RANGELANDS

RESPONSE OF AFRICAN RUE AND ASSOCIATED VEGETATION TO HERBICIDES

AUTHORS: Laurie Abbott, Kevin Branum, Nina Klypina, and Tracy Sterling

THE STORY IN BRIEF: African rue (*Peganum harmala*) is an invasive herbaceous perennial weed that was originally introduced to North America at Deming, New Mexico in 1928. African rue has been recorded in 8 western states, and its largest center of distribution is in southern New Mexico and west Texas. African rue typically occurs in areas where the soil has been disturbed or transported, such as roadsides, pipelines and railroads, adjacent to livestock travel routes and watering facilities, and abandoned cultivated fields. African rue reproduces both by seed and vegetatively by sprouting from shallow lateral roots or a woody crown. Mature plants have numerous fleshy stems, can reach 50 cm in height, and are globose to slightly flattened in shape. African rue produces new, bright green shoots in spring (March-April), showy white flowers in late spring (April-May), and its capsules mature in early summer (June-July). Plants typically senesce in mid-summer, but can produce a second cohort of shoots, flowers and fruits in response to midsummer rains (Abbott et al. 2007). African rue is extremely drought tolerant (Abbott et al. 2008); it often grows vigorously during drought years when other vegetation remains dormant. The leaves, stems, fruits, and seeds contain several alkaloids, and the plant is toxic to cattle, sheep, and probably horses. However, it is extremely unpalatable, and livestock avoid it if alternative forage is available (Sperry et al. 1964). African rue tends to dominate on sites where it has invaded; possibly because it may compete with native vegetation for resources, or it may be allelopathic, changing the chemical environment of the soil to disfavor native vegetation.

THE PROBLEM: African rue is classified as a Class B weed in New Mexico, and the recommended strategy for management is to control existing populations and prevent spread to new areas (Lee 1999). Control is warranted because established populations are persistent and tend to dominate on invaded sites, and the plant is toxic to cattle and sheep. African rue is difficult to control. Mechanical control is ineffective, and biological control is not available. Herbicide provides the most effective control, but often requires repeated application. The efficacy of herbicides can be influenced by plant water stress (Abbott and Sterling 2006) and by season of application (Branum 2006). In addition, herbicides used to treat African rue can have negative effects on other species in the existing plant community (McDaniel and Duncan 2006). Effective management with herbicides requires additional information concerning the choice of herbicide, timing of application, and the response of existing vegetation to herbicide treatment.

OBJECTIVES:

We examined the effects of 3 herbicides on African rue: we tested the effects of application season (spring, summer, and fall) and the influence of plant moisture stress on African rue control. We also documented the response of the existing vegetation to these herbicide treatments. This research was conducted on two separate populations: one population in Dona Ana County near the Lazy E Ranch, northeast of Deming (Lazy E), and a second population in Otero County on White Sands Missile Range (WSMR).

DURATION: April 2004 to present.

APPROACH: This experiment was arranged as a randomized complete block design, with a total of 15 replications per herbicide/water/application date treatment combination. Each experimental plot included a mature (target) African rue plant centered in a 1m X 1m plot. We applied two kinds of water treatments: plants received rainfall only or rainfall plus supplemental water. Supplemental water was applied using Dri-Water®, a polymer that slowly released water into soil for 90 days. We applied three kinds of herbicide treatments approximately 30 days after water treatments: hexazinone (Velpar), imazapyr (Arsenal), and metsulfuron (Escort) with a backpack sprayer at 0.02 kg ai ha^{-1}, 0.13 kg ae ha^{-1}, and 0.09 kg ai ha^{-1}, respectively. Herbicides were applied on 3 application dates in 2004: May, June, and October. For all water/application date treatments, we also had 15 control plants that did not receive herbicide.

Herbicide efficacy was evaluated in Fall 2004, Fall 2006, Spring 2007, and Fall 2007. Response variables included: 1) necrosis of the target plant (percent of necrotic stems); 2) number of African rue seedlings and mature (non-target) plants in the 1m X 1m plot surrounding the target plant; 3) size of the target plant, rated into 6 classes based on plant height, diameter, and number of green stems. To evaluate the effect of treatments on associated vegetation, we counted the number of grass and forb plants in the 1m X 1m plots in Fall 2006, Spring 2007, and Fall 2007.

RESULTS:

Herbicide Effects on Mature Plants

Target plants at both sites treated with hexazinone and imazapyr were at least 30 to 40% more necrotic than non-sprayed control plants through Fall 2007 (Figure 1). In addition to greater necrosis, the size of target plants was reduced by these two herbicides at both sites. Metsulfuron initially caused increased necrosis at both sites, but the effect was short-lived, and plants sprayed with metsulfuron were not different than un-sprayed plants at either site by Spring 2007. Size of the target plants sprayed with metsulfuron was reduced only at Lazy E. We observed initial effects of application date (data not shown). Hexazinone was more effective at both sites when applied in June, although by Fall 2007 the importance of application date was only observed at Lazy E. Imazapyr was consistently more effective when sprayed in October at Lazy E and in October and June at WSMR. Metsulfuron was most successful when sprayed in October at Lazy E, but this effect was not observed at WSMR. Hexazinone and imazapyr reduced the density of

mature non-target plants within the 1m^2 plot at WSMR only; effects of metsulfuron on non-target plants was negligible (data not shown).

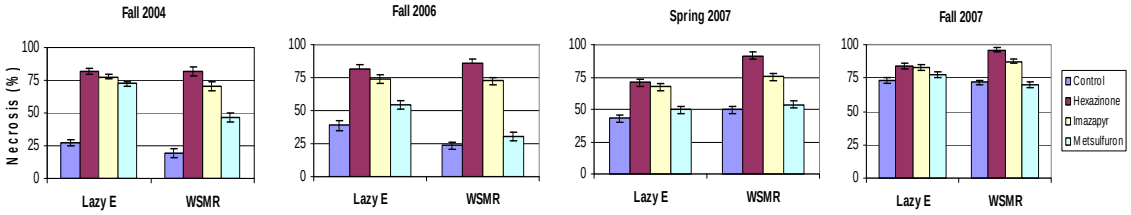

Figure 1. Effect of three herbicides on African rue necrosis (%). Target African rue plants were treated with herbicides in 2004. Control plants were not sprayed with herbicide. Necrosis (percent of necrotic stems) was evaluated in Fall 2004, Fall 2006, Spring 2007, and Fall 2007.

Herbicide Effects on African Rue Seedlings

Hexazinone reduced the number of African rue seedlings compared to all other treatments at WSMR (Figure 2). Imazapyr and metsulfuron reduced the number of African rue seedlings at WSMR in Fall 2004 only, after which point the number of seedlings was similar to or higher than unsprayed controls. In response to high precipitation in Summer 2006, a large increase in the number of seedlings at WSMR was detected in all plots in Fall 2006 except those treated with hexazinone. Although many of these seedlings did not persist into 2007, the number of seedlings in hexazinone-treated plots remained at least half of that found in control plots in Fall 2007 (Figure 2). Very few African rue seedlings were observed at Lazy E, and no herbicide effect was detected.

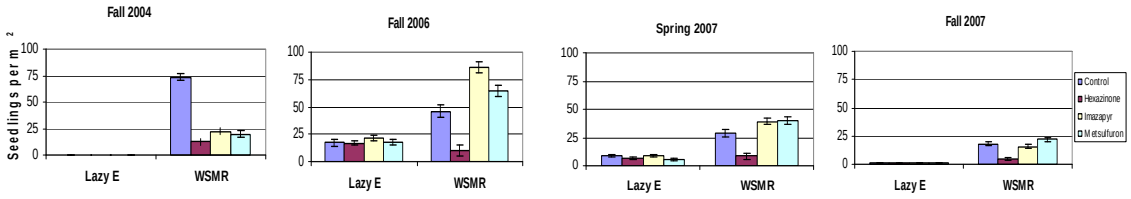

Figure 2. Effect of three herbicides on density of African rue seedlings in 1m X 1m plots centered on mature target African rue plant. Target African rue plants were treated with herbicides in 2004. Control plants were not sprayed with herbicide. Plots were evaluated in Fall 2004, Fall 2006, Spring 2007, and Fall 2007.

Herbicide Effects on Associated Vegetation

The existing vegetation at the two sites differed substantially: non-treated control plots show that grasses were more prevalent at WSMR, and forbs were more prevalent at Lazy E. Grass response varied with herbicide, but was not affected by application date at

either site (data not shown). Metsulfuron did not reduce grasses compared to controls. Imazapyr reduced grasses by 33 to 36%, and hexazinone reduced grasses by 64 to 74% compared to non-treated controls (Figure 3). Forb density was not reduced by metsulfuron or imazapyr. Hexazinone reduced forb density through Spring 2007 (Figure 4).

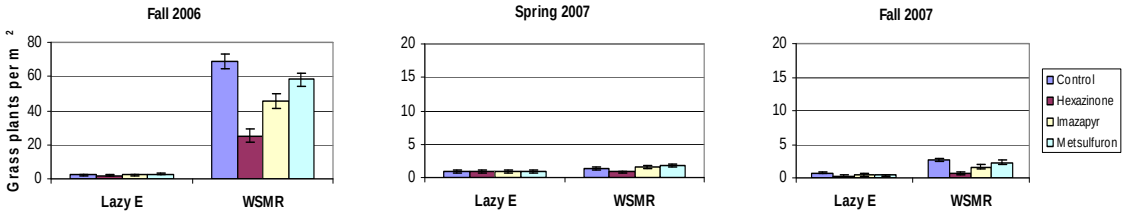

Figure 3. Effect of three herbicides on grass density in 1m X 1m plots centered on mature target African rue plant. Target African rue plants were treated with herbicides in 2004. Control plants were not sprayed with herbicide. Plots were evaluated in Fall 2006, Spring 2007, and Fall 2007. Note the different scale in the Fall 2006.

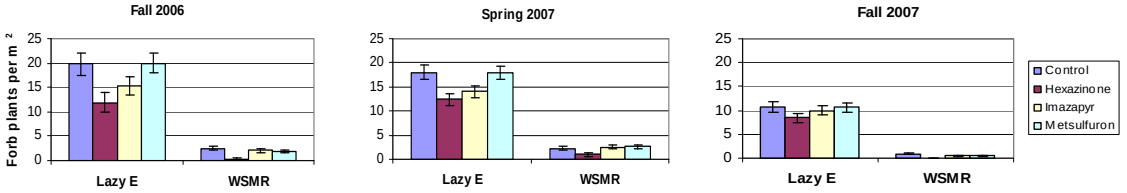

Figure 4. Effect of three herbicides on forb density (number of plants/m^2) in 1m X 1m plots centered on mature target African rue plant. Target African rue plants were treated with herbicides in 2004. Control plants were not sprayed with herbicide. Plots were evaluated in Fall 2006, Spring 2007, and Fall 2007.

Effects of Supplemental Water

We did not observe an interaction between supplemental water and herbicides, indicating that soil moisture status at the time of herbicide application did not influence the effect of herbicides on African rue or associated vegetation (data not shown). Supplemental water did increase the number of African rue seedlings and grass density at WSMR through Fall 2006, and forb density at Lazy E through Fall 2007.

POTENTIAL APPLICATION: African rue control was influenced by type of herbicide and application date, but not affected by soil moisture status. The herbicides tested had different effects on African rue and associated vegetation. Hexazinone was most effective at controlling African rue but was also most damaging to grasses and

forbs. Metsulfuron had the least impact on grasses and forbs, but was not very effective at controlling African rue. Imazapyr also provided good control, but was damaging to grasses. Decisions on how to control African rue are site-specific, and must consider the trade-off between effective control and recovery of the associated vegetation. Vigilance and early detection of new infestations enable land managers to use effective control methods while minimizing potential negative impacts on associated vegetation.

EDUCATIONAL PLAN: This research will be published in a refereed journal, and components will be incorporated into several classes at New Mexico State University.

REFERENCES:

Abbott, L.B., and T.M. Sterling. 2006. African rue (*Peganum harmala*) seedling response to herbicides applied under water-deficit-stress. Weed Science 54:198-204.

Abbott, L.B., G.T. Bettmann, and T.M. Sterling. 2008. Physiology and recovery of African rue (*Peganum harmala*) seedlings under water-deficit stress. Weed Science 56:52-57.

Abbott, L.B., D. Lepak, and D.L. Daniel. 2007. Vegetative and reproductive phenology of African rue (*Peganum harmala*) in the northern Chihuahuan Desert. Southwestern Naturalist 52:209-218.

Branum, K.S. 2006. African Rue (*Peganum harmala* L.) Physiology and Response to Herbicides under Water Deficit. MS Thesis. New Mexico State University. Las Cruces, New Mexico. 213 pp.

Lee, R.D. 1999. New Mexico's Invasive Weeds. New Mexico State University College of Agriculture and Home Economics Extension Service. Las Cruces, New Mexico.

McDaniel, K.C., and K.W. Duncan. 2006. African Rue Control: Ground Applications. New Mexico Cooperative Service Extension Publication BC-6. New Mexico State University College of Agriculture and Home Economics Cooperative Extension Service. Las Cruces, New Mexico.

Sperry, O.E., J.W. Dollahite, G.O. Hoffman, and B.J. Camp. 1964. Texas Plants Poisonous to Livestock. Texas A&M University Agricultural Extension Service Publication B-1028. Texas A&M University Agricultural Experiment Station and Agricultural Extension Service. College Station, Texas.