CALIFORNIA LEAFY GREENS RESEARCH PROGRAM

April 1, 2011 – March 31, 2012

WEED MANAGEMENT SYSTEMS FOR LEAFY GREENS

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SUMMARY

Projects reported here were undertaken to develop new herbicide options for lettuce and spinach. We have conventionally bred lettuce germplasm, IDBR1, from the University of Idaho that is resistant to sulfonyl urea herbicides. The herbicide resistance gene has been backcrossed into commercial lines of butterhead, green leaf, red leaf, romaine, and crisphead lettuce. The tolerance of these lines to Express (tribenuron) applied postemergence at 0.075, 0.17 and 0.33 oz product /A and Londax (bensulfuron) applied both Preemergence and Postemergence (2-3 true leaf stage) at 0.075 oz /A was tested at Salinas in July to October 2011. All resistant lettuce lines were tolerant to Express and herbicide susceptible lines were injured or killed by the herbicide. Sowthistle and common groundsel control with Express was superior to Kerb at all rates tested. We are developing herbicide tolerant spinach by screening spinach for tolerance to Lorox. From 390 spinach germplasm lines screened in 2009 for tolerance to Lorox, 21 lines were found to be partially to very tolerant to Lorox. In 2011 the most Lorox tolerant spinach lines were screened again with Lorox. If this increased urea herbicide tolerance can be bred into commercial spinach lines, then it may be possible to develop higher levels of herbicide tolerance in spinach and to use herbicides which would otherwise be too injurious. Tank mixes of Ro-Neet + Dual Magnum were evaluated in spinach in field station and commercial field trials. On commercial spinach fields, even the lowest rates of Ro-Neet + Dual Magnum tested, 2 + 0.17 pt/A resulted in yield loss in spinach. In the future even lower rates of Ro-Neet + Dual Magnum such as 1 + 0.1 pt/A should be tested in spinach. Lastly, a test was conducted to compare Dual Magnum applied at 0.17, 0.33, 0.66 and 1 pt/A 20 days before spinach planting compared to the same rates of Dual Magnum applied the day after spinach planting. Dual Magnum at 0.33 pt/A was the minimum rate needed for weed control when applied 20 days before spinach planting.

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OBJECTIVES:

A. Develop weed control programs for herbicide resistant lettuce.
B. Screen for new herbicide-tolerant spinach germplasm.
C. Evaluate tank mixes of Ro-Neet and Dual Magnum for spinach
D. Evaluate PPI and PRE application timings of Dual Magnum for spinach.

PROCEEDURES – OBJECTIVE A

A. Develop weed control programs for herbicide resistant lettuce.

Lettuce germplasm derived from IDBR1 was evaluated for tolerance to Express (tribenuron) herbicide applied post-emergence (2-3 true leaf stage) at 0.075, 0.17 and 0.33 oz /A, and Londax (bensulfuron) applied both preemergence and postemergence (2-3 true leaf stage) at 0.075 oz /A. The standard backcross procedure was used to transfer the resistance gene into different types of lettuce. The IDBR1 resistance gene was backcrossed into Buttercrunch, Lolla Rossa, Parris Island, and Salinas 88 and at each generation the progeny were screened for herbicide tolerance. Resistant butterhead, red leaf, Romaine and crisphead lettuce in addition to susceptible parents were seeded at Salinas on July 27, 2011. Harvest dates were as follows: butterhead, red leaf and IDBR1 September 15, Romaine October 3, and crisphead October 10, 2010.

RESULTS AND DISCUSSION – OBJECTIVE A

The data indicates that all tested rates of Express controlled sowthistle and common groundsel better than the standard Kerb application (Table 1). The PRE application of Londax controlled weeds better than the same rate applied POST. Lettuce fresh weights indicated that Express and Londax did not reduce lettuce yields in resistant lettuce lines, but did injure susceptible lines (Tables 2 & 3). These results suggest that the herbicide resistance gene from IDBR1 lettuce was successfully protecting lettuce from injury from Express herbicide.

Table 1. Weed densities in IDBR1 resistant lettuce following Pre and Post-emergence applications of Express and Londax.

Herbicide	Rate	Timing	Sowthistle	Groundsel	Total Weeds
			---------- Number (1000) / A ----------		
Express	0.075 oz/A	POST	27.9 bc	4.8 c	98.5 a
Express	0.16 oz/A	POST	19.2 c	8.3 bc	101.5 a
Express	0.33 oz/A	POST	19.2 c	3.9 c	63.2 b
Londax	0.075 oz/A	PRE	29.6 bc	2.6 c	57.9 b
Londax	0.075 oz/A	POST	44.9 abc	17.4 a	115.0 a
Kerb	2.9 pt/A	PRE	69.7 a	14.8 ab	119.4 a
Control	0	---	54.0 ab	19.2 a	117.2 a
LSD (0.05)			28.5	7.2	33.6

Table 2. Lettuce fresh weights in sulfonyl urea herbicide tolerant lettuce following Pre and Post-emergence applications of Express and Londax.

Herbicide	Rate	Timing	Butterhead	Red Leaf	Romaine "704"	Romaine "720"	Romaine "926"	Crisphead "730"	Crisphead "733"
			---------- Fresh weight (1000 lbs / A) ----------						
Express	0.075 oz/A	POST	11.4 ab	4.1 a	37.9 a	33.0 a	38.5 a	44.0 a	43.1 a
Express	0.16 oz/A	POST	12.6 a	3.7 a	39.7 a	32.3 a	42.2 a	46.9 a	41.1 a
Express	0.33 oz/A	POST	8.3 bc	3.4 a	37.8 a	32.2 a	41.1 a	47.7 a	42.0 a
Londax	0.075 oz/A	PRE	11.9 a	4.0 a	33.1 a	31.0 a	34.7 a	34.7 a	41.2 a
Londax	0.075 oz/A	POST	12.7 a	3.7 a	40.4 a	35.4 a	38.1 a	41.1 a	38.6 a
Kerb	2.9 pt/A	PRE	11.8 a	3.8 a	31.0 a	34.0 a	33.9 a	39.2 a	39.2 a
Control	0	---	7.9 c	3.5 a	37.0 a	34.1 a	38.6 a	36.3 a	38.2 a
LSD (0.05)			3.4	2.2	10.8	10.5	14.4	9.5	8.3

Table 3. Lettuce fresh weights in sulfonyl urea herbicide susceptible parent lines and the original herbicide tolerant parent IDBR1 lettuce following Pre and Post-emergence applications of Express and Londax.

Herbicide	Rate	Timing	Susceptible Butterhead	Susceptible Red Leaf	Susceptible Romaine	Susceptible Crisphead	IDBR1
			---------- Fresh weight (1000 lbs / A) ----------				
Express	0.075 oz/A	POST	0.04 c	0.01 c	0.33 c	0.01 b	5.7 a
Express	0.16 oz/A	POST	0.14 c	0.07 c	0.04 c	0.00 b	6.5 a
Express	0.33 oz/A	POST	3.30 bc	0.00 c	0.00 c	0.00 b	6.0 a
Londax	0.075 oz/A	PRE	1.80 c	0.74 b	8.40 b	6.00 b	5.2 a
Londax	0.075 oz/A	POST	0.12 c	0.30 c	1.90 bc	5.00 b	5.5 a
Kerb	2.9 pt/A	PRE	7.70 ab	1.70 a	35.00 a	47.60 a	5.8 a
Control	0	---	8.80 a	1.70 a	33.80 a	49.40 a	5.0 a
LSD (0.05)			4.40	0.41	7.60	7.60	1.9

PROCEEDURES – OBJECTIVE B

B. Screen for new herbicide-tolerant spinach germplasm.

Screening for herbicide tolerant spinach germplasm. Our objective is to identify spinach germplasm that has a higher level of tolerance to Lorox (linuron), using conventional breeding. We screened 21 populations (progenies of resistant accessions from our screening of the USDA germplasm collection in 2009) and 17 control cultivars. After the application of linuron at 1.0 lb ai/A, the survival rate for the breeding populations ranged 2.4 – 60.0 %, average 16.2 %. Survival rate for control cultivars ranged 0 – 36%, average 8.4%. We selected most surviving plants from resistant populations and cultivars, and transplanted them into isolators to produce seeds for further screening and selection in 2012.

PROCEEDURES – OBJECTIVE C

C. Evaluate tank mixes of Ro-Neet and Dual Magnum for spinach

Field Station trials. The purpose of this work was to determine if Ro-Neet (cycloate) and Dual Magnum (*S*-metolachlor) in combination can be safely used in spinach at low rates, and if weed control is improved by the combination. Spinach herbicide evaluation trials were conducted at the USDA Hartnell farm at Salinas, CA in sandy loam soil. The trials were arranged in a randomized complete block design, with four replicates. The spinach variety used was 'Whale'. PRE herbicide treatments tested were: Ro-Neet at 1, 2 and 4 pts/A; Dual Magnum at 0.17, 0.33 & 0.66 pts/A; tank mixes of Ro-Neet + Dual Magnum at 1+0.66, 2+0.66, 2+0.17, 2+0.33, & 4+0.66 pt/A. All treatments were spray applied to the bedtop, using a handheld, single-nozzle CO_2 backpack sprayer. A control was included in each trial. Weed density counts, spinach injury estimates and yield were taken in all trials.

The PRE applications were made on August 11 (trial A) and September 22, 2011 (trial B), and incorporated with sprinkler irrigation. All materials were applied by a CO_2 backpack sprayer with a single tip wand (8002E nozzle) at 30 psi applying 40 gallons of water per acre. Each plot was one 40-inch bed wide by 20 feet long. Crop stand counts were taken on August 25 (trial A) and October 7 (trial B). Crop injury was evaluated on September 1 (trial A) and November 3 (trial B). Weed densities were measured on August 26 (trial A) and October 13 (trial B). Harvest evaluations were conducted on September 16 (trial A) and November 14 (trial B) by harvesting all spinach leaves in 5 linear feet of bed (both plant lines) in each plot, and recording total fresh weights.

Commercial trials. ***Trial No. 1:*** The trial was conducted south of King City. Applications were made post planting on September 13 immediately following planting and incorporated into the soil with the germination water on September 14. The soil type was Mocho silt loam and the variety was Mississippi. ***Trial No. 2:*** The trial was east of San Juan Bautista. Applications were made post planting on September 16 immediately following planting and incorporated into the soil with the germination water on September 17. The soil type was Sorrento silty clay loam and the variety was Avenger. ***Trial No. 3:*** The trial was conducted north west of Salinas. Applications were made post planting on September 21 and incorporated into the soil with the germination water on September 22. The soil type at the site was Cropley silty clay and the variety was El Real. ***Details common to all trials:*** Each plot was one 80-inch bed wide by 10 feet long and randomized three times in a randomized complete block design. All treatments were applied with a backpack CO_2 applicator with 4 passes of a one-nozzle wand with an 8008E tip pressurized at 30 psi applying the equivalent of 66 gallons of water per acre.

RESULTS AND DISCUSSION – OBJECTIVE C

Field station. For both trials, all treatment rates &/or combinations of Ro-Neet and Dual Magnum had spinach stands equivalent to the control (Table 4).

In Trial A, where crop injury was evaluated 3 weeks following application, only Ro-Neet + Dual Magnum 4 + 0.66 pts/A resulted in injury >2.0 (Table 4). For Trial B, crop injury evaluations were made at 6 weeks post-application and by then, most plants had outgrown any earlier symptoms of herbicide injury. In Trial A, all rates &/or combinations of Ro-Neet and Dual Magnum produced yields equivalent to the control. In Trial B, the combinations of Ro-Neet + Dual Magnum at 2 + 0.17 or 2 + 0.33 pt/A resulted in significantly greater yields than Ro-Neet at 1, 2 or 4 pt/A alone, or the control (Table 4). For both trials, the following treatments reduced total weed population levels by greater than 70% compared to the control: Ro-Neet + Dual Magnum 0.66+1, 0.66+2, 0.66+4 and 0.33+2 pt/A (Tables 5 & 6).

Table 4. Crop stand, crop injury and crop yield in spinach following Pre-emergence applications of Ro-Neet and Dual Magnum.

Herbicide	**Rate** (pt/A)	**Timing**	**Crop Stand**		**Crop Injury**		**Crop Yield (Fresh Weight)**	
			# / 10 lin ft [A]		**0-10 [B]**		**Tons/A**	
			Trial A	**Trial B**	**Trial A**	**Trial B**	**Trial A**	**Trial B**
Ro-Neet	4	PRE	148	182	1.3 a-e	0.0	6.9	7.7 bcd
Ro-Neet	2	PRE	145	164	0.3 de	0.1	6.2	7.3 cd
Ro-Neet	1	PRE	140	183	0.6 cde	0.0	6.3	7.7 bcd
Dual Magnum	0.66	PRE	140	182	1.6 abc	0.2	6.9	8.4 abc
Dual Magnum	0.33	PRE	130	189	0.5 cde	0.1	6.9	8.7 ab
Dual Magnum	0.17	PRE	133	199	0.0 e	0.0	6.6	6.9 d
Ro-Neet Dual Magnum	4 + 0.66	PRE	139	156	2.4 a	0.2	6.0	8.3 abcd
Ro-Neet Dual Magnum	2 + 0.66	PRE	124	194	2.0 ab	0.0	5.4	8.6 abc
Ro-Neet Dual Magnum	1 + 0.66	PRE	141	169	0.9 b-e	0.1	6.7	8.7 ab
Ro-Neet Dual Magnum	2 + 0.33	PRE	131	180	1.0 b-e	0.0	6.6	9.1 a
Ro-Neet Dual Magnum	2 + 0.17	PRE	141	180	1.4 a-d	0.0	7.0	9.2 a
Control	0	---	134	182	0.0 e	0.0	6.6	7.4 bcd
LSD (0.05)			21.2	27.5	1.3	0.2	2.0	2.7

[A] Number of plants / 10' of plant line (3 seed lines / per plant line)
[B] Rating scale: 0 = no injury; ≤2 = safe; 10 = dead plants

Table 5. (Trial A) Weed control in spinach following Pre-emergence applications of Ro-Neet and Dual Magnum.

Herbicide	**Rate** (pt/A)	**Timing**	**Purslane**	**Burning Nettle**	**Nightshade**	**Total Weeds**
			---------- **Number (Millions) / A** ----------			
Ro-Neet	4	PRE	5.2 bcd	1.7	0.6 b	9.9 b-e
Ro-Neet	2	PRE	5.5 abc	2.6	1.4 b	12.5 bcd
Ro-Neet	1	PRE	7.9 ab	2.4	1.2 b	16.3 ab
Dual Magnum	0.66	PRE	1.3 e	1.7	1.4 b	5.7 de
Dual Magnum	0.33	PRE	4.5 cd	2.9	3.6 a	15.4 abc
Dual Magnum	0.17	PRE	4.6 cd	3.9	4.5 a	16.9 ab
Ro-Neet Dual Magnum	4 + 0.66	PRE	0.4 e	0.6	0.0 b	1.8 e
Ro-Neet Dual Magnum	2 + 0.66	PRE	0.6 e	0.4	0.2 b	2.2 e
Ro-Neet Dual Magnum	1 + 0.66	PRE	2.2 de	2.4	0.5 b	6.9 cde
Ro-Neet Dual Magnum	2 + 0.33	PRE	3.5 cde	2.5	0.9 b	9.0 b-e
Ro-Neet Dual Magnum	2 + 0.17	PRE	2.4 cde	3.2	1.4 b	8.7 b-e
Control	0	---	8.5 a	6.1	3.8 a	23.4 a
LSD (0.05)			3.1	3.2	1.8	8.6

Table 6. (Trial B) Weed control in spinach following Pre-emergence applications of Ro-Neet and Dual Magnum.

Herbicide	**Rate** (pt/A)	**Timing**	**Purslane**	**Burning Nettle**	**Chickweed**	**Total Weeds**
			---------- **Number (Millions) / A** ----------			
Ro-Neet	4	PRE	8.6 abc	3.1 cde	8.4	21.0 bc
Ro-Neet	2	PRE	6.8 bcd	4.1 cd	6.4	18.2 cd
Ro-Neet	1	PRE	12.4 a	5.2 bc	9.8	29.4 a
Dual Magnum	0.66	PRE	4.0 cde	2.8 cde	5.5	13.1 de
Dual Magnum	0.33	PRE	6.4 bcd	3.9 cd	6.9	18.0 cd
Dual Magnum	0.17	PRE	9.6 ab	7.3 ab	9.0	27.9 ab
Ro-Neet Dual Magnum	4 + 0.66	PRE	0.8 e	1.3 e	2.8	5.0 f
Ro-Neet Dual Magnum	2 + 0.66	PRE	0.6 e	1.4 e	2.7	5.0 f
Ro-Neet Dual Magnum	1 + 0.66	PRE	1.4 e	1.8 de	4.0	7.9 ef
Ro-Neet Dual Magnum	2 + 0.33	PRE	2.9 de	2.0 de	3.6	9.1 ef
Ro-Neet Dual Magnum	2 + 0.17	PRE	3.7 cde	2.2 de	8.0	14.8 cde
Control	0	---	12.6 a	8.0 a	6.4	29.0 a
LSD (0.05)			5.0	2.5	5.3	7.6

Commercial results. ***Trial No. 1:*** All treatments had fewer weeds than the untreated control on Sept. 26 (Table 7). The combination of Ro-Neet at 2.0 pints/A plus Dual Magnum at 0.66 pint/A had no weeds. Ro-Neet at 2.0 pints, Dual Magnum at 0.17 and 0.33 pints/A as well as the combination of Ro-Neet at 2.0 pints/A plus Dual Magnum at 0.17 pint/A had phytotoxicity ratings below 2.0* on September 26, indicating acceptable crop damage. However, the combination of Ro-Neet and Dual Magnum at 0.17 pint/A had a phytotoxicity rating greater than 2.0 on October 3. Weeding time of all treatments was less than the untreated control and Ro-Neet plus Dual Magnum at 0.33 or 0.66 had the lowest weeding time (not shown). Yield was reduced by all herbicide treatments; Ro-Neet at 2.0 pints, and Dual Magnum at 0.17 and 0.33 pints/A had the lowest reduction in yield. The combination of Ro-Neet plus Dual Magnum had greater yield reduction than Dual Magnum alone at the same rate. ***Trial No. 2:*** There were no weeds at this site. Phytotoxicity was at acceptable levels in the Ro-Neet at 2.0 pints/A and the Dual Magnum at 0.17 and 0.33 pints/A (Table 7). Ro-Neet at 2.0 pints/A plus Dual Magnum at 0.17 pint/A also had low phytotoxicity rating. All herbicide treatments reduced the yield of spinach; Ro-Neet at 2.0 pints/A and Dual Magnum at 0.17 pint/A reduced the yield the least. The combination of Ro-Neet plus Dual Magnum had greater yield reduction than Dual Magnum alone at the same rate. ***Trial No. 3:*** Weed pressure was light at this site, but all treatments had lower weeds per plot than the untreated control (Table 7). Phytotoxicity ratings were lowest in the Ro-Neet at 2.0 pints/A, Dual Magnum at 0.17 and 0.33 pints/A and the combination of Ro-Neet plus Dual Magnum at 0.17 pint/A. All herbicide treatments reduced the yield of spinach; Ro-Neet at 2.0 pints/A and Dual Magnum at 0.17 pint/A reduced the yield the least. The combination of Ro-Neet plus Dual Magnum had greater yield reduction than Dual Magnum alone at the same rate.

Conclusion. Even low rates of Ro-Neet + Dual Magnum at 2+0.17 pt/A resulted in yield loss in commercial spinach tests. There may be lower rates of Ro-Neet + Dual Magnum such as 1+0.1 pt/A that could be safe to spinach and yet control weeds. We recommend that future tests of these lower rates be conducted.

Table 7. Trials 1, 2 & 3: Weed control, phytotoxicity ratings and harvest evaluations

Treatments	**Rate (pt./A)**	**Total Weeds (1000/A)**	**Total Weeds (1000/A)**	**Phyto[1]**			**Harvest yield (tons/A)**		
		Trial #1	**Trial #3**	**Trial #1**	**Trial #2**	**Trial #3**	**Trial #1**	**Trial #2**	**Trial #3**
Untreated	---	135.5	6.5	0.0	0.0	0.0	9.38	4.3	4.4
Ro-Neet	2.0	60.5	2.2	0.7	0.8	0.0	8.26	3.7	4.0
Dual Magnum	0.17	33.9	2.8	0.3	0.8	0.2	8.55	3.5	4.0
Dual Magnum	0.33	21.8	0.0	1.7	2.0	0.7	8.65	2.6	3.0
Dual Magnum	0.66	0.0	0.0	2.3	3.3	2.5	7.14	1.6	1.8
Ro-Neet Dual Magnum	2.0 0.17	2.4	0.7	2.3	2.2	1.0	7.78	2.3	3.5
Ro-Neet Dual Magnum	2.0 0.33	4.8	0.0	3.0	3.2	2.3	7.64	1.9	2.5
Ro-Neet Dual Magnum	2.0 0.66	0.0	0.0	4.0	3.7	3.7	4.82	1.2	1.9
LSD (0.05)		57.4	1.7	0.90	0.9	0.8	1.06	0.8	1.1

1 – phytotoxicity rating scale: 0 = no crop damage to 10 = crop dead. **NOTE:** Phytotoxicity ratings less than 2.0 are assumed to have acceptable crop damage from the herbicide application

PROCEEDURES – OBJECTIVE D

D. Evaluate PPI and PRE application timings of Dual Magnum for spinach.

A test was conducted to see if Dual Magnum could be applied 20 days before spinach planting, yet control weeds. Dual Magnum at 0.17, 0.33, 0.66 and 1 pt/A applied preplant incorporated (PPI) and post plant preemergence (PRE) were evaluated in spinach. Ro-Neet (cycloate) at 2 pt/A was included as the standard. The trial was conducted at the USDA Hartnell farm site. The preplant incorporated materials were applied on September 1, 2011 (at 20 day prior to planting) and incorporated into the beds on the same day with 1 acre-inch of sprinkler irrigation. The PRE treatments were applied on September 22 (one day after planting) and incorporated with 1 acre-inch of sprinkler irrigation. All materials were applied by a CO_2 backpack sprayer with a single tip wand (8002E nozzle) at 30 psi applying 40 gallons of water per acre. Each plot was one 40-inch bed wide by 20 feet long. Crop stand counts were taken on October 7. Crop injury was evaluated on November 3. Weed densities were measured on October 10. Harvest evaluations were conducted on November 17, by harvesting all spinach leaves in 5 linear feet of bed (both plant lines) in each plot, and recording total fresh weights.

RESULTS AND DISCUSSION – OBJECTIVE D

All treatment rates & application timings of Dual Magnum produced crop stands equivalent to Ro-Neet and the untreated control (Table 8). All treatment rates & application timings of Dual Magnum produced crop injury ratings of less than 1. Crop injury evaluations were made later than originally scheduled, at 6 weeks post-application. By then, most plants had outgrown any earlier symptoms of herbicide injury, and all treatments were considered safe (Table 8). All treatment rates & application timings of Dual Magnum (with the exception of Dual Magnum PPI at 0.17 pt/A produced yields significantly higher than the untreated control. For Dual Magnum applied PPI, the highest two rates, 0.66 and 1 pt/A, produced significantly greater yields than the lowest rate 0.17 pt/A (Table 8).

Overall the Dual Magnum 20 day PPI timing resulted in less weed control than the PRE timing (Table 9). Dual Magnum at 0.33 pt/A was the lowest rate tested PPI that was required to control weeds.

Table 8. Crop stand, crop injury and crop yield (fresh weight) in spinach following preplant incorporated and post plant preemergence applications of Dual Magnum.

Herbicide	**Rate** (pt/A)	**Timing**	**Crop Stand**	**Crop Injury**	**Crop Yield**
			# / 10 lin ft [A]	**0-10 [B]**	**Tons/A**
Dual Magnum	0.17	PPI [C]	176	0.1	6.9 bc
Dual Magnum	0.33	PPI	182	0.1	8.6 ab
Dual Magnum	0.66	PPI	161	0.0	9.3 a
Dual Magnum	1	PPI	168	0.2	9.7 a
Dual Magnum	0.17	PRE	174	0.0	8.9 ab
Dual Magnum	0.33	PRE	172	0.0	8.2 ab
Dual Magnum	0.66	PRE	168	0.4	8.8 ab
Dual Magnum	1	PRE	175	0.6	9.2 a
Ro-Neet	2	PRE	178	0.1	8.2 ab
Control	0	---	173	0.0	5.8 c
LSD (0.05)			24.6	0.53	2.7

[A] Number of plants / 10' of plant line (3 seed lines / per plant line)
[B] Rating scale: 0 = no injury; ≤2 = safe; 10 = dead plants
[C] Preplant incorporated at 21 days before planting

Table 9. Weed control in spinach following preplant incorporated and post plant preemergence applications of Dual Magnum.

Herbicide	**Rate** (pt/A)	**Timing**	**Purslane**	**Burning Nettle**	**Nightshade**	**Total Weeds**
			---------- **Number (millions) / A** ----------			
Dual Magnum	0.17	PPI [A]	1.46 a	0.85 a	1.46 ab	4.01 a
Dual Magnum	0.33	PPI	0.74 bcd	0.41 cd	0.85 bcd	2.22 c
Dual Magnum	0.66	PPI	0.63 cde	0.46 cd	0.94 bcd	2.16 c
Dual Magnum	1	PPI	0.30 de	0.35 d	0.74 cd	1.42 cd
Dual Magnum	0.17	PRE	0.74 cd	0.44 cd	0.94 bcd	2.31 bc
Dual Magnum	0.33	PRE	0.65 cde	0.48 bcd	1.18 bc	2.50 bc
Dual Magnum	0.66	PRE	0.44 de	0.63 abc	0.94 bcd	2.11 c
Dual Magnum	1	PRE	0.17 e	0.28 d	0.39 d	0.91 d
Ro-Neet	2	PRE	1.13 abc	0.70 abc	1.50 ab	3.40 ab
Control	0	---	1.29 ab	0.74 ab	1.83 a	4.14 a
LSD (0.05)			0.54	0.28	0.65	1.11

[A] Preplant incorporated at 21 days before planting