

CALIFORNIA LEAFY GREENS RESEARCH PROGRAM

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WEED MANAGEMENT SYSTEMS FOR LEAFY GREENS

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ABSTRACT

Dual Magnum is being evaluated for use as a pre-transplant herbicide for lettuce. Prior research has shown it to be safe on traditional 30-day-old lettuce transplants. However, the latest transplanting technology is using plants that are less than 20 days old, and these lettuce plants are more sensitive to Dual Magnum than 30-day-old plants. Lettuce transplants at 1, 2, 3, 4 and 5 leaf stages were transplanted into soil treated with Dual Magnum at 0.67 pints/A. Transplants at the 4 and 5 leaf stages were tolerant of this rate of Dual Magnum while the younger transplants were not as tolerant. Another part of the project evaluated the use of Dual Magnum at 0.16, 0.33, 0.51 and 0.67 pints/A. Results indicated that rates greater than 0.5 pint/A were highly injurious to young lettuce transplants. The results clearly indicate that the focus of research should be on lower rates of Dual Magnum when used with Plant Tape technology. Tank mixes of Dual Magnum plus Kerb were evaluated and found that Dual Magnum plus Kerb improves control of common sowthistle compared to Kerb alone. Dual Magnum plus Kerb did not help improve control of common purslane or burning nettle compared to Kerb alone. The best role for Dual Magnum should be in 30-day-old transplants, and where young transplants are used, Dual Magnum should be used at a rate less than 0.51 pints per acre in combination with Kerb.

OBJECTIVES

The long-term goal of this project is to provide leafy vegetable growers with tools and information that leads to cost-effective and labor-efficient weed management systems that will be sustainable in the long-term. The objectives of this project were to determine the minimum size of lettuce transplants that are tolerant to Dual Magnum, and the minimum rate of Dual Magnum alone and in tank mix with Kerb required for effective weed control in transplanted lettuce.

PROCEDURES

Determine the minimum size of lettuce transplants that are tolerant to Dual Magnum

The tolerance of 1- to 5-leaf lettuce transplants to Dual Magnum was evaluated at the USDA-ARS facility in Salinas, CA during August to October 2018. Duplicate trials were conducted at the Hartnell research farm, on Antioch sandy loam soil, fine, with a pH of 7.0 and organic matter content of 2.1%. In each experiment, Romaine transplants of 1, 2, 3, 4 and 5-leaves were transplanted into soil treated previously with Dual Magnum 7.62 EC or Kerb 3.3 SC. Each trial was arranged in a randomized complete block design replicated four times. Each plot consisted of one 40" wide bed by 10' long. Romaine lettuce plugs (cv. Abilene), were grown in commercial "paper pot" cells.

Dual Magnum at 0.67 pints/A and Kerb at 2.9 pints/A were applied August 1 (Trial A) and 22, 2018 (Trial B), before transplant (PRE) to plots designated for planting with one of the five transplant sizes. Non-treated weedy and hand-weeded checks were included for comparison. The hand-weeded check was weeded every 1-2 weeks. All treatments were applied in water, at 40 GPA over finished beds, using a CO₂ backpack sprayer, with a single Tee-Jet EVS 8002 nozzle. On August 2 (Trial A) and 23, 2018 (Trial B) lettuce plugs at the 1, 2, 3, 4 and 5-leaf stages were transplanted by hand (two plant lines per bed, at 12" in-row and 12" between-row spacing) into five separate beds for each of the two herbicide treatments (Table 1). The plots were sprinkler irrigated immediately following transplanting, to set the transplants and activate the herbicides. The lettuce was cultivated and fertilized with 300 lbs./A 21-0-0-24 (S) at approximately 2 and 4-weeks after transplanting. During the trial period, the 1 and 2-leaf transplants in Trial B suffered moderate to heavy mortality due to the presence of Impatiens Necrotic Spot Virus (INSV), environmental affects (i.e., drying/separating of paper pot cell from plug roots) and bird damage.

Weed density counts (number by species per 2.8 ft²) were assessed on August 20 (Trial A) and September 11 (Trial B), 2018. Crop injury estimates, using a rating scale of 0 = no injury, 10 = dead, were made August 16 and 29, and September 13 (Trial A), and September 6 and 20, and October 4 (Trial B), 2018. Lettuce stand counts were made August 29 (Trial A) and September 20 (Trial B), 2018. On October 5 to 16 (Trial A) and October 22 to November 1 (Trial B), 2018, healthy, mature lettuce heads were harvested, counted and weighed (Table 1). All data were subjected to analysis of variance, and mean separation was performed using LSD (P=0.05).

Table 1. Critical trial events and dates

Trial Plot Designation:	Trial A	Trial B
Application Intervals:	8/1/18	8/22/18
Transplanting Date:	8/2/18	8/23/18
Lettuce Type / Variety:	Romaine (Abilene)	Romaine (Abilene)
Evaluations:		
Weed Control	8/20/18	9/11/18
Stand	8/29/18	9/20/18
Crop Injury	8/16/18 8/29/18 9/13/18	9/6/18 9/20/18 10/4/18
Harvest	10/5-16/18	10/22-11/1/18

RESULTS AND DISCUSSION

Weed Control: Common weeds in both trials were purslane (*Portulaca oleracea*), burning nettle (*Urtica urens*), henbit (*Lamium amplexicaule*) and annual sowthistle (*Sonchus oleraceus*). In both trials, Kerb provided equal or better control of purslane, and burning nettle than Dual Magnum (Tables 2 and 3). In Trial B, Dual Magnum applied PRE provided greater control of annual sowthistle than Kerb (Table 3).

Table 2. Weed density evaluation on 8/20/18; approximately 3-weeks after transplanting (Trial A).

Treatments	Rate (pints/A)	Growth Stage	Purslane	Burning Nettle	Henbit
			No. 1,000/Acre		
Dual Magnum	0.67	1-Leaf	95.9 bcd	86.5 b	7.9 cde
Kerb	2.9	1-Leaf	15.7 cd	39.3 bc	12.6 cde
Dual Magnum	0.67	2-Leaf	117.9 bc	78.6 b	6.3 cde
Kerb	2.9	2-Leaf	47.2 bcd	31.5 bc	25.2 abc
Dual Magnum	0.67	3-Leaf	132.1 b	69.2 bc	1.6 de
Kerb	2.9	3-Leaf	23.6 cd	17.3 bc	22.0 bcd
Dual Magnum	0.67	4-Leaf	141.5 b	31.5 bc	9.4 cde
Kerb	2.9	4-Leaf	51.9 bcd	53.5 bc	17.3 b-e
Dual Magnum	0.67	5-Leaf	80.2 bcd	86.5 b	6.3 cde
Kerb	2.9	5-Leaf	1.6 d	56.5 bc	36.2 ab
Weedy Check	0.0	4-Leaf	512.7 a	209.2 a	44.0 a
Handweeded	0.0	4-Leaf	0.0 d	0.0 c	0.0 e
LSD (P = .05)			105.4	73.9	20.4

Table 3. Weed density evaluation on 9/11/18; approximately 3-weeks after transplanting (Trial B).

Treatments	Rate (pints/A)	Growth Stage	Purslane	Burning Nettle	Sow Thistle
			No. 1,000/Acre		
Dual Magnum	0.67	1-Leaf	132.1 bc	36.2 bc	4.7 d
Kerb	2.9	1-Leaf	22.0 def	6.3 c	125.8 ab
Dual Magnum	0.67	2-Leaf	202.9 b	67.6 b	17.3 cd
Kerb	2.9	2-Leaf	7.9 f	4.7 c	174.6 a
Dual Magnum	0.67	3-Leaf	86.5 c-f	9.4 c	12.6 cd
Kerb	2.9	3-Leaf	6.3 f	0.0 c	78.6 bc
Dual Magnum	0.67	4-Leaf	116.4 b-e	39.3 bc	6.3 d
Kerb	2.9	4-Leaf	9.4 ef	12.6 bc	117.9 ab
Dual Magnum	0.67	5-Leaf	119.5	45.6 bc	22.0 cd
Kerb	2.9	5-Leaf	0.0 f	6.3 c	95.9 b
Weedy Check	0.0	4-Leaf	596.0 a	130.5 a	110.1 ab
Handweeded	0.0	4-Leaf	0.0 f	0.0 c	0.0 d
LSD (P = .05)			106.9	56.6	72.3

Crop stand: In Trial A, Dual Magnum reduced lettuce stands transplanted at the 1, 2 and 3-leaf stage, and Kerb reduced stands transplanted at the 1-leaf stage. In Trial B, plants within the 1, 2

and 3-leaf transplant stands were reduced by the presence of Impatiens Necrotic Spot Virus (INSV), bird damage, as well as Dual Magnum and Kerb injury. Neither Dual Magnum nor Kerb applied PRE reduced lettuce stands transplanted at the 4 or 5-leaf stage (Table 4).

Table 4. Lettuce stand at approximately 28 days after transplanting

Treatments	Rate (pints/A)	Growth Stage	Trial A	Trial B
			8/29/18 No./10' bed	9/20/18
Dual Magnum	0.67	1-Leaf	16.3 bcd	0.5 e
Kerb	2.9	1-Leaf	15.5 d	1.8 e
Dual Magnum	0.67	2-Leaf	15.8 cd	12.3 cd
Kerb	2.9	2-Leaf	18.0 a-d	11.0 d
Dual Magnum	0.67	3-Leaf	16.3 bdc	13.3 bcd
Kerb	2.9	3-Leaf	18.5 abc	16.8 ab
Dual Magnum	0.67	4-Leaf	18.8 ab	15.8 abc
Kerb	2.9	4-Leaf	19.8 a	17.0 ab
Dual Magnum	0.67	5-Leaf	20.0 a	17.0 ab
Kerb	2.9	5-Leaf	18.8 a	17.3 a
Weedy Check	0.0	4-Leaf	19.5 a	16.8 ab
Handweeded	0.0	4-Leaf	20.0 a	16.5 ab
LSD (P = .05)			2.9	4.0

Crop injury: In Trial A, Dual Magnum caused moderate injury to plants within the 1, 2 and 3-leaf transplant plots at 14- and 28-days after transplanting (Table 5). In Trial B, the high crop injury ratings for the 1st and 2nd-Leaf treatments reflects the moderate to high plant mortality seen; which may be attributable to the presence of Impatiens necrotic spot virus (INSV), bird damage and paper-pot barrier/seedling root drying, as well as herbicide phytotoxicity. Neither Dual Magnum nor Kerb applied PRE caused excessive injury to lettuce stands transplanted at the 4 or 5-leaf stage, and appear to be safe at these two transplant growth stages (Table 5).

Table 5. Crop injury estimates at approximately 14, 28 and 42-days following transplanting.

Treatments	Rate (pints/A)	Growth Stage	Trial A			Trial B		
			8/16/18	8/29/18	9/13/18	9/6/18	9/20/18	10/4/18
0 = no injury, 10 = crop death.								
Dual Magnum	0.67	1-Leaf	2.3	3.0 a	1.8	8.5 a	9.3 a	9.3 a
Kerb	2.9	1-Leaf	2.0	1.5 abc	1.4	9.3 a	9.5 a	9.4 a
Dual Magnum	0.67	2-Leaf	2.3	2.3 ab	1.6	3.3 b	3.5 b	3.6 b
Kerb	2.9	2-Leaf	0.8	1.0 bc	0.5	1.8 cd	2.0 bcd	2.4 bcd
Dual Magnum	0.67	3-Leaf	0.9	2.4 ab	1.0	2.0 bc	2.5 bc	2.8 bc
Kerb	2.9	3-Leaf	1.4	1.3 bc	1.1	0.8 cde	0.5 de	0.4 e
Dual Magnum	0.67	4-Leaf	0.7	0.3 c	0.8	1.0 cde	1.1 cde	2.6 bc
Kerb	2.9	4-Leaf	1.1	0.4 c	0.3	0.3 e	0.0 e	1.0 de
Dual Magnum	0.67	5-Leaf	0.5	0.0 c	0.3	1.0 cde	0.9 de	1.3 cde
Kerb	2.9	5-Leaf	0.8	1.0 bc	0.8	0.4 de	0.6 de	0.3 e
Weedy Check	0.0	4-Leaf	0.0	0.0 c	0.0	0.0 e	0.0 e	0.0 e
Handweeded	0.0	4-Leaf	0.0	0.0 c	0.0	0.0 e	0.0 e	0.0 e
LSD (P = .05)			1.7	1.7	1.3	1.5	1.6	1.6

Lettuce harvest: In Trial A, none of the treatments reduced numbers, weights and size of mature / healthy heads (Table 6). In Trial B, lettuce head numbers and weights for lettuce transplanted at

the 1, 2 and 3-leaf stage were reduced by the presence of Impatiens Necrotic Spot Virus (INSV), bird damage, as well as Dual Magnum or Kerb injury. In Trial B, none of the treatments reduced numbers, weights and size of mature / healthy heads for lettuce transplanted at the 4 or 5-leaf stage (Table 6).

Table 6. Crop yield: Number and fresh weight of mature / healthy lettuce heads.

Treatments	Rate (pints/A)	Growth Stage	Trial A		Trial B	
			10/5-16/18 1000s/A	tons/A	10/22-11/1/18 1000s/A	tons/A
Dual Magnum	0.67	1-Leaf	14.4	10.9	3.3 d	0.9 d
Kerb	2.9	1-Leaf	12.4	6.5	3.7 d	1.5 d
Dual Magnum	0.67	2-Leaf	14.8	8.6	14.4 c	10.7 abc
Kerb	2.9	2-Leaf	19.0	14.8	14.1 c	13.3 a
Dual Magnum	0.67	3-Leaf	15.0	10.4	15.0 bc	10.8 abc
Kerb	2.9	3-Leaf	17.0	12.1	20.0 ab	16.5 abc
Dual Magnum	0.67	4-Leaf	16.1	10.4	19.0 abc	12.4 bc
Kerb	2.9	4-Leaf	15.4	12.3	20.9 a	18.0 a
Dual Magnum	0.67	5-Leaf	17.6	13.5	22.0 a	13.8 c
Kerb	2.9	5-Leaf	17.6	16.2	21.3 a	15.4 abc
Weedy Check	0.0	4-Leaf	14.8	12.0	20.3 a	17.3 ab
Handweeded	0.0	4-Leaf	19.6	13.4	20.6 a	17.8 ab
LSD (P = .05)			6.0	6.6	5.1	5.6

Determine the minimum rate of Dual Magnum alone and in tank mix with Kerb required for effective weed control in transplanted lettuce (field station trial).

The tolerance of 4 to 5-leaf lettuce transplants to, and weed control efficacy of, Dual Magnum alone and in tank mix with Kerb, were evaluated at the USDA-ARS facility in Salinas, CA during June to November 2018. Two experiments were conducted at the Hartnell farm, on Antioch sandy loam soil, fine, with a pH of 7.0 and organic matter content of 2.1%. Lettuce transplants of 4 to 5-leaf stage were transplanted into soil previously treated with Dual Magnum alone or in combination with Kerb. Both trials were arranged in a randomized complete block design, with four replicates. Plots were a single bed, 40” wide by 20’ long. In Trial C, the Plant Tape head lettuce plugs used were acquired from Tanimura and Antle. For Trial D, Romaine (cv. Abilene) and head (cv. Regency 2.0) lettuce plugs were grown in standard trays.

On June 29 (Trial C) and September 11, 2018 (Trial D), Dual Magnum 7.62 EC at 0.16, 0.33, 0.51 and 0.67 pints/A, Kerb 3.3 SC at 1.9 pints/A, and Dual Magnum at 0.16, 0.33, 0.51 and 0.67 pints/A tank mixed with Kerb at 1.9 pints/A were applied pre-transplant (PRE). Non-treated weedy and handweeded controls were included in both trials; with the exception that a handweeded control for head lettuce was not included in Trial D due to insufficient planting material. The handweeded check was weeded at 1-2 week intervals. All treatments were applied at 40 GPA over finished beds, using a CO₂ backpack sprayer, with a single Tee-Jet EVS 8002 nozzle centered over the bed. On July 2, 2018, 3 days following the PRE application for Trial C, head lettuce plugs at 3-leaf stage were transplanted by hand (two plant lines per bed, at 12” in-row and 12” between-

row spacing) into the beds for each herbicide treatment (Table 7). On September 13, 2018, 2 days following the PRE application for Trial D, head and romaine lettuce plugs at 4 to 5-leaf stage were transplanted by mechanical transplanter (two plant lines per bed with one line each of head and Romaine, at 12” in-row and 12” between-row spacing) into the beds for each herbicide treatment (Table 7). The plots were sprinkler irrigated for 2-3 hours, immediately following transplanting, to set the transplants and activate the herbicides. The lettuce was cultivated and fertilized with 300 lbs./A 21-0-0-24 (S) at approximately 2 and 4-weeks after transplanting. The Romaine crop in Trial D suffered light to moderate mortality across all treatments, due to the presence of Impatiens Necrotic Spot Virus (INSV) and Downey mildew (*Bremia lactucae*).

Weed density counts (number by species per 2.8 ft²) were assessed on July 23 (Trial C) and October 2 (Trial D), 2018. Crop injury estimates, using a rating scale of 0-10 (0 = no injury, 10 = dead), were made July 16 and 31, and August 13 (Trial C), and September 27, and October 11 and 25 (Trial D), 2018. Lettuce stand counts (number of viable plants per 20’ of bed) were made July 31 (Trial C) and October 11 (Trial D), 2018. On August 13 (Trial C) and November 14-15 (Trial D), 2018, healthy, mature lettuce heads were harvested, counted and weighed (Table 7). All data were subjected to analysis of variance, and mean separation was performed using LSD (P=0.05).

Table 7. Critical trial events and dates

Trial Plot Designation:	Trial C	Trial D
Application date	6/29/18	9/11/18
Transplanting Date:	7/2/18	9/13/18
Lettuce Type / Variety:	Head	Romaine (Abilene) Head (Regency 2.0)
Evaluations:		
Weed Control	7/23/18	10/2/18
Stand	7/31/18	10/11/18
Crop Injury	7/16/18	9/27/18
	7/31/18	10/11/18
	8/13/18	10/25/18
Harvest	8/20/18	11/14/18 (Head) 11/15/18 (Romaine)

RESULTS AND DISCUSSION

Weed Control. Weeds common to both trials were purslane (*Portulaca oleracea*) and annual sowthistle (*Sonchus oleraceus*). Annual bluegrass (*Poa annua*) and burning nettle (*Urtica urens*) were also prevalent in Trial D. In Trial C, all herbicide treatments, with the exception of Dual Magnum at 0.16 pints/A, provided effective control of purslane. Purslane occurred at a higher density in Trial D; such that only the four rates of Dual Magnum tank mixed with Kerb, and the lone rates of Kerb at 1.9 and Dual Magnum at 0.67 pints/A provided effective purslane control (Table 8). In Trial C, Dual Magnum at 0.33, 0.51 and 0.67 pints/A, and Dual Magnum at all rates tank mixed with Kerb provided control of annual sowthistle that was better than Kerb alone. Sowthistle occurred at a higher density in Trial D; such that only Dual Magnum at 0.33, 0.51 and 0.67 tank mixed with Kerb, and the solo treatments of Dual Magnum at 0.51 and 0.67 pints/A

provided effective sowthistle control (Table 8). In Trial D, all herbicide treatments controlled annual bluegrass (Table 8). In Trial D, all four rates of Dual Magnum tank mixed with Kerb, and the solo rate of Kerb at 1.9 pints/A effectively controlled burning nettle (Table 8).

Table 8. Weed densities approximately 3-weeks after transplanting (Trials C and D).

Treatments	Rate (pints/A)	Purslane	Sowthistle	Purslane	Bluegrass	Sowthistle	Burning nettle
		No. 1,000 /acre		No. 1,000 /acre			
		-----Trial C-----		-----Trial D-----			
Dual Magnum	0.16	94.4 b	12.6 bc	374.3 ab	231.2 b	212.3 abc	223.3 a
Dual Magnum	0.33	9.4 c	0.0 c	335.0 ab	58.2 b	201.3 a-d	188.7 ab
Dual Magnum	0.51	9.4 c	1.6 c	248.5 bc	18.9 b	58.2 de	99.1 cd
Dual Magnum	0.67	4.7 c	0.0 c	152.5 cd	44.0 b	66.0 cde	141.5 bc
Kerb	1.9	4.7 c	95.9 a	47.2 d	4.7 b	162.0 a-d	55.0 de
Dual Magnum + Kerb	0.16 + 1.9	1.6 c	1.6 c	39.3 d	28.3 b	217.0 ab	34.6 de
Dual Magnum + Kerb	0.33 + 1.9	0.0 c	6.3 bc	31.5 d	4.7 b	62.9 de	12.6 e
Dual Magnum + Kerb	0.51 + 1.9	0.0 c	4.7 bc	20.4 d	15.7 b	113.2 b-e	28.3 de
Dual Magnum + Kerb	0.67 + 1.9	1.6 c	0.0 c	34.6 d	3.1 b	75.5 b-e	20.4 e
Weedy Check	0.0	264.2 a	56.6 ab	412.0 a	1179.4 a	309.8 a	259.5 a
Handweeded	0.0	0.0 c	0.0 c	0.0 d	0.0 b	0.0 e	0.0 e
LSD (P = .05)		58.2	53.5	154.1	284.6	149.4	75.5

Crop stand. None of the four rates of Dual Magnum applied, alone or tank mixed with Kerb, reduced head or romaine lettuce stands (data not shown).

Lettuce injury: In Trial C, Dual Magnum applied PRE at 0.51 and 0.67 pints/A, both alone and tank mixed with Kerb at 1.9 pints/A, caused slight to moderate injury to head lettuce transplanted at the 3-leaf stage. The plants were beginning to outgrow the symptoms by the 42-day post-transplant evaluation (Table 9). In Trial D, none of the Dual Magnum / Kerb PRE treatments caused any significant crop injury to head or romaine lettuce transplanted at the 4th to 5th-leaf stage (Table 10).

Table 9. Crop injury estimates approximately 14, 28 and 42 days following transplanting (Trial C).

Treatments	Rate (pints/A)	Applic. Interval	Head		
			7/16/18	7/31/18	8/13/18
0 = no injury, 10 = crop death					
Dual Magnum	0.16	PRE Trans	0.5 cd	0.4 cd	0.1 b
Dual Magnum	0.33	PRE Trans	0.8 bcd	1.3 c	0.8 b
Dual Magnum	0.51	PRE Trans	1.3 abc	3.5 ab	2.6 a
Dual Magnum	0.67	PRE Trans	2.0 bcd	4.5 a	3.3 a
Kerb	1.9	PRE Trans	0.8 bcd	0.3 cd	0.9 b
Dual Magnum + Kerb	0.16 + 1.9	PRE Trans	0.3 d	0.0 d	0.0 b
Dual Magnum + Kerb	0.33 + 1.9	PRE Trans	0.5 cd	1.0 cd	0.5 b
Dual Magnum + Kerb	0.51 + 1.9	PRE Trans	0.9 bcd	3.3 b	2.3 a
Dual Magnum + Kerb	0.67 + 1.9	PRE Trans	1.6 ab	4.6 a	3.0 a
Weedy Check	0.0	---	0.0 d	0.0 d	0.0 b
Handweeded	0.0	---	0.0 d	0.0 d	0.0 b
LSD (P = .05)			1.00	1.15	1.22

Table 10. Crop injury estimates approximately 14, 28 and 42 days following transplanting (Trial D).

Treatments	Rate (pints/A)	Applic. Interval	Romaine			Head		
			9/27/18	10/11/18	10/25/18	9/27/18	10/11/18	10/25/18
0 = no injury, 10 = crop death								
Dual Magnum	0.16	PRE Trans	0.4	0.3	0.3	0.8	1.0	1.0
Dual Magnum	0.33	PRE Trans	0.0	0.3	0.0	0.0	0.0	0.3
Dual Magnum	0.51	PRE Trans	0.1	0.9	0.9	0.0	0.3	0.3
Dual Magnum	0.67	PRE Trans	0.3	0.4	0.3	0.2	0.2	0.0
Kerb	1.9	PRE Trans	0.8	0.6	0.4	0.7	0.5	0.2
Dual Magnum + Kerb	0.16 + 1.9	PRE Trans	0.0	0.4	0.8	0.0	0.3	0.8
Dual Magnum + Kerb	0.33 + 1.9	PRE Trans	0.8	0.6	0.6	0.8	1.0	1.2
Dual Magnum + Kerb	0.51 + 1.9	PRE Trans	0.3	0.4	0.6	0.5	0.5	0.3
Dual Magnum + Kerb	0.67 + 1.9	PRE Trans	0.4	1.4	1.0	0.0	0.5	0.0
Weedy Check	0.0	---	0.0	0.0	0.0	0.0	0.0	0.0
Handweeded	0.0	---	0.0	0.0	0.0	---	---	---
LSD (P = .05)			0.77	0.94	1.10	1.11	1.27	1.44

Lettuce yield. In Trial C, none of the Dual Magnum / Kerb PRE treatments reduced numbers, weights and size of mature / healthy heads for head lettuce plugs transplanted at the 3-leaf stage. In Trial D, none of the Dual Magnum / Kerb treatments reduced numbers, weights and size of mature / healthy heads from “commercial tray” grown head and romaine lettuce plugs transplanted at the 4 to 5-leaf stage (Table 11).

Table 11. Crop yield: Number and fresh weight of marketable lettuce heads.

Treatments	Rate (pints/A)	Applic. Interval	Trial C		Trial D			
			8/20/18		11/14/18		11/15/18	
			Head		Head		Romaine	
			1000s/A	tons/A	1000s/A	tons/A	1000s/A	tons/A
Dual Magnum	0.16	PRE Trans	29.5	34.2	17.5	8.5	24.8	20.7
Dual Magnum	0.33	PRE Trans	24.8	28.8	21.6	11.1	26.1	22.7
Dual Magnum	0.51	PRE Trans	24.3	29.9	21.6	11.3	18.3	13.6
Dual Magnum	0.67	PRE Trans	21.7	27.2	20.9	10.1	24.3	19.7
Kerb	1.9	PRE Trans	26.9	31.7	14.9	7.4	19.6	16.8
Dual Magnum + Kerb	0.16 + 1.9	PRE Trans	31.4	35.5	15.7	8.7	24.3	19.5
Dual Magnum + Kerb	0.33 + 1.9	PRE Trans	28.2	29.2	13.8	7.9	20.3	14.8
Dual Magnum + Kerb	0.51 + 1.9	PRE Trans	20.4	23.6	21.6	12.0	26.9	24.2
Dual Magnum + Kerb	0.67 + 1.9	PRE Trans	24.8	29.6	19.6	11.6	19.6	15.0
Weedy Check	0.0	---	34.8	38.8	20.1	11.6	22.2	19.3
Handweeded	0.0	---	34.8	41.5	---	---	23.0	18.6
LSD (P = .05)			10.2	13.5	7.6	4.8	12.8	11.4

2018 Dual Magnum Evaluations on PlantTape Transplanted Lettuce

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Dual Magnum is being evaluated for use as a pre-transplant application for lettuce. Prior research has shown it to be safe on traditional lettuce transplanting operations in which the transplants used are typically 30 days old. This research project evaluated the use of Dual Magnum on lettuce planted with Plant Tape™ transplants that are smaller and younger, typically 14-18 days old at transplanting. Results indicated that rates greater than 0.5 pint/A were highly injurious to Plant Tape transplanted lettuce. The results clearly indicate that the focus of research should be on lower rates of Dual Magnum when used with Plant Tape technology. The trial was conducted to determine the efficacy of low rates of Dual Magnum to be used in future Dual Magnum trials with Plant Tape planted lettuce.

Methods: The trial was conducted in a commercial Romaine lettuce field near Chualar, CA. The soil type at the site was Chualar loam. The field had a good deal of residue from the prior crop which made planting conditions more challenging than normal. Romaine lettuce was planted with PlantTape™ July 20, 2018. Herbicide treatments were applied the day prior to transplanting on July 19. Materials were applied with a CO₂ backpack sprayer using a one-nozzle wand with an 8008EVS tip applying the equivalent of 76 gallons of water per acre. The field was sprinkler irrigated for the whole growth cycle. Weed counts were made on August 2 and on August 15. On August 15, each plot was hand weeded and the time to weed was recorded. Harvest evaluations were conducted on September 21 by harvesting and weighing 10 untrimmed plants from each

plot. Plots were one 80-inch bed wide by 10 feet long and randomized in a complete block design with four replications.

Results: The August 2 evaluation was conducted before cultivation. All Dual Magnum treatments had fewer purslane plants and total weeds than Kerb and the nontreated control (Table 12). Only Dual Magnum at 0.67 pint/A had measurable phytotoxicity on that day (Table 13). The August 15 evaluation date was conducted following cultivation. All Dual Magnum treatments except for 0.33 pint/A had fewer purslane and total weeds than Kerb and the nontreated control. All Dual Magnum treatments had lower weeding times than Kerb and the nontreated control. Dual Magnum at 0.67 pints/A had unacceptable phytotoxicity on this date, and on September 6 Dual Magnum at 0.51 and 0.67 pint/A had unacceptable phytotoxicity. The yield data indicates reduced yield in the 0.51 and 0.67 pint/A treatments (Table 13).

Table 12. Weed counts (1,000/acre) and weeding time

Treatment	Pints/Acre	Aug 2		Aug 18	
		Total weeds No. 1,000/Acre		Weed Time Hr./A	
Dual Magnum	0.16	61.9	53.0	9.8	
Dual Magnum	0.33	64.3	63.1	10.6	
Dual Magnum	0.51	53.0	41.7	7.8	
Dual Magnum	0.67	39.3	44.1	8.6	
Kerb	1.9	100.0	76.1	14.9	
Nontreated	0.0	107.6	69.6	13.4	
P		0.0087	0.0912	0.0002	
LSD _{0.05}		30.0	NS	2.6	

Table 13. Phytotoxicity rating and yield evaluation (mean head weight)

Treatment	Pints/Acre	Phytotoxicity ¹			lbs./head	
		Aug 2	Aug 15	Sept 6	Sept 21	
Dual Magnum	0.16	0.0	0.0	1.5	1.23	
Dual Magnum	0.33	0.0	0.1	1.5	1.30	
Dual Magnum	0.51	0.0	0.5	2.3	1.16	
Dual Magnum	0.67	0.3	2.5	2.3	1.06	
Kerb	1.9	0.0	0.0	0.5	1.22	
Nontreated	0.0	0.0	0.0	0.0	1.26	
P		0.4509	<0.0001	0.0027	0.0009	
LSD _{0.05}		NS	0.8	1.1	0.09	

1 – scale: 0 = no crop damage to 10 = crop dead

Conclusions

Dual Magnum tolerance on transplanted lettuce is marginal. Dual Magnum at 0.67 pints/A should not be used with lettuce transplants unless the lettuce plants have 4 to 5 leaves. Dual Magnum plus Kerb tank mixes of 0.16+1.9 and 0.33+1.9 pints/A are probably safe on 3 leaf lettuce transplants. The main benefit of using Dual Magnum will be to improve control of weeds that Kerb does not control such as common sowthistle. Kerb alone is effective on common purslane and burning nettle and does not benefit from mixture with Dual Magnum on these weeds.