



Figures 1 and 2. Stinknet plants prior to bloom (2 February 2020) and in bloom (17 March 2020). Photos courtesy Michael Chamberland

# The Short Journey from Stinknet Introduction and Spread to Eruptive Explosion in Arizona

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Stinknet (*Oncosiphon pilulifer*) was largely unknown to Arizonans in 2000. By 2020, it had invaded the Phoenix Metro Area across urban, suburban, and outlying natural areas alike. Rapidly spreading along roadsides, the stinknet infestation is now in full expansion around Tucson, Casa Grande, Buckeye, and Ajo. It is the fastest spreading invasive weed ever to have occurred in Arizona.

This paper traces the brief journey from the first sightings of stinknet in Arizona to its detection in multiple locations in central Arizona, and its explosive growth in the years 2017–2020.

## The Plant

Stinknet is a cool-season annual plant originating from South Africa (Kolokoto and Magee 2018). Seedlings produce deep green finely divided carrot-like leaves. Starting as a rosette of leaves, stinknet later bolts with longer stems (Figure 1). The plant has a distinctive pungent odor, like turpentine, most noticeable when foliage is crushed. Starting around mid-February, stinknet becomes conspicuous with ball-shaped yellow blooms at the top of the stems (Figure 2). Stinknet is a member of the Sunflower Family, and the balls are flower heads composed of numerous tiny individual flowers (florets). Starting in early April, the yellow flower heads will transition to tan-colored seed heads of the same size and shape. This will occur

later in the spring during favorable growth conditions. Stinknet may produce 100 seeds per seed head, with potentially hundreds of seed heads on larger mature plants. Plants begin to die and dry out after seed set and with the onset of summer conditions. The dry plants lose their leaves and appear as upright standing stems, often coppery to a dark reddish color, topped with tan-colored globes full of seeds (Figure 3). Dried stinknet with intact seed heads may continue standing for months, long after the plants have died. The dry plants are highly flammable (Chamberland 2020).

## Germination and Development

Seed germination may begin in November or following the first significant cool-season rain storm. The first flush of germination is the most consequential, and will yield a cohort of the largest plants. However, additional rainfall during the course of the winter can initiate new germination from the soil seed bank. This pattern of staggered germination is challenging for the control of stinknet, which may need to be revisited multiple times during the winter. Seedlings germinating later in the winter may reach maturity at a small size with greatly reduced branches. Years with poor rainfall may yield similar undersized stinknet plants, which may not be easily noticed or readily identified when compared to robust stinknet plants. Undersized plants will produce fewer flower heads and sometimes only one flower head.

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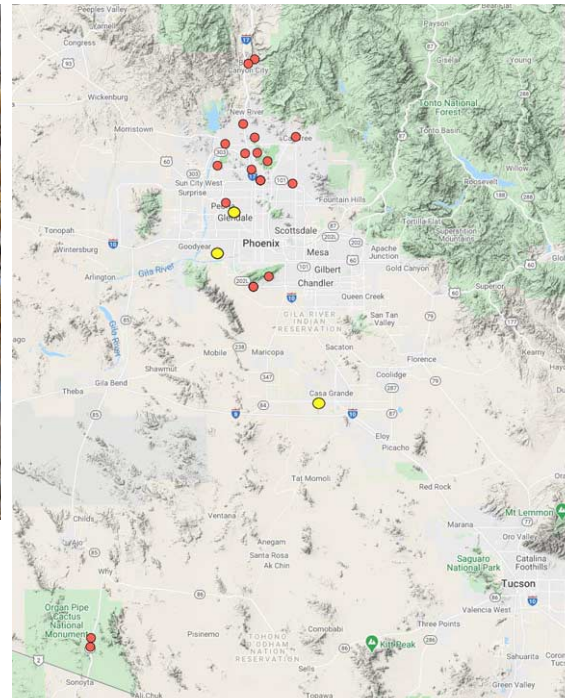
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Figure 3. Dried dead stinknet plants with spherical seed heads and reddish dry stems, 23 August 2019. Photo courtesy Michael Chamberland

Figure 4. Stinknet plants collected between 1997 and 2004 (yellow circles) and collected during the 2005 calendar year (red circles). Adapted from SEINet-generated map.



## The Short Journey from Stinknet Introduction *continued*

### Stinknet Seeds and Dispersal

Stinknet is an obligate annual reproducing and spreading only by seeds. All stinknet plants in Arizona die during the summer. The species persists through viable seeds in the soil seed bank and through viable seeds in seed heads on standing dried plants.

Stinknet seeds have no obvious structures to aid dispersal. The seeds are tiny, under 1/16 inch in length. Often the dried corolla of the flower, which is several times longer than the seed itself, remains attached to the seed at the time seeds are dispersed from the seed head.

Stinknet's method of holding dried seed heads aloft, poised for dispersal with disturbance, is likely instrumental in its spread. The small size of stinknet seeds permits a variety of means of dispersal.

Stinknet can be observed proliferating along roadsides in Arizona. Many kinds of roadside plants are known to benefit from the runoff of rainfall from paved road surfaces to the roadside. When vehicles pull off to the roadside into patches of seed-laden stinknet, vehicles and their occupants can break apart seed heads, freeing seeds to blow with the wind of passing traffic, and carrying seed or seed-infused soil to new sites. Seeds can be carried long distances with vehicles, equipment, and on clothing, with a likelihood of being dropped at residential or recreational destinations.

The lightweight stinknet seeds have potential to blow with the wind, especially when first released from the seed head. Seeds

have been reported to float and move with water flow down watercourses.

### Arizona Introduction and Spread

We do not know when or how stinknet came to the U.S. Introduced weeds often go unnoticed as they become established and form populations in the wild. Verifiable documentation of these occurrences is made when plants are noted, usually by botanists or plant enthusiasts, who preserve a dried pressed sample as a herbarium specimen.

The first documented occurrence of stinknet in the U.S. was in 1981 in Riverside County, California. Stinknet spread for over a decade in California, through Riverside and San Diego Counties, before being seen in Arizona. The introduction of stinknet to Arizona was most likely due to the inadvertent transport of seeds from California to Arizona on a vehicle or in infested soil.

The first record of stinknet in Arizona is from a specimen collected in 1997 at the Tres Rios water treatment plant in Phoenix. One specimen was collected in Glendale in 2002 and another in 2004 near Casa Grande. In 2005 a remarkable total of 25 specimens were collected from a range of sites in Arizona, from the Black Mesa foothills in Yavapai County to Organ Pipe Cactus National Monument in southwest Arizona (Figure 4). An account of stinknet's presence in Arizona was first published in a scientific journal as a consequence of the numerous collections made following the rainy winter of 2005 (Landrum et al. 2005).

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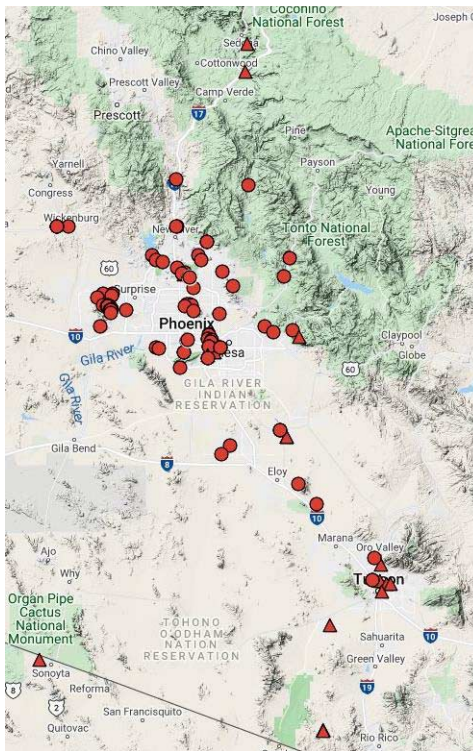


Figure 5. Stinknet documented occurrences between 2006 and 2020. Herbarium collections (red circles) and observations (red triangles). *Adapted from SEINet-generated map.*



Figure 6. Stinknet in bloom at the Ben Avery Shooting Facility, March 2019. *Photo courtesy John Scheuring*

## The Short Journey from Stinknet Introduction *continued*

The authors noted that stinknet had potential to become a weed of significance.

The first stinknet plant in Tucson was collected in 2015. Between 2016 and 2020, stinknet populations exploded across metropolitan Phoenix and Maricopa County and along major roadways from New River to Tucson (Figure 5).

### Stinknet Pattern of Spread

The stinknet infestation in the Phoenix area first became widespread north of the Metro Area in the vicinity of New River. The Ben Avery Shooting Facility (Figures 6 and 7) is noted as an area of early establishment of a major stinknet population in 2005 (Ed Northam, weed scientist with USDA, UofA Extension, and USFS, personal communication). Stinknet infestations were detected in communities along I-17 north of the Carefree Highway starting around 2007. The earliest and heaviest infestations in the Phoenix Metro Area radiated east from the Ben Avery Shooting Facility along the Carefree Highway through the Carefree and Cave Creek communities (Ed Taylor, professional herbicide applicator and owner of EST LLC, New River, AZ, personal communication).

Visitation to recreation sites infested by stinknet may have been instrumental in spreading the weed. The Ben Avery Shooting

Facility welcomes visitation for outdoor activities, particularly during an annual “Arizona Outdoors” event during the last two weeks of March, a time that can coincide with the early onset of stinknet seed maturation in some years. Mature seed from prior years’ stinknet growth would also be present in the soil and on standing dead plants. In Spring 2020, John Scheuring discovered stinknet plants in the camping area of Catalina State Park outside Tucson.

Stinknet seed can be spread by road construction equipment. Stinknet was found at a road construction site along Highway 85 running through Organ Pipe Cactus National Monument in 2005 (SEINet 2020). As this was an isolated infestation with no plants found north or south along Hwy 85, the most likely source was from soil contaminated with stinknet seeds and brought in by the construction vehicles. This population of stinknet has since been eradicated. In the vicinity of Casa Grande, early roadside infestations may have been introduced by road construction crews (Dan James, professional roadside hydroseeder and owner of Desert Seeders, Gila Bend, AZ, personal communication).

Ana Lilia Reina-Guerrero collected the first stinknet plant in Tucson in 2015 on an empty lot adjacent to the I-10 Prince Road

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Figure 7. Roadside stinknet infestation forming seed heads while plants continue to bloom in the distance, outside of Ben Avery Shooting Facility, 28 March 2020. *Photo courtesy Michael Chamberland*

Figure 8. Stinknet I-17 off-ramp infestation, March 2017. *Photo courtesy John Scheuring*

## The Short Journey from Stinknet Introduction *continued*

off-ramp. The infestation was already well established on recently disturbed soil. The lot had been the road construction equipment yard of the I-10 road widening project between 2011 and 2014. The leased heavy equipment came from Phoenix and was certainly the source of the infestation. By 2020, that infestation had become “Tucson’s stinknet ground zero” spreading along the adjacent Santa Cruz River and Silverbell Golf Course, the Union Pacific railway tracks, and parcels and roadways 15 blocks away.

### The Role of Winter Precipitation in Stinknet Spread and Detection

The bright yellow flowers of stinknet are conspicuous and easily noted by botanists and collectors. Stinknet is not easily confused with any native Arizona plants. Between 1997 and 2004 only three locations had been documented in Arizona. In 2005 alone there were 24 locations reported (SEINet 2020). The 2005 winter season was ideal for stinknet germination and growth as there was sustained above average rainfall from October through May. The Phoenix airport received 8.2 inches of rainfall, which was 3.6 inches of rainfall over and above the average of 4.6 inches falling between October and May.

Between 2005 and 2015, stinknet slowly expanded throughout Maricopa County, largely unnoticed by the public. Due to early season rains favoring stinknet emergence, stinknet became visible along medians and properties in the Phoenix Metro Area during the winter of 2016.

The wet winters of 2019 and 2020 produced visibly extensive stands of stinknet along Arizona highways and urban public lands in Maricopa County, including along highways all the way southwards to Tucson, and westwards to Buckeye (Figures 8 and 9).

The high rainfall years of 2005 and 2019, and 2020, with well above-average winter rains, were seasons when stinknet gained ground, built biomass and increased seed production to further its spread across the state (Table 1).

Table 1. 2019 and 2020 Phoenix and Tucson airport rainfall deviations from average in the Winter Seasons, October 1 to May 30 (Crimmins 2020a and b).

Year	Phoenix winter rain deviation above average (4.6 inches)	Tucson winter rain deviation above average (5.0 inches)
2019	+4.3	+4.5
2020	+1.2	+0.6

### Lessons to be Learned

When stinknet was first establishing in Arizona, it was already known as a weed in California. Stinknet proliferated surprisingly fast in Arizona’s Sonoran Desert, in a climate quite different from the habitats stinknet occupied in California. The two infested areas remain separated by a wide stretch of desert.

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# The Short Journey from Stinknet Introduction *continued*

As stinknet became discussed in Arizona, the common name “globe chamomile” was popularly used. When bouquets of stinknet started to show up in 2017 for sale in Phoenix area farmers’ markets, labelled as “wild chamomile,” weed experts expressed concern about this common name. In addition to having no properly documented medicinal use, reports of allergic reactions drew concern. People with sensitive skin complain about skin burns and rashes after handling stinknet plants. During flowering, some people complain of respiratory difficulties. These same reactions are well known to the people of Cape Province, South Africa, where stinknet is native (A. Schauss, CEO of AIBMR Life Sciences, Guest Lectured in Capetown Province, South Africa, personal communication). A switch to the name stinknet was encouraged to convey better the undesirable aspects of the plant, to disassociate it from herbal chamomile, and to be consistent with California where the name stinknet was already in use. The name stinknet has now been widely accepted in Arizona.

The proliferation of stinknet along roadways and its detection at recreation locations emphasizes the role of vehicles and human activity in facilitating its spread. Movement of soil contaminated with stinknet seed is another major source of infestation, as witnessed by the road construction site infestations along Highway 85 in 2005 and in Tucson in 2015.

Once stinknet becomes well established, its control is not possible without chemical applications. Roadside infestations must be controlled as soon as stinknet appears in order to thwart rapid expansion of the outbreak. Post-construction weed control must be implemented for at least three years to exhaust the soil seed bank. As soon as stinknet appears in a neighborhood, it must be eliminated to stop its further spread.

With the sudden appearance of stinknet, there was no information on chemical control methodology available. Stinknet treatment in Arizona was pioneered by one professional herbicide applicator in the private sector, in response to requests by property owners experiencing infestations. Effective treatments were determined by trial and error. Currently, volunteer weed specialists are conducting ad hoc experimental trials to determine the most effective herbicide controls. With the growing threat of new invasive weeds in Arizona, field control research

support is needed from our public institutions.

In January 2020, stinknet was added to the Arizona State Noxious Weed List, together with a set of other serious weeds warranting listing. This came after a delay of 11 years in which updates to the Weed List were prevented by a moratorium on new state regulations (Ducey 2020). Public awareness and concern about emerging noxious weeds needs to be matched by political concern and support for action.



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Figure 9. Stinknet in the I-10 median at Riggs Road, March 2020. Photo courtesy John Scheuring