

SSGWO Research Report

August 24, 2026

Alternative Early Season Herbicide Programs for Spinach Seed Production

Aaron Becerra-Alvarez

Department of Horticulture, Oregon State University

a.becerraalvarez@oregonstate.edu

Objective

Evaluate spinach crop response and weed control from Dual Magnum and Nortron herbicide mixtures and new herbicides (Outlook and Goltix) for potential alternatives to Ro-Neet in early season weed control of spinach seed crop.

Procedure

A field study was conducted at the OSU Vegetable Research Farm. Plots were 10' by 20' with four replications with spinach planted on two rows 20 inches apart with a precision Gaspardo planter at 10 seeds per foot on May 5, 2026. The field was irrigated 0.5 inches after application treatments and irrigated as needed. Rain was not significant at or near application timings. Weather data is shown in Figure 1.

Table 1. Application data

Application details	A (Ro-Neet app)	B (all other treatments)
Date	5/5/2026	5/6/2026
Method	PPI with rototiller	PRE
Timing	Before seeding	After seeding
Temperature	70 F	73 F
Relative Humidity	61%	42%
Wind	1 mph	5 mph
Soil moisture	Dry	Dry
Cloud cover	1%	20%
GPA	20	20
Nozzle	6-8002VS	6-8002VS
Nozzle spacing	20"	20"

Visual crop injury ratings of chlorosis, necrosis, stunting, and total injury will be collected 7, 14, and 21 days after treatment (DAT) on a scale of 0 to 10, where 0 is no injury and 10 is plant death. Spinach stand count and plant biomass were collected at 35 DAT. Visual weed control ratings by species and total control will be evaluated at 7, 14, and 21 DAT on a scale of 0 to 100, where 0 is no control and 100 is full control. Weed biomass was collected on 38 DAT by randomly sampling in a 2.5 ft length by 1 ft wide quadrat over each spinach row two times per

plot. All collected data has been analyzed with ANOVA and mean separation test where appropriate using Tukey's HSD $\alpha=0.05$.

Results and Discussion

Weed Control

Weed pressure in the field was high, mainly dominated by pigweeds and lambsquarters. Hairy nightshade, Shepherd's purse, and common groundsel were also present in lesser amounts. In the 400's block, some plots had areas with bindweed which may have affected stand and spinach establishment.

All treatments reduced weeds compared to the nontreated. At 7 DAT, weed control appeared low with most treatments at 47 to 60% (Table 2). By 14 DAT, weed control differences by plots were evident; however, no significance was observed with values of 60 to 90% (Table 2). Throughout the entire field and treatments, pigweed appeared controlled greater than lambsquarters (data not shown). The high weed control variation observed was most likely caused by the high weed pressure of the field. It was observed that some plots further from the irrigation lines appeared to look cleaner from weeds than those plots next to the irrigation lines. This may suggest that with more irrigation the more weeds that could have emerged after the initial flush was controlled by herbicide treatments. This year was a relatively dry spring and only irrigation was necessary for the activation of herbicide treatments. The results of this year may not tell us how these herbicides and herbicide mixtures perform in wetter conditions, when we may have wetter springs, which warrants further research.

Dual Magnum alone resulted in similar control to Ro-Neet; however, Nortron alone had poor weed control compared to Ro-Neet. By 21 DAT, the herbicide mixtures of Dual Magnum and Nortron only outperformed the Nortron alone treatments (Table 3 and Figure 2). The Dual Magnum mixtures with the 0.67 pt/A appeared to provide numerically higher weed control than the 0.33 pt/A both alone and in mixtures with Nortron (Table 3). The Dual Magnum at 0.67 pt/A and Nortron at 1 pt/A mixture appeared with good control and adequate crop response (Figure 2). The addition of Nortron did not demonstrate a clear synergism in weed control; however, it could still add broader spectrum control of weeds in fields with different weed species.

Outlook and Goltix were the two products not registered in spinach that were tested in this trial. Both Outlook and Goltix performed like the standard treatment of Ro-Neet only at the higher application rate when applied alone (Table 3; Figure 2). The herbicide mixtures of Goltix with Dual Magnum and Nortron did not appear to improve the visual weed control levels (Figure 2) and no difference in weed biomass either (Table 3). It is unclear if it was antagonism effect or effect of the high weed pressure this year. Preliminary research with Outlook the previous year demonstrated better weed control than this year and this may be attributed to the high weed pressure in this field. These products provided adequate weed control early on and will require

additional weed management after spinach emergence and before 21 DAT for improved weed control.

Crop response

There was no significant spinach response observed by any of the treatments. All rating values were from 0 to 2. Early on, Dual Magnum and Nortron treatments appeared to cause stunting by visually demonstrating slower emergence above the soil. The Dual Magnum and Nortron response remained up to 21 DAT; however, ratings were all below 3 and no different across treatments (Figure 2). There were no differences by treatments in stand counts and spinach dry biomass; however, it was visually apparent that where weeds were more controlled spinach plants had wider dense biomass (Figure 2). Plant biomass may have been collected too early to estimate potential for seed yields; however, the weedy field also played a factor in the response. Spinach plants were responding to high weed pressure by growing taller faster; therefore, biomass from weedy plots resulted like cleaner plots and this difference was not clearly characterized in the data collection.

Outlook and Goltix did not cause significant spinach response and appear safe to spinach when applied pre-emergence (Figure 1). In a separate area not part of this study, Goltix was applied postemergence over spinach to evaluate its potential as postemergence option. In a table beet study, Goltix performed very good when applied pre followed by two post emergence applications at 21.6 fl oz/A 7 days apart (data not shown here). However, when applied postemergence at this rate on spinach resulted in significant leaf burn (Figure 3).

Weed control was adequate for most plots; however, no treatment stood out over the standard of Ro-Neet. Our field was particularly weedy, and additional post emergence herbicides or other weed management would be necessary before 21 DAT to achieve improved control of weeds. No herbicide treatment from this trial caused significant spinach response. Both Outlook and Goltix appear to be options to pursue as pre-emergence applications. This report will be shared with registrants, and any response will be shared with the board. Additional research should evaluate these treatments in wetter and colder conditions to understand crop response in alternate common environmental conditions for our region earlier spring months and also since this year was a relatively dry spring.

Table 2. Weed control at 7 and 14 DAT from pre-emergence herbicide mixtures and new herbicides evaluated in spinach at the OSU Vegetable Research Farm in 2026

Vegetable Research Farm in 2020									
Trt	Herbicide trade name	Product rate	Active ingredient rate	Timing	Total weed control				
			lbs ai/A		7 DAT		%	14 DAT	
1	Nontreated	-	-	-	0	b		0	b
2	Handweeded check	-	-	-	-			56	a
3	Ro-Neet	4 pt/A	3	PPI	47	a		76	a
4	Dual Magnum	0.33 pt/A	0.31	PRE	45	ab		66	a
5	Dual Magnum	0.67 pt/A	0.64	PRE	62	a		82	a
6	Nortron	1 pt/A	0.5	PRE	45	ab		62	a
7	Nortron	1.88 pt/A	0.94	PRE	45	ab		56	a
8	Nortron	2 pt/A	1	PRE	27	ab		72	a
9	Dual Magnum + Nortron	0.33 + 1 pt/A	0.31 + 0.5	PRE	55	a		81	a
10	Dual Magnum + Nortron	0.67 + 1 pt/A	0.64 + 0.5	PRE	55	a		82	a
11	Dual Magnum + Nortron	0.33 + 1.88 pt/A	0.31 + 0.94	PRE	45	ab		80	a
12	Dual Magnum + Nortron	0.67 + 1.88 pt/A	0.64 + 0.94	PRE	65	a		91	a
13	Dual Magnum + Nortron	0.33 + 2 pt/A	0.31 + 1	PRE	60	a		81	a
14	Dual Magnum + Nortron	0.67 + 2 pt/A	0.64 + 1	PRE	52	a		90	a
15	Outlook*	2.66 fl oz/A	0.125	PRE	42	ab		61	a
16	Outlook*	5.3 fl oz/A	0.25	PRE	45	ab		75	a
17	Goltix 700 SC*	31.25 fl oz/A	1.42	PRE	35	ab		64	a
18	Goltix 700 SC*	62.5 fl oz/A	2.85	PRE	52	a		71	a
19	Dual Magnum + Goltix 700 SC*	0.33 pt/A + 31.25 fl oz/A	0.477 + 1.42	PRE	52	a		67	a
20	Nortron + Goltix 700 SC*	12 fl oz/A + 31.2 floz/A	0.375 + 1.42	PRE	37	ab		66	a

*, Not registered for use in spinach; PPI, pre plant incorporated before planting; PRE, pre-emergence post planting; DAT, days after treatment; Ratings are on a 0 to 100 scale where 0 is no control and 100 is complete control; means with the same letter within a column do not differ by Tukey's HSD $\alpha=0.05$.

Table 3. Weed control at 21 DAT from pre-emergence herbicide mixtures and new herbicides evaluated in spinach at the OSU Vegetable Research Farm in 2026

Trt	Herbicide trade name	Product rate	Active ingredient rate lbs ai/A	Timing	Weed control 21 DAT				Weed dry biomass
					Pigweed	Lambsquarters	Nightshade	Total weed control	
					%				g
1	Nontreated	-	-	-	0 e	0 c	0 b	0 f	140 a
2	Handweeded check	-	-	-	-	-	-	77 a-d	70 c
3	Ro-Neet	4 pt/A	3	PPI	70 a-d	85 a	87 a	77 a-d	82 bc
4	Dual Magnum	0.33 pt/A	0.31	PRE	47 cd	60 ab	72 a	61 a-e	102 abc
5	Dual Magnum	0.67 pt/A	0.64	PRE	80 a-d	65 ab	70 a	67 a-e	80 bc
6	Nortron	1 pt/A	0.5	PRE	55 a-d	45 b	62 a	37 e	120 ab
7	Nortron	1.88 pt/A	0.94	PRE	67 a-d	55 ab	65 a	50 a-e	110 abc
8	Nortron	2 pt/A	1	PRE	62 a-d	62 ab	67 a	57 a-e	97 abc
9	Dual Magnum + Nortron	0.33 + 1 pt/A	0.31 + 0.5	PRE	82 a-d	72 ab	80 a	80 abc	90 bc
10	Dual Magnum + Nortron	0.67 + 1 pt/A	0.64 + 0.5	PRE	87 ab	70 ab	77 a	78 abc	72 c
11	Dual Magnum + Nortron	0.33 + 1.88 pt/A	0.31 + 0.94	PRE	85 abc	52 ab	77 a	71 a-e	80 bc
12	Dual Magnum + Nortron	0.67 + 1.88 pt/A	0.64 + 0.94	PRE	90 a	81 ab	85 a	86 a	67 c
13	Dual Magnum + Nortron	0.33 + 2 pt/A	0.31 + 1	PRE	88 a	71 ab	85 a	75 a-d	72 c
14	Dual Magnum + Nortron	0.67 + 2 pt/A	0.64 + 1	PRE	91 a	77 ab	87 a	83 ab	67 c
15	Outlook*	2.66 fl oz/A	0.125	PRE	45 d	47 ab	60 a	42 de	112 abc
16	Outlook*	5.3 fl oz/A	0.25	PRE	77 a-d	67 ab	77 a	71 a-e	92 bc

17	Goltix 700 SC*	31.25 fl oz/A	1.42	PRE	48 bcd	57 ab	67 a	45 cde	102 abc
18	Goltix 700 SC*	62.5 fl oz/A	2.85	PRE	76 a-d	70 ab	72 a	72 a-e	97 abc
19	Dual Magnum + Goltix 700 SC*	0.33 pt/A + 31.25 fl oz/A	0.477 + 1.42	PRE	75 a-d	62 ab	82 a	67 a-e	85 bc
20	Nortron + Goltix 700 SC*	12 fl oz/A + 31.2 floz/A	0.375 + 1.42	PRE	55 a-d	65 ab	72 a	57 a-e	95 abc

*, Not registered for use in spinach; PPI, pre plant incorporated before planting; PRE, pre-emergence post planting; DAT, days after treatment; Ratings are on a 0 to 100 scale where 0 is no control and 100 is complete control; Weed biomass collected from 1 ft width by 5ft length quadrat in the crop row; means with the same letter within a column do not differ by Tukey's HSD $\alpha=0.05$.

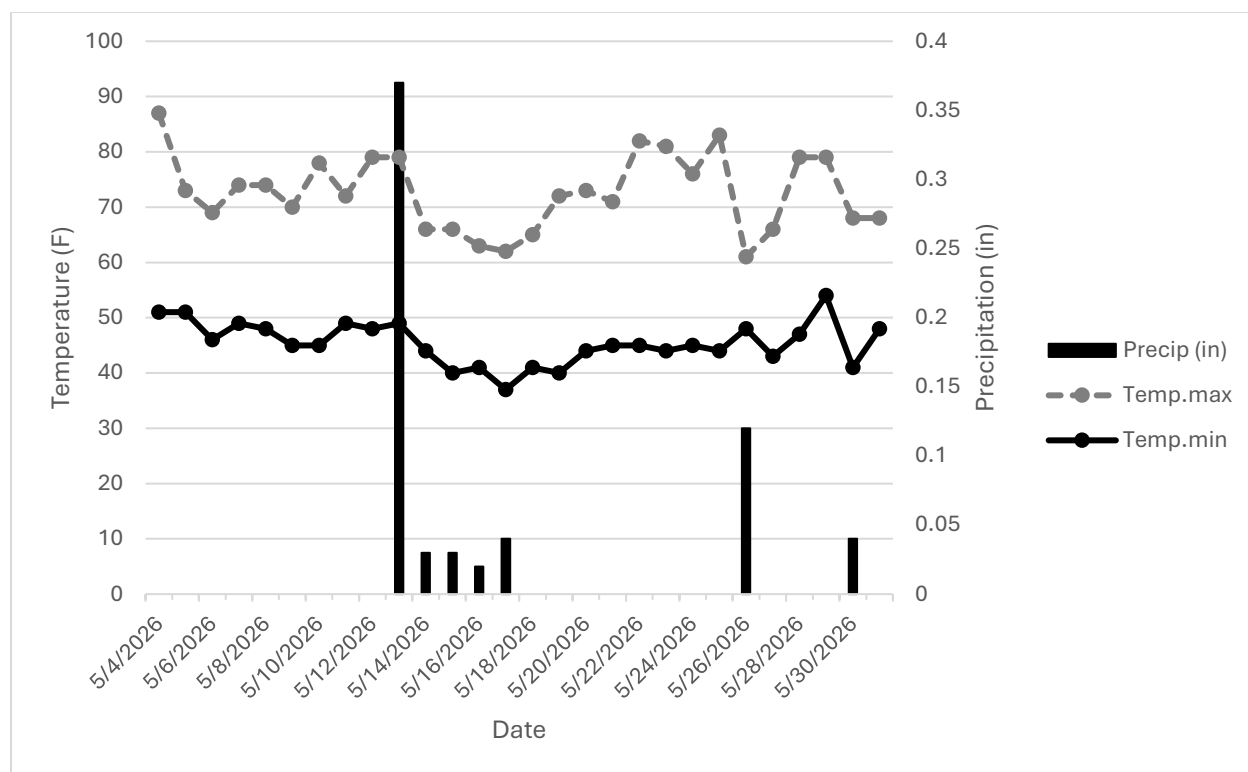


Figure 1. Temperature and weather conditions at the trial location in Corvallis, OR. Planting occurred on 5/5/2026 and treatments on 5/6/2026. Data obtained from OSU Hyslop Weather Station in Corvallis, OR.

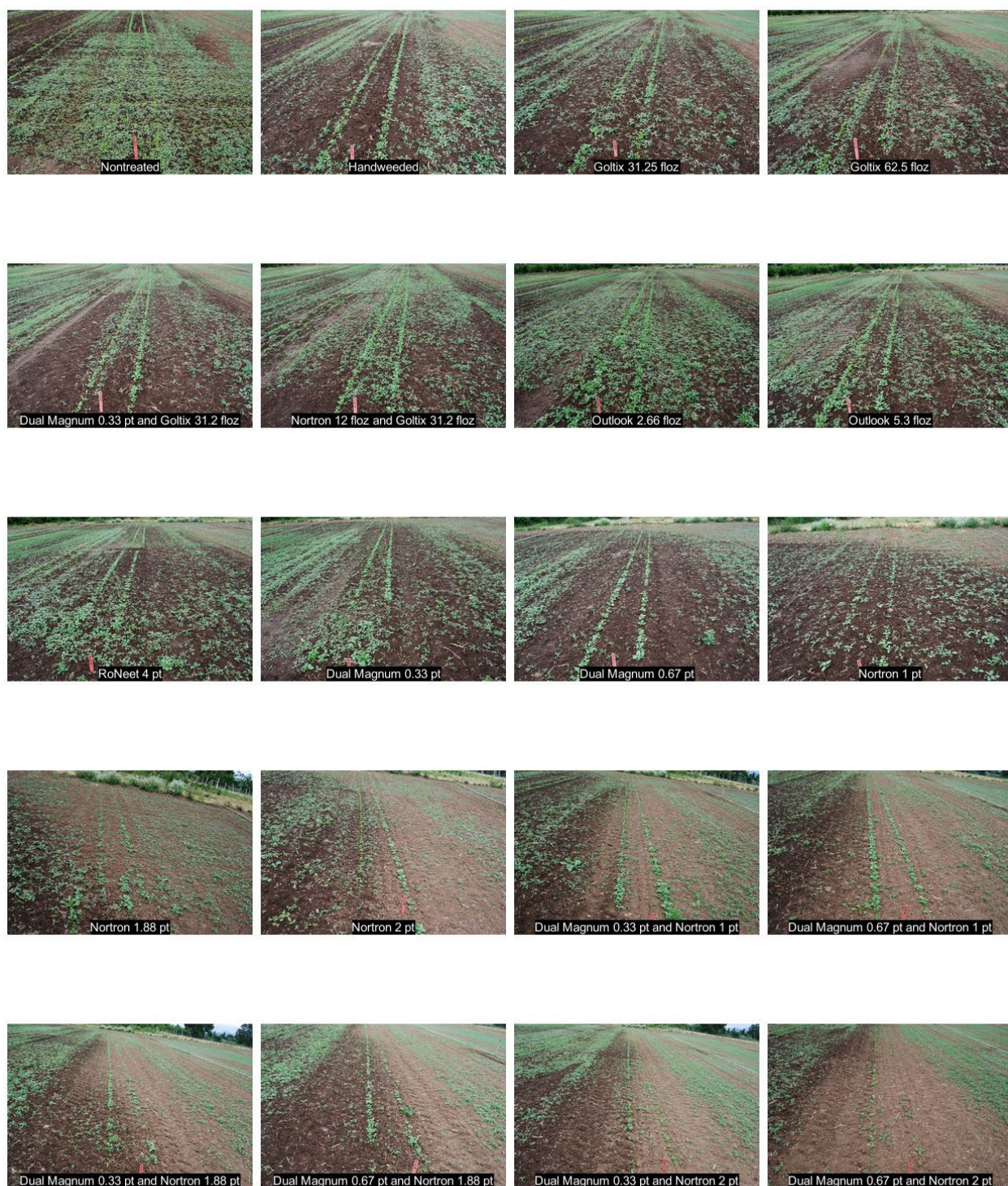


Figure 2. A representative plot for each treatment at 21 DAT of different pre-emergence herbicides alone and in mixtures applied on spinach in the OSU Vegetable Research Farm in Corvallis, OR, in 2026. Labels with an amount refer to the product rates per acre.



Figure 3. Goltix (metamitron; PSII inhibitor) injury when applied POST at 31.2 fl oz/A on 2-3 leaf spinach. When Goltix is applied PRE at 31.2 and 62.5 fl oz/A on spinach, no injury is observed.