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Kudzu-Vine, *Pueraria lobata* (Willd.) Ohwi

Leguminosae (Fabaceae)

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I. Nomenclature: A) *Pueraria lobata* (Wilid.) Ohwi (Fig. 1); B) kudzu-vine, kuzu, zoku; C) Synonyms: *Pachyrrhizus thunbergianus* Sieb. & Zucc. nom. superfl., *Dolichos lobatus* Willd. *D. trilobus* Houtt non L., *Pueraria thunbergiana* (Sieb. & Zuce.) Benth., *P triloba* (Houtt) Makino.

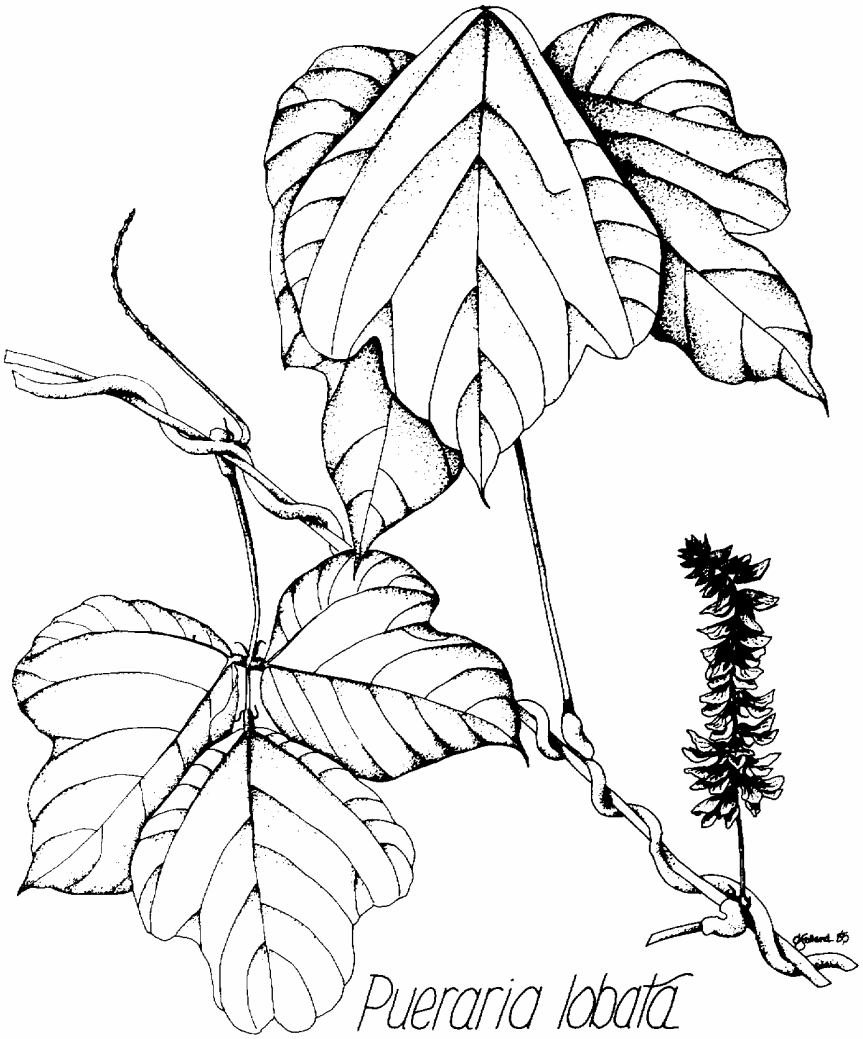

Fig.1.. Kudzu-vine, an adventive plant from Asia, has become a weed problem in some regions of Pennsylvania.

II. History: Pennsylvania appears to have been the first state in the United States to have received kudzu-vine. In 1876 the Japanese pavilion of the Philadelphia Centennial Exposition displayed live kudzu (Shurtleff and Aoyagi 1977). It was also a part of an exhibition at the New Orleans Exposition in 1883. It was soon used as a shade plant for southern homes (Miller and Edwards 1983). By the 1900's many people were involved in kudzu promotion projects. In 1902 David Fairchild, botanist, plant explorer for the USDA, and philanthropist who wrote "The World Was My Garden," planted kudzu seedlings on his Washington, D.C. property. To his dismay the vines sprawled over bushes and pines, smothering and bending them to the ground. In 1902 Mr. C. E. Pleas, of the Florida panhandle town of Chipley, planted kudzuvine; by 1910 it had grown onto 35 acres. So convinced of its merits, in 1925 he wrote a pamphlet entitled "Kudzu-Growing Forage of the South." For more than 40 years Pleas promoted kudzu culture with missionary zeal. In 1907 kudzu was part of an agricultural exhibition in Jamestown, VA. The Alabama Agricultural Experiment Station (Auburn), in 1917, started kudzu fodder-value research. In 1920, John Rigdon, the pioneer conservationist and agricultural agent for the Central of Georgia Railroad, convinced that kudzu hay would provide additional freight to be shipped by rail, launched a campaign in its favor. The railroad responded by undertaking a vast project that included distribution of free plants and technical literature on how to cultivate kudzu for animal feed. From 1910 through the 1930's kudzu was used for livestock feed in many states. Thus, by the mid-1930's kudzu had appeared in nearly all of the states east of the Mississippi from Pennsylvania to Florida. Its move as far west as Texas and its pululation were in progress.

From the mid-1930's kudzu experienced a burst of popularity (Shurtleff and Aoyagi 1977). The Soil Erosion Service, established in 1933 by Congressional action, promoted *Pueraria lobata* for erosion control. (This is the agency that became the Soil Conservation Service (SCS) in 1935). The Tennessee Valley Authority dam projects utilized kudzu as a major erosion control agent. The Civilian Conservation Corps, farmers, agricultural agents, and others planted millions of seedlings; the U.S. government offered assistance payments to farmers for planting it; USDA and state agricultural extension services provided literature claiming its merits; and mail order catalogues made kudzu readily available. By 1940 SCS nurseries are reported to have produced over 73 million seedlings. In a post-depression America, where dust bowls, boll weevils, erosion, low prices for agricultural products, and farm foreclosures caused abandoned lands, kudzu seemed to be a sign of hope. It grew rapidly and produced nutritional, lush, green foliage. In 1943 Channing Cope, a writer and radio talk show personality, organized the Kudzu Club of America, which could boast later of 20,000 members. *Readers Digest*, *Time* and *Newsweek* ran popular stories on the vine. In 1945, 500,000 acres of the southeastern U.S. were cultivated with kudzu; by 1948 Georgia alone could boast of 480,000 acres.

In the fervor, proponents ignored kudzu's rampant growth habits. By the 1940's it was becoming apparent that kudzu was too aggressive; in 1953 the USDA removed kudzu from the list of cover crops permissible under the Agricultural Conservation Program. In 1962 the SCS formally restricted recommendations for its use and in 1970 categorized kudzu as a weed. One reason was the difficulty in controlling it with conventional herbicide treatments (Tanner et al. 1980).

Miller and Edwards (1983) estimate that 2 million acres in the southeastern U.S. are infested with kudzu. It is reported to establish populations as far north as Pennsylvania, New York, and Connecticut; however; in these regions it has been slow in spreading. Recently the infestations have reached proportions that have drawn attention to the potential problem they pose.

III. Technical Characters: The genus *Pueraria* has more than a dozen species in the tropics of Asia (Ohwi 1965). *Pueraria lobata* is a perennial twining, trailing, coarse vine (Figs. 2-3) that scrambles over the ground and onto trees, telephone poles, etc; ***stems:*** whitish puberulent, elongate; hairs: brown, hispid, coarse spreading or reflexed; ***leaves:*** pinnately trifoliate, large; stipules: green, lanceolate, subacute, medifixed, 15-20 mm long; petioles: long, swollen at the base into a conspicuous pulvinus; leaflets: green, pubescent with the adaxial surface appressed-hirsute, abaxial surface densely whitish pubescent; entire to bi- or trilobed (Fig. 4), the terminal leaflet rhombic-orbicular; 10-15 cm long and often equally wide, abruptly acuminate and on a long petiolule (lateral leaflet petiolules reduced to swollen pulvinules); ***leaflet stipules*** (stipulules): green, linear, acicular to spiral; ***inflorescence:*** erect axillary racemes, densely many-flowered, sessile or short-peduncled, 10-20 cm long; ***flowers:*** reddish to violet purple, with a yellow throat, 18-20 mm long; ***floral bracts:*** linear; 8-10 mm long, setaceous, long-pilose, caducous; ***braeteoles:*** setaceous, caducous; ***calyx:*** 4-lobed, the upper triangular; the lower 1.5-2 times as long as the tube, linear; ***stamens:*** monadelphous; ***style:*** beardless; ***legumes*** (seed pods): not produced in abundance in PA; flat, with densely dark brown spreading-hispid hairs; linear, 6-8 cm long, 8-10 mm wide; roots: in tropical climates 3 m long and 1 m in diam., deep; ***phenology:*** in more tropical climates and the southeastern U.S. it flowers July-September. In PA it has been observed flowering late summer and fall. One population investigated for this study flowered throughout September; ***distribution:*** PA: Allegheny (Pittsburgh), Berks (Dreibelbis, Reading), Chester (Kennett Square), Lebanon (E of Rts. 322-72 split), Lancaster (Holtwood Station), Lehigh (Fogelsville), Montgomery (W. Conshohocken), Northampton (Freemansburg, Point Phillip), and Philadelphia (Fairmont Park) counties. These are often locally dense populations of scattered frequency. It is most commonly encountered in woodlots, parks, thickets, along fence rows, clearings, and near homes from where it escaped.

Fig. 2-3. Locally heavy infestations of kudzu-vine showing the strangling growth habit.

Fig. 4. Compound leaves of kudzu-vine detailing entire, bi- and trilobed leaflets.

IV. Diagnostic Characters: The trifoliate leaves, with the terminal leaflet (3 to 6 inches long) on an extended leaflet stalk (Fig. 1) and the lateral leaflets originating from short, swollen, stalks, are unmistakable. The dense stands of tangled vines, twining and draping other vegetation (Fig. 3) and bearing upright clusters of purple, fragrant, "pea-like" flowers (1/2 to 3/4 inch long), are characteristic of kudzu-vine. Flat, hairy seed pods (when produced) measure 2 to 4 inches long.

V. Confused Taxa: There are no plants in the Commonwealth that can be readily confused with kudzu-vine. The reader familiar with garden pole bean varieties, on encountering *Pueraria lobata,* will understand readily the simile: "Kudzu is like a monstrous 'Kentucky Wonder' gone wild." Everett (1981) light-heartedly suggests that it could have provided inspiration for the famous vegetable described in "Jack and the Bean Stalk." Other woody (or semi-woody) strangling vines that are encountered in Pennsylvania include *Lonicera japonica* Thunb. (Japanese honeysuckle), *Celastrus scandens* L. and *C. orbiculatus* Thunb. (bittersweet), *Rhus radicans* L. (poison-ivy), and *Vitis* spp. (wild grapes). All of these vines have simple leaves (not composed of leaflets) except poison-ivy. None of these produce erect deep-violet, purple flower clusters. Wisteria is a woody vine that develops purple flowers; however, they are light lavender and hang down in grapelike clusters. Wisteria leaves are composed of 9-15 leaflets in W *frutescens* (L.) Poir. and W. *macrostachya* Nutt., and 15-19 leaflets in W *floribunda* (Willd.) DC., never of 3 leaflets as is found in kudzu.

Polygonum perfoliatum L. (mile-a-minute, detailed in Weed Circular No.1 in the Bureau of Plant Industry series), a herbaceous vine that drapes over vegetation in a fashion similar to kudzu, has considerably thinner stems that do not twist in close coils as found in the growth habit of kudzu. Also, mile-a-minute stems are barbed and the leaves are simple.

VI. Natural History: Originating in China (Edwards 1982), kudzu is recorded occurring in Japan as early as 600 AD, and later from Korea. Plants can be grown from seeds, but it is more commonly propagated by root division and cuttings (Everett 1981).

The optimal temperature for photosynthesis in *Pueraria lobata* is about 30 ^{0}C or 86 ^{0}F (Wolf 1969). Therefore this species flourishes in the southern states; however; it is "hardy" as far north as southern NY. In Pennsylvania, winters kill many of the stems to ground level; new growth appears each spring. The plant is a prolific grower and various rates are reported in the scientific literature. Edwards (1982) states that stems grow 10-30 m (32 to 98 ft) long, and tendrils 18 m (60 ft). Vines can grow as much as 0.3 m (1 ft) in 24 hours.

The flowers open in late summer/fall and provide an energy source for bees during a period when food supplies are waning. A recent library search resulted in virtually no references for biological information or life history studies for kudzu in the northern extension of its range. The need to critically investigate this recent addition to our flora is great. At present, land in Alabama, Georgia, Mississippi, Tennessee, the Carolinas, Kentucky, Virginia, Maryland, eastern Texas, and Oklahoma have kudzu as a problem weed. In Pennsylvania it is becoming a pest.

VII. Economic Importance: A) Beneficial. The virtues of *Pueraria lobata* are better appreciated by the Asiatic peoples than by Americans. Tanner et al. (1980) list the agricultural and industrial uses of kudzu: leaves and vines for a high protein forage crop; soil erosion control; roots for the manufacture of starch; oriental medicine (for its relieving thirst, antifebrile, antiemetic, antispasmodic and counter poisonous properties, for colds, snake bites, and to counter alcoholic excess); for hay; woody, thicker vines burned with coal for production of steam in electric power plants; sugar source (starch conversion by amylase or other enzymatic processes to glucose and maltose), which could be used as a substrate for the production of lysine-enriched bakers yeast or further fermented to produce ethyl alcohol; fibers for the production of grasscloth wallpaper (as is now done in Korea); and for garment cloth, paper; fishing-line, and baskets. Kudzu has been used as an indicator of environmental quality (Sharma et al. 1980). The frequency of leaf stomata (pores) decreases in polluted habitats, while trichome (hair) frequency and length on the leaf surface increases with increasing environmental pollution. Shurtleff and Aoyagi (1977) extol its virtues and include 13 medicinal preparations and 70 recipes for its use. They utilize leaves, shoots, flowers, seeds, and roots in tempura, pressed salads, sautéed vegetables, and pickles. Kudzu fibers are used to stuff cushions, beds, and chairs. When burned, vines are reported to have mosquito-repellent properties. Other beneficial uses of kudzu include: as a source of methane; as a source of protein and free amino acids, flavonoids, and anthraquinones; placed on gardens as mulch or compost; and planted in barrels on the roof of buildings and allowed to grow so that it can serve as a natural coolant helping to reduce air-conditioning costs (Edwards 1982). B) Detrimental. In the United States kudzu is seen as undesirable. Because the plant has a thick tap root and a large reservoir of starch, it is difficult to kill with conventional herbicides or single applications. It is reported that growth is so rampant in the southeastern U.S. that an abandoned car can be covered with vines in a few weeks, and a vacant house completely overgrown in the course of a summer *(Time* 197^{1}6). In the southeastern U.S. kudzu preempts pine plantation establishment as well as agricultural production on thousands of acres (Miller 1982). It has recently been called one of the most widespread resource management problems in the upland parks of the southeastern U.S. (Bratton 1983).

VIII. Control: Past problems with herbicide control of kudzu are probably a result of improper timing in application, incorrect herbicide rates, and once-a year treatment without follow-up. It has been reported that late season application of Round-up' is more effective than early season; that too much foliar herbicide will "top kill" plants without killing the roots, while too little will "yellow" plants but they will survive; and that follow-up treatments are mandatory (Bratton 1983). Ornamentals: Roundup (glyphosate), rate: 1-5 lb ai (1-5 qt). Michael (1982) reports that DPX-6376, XRM-3972 (Lontrel), and Oust (TM) Weed Killer (formerly known as DPX-5648) gave more than 99% topkill for 3.5 months. Preliminary results of greenhouse tests on 1-year-old loblolly pine *(Pinus taeda* L.) seedlings indicate that Lontrel, Oust, and DPX-6376 are safe for foliar application at rates effective on kudzu. Oust appears to show substantial control and has the added benefit of pine tolerance (Miller and Edwards 1983).

Rangelands, permanent pastures: Banvel 10 G (dicamba), rate: 8-10 lb ai (80-100 lb l0 G), spot treatment 2.0-2.5 lb 10G/l000 sq ft, apply just before or during active growth of kudzu.

Noncropland: Acme Brush Killer 875 (2,4-D, mecoprop and dicamba), rate: (high volume) 2.17-8.68 lb ai (0.5-2.0 gal) in 100-200 gal of spray/A; (low volume) 2.17-8.68 lb ai (0.5-2.0 gal) in 15-25 gal of spray/A. Andon 101 (picloram + 2,4-D), rate: 0.5-4.0 gal product in 15-25 gal water. Amitrole-T (ammonium thiocyanate), rate: 2.0-4.0 lb ai (1.0-2.0 gal); retreatment will be necessary. Banvel 4-WS or Banvel Herbicide (dicamba), rate: (for suppression) 0.5-1.0 lb ai (1.0-2.0 pt); (for added stem control) 1.0-2.0 lb ai (1.0-2.0 qt); (stems and stem sprouts) 2.0-4.0 lb ai (2.0-4.0 qt); (stems and root sprouts) 4.0-8.0 lb ai (1.0-2.0 gal); retreatments may be necessary, but do not exceed 8.0 lb ai (2.0 gal)/A during a growing season. Banvel l0G (dicamba), rate: 8.0-10.0 lb ai (80-100 lb l0G); (spot treatment) 2.0-2.5 lb 10G/1000 sq ft. Reed 4-41 Brush Killer (2,4-D, mecoprop, and dicamba), rate: (high volume) 2.3-9.0 lb ai (0.5-2.0 gal) in 100-300 gal water; (low volume) 2.3-9.0 lb ai (0.5-2.0 gal) in 15-25 gal water. Reed 10-51 Brush Killer (2,4-D, mecoprop, and dicamba), rate: 2.11-3.69 lb ai (2.0-3.0 gal) in 100 gal water; apply 30-50 gal/A. Roundup (glyphosate), rate: (hand gun and high volume) mix 4 qt in 100 gal clean water; (boom equipment) use 2.0-4.0 qt in 20-30 gal clean water/A as broadcast spray; (aerial application) apply recommended rates per weed species in 5.0-15.0 gal of water/A on rights of way only; (hand sprayer) mix 3.0 oz (6 tablespoons)/gal of water and spray per 1000 sq ft. Tordon 101 Mixture (picloram + 2,4-D), rate: 1.25-10.0 lb ai (0.5-4.0 gal) when kudzu is actively growing; higher rates will be needed for kudzu control. Weedazol (amitrole), rates: 1.0-8.0 lb ai (2.0-16.0 lb); retreatments will be needed.

Other compounds and rates reportedly effective (Miller 1982) include: Tordon 10K (picloram) pellets at 5.9 lb ai/a; Spike 20P (tebuthiuron) pellets at 4.0 lb ai/a; Tordon 101 (picloram + 2,4-D) at 1.08 + 4.0 lb ai/a; Spike 80W (tebuthiuron wettable powder) at 8.0 lb ai/a; and Banvel 720 (dicamba + 2,4-D) at 4.0 + 8.0 and 3.0 + 6.0 lb ai/a. All will require follow-up spot treatments. Miller and Edwards (1983) suggest that amitrole (at least 3 applications required), 2,4-DP and 2,4-D are least effective for kudzu control while compounds containing picloram (e.g. Tordon 10K and Tordon 101) are the most effective products. One tablespoon of Tordon 10K per crown is recommended for spot treatments and can be used after any other initial broadcast treatment. Rainfall is required to activate the pellets, but excessive amounts may wash pellets from steep slopes. Tree planting should be planned at least 9 months after Tordon application, because of picloram residue.

Often the extirpation of kudzu-vine leaves bare soil that is prone to erosion. One study (Bratton 1983) suggests using Roundup in those areas to be revegetated with tree species. Short leaf pine *(Pinus echinata* P. Mill.), had the best survival rate; tulip poplar *(Liriodendron tulipifera* L.) was second best of those species studied. Recovery of native vegetation is an important consideration. The first two general applications of Roundup eliminated almost all vegetation in direct contact with the spray. Therefore, after the majority of kudzu is eliminated, the applicator should switch to spot treatments to allow native species to recover.

[1] *Disclaimer: when trade names are used, no discrimination is intended and no endorsement by either the authors or the affiliate institutions is implied.*

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