

HERBICIDE EFFICACY TO CONTROL PARTHENIUM (*PARTHENIUM HYSTEROPHORUS*) UNDER GROVE CONDITIONS IN HOMESTEAD, FLORIDA

JONATHAN H. CRANE^{1*}, ROBERT STUBBLEFIELD¹
AND CHARLES W. MEISTER²

¹Tropical Research and Education Center
18905 S.W. 280 St.
Homestead, FL 33031

²University of Florida, IFAS
Food Science and Human Nutrition Department
Gainesville, FL 32611

Additional index words. *Parthenium hysterophorus*, *Parthenium lobatum*, *Parthenium pinnatifidum*, *Tanacetum parthenium*, *Chrysanthemum parthenium*, *Matricaria parthenium*, *Matricaria parthenoides*, *Matricaria carpensis*, *Matricaria eximia*, *Matricaria odorata*, *Pyrethrum parthenium*, carrot weed, star weed, weed control

Abstract. *Parthenium hysterophorus* L. is in the Asteraceae and common names include parthenium, carrot weed, ragweed parthenium, and star weed. Indigenous to Mexico and Central and South America, parthenium is considered very invasive and is a major weed pest in India, Australia, Taiwan, Ethiopia, and parts of the U.S. In the U.S., parthenium is found in 23 states, and in Florida, parthenium is found in 22 of 67 counties. Parthenium invades agricultural areas, disturbed areas, range and grasslands, and urban areas, and has become resistant to control with glyphosate. Four herbicides alone and in specific combinations [Finale® (glyphosinate-ammonium), Roundup-Ultra Max® [glyphosate N-(phosphonomethyl) glycine], Finale®+Roundup-Ultra Max®, AIM® EC (carfentrazone-ethyl), and MM01 (proprietary)] were tested in two field trials for their efficacy in controlling parthenium under south Florida grove conditions. Treatments were laid out in a completely randomized design with three to five plots per treatment. Parthenium plants were counted within a 19-inch square grid prior and post herbicide application in each trial. Data were analyzed as repeated measures analysis. In the first trial, parthenium control was significantly greater for Finale® alone and Finale®+Roundup-Ultra Max® compared to water sprayed control, AIM® EC+crop oil, MM01+Silwet®, and Roundup-Ultra Max® alone. In the second trial, control of parthenium with Finale® alone at the rate of 3 or 4 quarts/acre and 2 rates of Finale®+Roundup-Ultra Max® were significantly better than the water sprayed control. Finale® alone effectively controlled parthenium under grove conditions in south Florida.

Parthenium (*Parthenium hysterophorus* L.) is in the Asteraceae (MacFadyen, 2004; Oudhia, 2001; Wunderlin and Hansen, 2002a). Common names include congress weed, carrot weed, ragweed parthenium, Santa Maria feverfew, whitetop weed, star weed, feverfew, white top, chatak chandani, bitter weed, ramphool, and gargas. Indigenous to Mexico and Central and South America, it is considered very invasive and

is a major weed pest in India, Australia, Taiwan, Ethiopia, and parts of the U.S. (MacFadyen, 2004; Oudhia, 2001). Parthenium is also present in Papua New Guinea, Madagascar, South Africa, and the Caribbean.

Parthenium invades agricultural areas, disturbed areas, range and grasslands, and urban areas (MacFadyen, 2004). This weed has a degradative impact on natural ecosystems by out competing native species in part due to allelopathy. Furthermore, some humans are allergic to parthenium weed (e.g., asthma, dermatitis, bronchitis, and hay fever) and consumption of parthenium by livestock may taint the meat (MacFadyen, 2004; Oudhia, 2001). Chemical analysis has shown that all the plants parts contain toxins called sesquiterpene lactones. The major components of the toxins include parthenin and other phenolic acids such as caffeic acid, vanillic acid, ansic acid, *p*-anisic acid, chlorogenic acid, and parahydroxy benzoic acid are poisonous to human beings and animals (Oudhia, 2001).

In the U.S., parthenium is found in 23 states (USDA-NRCS, 2004). In Florida, parthenium is found in 22 of 67 counties (Wunderlin and Hansen, 2002b) and has become resistant to control with glyphosate (J. H. Crane, personal communication). Invasion pathways in agriculture include contaminated seed, animals, road vehicles and machinery, wind and water currents (MacFayden, 2004).

Parthenium is an erect annual herb with vigorous growth and numerous small flowers (3/16 inch diameter; MacFadyen, 2004). Finely lobed leaves are light green and held on branching stems. Plants grow up to 5 ft, occasionally reaching 6.5 ft in deep rich soils. Young plants form a basal rosette of strongly dissected leaves that are up to 12 inches in length. Once stem elongation is initiated, smaller leaves are produced and the plant becomes much-branched in its extremities.

Reproduction is highly prolific with an average plant capable of producing 15,000 seeds (MacFayden, 2004). Temperature for seed germination ranges from 46 to 86°F (72-77°F is optimum). Buried seeds (~2 inches deep) are persistent and 70% or more of the seeds may remain viable in the soil for up to 2 years; surface seeds remain viable for up to 6 months.

The purpose of this study was to evaluate several herbicides for the control of parthenium plants and to determine the optimum rate of Finale® for parthenium control.

Materials and Methods

Experiment 1. Eighteen, parthenium infested 4 ft × 10 ft plots in a 0.67 acre sugar apple grove (*Annona squamosa* L.) at the Tropical Research and Education Center, Homestead, were used to compare the efficacy of 6 herbicide treatments. Weed species present in addition to parthenium included three-lobe false mallow (Malvaceae; *Malvastrum coromandelianum* (L.) Garcke), black medick (Fabaceae; *Medicago lupulina* L.) and Virginia pepperweed (Brassicaceae; *Lepidium virginicum* L.). In general, parthenium weeds were greater than 6 inches tall. Treatments were laid out in a completely randomized design and included: water sprayed control,

This research was supported by Dr. C. W. Meister, Prof., and S. E. Regional Coordinator, IR-4 Program and the Food Sci. and Human Nutrition Dept., Gainesville, FL and the Florida Agricultural Experiment Station. The authors thank Ms. M. Brennan, IFAS Statistics Dept., Gainesville, FL and Dr. W. Montas, UF-IFAS-TREC, for assistance with the statistical analysis.

*Corresponding author; e-mail: jhcr@ufl.edu

Table 1. Herbicide rates used to compare the efficacy of five herbicides on parthenium.

Treatment	Per acre rate
Water	None (40 gallons)
Finale® plus the adjuvant Liberate™	192 oz Finale® plus 6 oz Liberate™/40 gallons water
Aim EC plus SunSpray Ultra-fine Crop Oil	2 oz AIM® EC plus 32 oz SunSpray Ultra-fine Spray Oil/30 gallons water
MM01 plus the adjuvant Silwet L-77®	15 gallons MM01 plus 39 oz Silwet/45 gallons water
Roundup UltraMax®	77 oz Roundup UltraMax®/30 gallons water
Finale® plus Roundup Ultra Max®	32 oz Finale® plus 32 oz Roundup Ultra Max®/30 gallons water

Finale® (glufosinate-ammonium; Bayer Environmental Science, Research Triangle Park, N.C.) plus the adjuvant Liberate™ (lecithin, methyl esters of fatty acids, and alcohol ethoxylate; Loveland Products, Inc., Greeley, Colo.), Aim EC (carfentrazone-ethyl; FMC Corporation, Philadelphia, Pa.) plus SunSpray Ultra-fine Spray Oil (Sun Company, Philadelphia, Pa.), MM01 (preparatory compound) plus Silwet L-77® (organosilicone surfactant; Setre Chemical Co., Memphis, Tenn.), Roundup Ultra Max® (glyphosate; Monsanto, St. Louis, Mo.), and Finale® plus Roundup Ultra Max® (Table 1). Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the University of Florida. There were three plots per treatment. Plots were sprayed with individual containers with 2000 mL of mixed herbicide material attached to a CO₂-sprayer at 35 psi that had 2 flat-fan nozzles 20 inches apart.

Parthenium plant density was determined by using a 19 inch × 19 inch square (361 inch²) which was used to randomly select a section of each treated 4 ft × 10 ft plot for counting the number of living parthenium plants prior to the treatment application on 13 Jan. 2005. Treatment plots were sprayed on 21 Jan. 2005 and the number of live parthenium plants was counted again in the same manner on 18 (8 Feb. 2005) and 28 (18 Feb. 2005) d after spray application. Data were analyzed using SAS (proc mixed) and repeated measures analysis. Treatments were compared using a t-test adjusted for multiple comparisons.

Experiment 2. In a different section of the same sugar apple grove, 24, 4 ft × 10 ft plots infested with parthenium were used to compare the efficacy of 5 herbicide treatments. The same weed species present in the previous plots were also present in these new plots. In general, parthenium plants were 1/2 inch up to 12 inches tall. Treatments were laid out in a completely randomized design and included: water sprayed control, Finale® plus the adjuvant Liberate™ at two concentrations, and Finale® plus Roundup Ultra Max® at 2 concentrations (Table 2). There were five plots per treatment. Plots were sprayed with individual containers with 2000 mL of mixed herbicide material attached to a CO₂-sprayer at 35 psi that had 2 flat-fan nozzles 20 inches apart.

Table 2. Herbicide rates of Finale® and Finale® plus Roundup Ultra Max® used to control parthenium.

Treatment	Per acre rate
Water	None (40 gallons)
Low rate—Finale® plus the adjuvant Liberate™	96 oz Finale® plus 6 oz Liberate™/40 gallons water
High rate—Finale® plus the adjuvant Liberate™	128 oz Finale® plus 6 oz Liberate™/40 gallons water
Low rate—Finale® plus Roundup Ultra Max®	96 oz Finale® plus 51 oz Roundup Ultra Max®/40 gallons water
High rate—Finale® plus Roundup Ultra Max®	128 oz Finale® plus 102 oz Roundup Ultra Max®/40 gallons water

Parthenium plant density was determined as in the previous experiment: first prior to the treatment application on 10 May 2005 and post applications. Treatment plots were sprayed on 10 May 2005 and the number of live parthenium plants was counted again 7 (17 May 2005), 14 (24 May 2005), and 21 (31 May 2005) d after spray application. Data were analyzed using SAS (proc mixed) and repeated measures analysis. Treatments were compared using a t-test adjusted for multiple comparisons.

Results and Discussion

Experiment 1. There was a significant difference among treatments and dates but, no significant treatment × measurement date interaction (data not shown). Prior to herbicide applications, there were significantly fewer parthenium plants in the Finale®, Aim EC, and MM01 plots compared to the water control plots (Table 3). However, 18 (8 Feb. 2005) and 28 days (18 Feb. 2005) after herbicide application, Finale® alone and Finale® plus Roundup Ultra Max® had significantly fewer live parthenium plants than other treatments. Observations of the plots post herbicide application indicated that Finale® alone completely killed the mature parthenium, black medick, and Virginia pepperweed but did not kill the three-lobed false mallow; however, Finale® plus Roundup Ultra Max® killed all four weed species present. The lack of parthenium control with AIM and MM01 may be due to the size (maturity) of the parthenium during application.

Experiment 2. There was a significant difference among treatments, measurement dates, and a significant treatment × measurement date interaction (data not shown). There was no significant difference in the number of live parthenium plants prior to herbicide spray applications (Table 4). Seven, 14, and 21 d after herbicide application all herbicide treatments had significantly fewer live parthenium plants compared to water-sprayed control plots. Fourteen and 21 d after herbicide applications, plots with Finale® alone at low and high rate had significantly fewer live parthenium plants than the low and high rates of Finale® plus Roundup Ultra Max®. Finale® alone and Finale® plus Roundup Ultra Max® at the low rates only damaged some of the most mature parthenium weeds.

Table 3. Effect of Finale® plus Liberate, Aim plus SunSpray Ultra-fine Crop Oil, MM01 plus Silwet®, Roundup Ultra Max® and Finale® plus Roundup Ultra Max® on the number of live parthenium plants prior and 18 and 28 days after application.

Date	Treatment	Mean number of live plants ±SD	Significant differences ^z
13 January 2005 ^y	Water	10.0 ± 6.1	-
	Finale®	5.0 ± 5.2	+
	Finale® plus Roundup Ultra Max®	9.7 ± 7.6	ns
	Aim® EC	5.3 ± 0.6	+
	MM01	4.3 ± 1.5	+
	Roundup Ultra Max®	7.7 ± 5.0	ns
8 February 2005	Water	5.0 ± 2.0	-
	Finale®	0	+
	Finale® plus Roundup Ultra Max®	0	+
	Aim® EC	3.7 ± 3.2	ns
	MM01	4.3 ± 2.3	ns
	Roundup Ultra Max®	9.0 ± 5.6	ns
18 February 2005	Water	5.7 ± 1.5	-
	Finale®	0	+
	Finale® plus Roundup Ultra Max®	0	+
	Aim® EC	6.0 ± 3.6	ns
	MM01	7.3 ± 5.1	ns
	Roundup Ultra Max®	9.7 ± 3.8	ns

^zt-test comparison among water control and treatments; significance at the P ≤ 0.1 or greater; -, control, +, significant difference, ns, non-significant difference.

^yParthenium plant count prior to application on 21 January 2005.

This may be due to the low Finale® rate which was one-half and two-thirds of the rate recommended for control of mature parthenium. By the 14th day after herbicide applications many new parthenium plants had sprouted indicating a large seed source present throughout all plots. As observed in the first experiment, Finale® plus Roundup Ultra Max® controlled all four weed species present compared to Finale® alone.

Summary

Finale® at the three rates tested controlled parthenium, with the best control at the highest rate tested (192 oz per 40 gallons of water/acre) (Tables 3 and 4). AIM, MM01, and Roundup Ultra Max® alone did not control mature parthenium at the rates tested. The combination of Finale® plus

Table 4. Effect of Finale® plus Liberate™ alone and Finale® plus Roundup Ultra Max® at two rates on the number of live parthenium plants prior and 7, 14, and 21 days after application.

Date	Treatment	Mean number of live plants ±SD	Significant differences ^z
10 May 2005 ^y	Water control	72.0 ± 28.7	-
	Low rate—Finale® plus Liberate™	86.6 ± 35.8	ns
	High rate—Finale® plus Liberate™	82.4 ± 21.0	ns
	Low rate—Finale® plus Roundup Ultra Max®	95.0 ± 24.7	ns
	High rate—Finale® plus Roundup Ultra Max®	75.2 ± 3.4	ns
	17 May 2005	Water control	66.8 ± 34.6
Low rate—Finale® plus Liberate™		9.8 ± 7.9	+
High rate—Finale® plus Liberate™		4.2 ± 5.8	+
Low rate—Finale® plus Roundup Ultra Max®		6.4 ± 6.0	+
High rate—Finale® plus Roundup Ultra Max®		2.8 ± 3.9	+
24 May 2005		Water control	105.0 ± 57.8
	Low rate—Finale® plus Liberate™	4.2 ± 5.2	+
	High rate—Finale® plus Liberate™	7.6 ± 12.9	+
	Low rate—Finale® plus Roundup Ultra Max®	23.6 ± 32.0	+
	High rate—Finale® plus Roundup Ultra Max®	13.8 ± 22.1	+
	31 May 2005	Water control	73.0 ± 40.0
Low rate—Finale® plus Liberate™		7.0 ± 9.5	+
High rate—Finale® plus Liberate™		6.4 ± 7.4	+
Low rate—Finale® plus Roundup Ultra Max®		20.2 ± 26.7	+
High rate—Finale® plus Roundup Ultra Max®		9.4 ± 13.8	+

^zt-test comparison among water control and treatments; significance at the P ≤ 0.05 or greater; -, control; +, significant difference; ns, non-significant difference.

^yParthenium plant count prior to application on 10 May 2005.

Roundup Ultra Max® controlled parthenium and three other weed species present. Registration of Finale® for use in tropical fruit groves in Florida would be useful as a part of the weed control program.

Literature Cited

- MacFadyen, R. 2004. *Parthenium hysterophorus* (herb) [web page from Global Invasive Species Database]; <http://www.issg.org/database/species/ecology.asp?si=153&fr=1&sts=> [Accessed 23 Dec. 2004].
- Oudhia, P. 2001. *Parthenium hysterophorus* L. [web page from NewCROP™ the New Crop Resource Online Program]; <http://www.hort.purdue.edu/newcrop/CropFactSheets/parthenium.html> [Accessed 23 Dec. 2004].
- USDA-NRCS. 2004. Plants Profile, *Parthenium hysterophorus* L. [web page from the USDA-NRCS Plants Profile]; http://plants.usda.gov/cgi_bin/plant_profile.cgi?symbol=PAHY&photoID=pahy_001_avd.tif [Accessed 23 Dec. 2004].
- Wunderlin, R. and B. Hansen. 2002a. *Parthenium hysterophorus* [web page from Institute for Systemic Botany, Atlas of Florida Vascular Plants]; <http://www.plantatlas.usf.edu/default.asp> [Accessed 23 Dec. 2004].
- Wunderlin, R. and B. Hansen. 2002b. Distribution map [web page from Institute for Systemic Botany, Atlas of Florida Vascular Plants]; <http://131.247.163.11/website/plantatlas/maps.asp?plantID=207> [Accessed 23 Dec. 2004].