



Field Guide for Managing Sahara Mustard in the Southwest



Cover Photos

Upper left and right: Max Licher, ASU Vascular Plant Herbarium, swbiodiversity.org

Bottom: Patti Fenner, US Forest Service

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TTY). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TTY). USDA is an equal opportunity provider and employer.

Printed on recycled paper

Sahara mustard (*Brassica tournefortii*)

Mustard family (Brassicaceae)

Sahara mustard is an invasive plant that is listed as a noxious weed in Arizona and is on the watch list in New Mexico. This field guide serves as the U.S. Forest Service's recommendations for management of Sahara mustard in woodlands, rangelands, and deserts associated with the Service's Southwestern Region. The Southwestern Region covers Arizona and New Mexico, which together have 11 national forests. The Region also includes four national grasslands located in northeastern New Mexico, western Oklahoma, and the Texas panhandle.

Description

Sahara mustard (synonyms: wild turnip, African or Asian mustard) is an introduced short-lived annual that is native to North Africa, the Middle East, and Mediterranean lands of southern Europe. Although it favors arid sandy soils, it occupies a wide variety of disturbed habitats. New plants are commonly seen following fall and winter precipitation and are difficult to differentiate from native mustards as they are similar in shape and form. Sahara mustard is quick growing and can complete its life cycle within a few months. In the Southwest, adult plants typically flower from February–April and then senesce by May. While this plant is not yet common in New Mexico, it has expanded rapidly in Arizona, Nevada, and California.

Growth Characteristics

- Annual broadleaf plant; average height is 3 inches to 3 ft tall flower stalks.
- In early growth plants form a large basal rosette with leaves 3-12 inches long that are deeply lobed and toothed; leaves are present on inflorescences but they later rapidly decrease in size and appear as small bracts; stems and leaf surfaces may be covered with simple hairs.
- Inflorescences can vary widely in size depending upon the health of plants; ranging from 4-40 inches in height. Inflorescences consist of racemes that include anywhere from 6 to 20 flowers.

- Flowers are small and dull yellow, often making them inconspicuous. Petals consist of two pairs, which form a cross-like shape. Petals range in size but are generally 0.6 inches wide, 0.2-0.3 inches long, and only slightly longer than the length of sepals.
- Fruit are specialized structures called siliques that can actively dehisce when mature. Siliques are 1.4-2.6 inches long with an obvious beak at the tip of the fruit. Siliques contain 14-30 seeds (0.04 inches in diameter) that are red with a mucilaginous coating.

Ecology

Impacts/threats

Sahara mustard takes early advantage of fall and winter soil moisture and can develop dense, monotypic stands resulting in lower diversity of flora and fauna species. As the foliage and flower stalks dry up, the litter material can become a fire hazard capable of spreading fire into areas where native plants are typically fire intolerant. Since this plant is not well established in New Mexico, actively eradicating new infestations is highly encouraged.

Location

Sahara mustard primarily invades disturbed, arid habitats. In the Southwest, it is commonly found along bladed and mowed roadsides and other areas disturbed by machinery. However, Sahara mustard does not require soil disturbance to be invasive. Sahara mustard has been observed across a wide range of habitats in the Mojave and Sonoran desert regions including residential and industrial areas, ephemeral riparian corridors, rangeland and pastures, and cultivated fields.

Spread

Sahara mustard spreads exclusively by seed; however, more knowledge is needed to learn about the biology, reproduction, and spread of this species. Well-developed plants produce 750-9,000 seeds that reportedly remain viable for more than 3 years. Observations suggest that seeds can germinate with as little as 1.5 inches of rainfall. Rodents cache seeds and may be capable of moving flower heads

and seed far from their source thereby enhancing spread. Seed spread occurs with wind as dry plants easily break off at ground level and tumble across the landscape, spreading seed into new locations. Dried seed and plant fragments also adhere to surfaces and undercarriages of vehicles and road maintenance equipment.

Invasive Features

Sahara mustard is well-adapted to desert landscapes and is likely to continue its spread into unfilled niches. With its high seed production capacity and ability to rapidly propagate under low soil moisture conditions, this weed should be expected to thrive across a wide range of habitats. Successful management prevents seed production/spread.

Management

Early detection and proactive management is the best approach for controlling Sahara mustard since well-established stands are difficult to control. Frequent monitoring is critical to locate new populations before they become established. If new infestations are discovered, plants should be removed immediately to prevent further spread. Small or isolated infestations on otherwise healthy sites should be given high priority for treatment, followed by treatment of corridors such as roadways and hiking trails that act as pathways for spread. Regardless of the management approach, Sahara mustard typically cannot be effectively controlled within a single year or by using only one method. Complete eradication will likely require 3 to 10 years of repeated management methods. The following actions should be considered when planning an overall management approach:

- Healthy plant communities should be maintained to limit Sahara mustard infestations. If necessary, include revegetation methods to reduce the possibility of further invasion.
- Detect, report, and map known infestations. Keep annual records of reported infestations.

- Eradicate new populations of Sahara mustard as early as possible.
- Combine mechanical, cultural, biological, and chemical methods for most effective Sahara mustard control.

Table 1 summarizes some management options for controlling Sahara mustard under various situations. Choice of individual control method(s) for Sahara mustard depends on the degree and density of infestation, current land use, and site conditions (accessibility, terrain, microclimate, other flora and fauna present, etc.). Other important considerations include treatment effectiveness, overall cost, and the number of years needed to achieve control. More than one control method may be needed for a particular site.

Physical Control

Although labor intensive, physical methods used consistently and repeatedly are effective at controlling Sahara mustard. In general, effectiveness of physical methods is improved when combined with herbicide control.

Manual Methods

Hand-pulling or hoeing – Plants of all ages are easily controlled by hand-pulling, hoeing, or grubbing; but removal is best before flowering and seed set. Always remove as much of the above- and below-ground plant parts as possible, and dispose of debris by bagging and depositing bags in a landfill, or by burning.

Mechanical Methods

Mowing – Without serious attention, mowing can contribute to further spread and increased densities of Sahara mustard. Mowing is a helpful tool for removing accumulated leaf and early flower material. For best results, mow Sahara mustard at the early bolting or flower bud stage to prevent seed production. Monitor plants carefully and repeat mowing if the weed produces new flower shoots.

Tillage – By itself, cultivation is often not a viable alternative for Sahara mustard control. Shallow disking will effectively eliminate new plants, but disturbing the soil

Table 1. Management options*

Site	Physical Methods	Cultural Methods	Biological Methods	Chemical Methods
Roadsides, trails, or non-crop areas	Mow at early flower stage; apply herbicide to re-growth. Hand-pull or hoe small patches.	Clean machinery following activity in infested areas. Train road crews and the public to identify and report infestations; map reported populations.	Biological control agents are unavailable.	Spray at early leaf stage before flower bolt. For ground application, use truck-mounted or tractor-pulled spraying equipment. Wash under vehicle after application to prevent spread.
Rangeland or pasture	Disking in early growth can eliminate the weed; consider combining any cultivation with follow-up herbicide control. Fire, except as spot burning, is not recommended.	Monitor areas where soil was imported or hay bales were used for erosion control. Re-seed with plants that are desirable and will provide competition.	Use of a grazing strategy to reduce or eliminate Sahara mustard has not been researched. Closely manage grazing to prevent overuse. Biological control agents are unavailable.	Spray at early leaf stage before flower bolt. For ground application, use truck-mounted or tractor-pulled spraying equipment. Wash under vehicle after application to prevent spread. Spot spray sparse populations; use a backpack or hand held sprayer.
Riparian areas, wilderness and other natural areas, and/or small infestations	Hand-pull or hoe small patches; remove as much of the root as possible; bag and dispose of debris appropriately.	Educate the public to identify and report infestations. After passing through infested areas, inspect and remove any seed or root fragments from animals, clothing, and vehicles.	Same as above.	Same as above.

* Choice of a particular management option must be in compliance with existing regulations for land resource.

surface may enhance later seed germination. Cultivation in combination with later well-timed herbicide use can reduce population size in areas suitable for these practices. Research using this integrated approach is limited, however.

If using machinery to manage Sahara mustard, equipment should be cleaned to prevent the movement of seeds or root fragments to un-infested areas.

Prescribed Fire

Burning actively growing Sahara mustard with prescribed fire is usually impractical and is not recommended. Flaming or spot burning individual plants in areas with low wildfire severity conditions may be a suitable alternative to physical

control to prevent soil disturbance. Piling pulled or hoed growth material and burning is an acceptable way to dispose of plant debris.

Cultural Control

Early detection and plant removal are critical for preventing Sahara mustard establishment. Land managers, the local public, and road crews should be educated as to how to identify Sahara mustard in all life stages so they can help report suspected infestations. Vehicles, humans, and livestock should be discouraged from traveling through infested areas to minimize seed spread.

Biological Control

Grazing

There is little research or practical experience reported related to grazing Sahara mustard by livestock. However, caution should be exercised when grazing these areas as other plant members of the mustard family are known to be poisonous to goats, sheep, horses, and cattle.

Classical Biological Control

There are no classical biological control agents currently approved by USDA for management of Sahara mustard.

Chemical Control

Herbicides can be an effective tool for managing Sahara mustard, especially when used as part of an integrated strategy. Scouting and detection of new plants is key as herbicide applications should be made in early leaf stages of development and always before flowering. If young plants or seedling are found, apply herbicides as soon as possible to prevent them from producing flower heads or seed. If the majority of plants have already produced fruits, then plants should be hand-pulled or hoed and removed from the site.

Numerous herbicides are available that can easily control Sahara mustard as well as other annual members of the mustard family. Herbicide choice depends on local conditions, label restrictions, land use objectives, and cost. See table 2 for a summary of some effective herbicide choices.

Precautions should be taken if non-target plants (including woody species) need to be protected. This includes situations where spray drift, soil erosion, or water movement potentially could occur. Each herbicide product will have different requirements and restrictions according to the label. Read and understand prior to any application. Consult the registrant if you have questions or need further detail.

Herbicides may be applied in several ways including backpack, ATV or UTV sprayers, or conventional boom sprayers that are pulled or attached to a tractor or truck.

For sparse populations, one person or a small team can spot spray Sahara mustard. With this method, simply walk through the infested area and directly spray the foliage of individual plants without dripping by using an adjustable spray nozzle attached to a hand-held or backpack sprayer.

Control Strategies

Because each treatment situation is unique, the control strategy adopted for Sahara mustard must involve (1) careful planning, (2) often a rapid response to control treated plants and new infestations, and (3) a long-term commitment to management actions. Combining methods, as outlined in this guide, should always be considered as a long-term approach to Sahara mustard control. For example, physical methods (such as shallow disking) used in combination with follow-up chemical control can be effective.

Regardless of the strategy used, components of a successful control program for Sahara mustard should include scouting for new populations and taking quick measures to control newly emerged seedlings. Monitoring should be conducted after major rain events in early winter through spring to detect rosettes that form the leading edge of expanding populations. To enhance long-term control, consider an approach that encourages and maintains competitive desirable plants. A healthy, well-maintained population of native plants can dramatically slow the introduction and spread of Sahara mustard.

Table 2. Herbicide recommendations

Common Chemical Name (active ingredient)	Product Example ¹	Product Example Rate per Acre (broadcast)	Backpack Sprayer Treatment Using Product Example ²	Time of Application	Remarks
2,4-D ester or amine ³	Several names and manufacturers	Depends upon formulation (1-2 lbs ae)	3 to 5%	Spring	Selective; apply in early leaf stage. If infestation is dense, mow first and apply to re-growth before flower stage.
Aminopyralid	Milestone	1/4 to 1/3 pint	3 to 5%	Same as above.	Broadleaf-specific herbicide; does not harm grasses. Best applied as a course low-pressure spot spray. Use 0.25% - 0.5% v/v NIS when conditions are adverse (high heat, low relative humidity or dusty conditions) or on mature stands. ⁴ Labeled for use up to water's edge. Some grazing recommendations. May be used in combination with 2,4- D.
Aminopyralid + metsulfuron methyl	Opensight Chaparral	2.5 to 3.3 oz/ acre	n/a	Spring or fall	A selective granule herbicide for use on non-cropland, rights-of-way, non-irrigation ditch banks, natural areas, and grazed areas in and around these sites.
Clopyralid	Curtail others	2 to 3 quarts	1 to 3%	Same as above	Broadleaf-specific herbicide; does not harm most established grasses. Wait 30 days to establish perennial grasses. Can be used on rangeland, irrigated pasture or meadow, but not directly to water. Not recommended for highly permeable soils or shallow groundwater areas. May be used in combination with 2,4- D. May use up to 0.5% v/v NIS
Dicamba + 2,4-D	Weedmaster	2 to 4 pints	1 to 3%	Seedling to rosette stage	Selective with a broad spectrum; may affect some sensitive pasture grasses such as bentgrass and legumes like alfalfa. Not for use near water.
Metsulfuron-methyl	Escort Ally others	0.5 to 1.0 oz.	n/a	Early leaf stage; usually fall or winter	Selective; safe for most perennial grasses; add 0.25% v/v NIS. Not for use near irrigation water. Apply to green healthy plants. May be used in combination with 2,4- D.
Triclopyr	Garlon 3A Remedy others	3 quarts	3 to 5%	Same as above.	Selective; safe for most perennial grasses; add 0.25% v/v NIS; labeled for riparian areas and use near water bodies.

¹ Trade names for products are provided for example purposes only, and other products with the same active ingredient(s) may be available. Individual product labels should be examined for specific information and appropriate use with perennial pepperweed.

² Herbicide/water ratio – As an example, a gallon of spray water with a 3% mixture is made by adding a sufficient volume of water to 4 oz of herbicide until a volume of one gallon is reached ($4 \text{ oz/gal} \div 128 \text{ oz/gal} = 0.03$ or 3%).

³ 2,4-D is a restricted use pesticide in New Mexico only. A certified applicator's license is required for purchase and use.

⁴ NIS is an abbreviation for non-ionic surfactant which is an additive commonly recommended by herbicide labels for post-emergent foliar application of herbicide.

References and Further Information

Brooks, M.L., J.V. Draper, and M.R. Trader. 2006.

Controlling Sahara mustard: evaluation of herbicide and mechanical treatments (California). *Ecol. Restor.* 24: 277-278.

Deuser, C. 2005. Sahara mustard control strategies. Sahara mustard workshop. Available at http://www.cal-ipc.org/ip/research/saharan/pdf/SahMust_ControlStrat.pdf (accessed July 2014).

Graham, J., W.S. Johnson, and E. Powell. 2002. Identifying and managing Sahara mustard. Univ. of Nev, Fact Sheet-05-02. Available at <https://www.unce.unr.edu/publications/files/nr/2005/FS0502.pdf> (accessed July 2014)

Holt, J.S. and C.W. Barrows. 2010. Sahara mustard (*Brassica tournefortii*). Available at https://civr.ucr.edu/sahara_mustard.html (accessed July 2014).

Invasive Plant Atlas of the United States. Available at <http://www.invasive.org/weedus/index.html> (accessed July 2014)

Malusa, J., B. Halvorson, and D. Angell. 2003. Distribution of the exotic mustard *Brassica tournefortii* in the Mohawk Dunes and Mountains, Arizona. *Desert Plants* 19(1):31-36.

Minnich, R.A. and A.C. Sanders. 2000. *Brassica tournefortii* Gouan. In: C.C. Bossard et al. (eds.) *Invasive Plants of California's Wildlands*. Univ.of Calif. Press, Berkeley and Los Angeles. 360 pp.

Renz, M.J. 2006. Sahara mustard (*Brassica tournefortii*). NMSU Weed Factsheet. Available at http://weeds.nmsu.edu/pdfs/sahara_mustard_factsheet_3-14-06.pdf (accessed July 2014)

Sanders, A., and R. Minnich. 2000. *Brassica tournefortii*. In: C.C. Bossard et al. (eds.) *Invasive Plants of California's Wildlands*. Univ.of Calif. Press, Berkeley, CA. 360 pp.

USDA Plants Database. 2010. Available at <http://plants.usda.gov/index.html>. (accessed July 2014)

USGS Western Ecological Research Center. Invasive weed removal and habitat restoration: Sahara mustard. Available at <http://www.werc.usgs.gov/Project.aspx?ProjectID=95> (accessed July 2014).

Suggested Websites

For information on invasive species:

<http://www.invasivespeciesinfo.gov/>

<http://www.invasive.org/weedus/index.html>

**For more information
or other field guides, contact:**

USDA Forest Service
Southwestern Region
Forest Health
333 Broadway Blvd., SE
Albuquerque, NM 87102

Or visit:

<http://www.fs.usda.gov/main/r3/forest-grasslandhealth/invasivespecies>

The use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.



CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.