

Ecology and Management of Tall Buttercup (*Ranunculus acris* L.)

By

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Figure 1. Tall buttercup

Abstract

Tall buttercup is a perennial forb native to central and northeastern Europe where it is a weed of old pastures and hay meadows. Stems grow up to three feet tall (about one meter) with deeply-lobed leaves (three- to five-lobes) on the lower stem and leaves reduced in size with three to four narrow segments on the upper stem. Flowers are bright yellow and about one inch (2.5 centimeters) in diameter. Tall buttercup reproduces both by seed production and by short splitting rhizomes. First found in the Bozeman area in Gallatin County in 1916, it currently is reported from 23 counties in western and central Montana. Ingestion of tall buttercup by grazing animals causes blistering of the lips and tongue, intestinal disorders, and potentially fatal ventricular fibrillation and respiratory failure as a result of the enzymatic breakdown of ranunculin, a glycoside toxin.

Tall buttercup is listed on the Milestone® and Clarity® herbicide labels. It can also be controlled using the non-selective herbicide glyphosate. Consult with your extension agent or county weed coordinator for herbicide recommendations in your area. Always read and follow label instructions. Currently there are no biological control insects available to manage tall buttercup. However, research shows the *Sclerotinia* fungus reduced dry weight in dairy pastures. Mowing may reduce seed production. Tall buttercup generally increases under grazing, including sheep grazing. Fertilization of pastures does not affect tall buttercup, but it may promote grasses.



Figure 2. A line drawing of the root, stem, leaves, inflorescence, flower and seed of tall buttercup (Britton and Brown 1913, available from USDA PLANTS Database)

PLANT BIOLOGY

Identification

Tall buttercup is a perennial that grows from a stout, abruptly ending root stock (praemorse). It has a short, thick rhizome capable of splitting to form daughter plants in clumps reaching about three feet (one meter) in diameter. There are thick roots on the underside of the rhizome and wiry, persistent fibers from the vascular bundles of decayed leaf petioles on the upper side. Axillary buds form on the rhizomes at the tightly-spaced nodes from which the basal leaves grow.

Basal leaves grow directly from the rhizome or root crown and have petioles up to eight inches (20 centimeters) in length. Leaf blades are one to three inches (3-8 centimeters) long, are broadly pentagonal in outline, but can also be ovate or heart-shaped. They are more or less deeply divided into three palmate lobes that are each divided again two to three times into acute segments (see Figure 2). There can be 40 to 50 basal leaves.

Freely branching, erect flower stems are one to three feet (30 to 100 centimeters) tall, and there may be one to several stems per plant. Hairs on the stem are sparse to copious, and soft and spreading or appressed to the stem. Similar hairs are on the leaves, leaf petioles, and sepals. The stem leaves resemble the basal leaves but are smaller, alternate in arrangement along the stem and reduced upward to three- to five-lobed bracts (see Figure 2). The upper leaves lack petioles.

The regular flowers have radial symmetry and form on the branch ends in cymose inflorescences (see Figure 2). Flower pedicels can be up to five inches (12 centimeters) long and are hairy. The five floral sepals are bent downward (reflexed), about one-quarter inch (4-6 millimeters) long, greenish, with long, soft, spreading hairs. The sepals shed early during flowering. There are usually five (but as many as eight) glossy petals which are typically bright yellow, but may be pale yellow or white. Each petal is approximately one-half inch (10-14 millimeters) long and roundish

in shape. There is a nectary about one millimeter long at the base of the inner surface of the petal. Thirty to 70 stamens surround the 15 to 40 pistils that are on a globe-shaped receptacle. The fruit is a small (two to three millimeters long), dry walled achene containing a single seed (see Figure 2). Achenes are roundish, compressed, and smooth with a prominent keel and a hooked beak at the tip.

There are a number of infra-specific taxa within the tall buttercup species. The most widespread subspecies is *R. acris* subsp. *acris*. It is most likely the subspecies found throughout Montana. It varies in stem and petiole hair characteristics, petal and achene size, and the degree of leaf dissection.

Life History

Tall buttercup is a true perennial, reproducing by both rhizomes and seeds. In late winter and early spring, 40 to 50 new leaves form rapidly at the apex of elongating rhizomes. After basal leaf formation, there is a leafy phase indicated by a delay between the growth of the last leaf and the growth of the flowering stem. Leaf area peaks at this time, and declines thereafter.

Development of flower buds begins in late summer the year before flowering and is promoted by low winter temperatures. Flowering occurs in late spring, peaks in early summer, and typically lasts two months. The duration of flowering can be extended by high soil moisture. In Norway, flowering continued into early autumn, and in New Zealand flowering occurred all year. Seed set begins in late summer and continues into autumn. Cross pollination is required for seed production because pollen is produced after the stigmata of the same flower are receptive, thus seed set can be limited where pollinators are lacking. The basal leaves begin to die at flowering, and the flower stems die after flowering.

When grown under cultivation, tall buttercup will flower in the first year. However, naturally growing plants may not flower until the second year or for up to 10 years. The reproductive potential does not decline with age at least up to 10 years. Flowering is reduced at high population densities. Plants flowering late in the season are less likely to flower the following year, most likely because of insufficient accumulation of energy reserves needed to flower. Tall buttercup generally has low fecundity, typically producing less than four flowers per plant. The exceptions are on sites with low species diversity or high soil fertility.

Seed survival rate in the soil is generally less than two years. Seed bank studies indicate the proportional contribution of tall buttercup to the soil seed bank mimics its proportional contribution to the plant community. Seed bank densities have been reported at three seeds per square yard in Quebec, 300 seeds per square yard in England, to 2,600 seeds per square yard in a dense population in New Zealand. Most seeds accumulate in the top inch (2.5 centimeters) of the soil and are lost mainly through germination. Seeds buried deeper than one inch can survive longer than two years. One study found 20% of the seeds buried below 1.5 inches (4 centimeters) survived for 16 years, and another study found seeds in the top 1.2 inches (3 centimeters) survived 10 years, even after tall buttercup had disappeared from the plant community.

Many tall buttercup seeds germinate within their first year, but less than one percent of the seedlings survive. Survival increases under disturbance that removes neighboring vegetation. Both well-drained and waterlogged soil conditions reduce seedling recruitment. The survival of plants produced from rhizomes is also below one percent. There are variable reports on the lifespan of tall buttercup ranging from four years on the grasslands of Wales to 14 years in Russia.

Reproduction by Rhizomes

Rhizomes reproduce after flowering or removal of the flowering stem by cutting, defoliation, disease, livestock trampling, or other disturbances. Lateral buds on the rhizomes are released from the apical dominance of the main stem and grow to form new rhizomes that later separate from the parent. New shoots re-impose apical dominance over the remaining buds on the rhizome, ensuring a continuous supply of buds capable of regenerating new shoots. Regeneration from rhizomes is reduced in species-rich plant communities.

Response to Competition

The growth and reproduction of tall buttercup is reduced under plant competition. A field study in Sweden found tall buttercup production was greatly reduced when grown in species mixtures suggesting diverse plant communities may competitively suppress the weed. The investigators related this to the relatively small stature of tall buttercup (i.e., the basal leaves of tall buttercup were overtopped by taller growing grasses such as orchardgrass – *Dactylis glomerata* and reed canarygrass – *Phalaris arundinacea*). They also noted that tall buttercup did not respond to increased species richness by increasing its stature. However, it may adapt to low-light intensities by increasing light-harvesting efficiencies under high-nitrogen conditions. Population increase by rhizome reproduction is a strategy of tall buttercup to reduce interspecific competition by excluding other species within a colony of ramets.

Habitat

In its native range, tall buttercup is common and abundant in damp meadows and pastures on calcareous or neutral substrata. On the British Isles it is frequently found on rock ledges, gullies, and occasionally on mountain top detritus at elevations of 4,000 feet. On Dutch river flood plains, the habitat preference of tall buttercup is the intermediate position on the elevational gradient in a zone with approximately 30 days of flooding per year. Tall buttercup can tolerate low-oxygen conditions created by flooding for 30 days by the formation of air storage aerenchyma cells in the roots. In Montana, it has been found predominantly in moist fields, meadows, pastures, and grasslands, and in irrigated and sub-irrigated meadows. It has also been found along rivers, streams, and lakes; in borrow pits, along roads with gravelly substrata, along irrigation ditches, in parking lots and in gravel pits. It has been collected from elevations as high as 8,400 feet (2,500 meters) in Carbon County.

Spread

Tall buttercup spreads short distances (three to five feet) by the splitting of rhizomes and seeds dropping from parent plants. Seeds have no mechanism for long distance dispersal other than the short-hooked beak at the tip of the achene which allows them to be carried long distances in the pelts of animals. Seed can also be transported in soil stuck to animal hooves, and when ingested, in the gut of grazing animals. A large portion of seeds fed to cows were still viable after being voided in dung, and one study estimated one cow could disperse about 9,400 seeds during a 165-day grazing season. Other long distance dispersal mechanisms include contaminated hay, farm equipment, water currents, clothing and shoes.

Impacts

Tall buttercup is usually avoided by livestock because of the glycoside ranunculin, thereby reducing the grazing capacities of pastures. When ingested, it causes blistering of the lips and tongue, intestinal disorders, and ventricular fibrillation and respiratory failure, which can be fatal. Milk from dairy cattle that have eaten tall buttercup is bitter. This flavor can persist in butter made from the milk. Dense clones of tall buttercup crowd out native and non-native pasture plants reducing forage capacity and plant diversity.

MANAGEMENT ALTERNATIVES

Herbicide ^{1/}

Tall buttercup is listed on the Milestone® (aminopyralid) and Clarity® (dicamba) herbicide labels. Consult your local county extension agent or county weed coordinator for herbicide recommendations in your area. Always check the herbicide label to confirm formulation and proper usage of the product before applying. Always follow label instructions to reduce toxicity or other unintended risks to humans and the environment, and to confirm potential grazing and re-planting restrictions. Optimum timing for herbicide application is during the leafy phase in late spring prior to flower-shoot growth. This is a period of active growth and the time of greatest leaf area for herbicide absorption. Tall buttercup populations resistant to the phenoxy herbicide MPCA have been found in New Zealand. To avoid the development of herbicide resistant populations, integrate herbicidal control with other control methods and use herbicides with different modes of action.

Hand Pulling

Hand pulling and digging to extract all of the rootstock may be an effective method to temporally reduce small-scale infestations and scattered plants, either as new invaders or those persisting after herbicide treatments. However, any rhizomes left in the soil will regenerate into new plants and follow-up control will be needed to target those plants and plants regenerating from the soil seed bank. Pulling rosette and flowering plants will reduce seed set.

Mowing

Mowing timing and frequency for tall buttercup management should promote competitiveness of desirable pasture plants and reduce tall buttercup flowering. For example, in red fescue dominated dry valley meadows in Russia, mowing reduced flowering of tall buttercup. Frequent mowing reduced the occurrence of tall buttercup in meadows and grasslands in Europe. However, frequent cuttings in Slovenia reduced the competitiveness of tussock grasses and enabled tall buttercup encroachment.

^{1/} Any mention of specific products in this publication does not constitute a recommendation by the NRCS. It is a violation of Federal law to use herbicides in a manner inconsistent with their labeling.

Tilling

Rhizomes and seeds of tall buttercup can regenerate populations after tillage. The disturbance of tillage can create a favorable environment for tall buttercup growth and reproduction by reducing competitive perennial plants. Therefore, tillage has the potential to spread tall buttercup and is not recommended unless integrated with herbicide management and followed by revegetation with desired, competitive plants.

Irrigation

Tall buttercup is commonly found in moist meadows and pastures including irrigated and sub-irrigated fields. Where tall buttercup invades irrigated pastures and hayland, carefully planned irrigation management will stimulate the competitiveness of the forage crop, and when combined with nutrient, forage harvest, and grazing management practices will help prevent the re-establishment of tall buttercup after other control practices are applied. Because tall buttercup can tolerate up to 30 days of flooding, flood irrigation may favor it over less flood-tolerant pasture plants.

Fertilization

Fertilizer applications to deteriorated pastures in Austria had little effect on the abundance of tall buttercup. However, other studies in Europe showed applications of nitrogen, phosphorus, and potassium reduced the relative abundance of tall buttercup by increasing the proportion of palatable grasses. These contradictory results indicate there may be a trade-off between competitive suppression of tall buttercup and its ability to compensate for reduced light levels resulting from overtopping competitors. On cultivated pastures and hay meadows, nutrient management is important to maintaining the competitiveness of desired perennial grasses, but management of the competing plants to optimize their vigor is equally important. Nutrient management combined with judicious use of herbicides and crop rotation is recommended where tall buttercup invades non-native pastures and hay meadows.

Prescribed Burning

Tall buttercup is most commonly found in moist meadows and pastures where fire is not commonly used as a management tool. In addition, tall buttercup can regenerate from rhizomes and seeds in the soil after a fire. However, fire is sometimes used to maintain vigor and density of grassland communities by burning excess plant litter and possibly increasing soil fertility. Fire can be used as a preventative measure or in combination with other control methods to reduce tall buttercup populations.

Grazing Management

Several studies suggest that tall buttercup increases with grazing. In northern Finland, tall buttercup increased when sheep were introduced into abandoned semi-natural grasslands. In Iceland, tall buttercup increased in fields that were grazed in the spring. In Britain, tall buttercup increased in abundance with pasture age, cropping for hay, and with overgrazing. In these studies, litter removal, exposure of bare ground, and suppression of competitive grasses were believed to facilitate the increase of tall buttercup. However, in New Zealand, tall buttercup was less prevalent

in sheep pastures than in dairy pastures, but it is not clear if this is due to sheep grazing tall buttercup or the relative impact of the different management systems on other competitive pasture plants.

Tall buttercup contains the glycoside ranunculin which deters grazing by livestock and, when ingested, causes potentially fatal disorders. Further studies are needed to determine the feasibility of using sheep or goats to control tall buttercup. However, prescribed grazing to promote the competitiveness of desirable pasture forage plants will prevent tall buttercup invasion and re-invasion after weed control. Spring grazing is not recommended because it is likely to favor tall buttercup by removing the shading canopy of competitive plants when tall buttercup leaf area is greatest.

Biological Control

Tall buttercup is host to insects in its native range that may contribute to its population regulation. However, at this time, there are no insects available as biological control agents in North America. Tall buttercup is host to the naturally occurring soil fungus, *Sclerotinia sclerotiorum*. A New Zealand study found one virulent isolate of *Sclerotinia* temporarily reduced tall buttercup total dry weight by 57 percent, suggesting this pathogen may reduce the invasiveness of this weed.

Integrated Pest Management (IPM)

Tall buttercup is predominantly a weed problem on moist hay meadows and pastures. For severe infestations, the goal of integrated weed management is to increase the time intervals between initial herbicidal control and subsequent reapplications. This is best accomplished by encouraging a diverse plant community with a strong component of grasses with tall stature. Prescribed grazing to maintain vigorous grasses is fundamental and spring grazing is discouraged to ensure a shading canopy when tall buttercup leaf area peaks. On decadent meadows and pastures, apply crop rotation to provide weed control and to re-establish vigorous grass and legume hay and pasture species. On irrigated pastures and hay meadows, flooding is discouraged as it will favor tall buttercup over less flood-adapted grasses. Nutrient management should avoid over application of nutrients as high nutrients may facilitate the adaptation of tall buttercup to photosynthesis under low-light conditions of a shading canopy. Persistent hand pulling and grubbing of rhizomes may be substituted for herbicide application on small patches.

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