic mint production. Prickly lettuce was controlled well in container trials with preemergence Karmex, Sinbar, Spartan, and Chateau. Small, 1-inch diameter prickly lettuce was completely controlled by several herbicide treatments whereas larger prickly lettuce or tall hedge mustard were not completely controlled. Karmex plus Gramoxone or Sinbar plus Gramoxone provided the most consistent control of these two weeds when applied to larger seedlings. Rattail fescue was controlled in containers by preemergence applications of Sinbar, Command, and ProwlH2O and postemergence only by the highest rate of SelectMax at 0.24 lb ai/a.

Caution Proprietary Information

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Table 1. Weed control, peppermint injury, hay, and oil yield after treating with Chateau tank mixes applied in December 20, 2006 and/or February 27, 2007 at Prosser, WA.

Treatment	Rate	Timing	Prickly lettuce Control 4/30/07	Flixweed Control 4/30/07	Peppermint Injury 4/2/07	Peppermint Injury 4/30/07	Peppermint Hay yield 7/16/07	Peppermint Oil yield 7/16/07
	(Lb ai/a)		(%)	(%)	(%)	(%)	(T/a)	(lb oil/a)
Chateau Gramoxone	0.13 0.38	Dec. Dec.	98 ab	100 a	3	2 bc	13.6 ab	72 ab
Chateau Gramoxone	0.13 0.38	Dec.+ Feb. Dec.+ Feb.	100 a	100 a	5	3 abc	13.8 ab	80 ab
Chateau Gramoxone	0.13 0.38	Feb. Feb.	97 b	99 a	4	2 bc	12.9 ab	68 ab
Chateau Gramoxone Sinbar	0.13 0.38 0.8	Dec. Dec. Dec.	100 a	100 a	1	0 c	13.8 ab	62 bc
Chateau Gramoxone Sinbar	0.13 0.38 0.35	Dec.+ Feb. Dec.+ Feb. Dec.+ Feb.	100 a	100 a	7	5 abc	15.7 a	92 a
Chateau Gramoxone Sinbar	0.13 0.38 0.8	Feb. Feb. Feb.	100 a	100 a	8	3 abc	13.8 ab	79 ab
Chateau Gramoxone Command	0.128 0.38 0.19	Dec.+ Feb. Dec.+ Feb. Dec.+ Feb.	100 a	100 a	3	7 ab	14.8 a	71 ab
Chateau Gramoxone Command	0.13 0.38 0.38	Feb. Feb. Feb.	99 ab	100 a	7	8 a	16.0 a	74 ab
Chateau Gramoxone Prowl H2O	0.13 0.38 1.0	Feb. Feb. Feb.	98 ab	98 a	5	3 abc	15.0 ab	79 ab
Nontreated Check			0 c	0	0	0 c	10.73 b	41.4 c
		LSD (P=.05)	2.66	1.62	n.s.	4.53	3.12	23.96

R-11 nonionic surfactant added at 0.25% (v/v) spray solution to all treatments.
Means followed by same letter do not significantly differ (P=.05, Protected LSD)

Table 2. Weed control, peppermint injury, and peppermint hay and oil yield after treating with herbicides February 28, 2007 and/or May 7, 2007 at Prosser, WA.

Treatment	Rate	Timing	Prickly Lettuce Control 4/30/07	Prickly Lettuce Control 6/15/07	Flixweed Control 4/30/07	Flixweed Control 6/15/07	Tall Hedge Mustard Control 6/15/07	Peppermint Injury 4/3/07	Peppermint Injury 5/16/07	Peppermint Hay yield 7/16/07	Peppermint Oil Yield 7/16/07
	(lb ai/a)		-----(%)----		------(%)------		--(%)--	------(%)------		(Ton/a)	(lb/a)
Asulox XP	1.25	Feb.	83 b	79 b	77 c	0 c	45 bc	4 c	0 c	9.1 bc	50 cd
Gramoxone Asulox	0.5 1.25	Feb. May	86 b	100 a	90 abc	100 a	96 a	0 d	0 c	11.8 ab	67 abc
Asulox XP	2.5	Feb.	100 a	97 a	78 bc	0 c	80 ab	7 b	0 c	11.3 ab	58 c
Gramoxone Asulox	0.5 2.5	Feb. May	95 ab	100 a	100 a	100 a	100 a	0 d	2 c	13.6 a	79 a
Gramoxone Huskie (pyrasulfotole + bromoxynil)	0.5 0.2	Feb. May	91 ab	100 a	95 ab	100 a	100 a	0 d	83 a	10.0 ab	56 c
Everest (Flucarbazone)	0.026	Feb.	0 c	0 c	100 a	100 a	33 c	20 a	3 c	5.2 cd	31 e
Gramoxone Everest (Flucarbazone)	0.5 0.026	Feb. May	93 ab	77 b	90 abc	100 a	100 a	0 d	70 b	8.3 bcd	59 bc
Asulox XP Asulox	1.25 1.25	Feb. May	83 b	99 a	78 bc	99 b	99 a	4 c	0 c	11.5 ab	77 ab
Nontreated Check			0 c	0 c	0 d	0 c	0 c	0 d	0 c	4.2 d	33 de
	LSD (P=.05)		13.1	17.1	16.8	0.3	45.9	2.0	6.3	4.4	18.5

R-11 nonionic surfactant added at 0.25% (v/v) spray solution to all treatments.
Means followed by same letter do not significantly differ (P=.05, LSD)

Table 3. Pigweed control and peppermint response to herbicides applied after the first cutting of peppermint at Prosser, WA in 2007.

Treatment	Rate	Timing	Peppermint Injury 8/10/07	Peppermint Injury 8/24/07	Pepper mint Height 9/21/07	Pigweed Control 8/10/07	Pigweed Counts 9/21/07	Peppermint Hay Yield 9/24/07	Peppermint Oil Yield 9/24/07
	(lb ai/a)		------(%)------		(in.)	---(%)---	(no./plot)	(ton/a)	(lb/a)
Spartan (Sulfentrazone)	0.063	July 23	4 c	1	16	100 a	0.0 b	6.5	42
Spartan (Sulfentrazone)	0.125	July 23	3 c	3	15	100 a	0.0 b	6.2	50
Chateau (Flumioxazin)	0.047	July 23	9 b	0	18	100 a	0.0 b	7.3	47
Chateau (Flumioxazin)	0.063	July 23	18 a	1	18	100 a	0.0 b	7.7	51
Aim (Carfentrazone)	0.015	July 23	0 c	1	18	33 b	5.3 ab	7.0	39
Aim (Carfentrazone)	0.028	July 23	0 c	0	17	33 b	5.3 ab	7.0	42
Aim (Carfentrazone)	0.015	July 31	13 b	1	18	100 a	0.0 b	7.4	41
Nontreated Check			0 c	0	18	0.0 b	6.3 a	8.1	43
LSD (P=.05)			4.8	N.S.	N.S.	52.3	6.04	N.S.	N.S.

All treatments included COC crop oil at 1% (v/v) spray solution.
Means followed by same letter do not significantly differ (P=.05, LSD).

Table 4. Native spearmint injury, and hay and oil yield after treating with herbicides February 28, 2007 and/or May 7, 2007 at Prosser, WA.

Treatment	Rate	Timing	Native Spearmint Injury 4/30/2007		5/11/2007		5/30/2007		Native Spearmint Hay yield 9/13/2007		Oil Yield 9/13/2007	
	(lb ai/a)		-------------(%)-------------						(Ton/a)		(lb/a)	
Asulox (Asulam)	1.25	Feb. 28	0	b	--		--		9.9	abc	32	ab
Gramoxone Asulox (Asulam)	0.5 1.25	Feb. 28 May 7	0	b	9	d	0	c	14.0	a	62	a
Asulox (Asulam)	2.5	Feb. 28	0	b	--		--		10.4	abc	45	ab
Gramoxone Asulox (Asulam)	0.5 2.5	Feb. 28 May 7	0	b	10	d	0	c	14.1	a	57	ab
Gramoxone Amicarbazone	0.5 0.056	Feb. 28 May 7	0	b	23	c	0	c	12.5	ab	45	ab
Reflex (Fomesafen)	0.25	Feb. 28	20	a	3	d	--		12.4	ab	61	a
Gramoxone Reflex (Fomesafen)	0.5 0.25	Feb. 28 May 7	0	b	47	b	43	a	11.8	ab	38	ab
Everest (Flucarbazone)	0.026	Feb. 28	17	a	2	d	--		8.2	bc	27	ab
Gramoxone Everest (Flucarbazone)	0.5 0.026	Feb. 28 May 7	0	b	23	c	13	bc	13.8	a	53	ab
Gramoxone Huskie (Pyrasulfotole + bromoxynil)	0.5 0.2	Feb. 28 May 7	0	b	57	a	23	b	10.6	abc	37	ab
Asulox (Asulam) Asulox (Asulam)	1.25 1.25	Feb. 28 May 7	2	b	12	d	0	c	13.3	a	55	ab
Nontreated Check			0	b	0		0		6.7	c	22	b
LSD (P=.05)			6.1		6.9		14.9		3.05		22.2	

R-11 nonionic surfactant added to all treatments at 0.25% (v/v).
Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 5. Weed control in native spearmint after treating with herbicides February 28, 2007 and/or May 7, 2007 at Prosser, WA.

Treatment	Rate	Timing	Flixweed 5/30/07	Prickly Lettuce 5/30/07	Tall Hedge Mustard 5/30/07	Downy Brome 4/2/07	Com. Lambs-quarters 5/30/07
	(lb ai/a)		------------------(Percent Control)------------------				
Asulox (Asulam)	1.25	Feb. 28	0 e	70 b	0 e	68 ab	0 c
Gramoxone Asulox (Asulam)	0.5 1.25	Feb. 28 May 7	88 c	93 ab	0 e	85 ab	0 c
Asulox (Asulam)	2.5	Feb. 28	40 d	80 ab	0 e	90 ab	0 c
Gramoxone Asulox (Asulam)	0.5 2.5	Feb. 28 May 7	100 a	99 a	99 ab	100 a	100 a
Gramoxone Amicarbazone	0.5 0.056	Feb. 28 May 7	98 a	100 a	95 c	90 ab	100 a
Reflex (Fomesafen)	0.25	Feb. 28	100 a	100 a	80 d	0 c	0
Gramoxone Reflex (Fomesafen)	0.5 0.25	Feb. 28 May 7	100 a	100 a	100 a	100 a	58 b
Everest (Flucarbazone)	0.026	Feb. 28	100 a	0 d	80 d	83 ab	0 c
Gramoxone Everest (Flucarbazone)	0.5 0.026	Feb. 28 May 7	100 a	98 a	98 abc	100 ab	100 a
Gramoxone Huskie (Pyrasulfotole + bromoxynil)	0.5 0.2	Feb. 28 May 7	100 a	98 a	95 bc	100 a	100 a
Asulox (Asulam) Asulox (Asulam)	1.25 1.25	Feb. 28 May 7	0 e	33 c	1 e	60 b	0 c
Nontreated Check			0	0	0	0	0
LSD (P=.05)			2.4	17.9	4.6	21.3	27.7

R-11 nonionic surfactant added to all treatments at 0.25% (v/v).

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 6. Annual grass control with two formulations of clethodim applied postemergence in native spearmint August 22, 2007 at Prosser, WA.

Treatment	Rate	Grass leaf blade browning[1] 2 DAT	Annual Grass control 1 WAT	Annual Grass control 2 WAT	Annual Grass control 3 WAT
	(lb ai/a)	(% brown)	-------------(%)-------------		
Select Max	0.09	87 a	98 a	99 a	100 a
Select Max	0.12	93 a	96 a	100 a	100 a
Select Max	0.24	92 a	98 a	100 a	100 a
Select	0.125	92 a	98 a	100 a	100 a
Select	0.19	88 a	99 a	100 a	100 a
Select	0.25	92 a	100 a	100 a	100 a
Nontreated Check		0.0 b	0.0 b	0.0 b	0.0 b
	LSD (P=.05)	9.2	2.7	0.8	0

[1]Percent of leaf blades easily pulled with brown discoloration at the base.
Annual grass weeds consisted of mainly barnyardgrass with lesser amounts of green foxtail.
DAT = days after treatment. WAT = weeks after treatment.
Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)
R-11 nonionic surfactant added at 0.25% (v/v) to all Select Max treatments and COC added at 1% (v/v) to all Select treatments. Ammonium sulfate was added at 2.5 lb/a to all Select Max and Select treatments.

Table 7. Peppermint injury, hay, and oil yield after treating with ten herbicide treatments applied early postemergence on April 6, 2007 at Prosser, WA.

Treatment	Rate	Peppermint Percent Injury 4/20/07	Peppermint Percent Injury 5/16/07	Peppermint Hay Yield 7/17/07	Peppermint Oil Yield 7/17/07
	(lb ai/a)	(%)		(ton/a)	(lb/a)
Callisto (Mesotrione)	0.032	12 ef	6	7.5 a-d	54 ab
Callisto (Mesotrione) + Basagran (Bentazon)	0.032 + 0.75	13 def	8	8.7 a-d	65 a
Callisto (Mesotrione) + Sinbar (Terbacil)	0.032 + 0.35	10 f	5	11.1 a	66 a
Starane (Fluroxypyr)	0.13	22 b	3	9.0 abc	45 bc
Starane (Fluroxypyr)	0.19	33 a	10	11.4 a	54 ab
Starane NXT (Flurox. + bromoxynil)	0.29	13 def	0	10.7 ab	42 bcd
Starane NXT (Flurox.+ bromoxynil)	0.54	17 cd	0	6.2 bcd	43 bc
Thistrol (MCPB)	0.25	0 g	0	4.2 d	23 e
Thistrol (MCPB) + Buctril (Bromoxynil)	0.25 + 0.35	15 cde	0	4.8 cd	33 cde
Buctril (Bromoxynil)	0.35	18 bc	0	8.5 a-d	37 b-e
Nontreated Check		0 g	0	7.1 a-d	26 de
LSD (P=.05)		3.8	N.S.	4.7	17.3

All Callisto treatments included COC at 1% (v/v) and 32% UAN fertilizer at 2.5% (v/v) spray solution. All other treatments included R-11 nonionic surfactant at 0.25% (v/v) spray solution. Means followed by same letter do not significantly differ (P=.05, LSD).

Table 8. Weed control in peppermint after treating with ten herbicide treatments applied early postemergence on April 6, 2007 at Prosser, WA.

Treatment	Rate	Flixweed 4/30/07	Prickly Lettuce 4/30/07	Common Groundsel 5/16/07	Salsify 5/16/07
	(lb ai/a)	-----------(% control)--------------			
Callisto (Mesotrione)	0.032	94 a	90 a	70 d	45 a
Callisto (Mesotrione) + Basagran (Bentazon)	0.032 + 0.75	100 a	97 a	82 bcd	53 a
Callisto (Mesotrione) + Sinbar (Terbacil)	0.032 + 0.35	100 a	98 a	95 a	48 a
Starane (Fluroxypyr)	0.13	2 e	93 a	0 e	0 b
Starane (Fluroxypyr)	0.19	3 e	97 a	0 e	0 b
Starane NXT (Flurox. + bromoxynil)	0.29	12 d	42 b	73 d	0 b
Starane NXT (Flurox.+ bromoxynil)	0.54	35 b	40 b	77 cd	0 b
Thistrol (MCPB)	0.25	0 e	10 de	0 e	0 b
Thistrol (MCPB) + Buctril (Bromoxynil)	0.25 + 0.35	27 c	35 bc	90 ab	0 b
Buctril (Bromoxynil)	0.35	33 bc	20 cd	88 abc	0 b
Nontreated Check		0	0	0	0
LSD (P=.05)		7.6	16.1	12.3	9.8

All Callisto treatments included COC at 1% (v/v) and 32% UAN fertilizer at 2.5% (v/v) spray solution. All other treatments included R-11 nonionic surfactant at 0.25% (v/v) spray solution. Means followed by same letter do not significantly differ (P=.05, LSD).

Table 9. Broadleaf (brlf) and grass weed density in newly planted peppermint after application of white mustard seed meal, field pennycress seed meal, or terbacil at Prosser, WA in 2007. Peppermint rhizomes were planted April 12, 2007.

Treatment	Rate	brlf counts 4/27/2007	brlf counts 5/9/2007	brlf control 5/21/2007	grass counts 4/27/2007	grass counts 5/9/2007	grass control 5/21/2007	Total counts 4/27/2007
	(Ton/acre)	(16 ft^2)	(16 ft^2)	(%)	(16 ft^2)	(16 ft^2)	(%)	(16 ft^2)
Weedy check	--	126 a	78 ab	0 c	83 a	420 a	0 c	209 a
White Mustard	0.5	2 b	34 ab	0 c	3 c	123 bc	70 b	5 b
White Mustard	1	0 b	19 b	83 b	0 c	58 c	90 ab	0 b
White Mustard	2	0 b	43 a	69 b	0 c	198 abc	87 ab	0 b
Field Pennycress	0.5	134 a	64 a	10 c	15 ab	139 ab	9 c	149 a
Field Pennycress	1	176 a	76 a	0 c	85 ab	415 a	5 c	261 a
Field Pennycress	2	55 a	53 a	3 c	14 b	241 a	14 c	69 a
Terbacil (Sinbar)	0.5 lb ai/a	0 b	0 c	100 a	0 c	3 d	100 a	0 b
	LSD (P=.05)	0.53 (log)	0.55 (log)	16.09	0.50 (log)	0.41 (log)	17.73	0.53 (log)

Means followed by same letter do not significantly differ (P=.05 LSD test). Weed count data was log transformed prior to analysis and mean separation to meet analysis of variance normality requirements.
Broadleaf weeds consisted of common lambsquarters, pigweed, henbit, and common mallow. Grass weeds consisted of barnyardgrass and green foxtail.
White mustard seed meal obtained from McKay Seed in Moses Lake, Wa. Field pennycress seed meal obtained from USDA-ARS lab in Peoria, Illinois.

Table 10. Prickly lettuce and tall hedge mustard control with preemergence applied herbicides in containers at Prosser, WA in 2007.

Treatment	Rate	Prickly Lettuce 2/13/07	Tall Hedge Mustard 4/10/07
	(lb ai/a)	(no. live plants/pot)	
Karmex	1.0	0	0
Sinbar	0.75	0	0
Chateau	0.13	0	0
Spartan	0.19	0	0
Nontreated		8	13
	LSD (0.05)	0.8	1.8

Prickly lettuce rated at 5 weeks after treatment.
Tall hedge mustard rated at 4 weeks after treatment.
Means followed by same letter do not significantly differ (P=.05, Least Signif. Difference test)

Table 11. Prickly lettuce control with herbicides applied postemergence at three stages of prickly lettuce growth in outdoor containers at Prosser, WA in 2007.

		Prickly Lettuce Size (diam.) when herbicides applied		
		1 inch	2-3 inch	3-4 inch
		Live Plants	Percent Control	
Treatment	Rate	2/13/07	4/27/07	4/27/07
	(lb ai/a)	(no./pot)	------(%)------	
Karmex + Gramoxone	1 + 0.5	0 b	100 a	98 ab
Sinbar + Gramoxone	0.75 + 0.5	0 b	100 a	98 ab
Chateau + Gramoxone	0.13 + 0.5	0 b	95 a	99 a
Gramoxone	0.5	0 b	99 a	93 b
Starane	0.13	0 b	98 a	93 b
Buctril	0.25	0 b	46 c	0 d
Starane NXT	0.29	0 b	95 a	35 c
Asulox + Gramoxone	1.25 + 0.5	--	76 b	--
Nontreated	--	4.2	0	0
	LSD (0.05)	0.4	9.9	5.1

Prickly lettuce (1 inch size) were counted at 2 weeks after treatment. Control of larger prickly lettuce was rated at 4 weeks after treatment.
Means followed by same letter do not significantly differ (P=.05, Least Signif. Difference test)
All treatments containing Gramoxone included COC at 1% (v/v) spray solution. Starane, Buctril, and Starane NXT treatments included R-11 nonionic surfactant at 0.25% (v/v) spray solution.

Table 12. Tall hedge mustard control with herbicides applied postemergence at two stages of mustard growth in outdoor containers at Prosser, WA in 2007.

Treatment	Rate	Tall Hedge Mustard Size (diameter) when herbicides applied 1-2 inch Percent Control 4/27/07	2-3 inch 4/27/07
	(lb ai/a)	------(%)------	
Karmex + Gramoxone	1 + 0.5	100 a	100 a
Sinbar + Gramoxone	0.75 + 0.5	100 a	100 a
Chateau + Gramoxone	0.13 + 0.5	93 a	81 b
Gramoxone	0.5	77 ab	86 b
Starane	0.13	56 bc	62 c
Buctril	0.25	42 c	0 d
Starane NXT	0.29	45 c	5 d
Asulox + Gramoxone	2.5 + 0.5	--	78 b
Nontreated	--	0	0
	LSD (0.05)	22.9	10.6

Control of tall hedge mustard was rated at 4 WAT.
Means followed by same letter do not significantly differ (P=.05, Least Signif. Difference test)
All treatments containing Gramoxone included COC at 1% (v/v) spray solution. Starane, Buctril, and Starane NXT treatments included R-11 nonionic surfactant at 0.25% (v/v) spray solution.

Table 13. Rattail fescue response to two formulations of clethodim (Select) applied postemergence and three herbicides applied preemergence in outdoor container trials.

Name Treatment	Rate	Timing	Rattail Fescue (Planted 3/5/07) 3/12/07	3/26/07	4/9/07	Rattail Fescue 5/9/2007	Rattail Fescue 5/9/2007	5/30/2007
	(Lb ai/a)		------(No. live plants/pot)------			(% Control)	--- (% Control) ----	
Prowl H2O	1.0	PRE	11 b	6 b	2 b	94 a		
Command	0.25	PRE	17 a	0 c	0 b	100 a		
Sinbar	0.5	PRE	18 a	0 c	0 b	100 a		
Select Max	0.06	POST					20 b	21 c
Select Max	0.12	POST					55 a	22 c
Select Max	0.24	POST					78 a	99 a
Select	0.25	POST					67 a	81 b
Nontreated Check			17 a	17 a	15 a	0 b	0 b	0 d
	LSD (P=.05)		1.8	2.6	1.6	6.7	20.4	15.4

R-11 nonionic surfactant added at 0.25% (v/v) to all Select Max treatments and COC added at 1% (v/v) to Select treatment. 32% UAN solution was added at 1.2% (v/v) to all Select Max and Select treatments.
Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls).