2025 Report

Use of PRE- and POST-emergent Herbicide Admixtures to Optimizing Long-lasting Weed Control in Pear Orchards

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ABSTRACT

There is a growing demand for a broad-spectrum herbicide alternative to glyphosate and an adequate tank mixture with other PRE-emergent herbicides to improve efficiency and long-lasting weed control in pear orchard floors. To meet the practitioner's demand, the objective of these studies was to examine different PRE- and POST-emergent herbicide programs and application rates in the field to improve weed management on the pear orchard floor. We compared PRE- and POST-emergent herbicide programs for a broad spectrum of weed control. Two field trials were conducted during the 2025 growing seasons from May to September as randomized complete block designs with an existing stand of mixed grasses and broadleaf weeds. Treatments included PRE-and POST-emergent herbicide programs at different rates. In general, Glyphosate (Roundup PowerMAX®) or Glufosinate (Rely® 280) applied alone or in tank mixtures with indaziflam (Alion®), rimsulfuron (Matrix®), or pendimethalin (Prowl H2O®) at all tested rates were safe for pear trees, with no injury observed. Preliminary results showed that the POST-emergent herbicides Roundup PowerMAX® and Rely® 280 present similar efficacy for controlling a broad spectrum of weeds. However, due to the high soil moisture from weekly irrigation, especially in June and July, when the fruit is increasing in size, and because of the high soil weed seed, most summer weeds will recover within four to six weeks after the initial application of only the POST-emergent herbicide application programs, requiring a sequential application to keep the orchard floors free of weeds during the growing season. The results showed that Roundup PowerMAX® or Rely® 280 tank mixture with the PRE-emergent herbicides Alion®, Matrix®, or Prowl H2O® improved efficiency and long-lasting weed control when compared to Roundup PowerMAX® or Rely® 280 applied alone. The results of two-year studies (2024 and 2025) strongly suggest that PRE- and POST-emergent herbicide programs may improve long-term weed control and reduce the total number of control operations required.

INTRODUCTION

Glyphosate [N-(phosphonomethyl)glycine] is a non-selective herbicide registered to control annual and perennial weeds in agricultural, industrial, forestry, rights-of-way, and residential areas by inhibition of the enzyme 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS). However, poor control of weeds such as ryegrass (*Lolium rigidum*), horseweed (*Conyza canadensis*), and hairy fleabane (*Conyza bonariensis)*, with glyphosate application programs have been observed in orchards, vineyards, and noncrop areas (Bo et al. 2021; Moretti, 2016, 2021; Moretti and Hanson, 2017; Shrestha et al. 2008).

Beyond that, in recent years, litigation regarding glyphosate and its implication as a human carcinogen (Berry, 2020) has led to uncertainty in the agrochemical industry. Many distributors have pulled glyphosate products from their product lines. In some cases, communities and facilities are also preventing maintenance personnel from using glyphosate.

Practitioners are seeking broad-spectrum herbicide alternatives to glyphosate and adequate tank mixture with other PRE-emergent herbicides to improve efficiency and long-lasting weed control, but substitutes have scarcely been evaluated due to glyphosate's history of being effective and affordable. Although this doesn't seem imminent, if glyphosate were no longer available, Rely® 280 (glufosinate-ammonium) appears to be the most efficient and economical option.

Due to year-round weed problems in pear orchards, POST-only programs are not very economically or environmentally viable; thus, PRE herbicides may help improve weed control and reduce the total number of control operations required. The main objective of this study is to evaluate the advantages and disadvantages of (PRE and POST) herbicide programs in the field with different modes of action to improve weed management in pear orchards. Also, adopting spray programs with PRE-and POST-emergent herbicides may increase the time window between the last herbicide application and the harvest season and reduce the risk of herbicide residue in the crop.

OBJECTIVES:

The objective of these studies was to examine different PRE- and POST-emergent herbicide programs and application rates in the field to improve weed management on the pear orchard floor. We compared PRE- and POST-emergent herbicide programs for a broad spectrum of weed control.

PROCEDURES:

In late spring of 2025, we established two herbicide field trials in Lake and Mendocino Counties to compare the effectiveness of glyphosate and glufosinate sprayed side by side and to evaluate the advantages and disadvantages of (PRE and POST) herbicide programs with different modes of action to improve weed management in pear orchards.

The treatments included an untreated control, as well as glyphosate, and glufosinate applied alone and in a tank mixture with indaziflam, rimsulfuron, or Pendimethalin at two different rates, totaling 15 treatments (Table 1).

The treatments were applied in a water carrier volume of 30 gallons per acre using a CO2 pressurized backpack sprayer equipped with 11003 VS flat-fan spray nozzles at 19-inch spacing (TeeJet, Spraying Systems Co, Glendale Heights, Illinois, USA). Grass and broadleaf weed control were assessed at 14, 28, 42, 56, 70, 84, and 104 days after treatment (DAT) using visual weed control estimations and digital images.

Statistical analysis

Data was tested for normality and homogeneity of variance and subjected to ANOVA in R version 4.4.2 (R Core Team 2024). Appropriate nontransformed means of weed control was separated by Fisher's Protected LSD at P = .05. Graphs were plotted with Sigma Plot 11.0 (Systat Software Inc.).

RESULTS AND DISCUSSION

In general, Glyphosate (Roundup PowerMAX®) or Glufosinate (Rely® 280) applied alone and in a tank mixture with indaziflam (Alion®), rimsulfuron (Matrix®), or pendimethalin (Prowl H2O®) at all different rates were safe for pear trees with no injury observed (data not shown).

The experimental plots in the Mendocino County trial were disturbed by wild pigs, rendering data collection impossible; therefore, only the Lake County data will be presented in this report. The main weeds present at the Lake County trial site were jungle rice (*Echinochloa colona*) and large crabgrass (*Digitaria sanguinalis*). However, no statistical difference was observed between the two species, so the data are presented as total weed control.

The results showed that Roundup PowerMAX® or Rely® 280 applied alone provided excellent total weed control equal to or greater than 90 % at 14 DAT (Table 2, Fig. 1). However, control begins to decrease after 28 days of treatment. Rely® 280 proved to be a broad-spectrum herbicide with equivalent jungle rice and large crabgrass control similar to Roundup PowerMAX® for all dates assessed in this study.

However, after 4 weeks, a new population begins to germinate from the soil weed seed bank, indicating the need for sequential application around 5 to 6 weeks after initial application for effective long-term (Table 2, Fig. 1). By harvest season, 75-85 days after treatment, weed control decreases to 0% with a single application.

Roundup PowerMAX® or Rely® 280 tank mixture with the PRE-emergent herbicides Alion®, Matrix®, or Prowl H2O® improved efficiency and long-lasting weed control when compared to Roundup PowerMAX® or Rely® 280 applied alone (Table 2, Fig. 1).

The results showed that for all PRE-emergent herbicides used in this study, PRE-emergent herbicide-by-rates interaction was nonsignificant ($P > 0.05$) for weed control; thus, data were pooled over (Fig. 1).

The PRE-emergent herbicides Alion® and Prowl H2O® provided better long-term control of grass weed than Matrix®(Fig. 1).

FINAL CONSIDERATIONS AND FUTURE RESEARCH

The results of two-year studies (2024 and 2025) suggest that the POST-emergent herbicides Roundup PowerMAX® and Rely® 280 present similar efficacy for controlling a broad spectrum of weeds in pear orchards. However, due to year-round weed germination, most weeds will recover within four to six weeks after the initial application from only POST-emergent herbicide application programs, requiring a sequential application to keep the orchard floors free of weeds during the growing season.

The results of this study strongly suggest that PRE- and POST-emergent herbicide programs may improve long-term weed control and reduce the total number of control operations required.

The literature review and the results of this study strongly suggest that developing more efficient herbicide application programs or alternatives to glyphosate by use of herbicides with different modes of action helps to reduce potentially resistant weeds. Also, adopting spray programs with PRE-and POST-emergent herbicides promotes longer-lasting weed control, reducing the number of herbicide applications, increasing the time window between the last herbicide application and the harvest season, and reducing the risk of herbicide residue in the crop.

These studies may contribute to growers and PCA developing a more complete integrated weed management program in conventional pear orchard systems and potentially resulting in savings of $ 65 per acre by not adopting pre-harvest strip spray. To reduce costs, growers may also consider using generic herbicides rather than their brand-name counterparts. In many cases, generic herbicides may have the same effectiveness as brand-name counterparts at a lower cost (consult your UCCE Farm Advisor or your PCA).

For 2026 growth seasons, these studies will be repeated in large-scale plots and compared with a commercial late-season herbicide spray to confirm the data collected in 2024 and 2025.

ACKNOWLEDGEMENTS

We would like to thank the California Pear Advisory Board for funding the studies. We thank grower cooperator Terry Rosetti (Mendocino County) and Andy Scully (Lake County). We thank Wilfredo Bello (Lake County Agricultural Technician) and Taylor Delbar (Mendocino County Agricultural Technician) for field trial assistance.

REFERENCES

Bo et al. (2021). Mechanisms of glyphosate-resistant horseweed (*Conyza canadensis*) collected from tangerine orchards in Korea. Horticulture, Environment, and Biotechnology, 62, 995-1002.

Berry, C. (2020). Glyphosate and cancer: the importance of the whole picture. Pest Management Science, 76(9), 2874-2877.

Moretti, M. L., Sosnoskie, L. M., Shrestha, A., Wright, S. D., Hembree, K. J., Jasieniuk, M., & Hanson, B. D. (2016). Distribution of *Conyza* sp. in orchards of California and response to glyphosate and paraquat. Weed Science, 64(2), 339-347.

Moretti, M. L., & Hanson, B. D. (2017). Reduced translocation is involved in resistance to glyphosate and paraquat in *Conyza bonariensis* and *Conyza canadensis* from California. Weed Research, 57(1), 25-34.

Moretti, M. L. (2021). POST control of Italian ryegrass in hazelnut orchards. Weed Technology, 35, 638-643.

Shrestha, A., Hanson, B., & Hembree, K. (2008). Glyphosate-resistant hairy fleabane documented in the Central Valley. California Agriculture, 62(3), 116-119.

Tables and Figures

Table 1. Trade names, active ingredients, and applications rates suggested for this study.

No.	*Treatment	Active ingredient	Rate (fl oz/ac)
1	Untreated	-	-
2	**Roundup PowerMAX®**	Glyphosate	64
3	**Rely® 280**	Glufosinate	56
4	**Roundup PowerMAX® + Alion®**	Glyphosate + Indaziflam	64 +3.5
5	**Roundup PowerMAX® + Alion®**	Glyphosate + Indaziflam	64 + 4.5
6	**Rely® 280 + Alion®**	Glufosinate + Indaziflam	56 + 3.5
7	**Rely® 280 + Alion®**	Glufosinate + Indaziflam	56 + 4.5
8	**Roundup PowerMAX® + Matrix®**	Glyphosate + Rimsulfuron	64 + 3.0
9	**Roundup PowerMAX® + Matrix®**	Glyphosate + Rimsulfuron	64 + 4.0
10	**Rely® 280 + Matrix®**	Glufosinate + Rimsulfuron	56 + 3.0
11	**Rely® 280 + Matrix®**	Glufosinate + Rimsulfuron	56 + 4.0
12	**Roundup PowerMAX® + Prowl H2O®**	Glyphosate + Pendimethalin	64 + 70.4
13	**Roundup PowerMAX® + Prowl H2O®**	Glyphosate + Pendimethalin	64 + 102.4
14	**Rely® 280 + Prowl H2O®**	Glufosinate + Pendimethalin	56 + 70.4
15	**Rely® 280 + Prowl H2O®**	Glufosinate + Pendimethalin	56 + 102.4

*Ammonium sulfate (AMS) at 1% and nonionic surfactant was added to all treatments.

Table 2. Total Weed Control (%) following Glyphosate (Roundup PowerMAX®) or Glufosinate (Rely® 280) application alone or admixture with indaziflam (Alion®), rimsulfuron (Matrix®), or pendimethalin (Prowl H2O®) at two different rates (Trials started on May 22, 2025).

TREATMENT	Rate (fl oz/ac)	Total Weed Control (%)													
		14 DAT		28 DAT		42 DAT		56 DAT		70 DAT		84 DAT		104 DAT	
Non-Treated Check		0	e	0	e	0	f	0	d	0	c	0	c	0	c
Roundup PowerMAX	**64**	91	d	76	c	52	e	14	c	0	c	0	c	0	c
Rely 280	**56**	90	d	68	d	49	e	15	c	0	c	0	c	0	c
Roundup PowerMAX + Alion	**64 + 3.5**	97	a	96	a	88	ab	82	a	79	a	74	a	66	a
Roundup PowerMAX + Alion	**64 + 4.5**	96	a	96	a	89	ab	83	a	79	a	75	a	68	a
Rely 280 + Alion	**56 +3.5**	98	a	96	a	88	ab	80	a	75	a	68	a	58	a
Rely 280 + Alion	**56 +4.5**	97	a	94	a	86	bc	80	a	77	a	71	a	61	a
Roundup PowerMAX + Matrix	**64 + 3**	93	bcd	86	b	80	d	58	b	51	b	41	b	31	b
Roundup PowerMAX + Matrix	**64 + 4**	92	bcd	87	b	80	d	62	b	53	b	44	b	36	b
Rely 280 + Matrix	**56 + 3**	93	bcd	87	b	78	d	58	b	50	b	40	b	27	b
Rely 280 + Matrix	**56 + 4**	92	cd	87	b	82	cd	63	b	56	b	46	b	34	b
Roundup PowerMAX + Prowl H2O	**64 + 70**	95	abc	95	a	88	ab	83	a	79	a	72	a	62	a
Roundup PowerMAX + Prowl H2O	**64 + 102**	98	a	97	a	92	a	88	a	83	a	80	a	70	a
Rely 280 + Prowl H2O	**56 + 70**	91	d	92	ab	86	abc	81	a	77	a	70	a	61	a
Rely 280 + Prowl H2O	**56 + 102**	96	ab	96	a	91	ab	87	a	83	a	79	a	72	a
LSD (P=.05)		**2.3**		**4.3**		**4**		**8.2**		**7.1**		**9.6**		**11.9**	

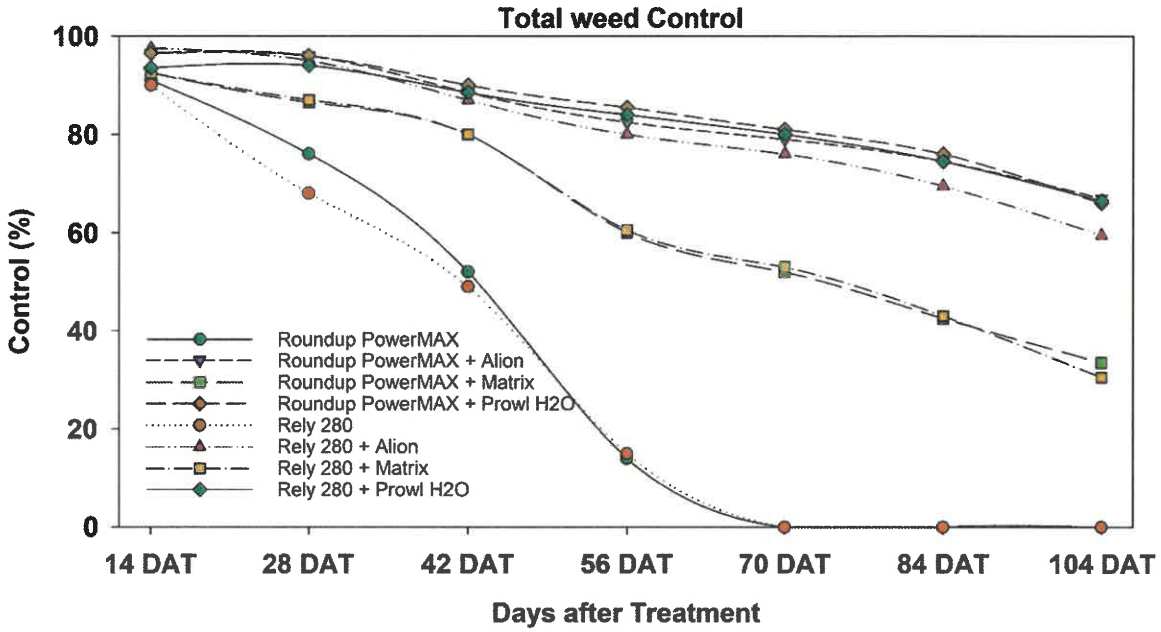

Figure 1. Total Weed Control (%) following glyphosate or glufosinate application alone or admixture with indaziflam (Alion®), rimsulfuron (Matrix®), or pendimethalin (Prowl H2O®), rates data were pooled over.