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Identification, Impacts, and Control of Ragweed Parthenium (*Parthenium hysterophorus* L.)[1]

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Ragweed parthenium (a.k.a. parthenium weed, Santa Maria feverfew, congress grass, carrot weed, white top, etc.), a member of the Asteraceae (Compositae) family, is native to Mexico and Central and South America and is becoming an increasingly troublesome weed around the world (Figure 1). Considered one of the world's most invasive weeds, it is an increasing problem in Africa (McConnachie et al. 2011). It is possibly the worst weed in both rural and urban areas of India (Kohli et al. 2006) and is also a weed of national significance in Australia (Evans 1997; National Weeds Strategy Executive Committee 2001). This foreign weed is increasingly becoming a problem in Florida.

Figure 1. Estimated distribution of parthenium weed in 1994 (*Source*: Adkins and Navie 2006)

Identification

Ragweed parthenium is an ephemeral, herbaceous, annual weed that spreads by seed. Plants first form a basal rosette, up to a foot in diameter, of finely lobed (pinnatifid to bipinnatifid) leaves (Figure 2). Plants then form a paniculately branched pubescent stem with lengthwise grooves (Figure 3) growing to heights of 5–6½ feet (Figure 4). The leaves on the stem are alternate, and the upper leaves are entire to slightly lobed. All leaves are light green and pubescent on both sides. Flowers, which are borne on the stem tips, are small (1/8–1/5 inch wide) and whitish with tiny ray florets at each of the five distinct corners (Figure 5). A small seed is produced in each of the five corners (Figure 6).

Movement: Ragweed parthenium spreads by movement of seed, with each plant producing an average of 2,400–30,000 seeds (Haseler 1976; Rodriguez and Cepero 1984; Williams and Groves 1980). Dispersal is thought to be mainly mechanical on animals and equipment, in fodder and grain, with nursery plants, with flowing water, and, to a limited extent, via wind (Sankaran 2008).

Adaptablility: Ragweed parthenium is a drought-tolerant plant and can grow in almost all soil types (Mahadevappa 1997). This weed can grow over a wide range of moisture and temperature conditions but requires high soil moisture for seed germination (Singh et al. 2004). Ragweed parthenium is reportedly photoperiod and thermoperiod insensitive and can flower year-round (Mahadevappa

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1997). Seed germination can take place over a wide range of temperatures (Tamado, Schutz, and Milberg 2002) and soil pHs (Ahlawat, Dagar, and Singh 1979). Further, ragweed parthenium is very competitive and has been reported to gain an advantage over a C_4 pasture grass (*Cenchrus ciliaris*) as atmospheric CO_2 concentrations increase, despite being a C_3 plant (Navie et al. 2005). This is fairly typical of the response of C_3 and C_4 plants when grown in enriched CO_2 atmospheres.

Figure 2. Lobed leaves of a basal rosette
Credits: R. Stamps

Figure 3. The stem of ragweed parthenium has distinct lengthwise grooves.
Credits: R. Stamps

Figure 4. Mature ragweed parthenium can form dense stands and reach heights of over 6 feet.
Credits: R. Stamps

Figure 5. Ragweed parthenium flowers are pentagonal with very small ray florets at each corner.
Credits: R. Stamps

Regulatory status: Ragweed parthenium is listed as a noxious weed by the governments of Australia, Kenya, and Puerto Rico.

Dates of introduction: Australia (1950s in contaminated grass seed) (Department of Natural Resources, Mines and Energy 2003), Ethiopia (1988 in imported wheat grain), South Africa (1880), United States (native to Texas, Minnesota-1951?, Louisiana-1957?, Florida-1980?). In India, parthenium weed was first described in 1810 but did not become a serious problem until after it was introduced in 1955 in contaminated cereal grain (Rao 1956). That

observation and the existence of two introduced biotypes in Australia with differing invasiveness (Navie et al. 1996) indicate that different strains of parthenium weed pose different threat levels.

Figure 6. Ragweed parthenium achene: Each ray floret produces an "achene complex" containing a single, small seed that may remain viable for years.
Credits: R. Stamps

Current distribution outside of native range: Australia (Queensland, New South Wales, and the Northern Territory), Bangladesh, Ethiopia, India, Kenya, Madagascar, Nepal, New Caledonia, Pakistan, Papua New Guinea, Puerto Rico, South Africa, Sri Lanka, Swaziland, Taiwan, Vietnam, and the United States, among other areas (IUCN SSC Invasive Species Specialist Group 2010; Sankaran 2008)

Current distribution in the United States and Florida: Ragweed parthenium has been found in 23 U. S. states, Puerto Rico, the Virgin Islands, the District of Columbia (USDA/NRCS 2011), and in 23 of 67 counties in Florida (Wunderlin and Hansen 2011).

Impacts: Environmental and Business

Environmental

- Natural areas
  - Serious threat to native fauna and flora and can cause severe reductions in biodiversity (Javaid, Shafique, and Shafique 2007; Nigatu et al. 2010)
    - Allelopathic (parthenin and other chemicals inhibit the growth, survival, and reproduction of other plants) (Adkins and Sowerby 1996; Belz et al. 2007; Joshi et al. 2009; Kohli et al. 2006; Oudhia 1999; Oudhia 2000; Rahman 2006; Singh et al. 2005; Valliappan and Towers 1988)
    - Forms dense monocultural stands
- Human health
  - Can cause asthma, bronchitis, contact dermatitis, eye irritation, rhinitis (Gupta et al. 1996), and sinusitis (hayfever) (Agarwal and D'Souza 2009; Towers and Mitchell 1983; Towers and Subba Rao 1992; Wiesner et al. 2008).
    - All the plant parts, including trichomes and pollen, contain toxins called sesquiterpene lactones (Reinhardt et al. 2004; Sharma and Sethuraman 2007).

Business

- Rangelands
  - Poisonous to mammals (Narasimhan et al. 1984)
  - When not lethal, consumption by livestock (sheep) can taint meat (Tudor et al. 1982)
  - Reduces fodder (animal feed)
    - In 1994 in Queensland, Australia, the presence of ragweed parthenium added an estimated cost of US$16.7 million (reduced stock numbers and weight gains, added production and control costs) (Chippendale and Panetta 1994). An earlier preliminary assessment suggested an inverse relationship existed between ragweed parthenium and pasture grass populations (Dale, Jacobsen, and Tucker 1978).
- Grain and other crops
  - Potential seed contaminant (Lazarides and Hince 1993)
    - The presence of ragweed parthenium in cropped lands can almost double cultivation costs and restrict the sale and movement of contaminated produce (Chippendale and Panetta 1994).
  - Crop yield reductions
    - Yield of grain sorghum was reduced by 69% when the parthenium density was only three plants per square meter; reductions as high as 97% occurred at higher weed densities (Tamado, Ohlander, and Milberg 2002).
    - Although germination and growth of legumes were reduced more than that of cereals, growth of barley, oats, and rice was reduced considerably in pot trials (Muniyappa and Krishnamurthy 1981).
    - Pollen allelopathy – Ragweed parthenium pollen can inhibit fruit set (beans, eggplant, peppers, tomatoes, and other plants) (Sukhada and Jayachandra 1980) and grain filling (corn). Stands of ragweed parthenium are capable of producing an average of 316 million pollen grains per square foot (Sukhada and Jayachandra 1980).

- Ornamental crops
  - Currently a weed problem in South and Central Florida ornamental nurseries
    - Increased weed management costs
    - Potential crop rejection problems
  - Landscape problems likely
- Miscellaneous crops
  - Host for insects (cotton mealybug) (Dhawan, Sarika, and Kamaldeep 2010) and disease-causing organisms (tomato leaf curl virus [Reddy et al. 2010], tobacco streak virus [Sharman, Persley, and Thomas 2009], aster yellows phytoplasmas [Lee et al. 2003])
- Industrial areas, rights-of-way, etc.
  - Ragweed parthenium could be a health, fire, safety, or other hazard.

Threat

May become more prevalent throughout the United States as it has in many other countries long after initial introduction. For example, although it was first reported in India in 1880, it was not recognized as a threat until the 1950s. In 2005, it was estimated that it infested over five million acres of the Indian subcontinent: "*Parthenium hysterophorus* is perhaps the most troublesome and noxious weed of urban and rural India" (Kohli et al. 2006, p. 1501). Parthenium weed is capable of adapting to a variety of habitats (Annapurna and Singh 2003). It is an invader of cultivated and disturbed areas, as well as natural areas. Individual plants can produce tens of thousands of seeds (Haseler 1976), and some of those seeds can remain viable for years (Butler 1984; Navie et al. 1998a; Tamado, Schutz, and Milberg 2002), making eradication of established infestations a difficult and long-term challenge. The seeds can germinate year-round in subtropical and tropical areas, such as those that exist in Florida.

Best Management Practices

Best weed management practices involve the use of an integrated range of methods—cultural, physical, chemical, and biological.

Cultural

- Cultural control practices can often be the most cost-effective methods.
  - Prevent weed seed introduction
    - Clean animal feed, growing medium, seeds, and plants.
    - Clean equipment, livestock, people, and vehicles; do not physically spread the seeds on cultivators, mowers, shoes, tires, etc.
  - Competitive crops/vegetation
    - Optimize growth of crops to maximize competitiveness.
    - Avoid overgrazing (Vogler et al. 2002)
      - Ragweed parthenium is seldom a problem in healthy pastures that are in good condition (Chamberlain and Willcocks 1996). Its abundance increases in overgrazed fields and paddocks (Fensham, Holman, and Cox 1999).
    - Displacement with beneficial plants
      - For example, a greenhouse study indicated that there are plants—in this case, several grasses and one legume—that can successfully compete with ragweed parthenium (O'Donnell and Adkins 2005).
    - Smother crops
      - Parthenium weed can be suppressed using crops such as cowpeas (Tadesse, Das, and Yaduraju 2010; Tamado and Milberg 2004).
  - Scout and catch infestations early.

Physical

- These methods must be used carefully to avoid spreading seed.
  - Cultivation
    - Hand weeding/hoeing
      - Although labor intensive, hand weeding and hoeing can be beneficial, especially if done before the weeds produce seed (Goodall et al. 2010; Tadesse, Das, and Yaduraju 2010; Tamado and Milberg 2004).
    - Plowing and rototilling
      - Parthenium seedling emergence was prevented when seeds were buried 2 inches or deeper in two types of soil (Tamado, Schutz, and Milberg 2002); however, burying seed shallowly has been shown to increase duration of seed survival (Navie et al. 1998a).
      - Care should be taken to prevent spread of ragweed parthenium due to seed being moved around on the cultivation equipment.
  - Fire
    - Fire can kill ragweed parthenium weed seed near the soil surface, but buried seeds may survive (Vogler et al. 2002).

- Fire can temporarily increase ragweed parthenium densities, but repeated burnings can reduce ragweed parthenium populations, especially if post-fire management maintains competitiveness of desirable pasture plants (Vogler et al. 2002).
- However, smoke has been shown to stimulate parthenium weed seed germination and, in some cases, seedling emergence (Adkins et al. 2000; Adkins et al. 2003).

- Mowing
  - Cutting plants off at ground level can help temporarily, but plants will regrow (Muniyappa, Prasad, and Krishnamurthy 1980).
- Mulching (see also "Cultural – smother crops")
  - Rice straw mulch was effective during rose production in controlling an array of weeds that included parthenium weed (Singh 2005). This suggests that mulching, common in landscaping, may help control ragweed parthenium.
  - The use of inorganic mulches, like woven polypropylene groundcovers, can be effective in controlling weeds in nurseries, especially if they are kept free of organic debris.

Chemical

- Weed control using herbicides can be more economical than using physical control methods (Muniyappa, Prasad, and Krishnamurthy 1980). Always ***READ THE LABEL***; it's the law. Individual herbicides can only be used at certain locations, on certain plants, and at certain application rates, and there may be limitations on how much can be applied to an area on a yearly basis. Additional restrictions may also apply.
  - Preemergence herbicides – These herbicides must be applied repeatedly in areas where the seed bank contains parthenium seeds since they may remain viable for 2–6 years (Butler 1984; Navie et al. 1998a; Tamado, Schutz, and Milberg 2002). The herbicide barriers need to be in place during all times of the year when the seeds are likely to germinate.
    - Provide good control: alachlor (Muniyappa and Krishnamurthy 1976), atrazine (Adkins et al. 1997; Muniyappa, Prasad, and Krishnamurthy 1980; Tadesse, Das, and Yaduraju 2010), chlorimuron (Reddy, Bryson, and Burke 2007), flumioxazin (Grichar 2006), fluometuron, imazaquin, norflurazon, quinclorac (Reddy, Bryson, and Burke 2007), flumioxazin, indaziflam, isoxaben, oxyfluorfen + oryzalin, oxyfluorfen + oxadiazon, oxyfluorfen + pendimethalin, oxyfluorfen + prodiamine, trifluralin + isoxaben (Stamps, unpublished data), simazine (Muniyappa and Krishnamurthy 1976)
    - Do not provide good control: dithiopyr, oryzalin, oxadiazon + pendimethalin, prodiamine, trifluralin (Muniyappa and Krishnamurthy 1976), pendimethalin (Reddy, Bryson, and Burke 2007)
  - Postemergence herbicides – Some of these herbicides are not selective, and the ones that are selective can still damage many crop plants, so care in selection and application is very important. Some of these herbicides should only be used in noncrop areas. Additionally, some of these products are listed as both effective and ineffective, depending on the parthenium weed biotype being treated.
    - Effective: 2,4-D amine salt (Muniyappa, Prasad, and Krishnamurthy 1980; Muniyappa and Krishnamurthy 1976; Reddy, Bryson, and Burke 2007) (may require repeat applications), 2,4-D plus atrazine, acifluorfen (Muniyappa, Prasad, and Krishnamurthy1980), atrazine, bentazon (Muniyappa and Krishnamurthy 1976), dicamba, diquat (Muniyappa, Prasad, and Krishnamurthy 1980), glufosinate (Crane, Stubblefield, and Meister 2006; Reddy, Bryson, and Burke 2007), glyphosate (Muniyappa, Prasad, and Krishnamurthy 1980; Reddy, Bryson, and Burke 2007; Singh et al. 2004), halosulfuron (Reddy, Bryson, and Burke 2007), metribuzin (Sharma 2003), metsulfuron methyl, picloram (Goodall et al. 2010), saflufenacil (BASF Corp. 2010), sulfosulfuron (Tiwari et al. 2009), trifloxysulfuron (Reddy, Bryson, and Burke 2007)
    - Ineffective: 2,4-D amine (Goodall et al. 2010), chlorimuron-ethyl (Sharma 2003), glyphosate (Rosario et al. 2009), paraquat (Reddy, Bryson, and Burke 2007; Yadav et al. 2006)
    - Younger, nonflowering plants are more susceptible to postemergence herbicides.

Biological

- In the long run, biological control may prove to be the most cost-effective method for dealing with ragweed parthenium. It is likely that a combination of biocontrol agents—not necessarily the same ones at any given location—will be needed to suppress this weed (Dhileepan 2007).
  - Insects – Several insects are being studied for their ability to help control parthenium weed: *Epiblema strenuana* (stem-galling moth) (Dhileepan 2001; Dhileepan 2007; McFadyen 1992; Navie et al. 1998b), *Bucculatrix parthenica* (leaf-mining moth),

Smicronyx lutulentus (seed-feeding weevil), *Listronotus setosipennis* (stem-boring weevil) (Dhileepan 2003), *Zyogramma bicolorata* Pallister (leaf-feeding beetle) (Dhileepan 2001; Dhiman and Bhargava 2010; Pandey, Joshi, and Tiwari 2001)
    - Additional possibilities - *Platphalonidia mystica* (stem-boring moth) and *Conotrachelus* spp. (stem-galling weevils)
- Fungi – A number of mycoherbicides is being evaluated for parthenium weed control: *Alternaria alternata* (Saxena and Kumar 2010), *Puccinia abrupta* var. *partheniicola* (parthenium rust) (Dhileepan 2007; Wood and Scholler 2002), *P. xanthii* (cocklebur rust), and other rusts.
- Plants – (see also "Cultural – smother crops") Vigorously growing, healthy crops and/or native vegetation can reduce parthenium weed establishment and growth. Research has shown that grasses and legumes (Joshi 1991; O'Donnell and Adkins 2005) can suppress parthenium weed through competitive displacement/interference.

Parthenium weed is a difficult weed to manage, and a wide variety of methods, starting with exclusion/sanitation, is necessary to reduce the incidence and spread of this weed. An integrated approach using cultural, physical, chemical, and biological techniques is necessary to be successful.

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