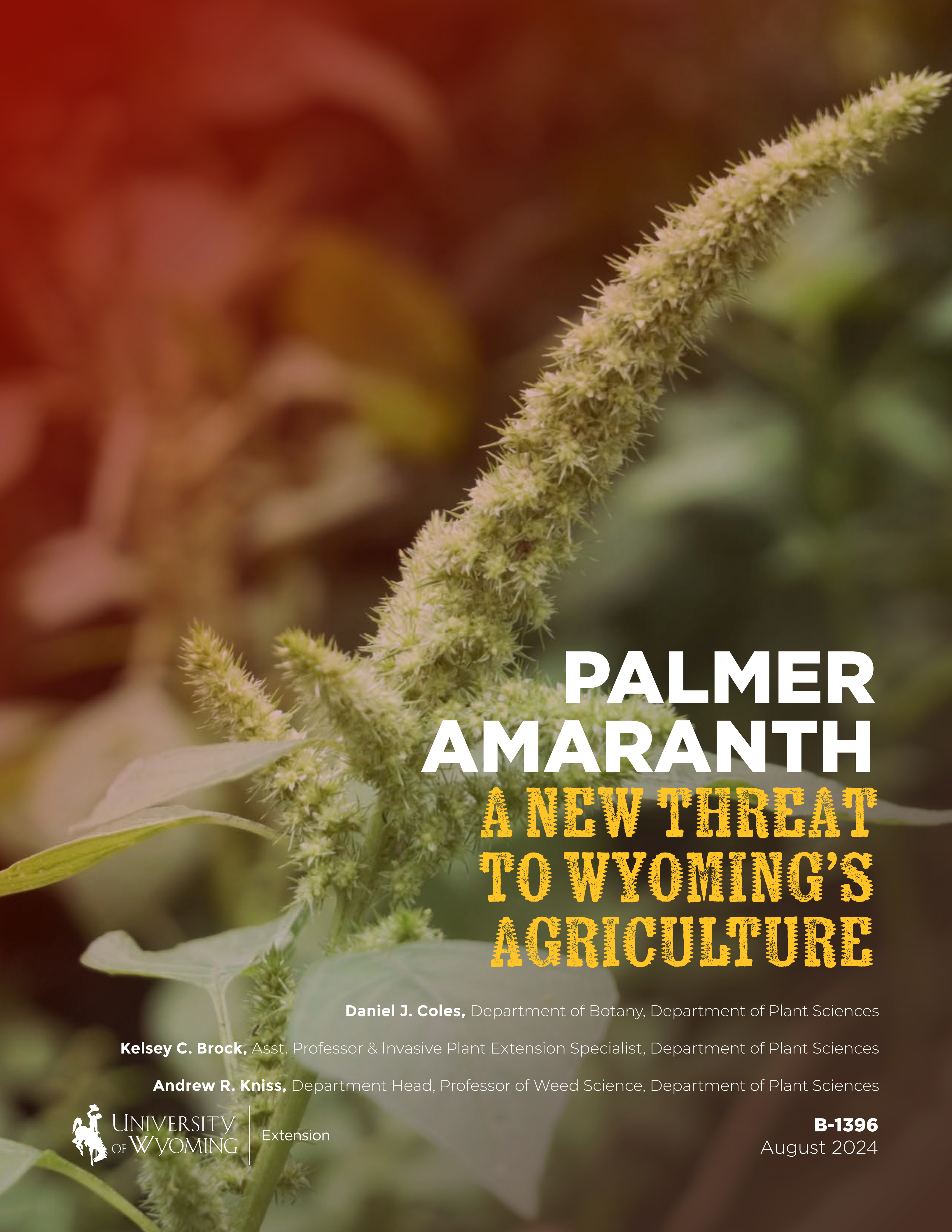

PALMER AMARANTH

A NEW THREAT TO WYOMING'S AGRICULTURE

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University of Wyoming | Extension

B-1396
August 2024

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B-1396 | August 2024
Editor: Brooke Ortel, University of Wyoming Extension
Cover Photo: Photo by Albin, stock.adobe.com.

Issued in furtherance of extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Mandy Marney, Director, University of Wyoming Extension, College of Agriculture, Life Sciences and Natural Resources, University of Wyoming Extension, University of Wyoming, Laramie, Wyoming 82071.

Figure 1. Palmer amaranth overtopping a corn crop.

Basic Biology	
Scientific Name	• *Amaranthus palmeri* S. Watson
Life Cycle	• Annual (broadleaf)
Reproduction	• By seed only • Dioecious (separate male and female individuals)
Emergence	• Early spring and continuing throughout the growing season
# of Seeds Produced	• Variable – up to 600,000/plant
Seed longevity in soil	• Approx. 3–4 years for *most* seeds

Overview

Palmer amaranth is one of the worst agricultural weeds in the United States, where it significantly reduces crop yield and profitability. This plant has only recently invaded many areas of the United States, and research aiming to understand and manage impacts has not kept pace with the need to mitigate damages. Native to the southwestern United States and northwestern Mexico, Palmer amaranth has spread to 44 of the Lower 48 states, including Wyoming, where it was first identified in 2018 (Figure 2; *1*, *2*). In 2023, Palmer amaranth was added to Wyoming's noxious weed list. Major impacts to Wyoming's crop production are expected unless measures are taken to prevent further establishment.

Origins & Current Distribution

Less than 100 years ago, you would've had better luck finding this plant on a gravelly floodplain in its native range in the southwestern U.S. and northwestern Mexico (Figure 2) than interfering with modern agricultural production. Historical accounts show that Native American tribes used Palmer amaranth as a potherb and grain similar to modern quinoa (*1*). Indeed, this plant has only become troublesome since around the 1970s, when it mysteriously started to invade areas to the north and east of its native range. Records of this weed have now been reported on every continent except Antarctica and Australia. The outstanding question is *why* has this plant moved beyond its original habitat?

Current research hints that today's Palmer amaranth may be quite different from the original native of the U.S. Southwest. For example, modern-day plants seem to have different temperature and moisture preferences and tend to inhabit landscapes modified by human activity, such as agricultural fields, irrigation ditches, and roadsides (*3*)—even in their native range (*4*).

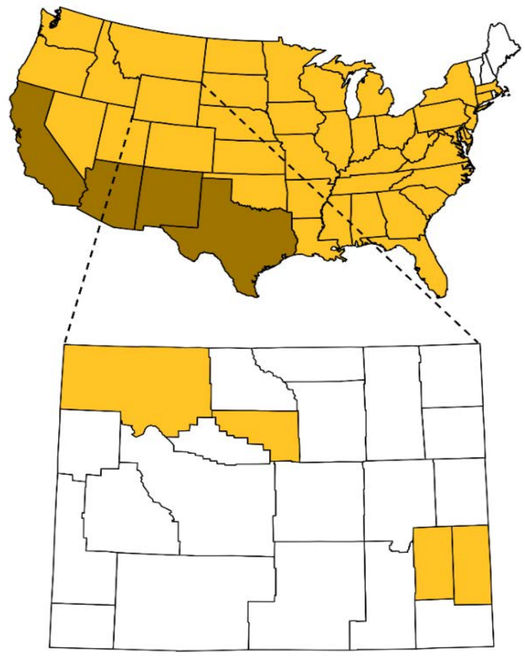


Figure 2. Palmer amaranth distribution within the contiguous U.S. (top) and Wyoming (bottom). Brown represents native range, yellow represents invaded range, and white represents no recorded occurrence. Presence data include both observations and collected specimens.

Many possible reasons for this sudden change exist. A likely piece of the puzzle is that, as agriculture expanded throughout the U.S., Palmer amaranth was provided with new ideal habitat and plenty of opportunities for long-distance dispersal via the trade of agricultural goods (*2*). An additional possibility is that Palmer amaranth underwent rapid evolution alongside the expansion of modern agriculture, which allowed it more success in human-made habitats. During this time, poor pesticide stewardship likely created favorable conditions for this plant to evolve herbicide resistance. Similar stories of rapid evolution have been recently discovered in a close relative (waterhemp, or *Amaranthus tuberculatus*), where the evolution of genes for weedy traits (e.g., herbicide resistance, salt tolerance, germination timing) appear to have occurred alongside the intensification of agriculture (*5*).

Climate change also plays a role in the distribution of Palmer amaranth, as warmer temperatures are expected to allow this plant to thrive in areas that used to be too cold. However, climate change is not thought to be the culprit behind its initial range expansion (*3*).

Ultimately, the sudden invasion of Palmer amaranth remains a mystery, and more research is needed to understand how and where it will spread. These efforts are of interest to Wyoming, where reports have now been recorded in four counties (Figure 2).

Dispersal

Palmer amaranth seeds are only 1–2 mm (1/25 of an inch) in diameter, making unintentional dispersal very likely.

Documented avenues of Palmer amaranth transport	
Manure-based fertilizer	• Seeds survive the digestive systems of livestock (*6*).
Contaminated Seed	• Found in agricultural and restoration seed mixes as well as in bird feeder seed (*7*).
Hitchhiking	• Seeds transported via mud stuck to tires, equipment, and footwear (*6*, *8*).
Waterways	• Seeds travel through irrigation systems and natural waterways (*9*).
Animals	• Seeds have been found in the excrement of rodents and birds (*10*).

Once a mature plant is introduced, widespread dispersal throughout a field can take place in just one year due to the abundance of seeds produced (Figure 3).

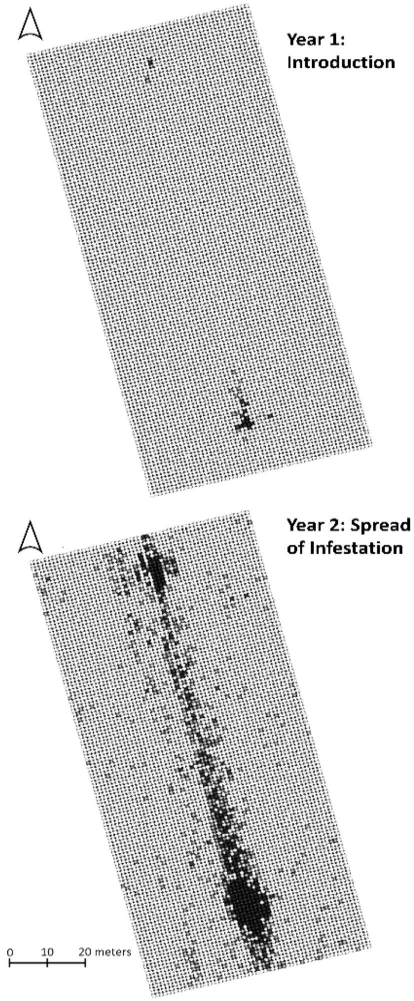


*Figure 3. Spread of Palmer amaranth (bottom) in a field one year after introduction (top). Redrawn from Norsworthy et al. (*11***).***

Impacts

Invasions of Palmer amaranth have had a large impact on crops. For row crops in particular, the space between rows offers plentiful light, water, and nutrients for Palmer amaranth to establish and grow quickly. Palmer amaranth also poses a threat to crops that emerge later in the season because it can establish early at low temperatures and get a "head start" on crop seedlings (*12*).

Palmer amaranth's ability to germinate throughout the growing season is one of its most troublesome traits. This extended germination window prevents farmers from controlling it effectively before crop emergence, which is of particular concern for crops with a slow rate of growth or canopy formation.

Palmer amaranth also complicates farm operations and can increase labor costs. Its persistent emergence throughout the growing season may require multiple control methods to be applied continuously. Also, its propensity to evolve herbicide resistance may render many chemical controls a short-lived option, leaving few reliable tools to lighten the burden (*13*). As of 2024, for example, there are no widely available herbicides to control glyphosate-resistant Palmer amaranth in sugar beet in Wyoming.

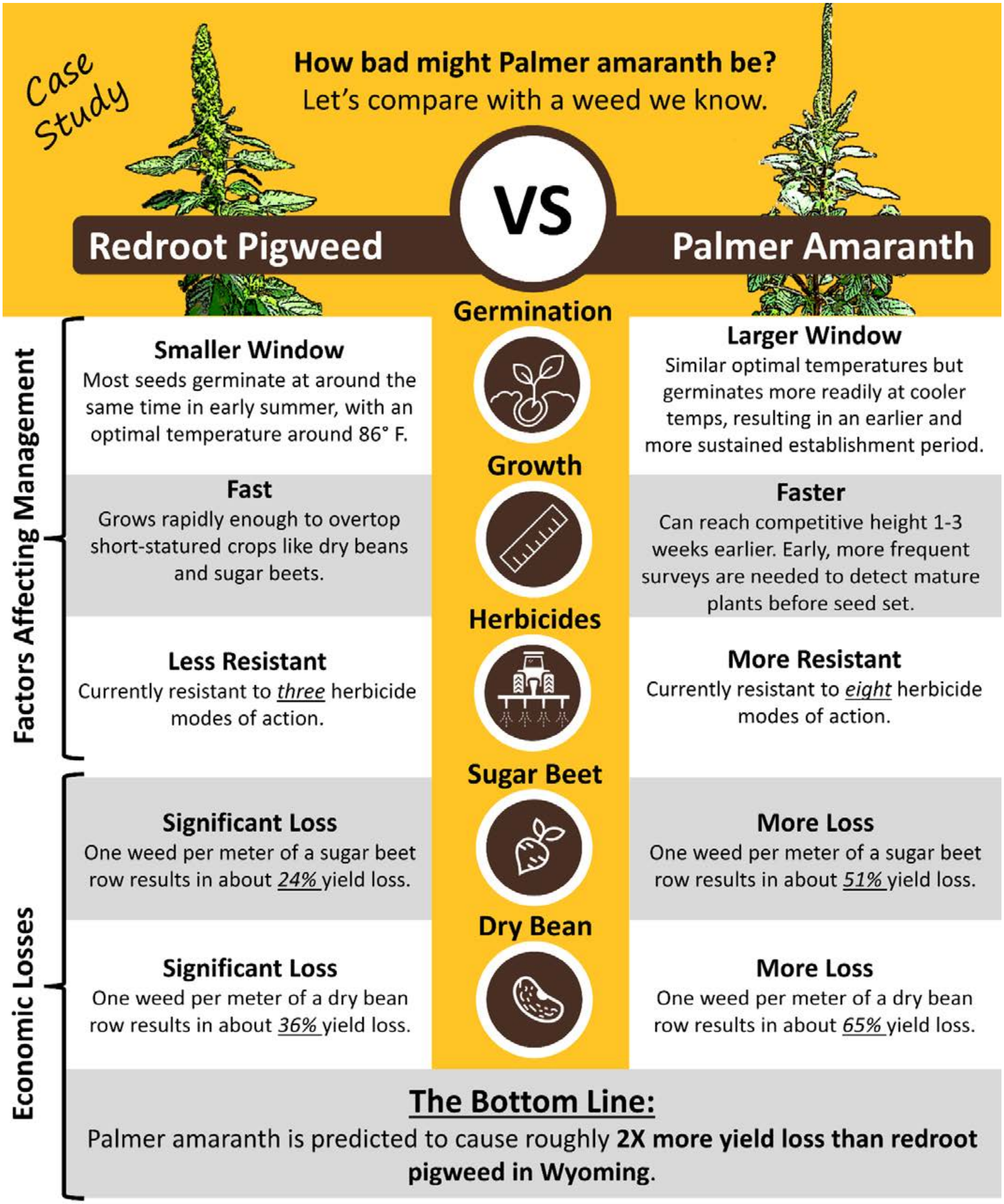
So far there have been no recorded impacts to natural ecosystems, although few data are being collected in these areas. However, Palmer amaranth's affinity for tilled soil and man-made habitats suggests that it may invade natural areas experiencing human disturbance or soil erosion.

Other recorded impacts include:

- Seed contamination of seed stocks/mixes and other commodities such as compost and manure (*7*, *14*, *15*).
- Toxicity to livestock can occur if the plant generates high levels of nitrates, which may occur during dry conditions (*6*).
- It can provide an alternate host for insect pests and pathogens of crop species (*16*).
- Release of harmful chemicals (allelopathy) that affect growth and germination success of other plants (*2*, *17*, *18*).

Specific Concerns for Wyoming

In Wyoming, Palmer amaranth is expected to reduce yields of corn, dry edible beans, and sugar beets, which are some of the state's most important agricultural crops. Elsewhere, Palmer amaranth has reduced corn yields by up to 91% if the crop and weed emerge simultaneously (*19*, *20*). No studies have been conducted on impacts to alfalfa, although it's possible that herbicide-resistant populations could pose a threat during establishment, and the weed may find suitable habitat in old, sparse stands.



Predictions are derived from published studies of direct comparisons between species (*21–32*) and Wyoming economic data from USDA-NASS (*33*).

Identification

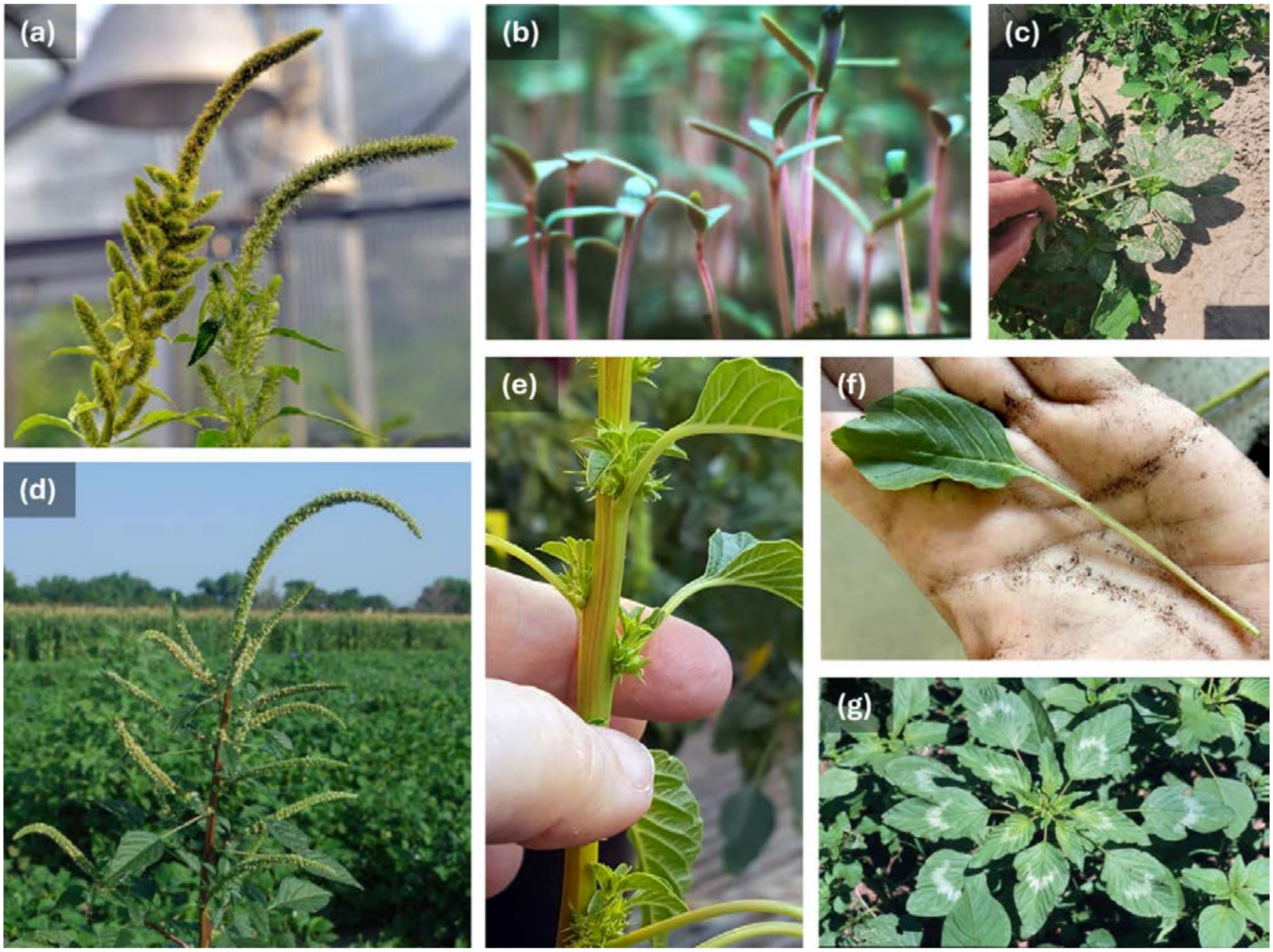


Figure 4 Typical Palmer amaranth characteristics. a) male inflorescence (left) and female inflorescence (right); b) seedlings; c) leaf displaying long petiole; d) mature plant; e) smooth, hairless stem; f) leaf detail; g) white chevron "V" mark that is occasionally present in some individuals (also observed on redroot pigweed throughout Wyoming).

A typical Palmer amaranth specimen ranges between 1.5–5 feet in height, but can grow taller in competitive crops like corn. Palmer amaranth plants have leaves with long petioles (leaf stalks) that are attached to a hairless stem. Male and female plants can be distinguished from each other by the texture of their inflorescence (flowering spike). Males are soft to the touch while females are prickly (Figure 4).

Palmer amaranth can be a difficult species to identify for two reasons: 1) there are other large upright amaranths in Wyoming (Figure 5); and 2) many atypical individuals may exist, especially where growing conditions are not ideal (Figure 6). Even when they reach only a few inches in height, Palmer amaranth plants can produce hundreds of seeds. Occasionally, the species can have a prostrate growth habit, resembling those of other closely related *Amaranthus* species. Amaranths readily hybridize, which may give rise to intermediate forms between two species. The inflorescence of Palmer amaranth also varies. Some specimens may have a single long, drooping spike, while others have several spikes originating near the base of the main spike.

Need ID help?

Find an expert through University of Wyoming Extension at **www.uwyo.edu/uwe**.

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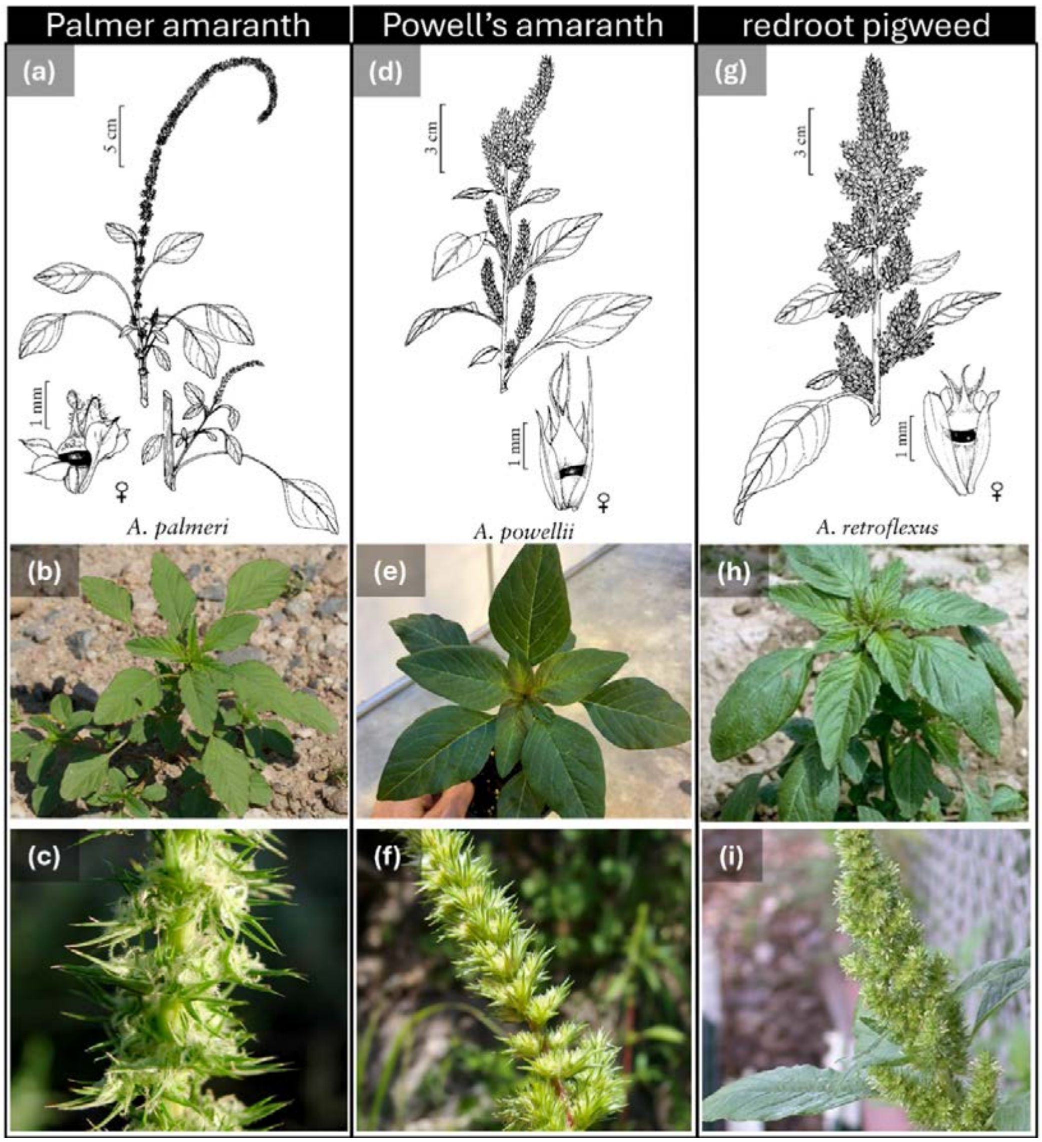

Figure 5. Palmer amaranth (column 1 a-c) and its lookalikes in Wyoming, including Powell's amaranth (column 2 d-f), and redroot pigweed (column 3 g-i), with a, d, g showing line drawings of inflorescence shape and detail of female flowers; b, e, h showing comparisons of leaf arrangement due to petiole length in young plants; and c, f, i showing close-ups of flowers and prickly bracts in Palmer and Powell's amaranths.

Characteristic	**Palmer amaranth** (*Amaranthus palmeri*)	**Powell's amaranth** (*Amaranthus powellii*)	**Redroot pigweed** (*Amaranthus retroflexus*)
Leaf Shape	Lance-shaped to spoon-shaped (Fig. 5a–b)	Lance-shaped to spoon-shaped or diamond-shaped (Fig. 5d–e)	Spoon-shaped to diamond-shaped (Fig. 5g–h)
Leaf Length	0.5–3 in	1.5–3 in	1–6 in
Petiole (leaf stalk)	Usually longer than the leaf blade	Equal to or longer than the leaf blade	Equal to or shorter than the leaf blade
Stem Hairs	Smooth	Usually sparse hairs; sometimes smooth	Densely hairy
Inflorescence (flower spike)	Male and female flowers on different plants; female inflorescences prickly	Male and female flowers on same inflorescence; inflorescences prickly	Male and female flowers on same inflorescence; inflorescences not prickly
Height	Typically 1.5–5 ft; up to 10 ft	Typically 1–5 ft; up to 6.5 ft	Typically 0.5–5 ft; up to 6.5 ft

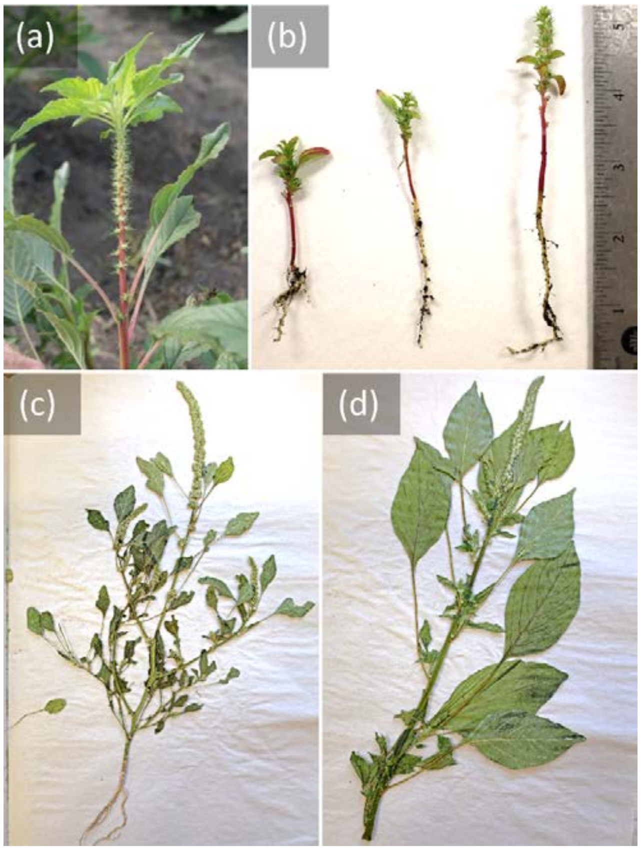

Figure 6. Examples of highly variable Palmer amaranth individuals that can confuse identification, including: a) an unusual specimen with inflorescence developing below stem leaves; b) mature plants grown in a light-stressed environment, each less than 3 inches tall and setting 25–80 seeds each; c) and d) two dried and pressed specimens with different leaf morphology collected from the same corn field in Wyoming.

Control

Unfortunately, the only universal recommendation we can make regarding Palmer amaranth control is that prevention is best. In some cases, prevention may be the only feasible option because this plant is exceptional in its ability to rapidly evolve herbicide resistance and alternatives may be expensive, time consuming, and possibly ineffective. In fact, many farmers first identify this plant simply as the only weed that did not die in their fields after routine herbicide applications. It is possible that some populations can be resistant to more than one herbicide type, and some fields have been abandoned due to a lack of practical control methods.

We recommend taking every opportunity to detect Palmer amaranth early and prevent it from going to seed. In cases where seed production cannot be prevented and harvesting will spread seeds further, producers may consider sacrificing production on parts of a field, especially if the infestation is caught early (see Figure 3). This tactic may be the cheapest option because, once established, multiple control methods (including non-chemical ones) will likely be necessary to control Palmer amaranth in perpetuity, and methods may need to change frequently to manage resistance.

Control strategies that have had some success elsewhere:	
Deep Tillage	• Deep tillage has been shown to reduce populations by 81% (*34*).
Herbicides	• A mixture of pre-emergent and post-emergent herbicides consisting of different modes of action can help prevent resistance and manage resistant populations in some cases (*35*).
Hand-pulling	• Can be effective for small populations, but plants probably should be removed from the field because they may re-root and produce seeds even after being pulled (*37*).

Acknowledgements

We are grateful to Dr. Albert Adjesiwor, Dr. Rebecca Larson, Dr. Clint Beiermann, and Brooke Ortel for providing constructive feedback to improve this bulletin.

We would also like to thank the following people for allowing us to use their photographs: Figure 1: Lynn Sosnoskie. Figure 4: (a) Jhala et al. 2020 (*38*); (b) Shawn Askew; d) Montana Department of Agriculture; (e) University of Minnesota Extension; (f) Cornell University; (g) Mark Renz. Figure 5: (a), (d), (g) Flora of North America; (c) Max Licher; (e) Cornell University; (f)

Sue Carnahan; (h) Howard F. Schwartz; (i) – Peter M. Dzuk. Figure 6: (a) Robert Hartzler.

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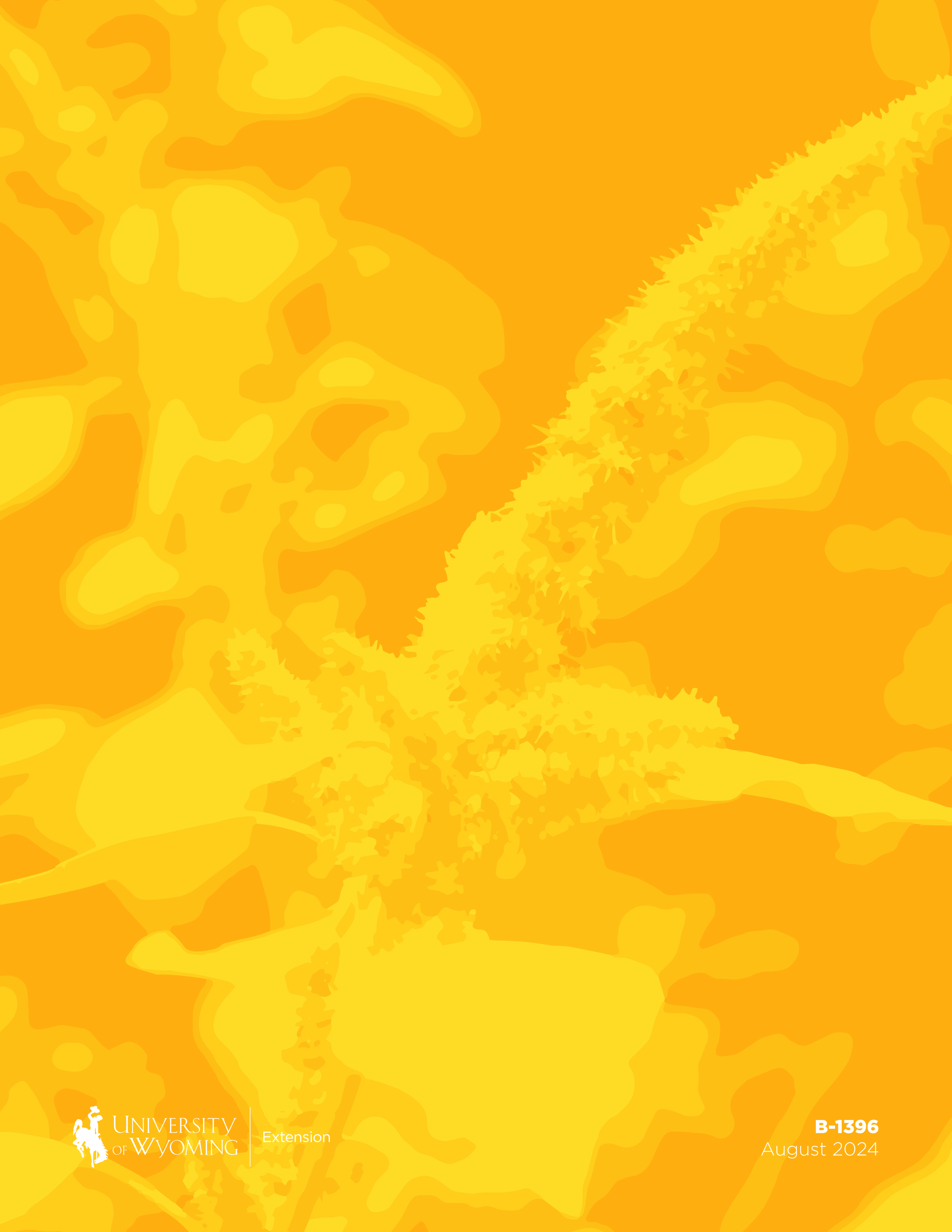

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