Kudzu

< Archive:BCIPEUS

Kerry O. Britton, David Orr, and Jianghua Sun in Driesche, F.V.; Blossey, B.; Hoodle, M.; Lyon, S.; Reardon, R. Biological Control of Invasive Plants in the Eastern United States. United States Department of Agriculture Forest Service. Forest Health Technology Enterprise Team. Morgantown, West Virginia. FHTET-2002-04. August 2002. 413 p.

Contents [hide]

Pest Status of Weed

Nature of Damage

Kudzu (*Pueraria montana* [Lour.] Merr. var. lobata [Willd.] Maesen and Almeida) was originally introduced into the United States as an ornamental vine at the Philadelphia Centennial Exposition of 1876. David Fairchild observed extensive use of kudzu as pasturage in Japan. In 1902, he planted seedlings around his Washington, D.C. home to explore their potential in the United States. By 1938, he became disenchanted with kudzu because it “grew all over the bushes and climbed the pines, smothering them with a mass of vegetation which bent them to the ground and became a tangled nuisance. I spent two hundred dollars in the years which followed trying to get rid of it, but when we sold the place there was still some kudzu behind the house….” (Fairchild, 1938). In 1907, kudzu hay was exhibited at Jamestown, Virginia. Mr. C. E. Pleas, a farmer in Chipley, Florida, was thrilled to accidentally discover the growth potential of kudzu, and that many animals on his farm liked to eat it. He became an enthusiastic promoter of kudzu, grew 35 acres to sell as a fodder crop, and sold rooted cuttings through the mail (Shurtleff and Aoyagi, 1985). In the 1930s and 1940s, kudzu was propagated and promoted by the Soil Conservation Service as a means of holding soil on the swiftly eroding gullies of the deforested southern landscape, especially in the Piedmont regions of Alabama, Georgia, and Mississippi. Farmers were paid $8.00 per acre by the Soil Erosion Service to plant kudzu, and more than 1.2 million acres were planted under this subsidized program. Kudzu seedling nurseries produced

and distributed more than 73 million seedlings between 1935 and 1941 (Tabor and Susott, 1941). In his 1949 book, Front Porch Farmer, Channing Cope presents kudzu as the panacea that will allow farmers to adopt a life of leisure and relaxation, as this new crop “works while you sleep.” Kudzu was widely promoted as a drought-resistant, high-nitrogen forage crop. Research in the 1930s examined optimum planting density, fertilization (Ahlgren, 1956), and the optimum time of mowing to maximize yield without depleting the kudzu root starch so much as to prevent regrowth each spring (Sturkie and Grimes, 1939). However, it proved difficult to bale. Direct grazing was used to some extent, but the vines are damaged by trampling, and this practice fell into disuse. In the 1950s, kudzu was recognized as a weed, and removed from the list of species acceptable for use under the Agricultural Conservation Program. In 1998, kudzu was listed by the U.S. Congress as a Federal Noxious Weed. Ornamental use accounts for the predominance of kudzu around many old, collapsed southern homesteads (Fig. 1). Erosion control plantings explain the extensive colonization of ravines in fields that once grew cotton or native forests, but have since been abandoned or turned into pasture. Although most spread is slow (apparently through local movement of infested soil), where kudzu exists it completely covers all other vegetation (Fig. 2). Estimates of kudzu infestation in the southeast vary greatly, from as low as two million (Corley et al.., 1997) to as high as seven million acres (Everest et al.., 1991).

Figure 1

Figure 2

Economic damage. Kudzu completely replaces existing vegetation. No information has been published on the resulting economic damage, and the following estimates rely upon the personal experience of Dr. Coleman Dangerfield (University of Georgia, forest economist). “Losses vary with the potential use of the land in an uninfested state. Where productive forest land has been overtaken, lost productivity is estimated at $48 per acre per year. The present net value of an average stand of pines grown on cutover land for 25 years in the southeast is approximately $650 per acre. Kudzu control costs exceed $200 per acre per year for five years. Thus, kudzu control for forest production is not economically feasible.” Dr. James Miller (USDA Forest Service plant ecologist, Auburn, Alabama), who has researched herbicides for kudzu control for the last 20 years, estimates control costs by power companies alone at $1.5 million per year.

Ecological damage. Few plants can survive once smothered by kudzu. It does not strangle competition, but simply blankets trees with a dense canopy, through which little light can penetrate. Kudzu’s competitive edge has been attributed to its resource allocation strategy (i.e., its very high ratio of leaf surface area to structural tissues) (Wechsler, 1974); a high rate of net photosynthesis; and diurnal leaf movements that maximize exposure of lower canopy leaves and reduce overheating of upper canopy leaves (Forseth and Teramura, 1987). There is little spread by seed, so expansion of kudzu patches occurs mainly by rooting of runners at nodes. Adventitious rooting gives rise to large storage tubers that can survive repeated herbicide treatments over many years (Miller, 1985; Moorhead and Johnson, 1996).

Geographical Distribution

Van der Maesen (1985) considered China, Indo-China, Japan, Malaysia, Oceania, and the Indian subcontinent the native range of the genus Pueraria. Despite repeated introductions, *P. montana* var. *lobata* was not known to have established in Africa. This variety was successfully introduced to South

America and Switzerland, as well as Queensland and New South Wales, Australia. Only in the southeastern United States is kudzu considered a serious pest.

Kudzu rarely occurs in the northeastern United States (Frankel, 1989), but is occasionally found from Connecticut to Illinois. In Illinois, more than 90 infestations have been documented (Wiedenmann, 2001). Kudzu is distributed south as far as Florida, and as far west as eastern Oklahoma and Texas. The most severe infestations occur in the piedmont regions of Mississippi, Alabama, and Georgia.

Background Information On The Pest Plant

Taxonomy

Kudzu is a perennial, semi-woody, climbing leguminous vine, of the tribe Phaseoleae Benth., subtribe Glycininae Benth. (Maesen, 1985). The kudzu species present in the United States is currently considered *Pueraria montana* (Lour.) *Merr*. var. *lobata* (Willd.) Maesen and Almeida (Ward, 1998). The most common synonyms are *Pueraria lobata* (Willd.) Ohwi, *P. thunbergiana* (Sieb. and Zucc.) Benth, and *P. hirsuta* (Thunb.) *Matsumura non* Kurz (Maesen, 1985). Characteristics that had been used previously to differentiate *P. montana* from *P. lobata* and *Pueraria thomsoni* (Benth.) are lobed leaflets, and the size of wing and keel petals, all of which can be quite variable. Maesen, therefore, treated these as varieties of one species, now called *P. montana* (Maesen and Almeida, 1988).

Hairy, sprawling vines emerge from a root crown and produce alternate, pinnately trifoliate leaves 7 to 25 cm long with three leaflets that may or may not exhibit shallow lobes. The vines grow up to 18m/yr in Georgia (Weschler, 1977). In late July to early September, plants in full sun produce flower clusters on upright, climbing vines, but rarely on horizontal vines. The flowers are borne in panicles, pea-like and purple, with a pronounced grape-like odor. Clusters of 20 to 30 hairy, bean-shaped pods are produced that contain tiny kidney-bean-shaped seeds. Seed pods are often empty, but may contain 10 to 12 seeds per pod (Tabor, 1942).

Biology

Seed production by kudzu in the United States varies from 0 to 1,800 seeds per m^2 soil surface, with higher values occurring where vines are climbing on structures (Thornton, 2001). The extremely low viability of these seeds has been assumed to be due to a lack of pollinators. However, Thornton demonstrated that there are a variety of both native and naturalized pollinators, the most important of which are native Hymenoptera. An exclusion cage study conducted in 1998 and 1999 revealed that low levels of kudzu seed viability were the result of arthropod damage. A concurrent inclusion cage study demonstrated that most of this damage was due to feeding by native Hemiptera (Thornton, 2001). Feeding by a naturalized Asian bruchid (Borowiecius ademptus Sharp) resulted in a small amount of damage in both years (Thornton, 2001).

Seedlings develop a woody root crown, with multiple runners and extensive tuberous roots. These roots contain carbohydrate reserves that permit the plant to survive repeated mowing and/or herbicide applications.

Analysis of Related Native Plants in the Eastern United States

No congeners of kudzu exist in the continental United States, but there are many important economic relatives (Pemberton, 1996). Kudzu's nearest relative in the United States is the soybean, *Glycine max* (L.) Merr., which also is of Asian origin. Native American members of the subtribe Glysininae are *Amphicarpaea bracteatea* (L.) Elliott ex. Nutall (American hog peanut), and four Cologania species: *C. angustifolia* Kunth, *C. lemmonii* Grey, *C. pallida* Rose, and *C. pulchella* Kunth. Native American genera in the tribe Phaseolinae that contain plants of ecological and/or economic importance include: *Phaseolus* (*P. vulgaris* L., *P. lunatus* L., *P. coccineus* L., and *P. acutifolius* Gray), *Strophostyles* (S. helvola [L.] Ell. and *S. umbellata* [Muhl. ex Willd.] Britton), and *Vigna* (*V. radiata* [L.] Wilczek, *V.*

unguiculata [L.] Walp. and *V. subterranea* [L.] Verdc.).

History of Biological Control Efforts in the Eastern United States

Area of Origin of Weed

The genus Pueraria contains seventeen species, distributed from Japan to northeastern India, south to eastern Australia, and east throughout Micronesia. Maesen's (1985) extensive examination of herbarium specimens led him to conclude that the kudzu in Japan, Korea, China north of Shanghai, and throughout the Phillipines, Malaysia, and Indonesia, was *P. montana* var. *lobata*. This is the variety that has been introduced to the United States, and South America. The range of this variety overlaps with that of *P. montana* var. *montana* in China south of the Yangtze River to Hong Kong. The distribution of *P. montana* var. *montana* also includes Vietnam, Burma, Laos, and Thailand. In these countries, and in southern China, *P. montana* var. *montana* shares its distribution with *P. montana* var. *thomsoni*. Specimens from northeast India were identified as *P. montana* var. *thomsoni* (Maesen, 1985).

Areas Surveyed for Natural Enemies

Pemberton (1988) reported an abundance of natural enemies of kudzu in China and Korea. Other researchers who visited China (DeLoach, Markin, and Schiff, pers. comm.) agreed and encouraged the initiation of a biological control research program. A climatic matching study showed that Anhui Province was the area of China most similar in climate to Atlanta, Georgia. Three systematic survey sites were therefore established in Anhui Province in 1999, in a program funded by the USDA Forest Service. Because of intensive agricultural land use, most of the kudzu that exists in China occurs in mountain regions, which could be cooler than indicated by current weather records. A fourth survey site was therefore established in Guangdong Province. In 2000, a site in Shaanxi Province was added to this survey.

Natural Enemies Found

A systematic survey for kudzu biocontrol agents was initiated in May 1999. At each of the four survey sites, five vines were chosen for sampling. Insect feeding, mating, and egg laying behavior was observed at 10-day intervals from May through November. Representative insects, and herbarium specimens of their feeding damage were collected and preserved. Defoliation was visually estimated in five 1 ft2 areas on each vine. The main vine and branches were monitored for feeding damage and gall formation.

The insects that fed on kudzu are still being identified. So far, seven out of 25 species (*Deporaus* sp., *Alcidodes trifidus* [Pasco], *Sagra femorata* [Drury], *Aristobia hispida* [Saunders], *Paraleprodera diophthalma* [Pascoe], *Anomala corpulenta* [Motschulsky], and *Epicauta chinensis* [Castelnau]) are known to feed on other crops (often beans), and therefore, have been dropped from consideration. Leaf-feeding beetles and sawflies that have no other known hosts have been identified. Two kinds of weevils were found to attack the succulent stems, and eight kinds of large beetles (Cerambycidae, Buprestidae, Scarabidae) lay eggs and develop as larvae in the main vines or roots.

Six fungal pathogens have been identified by collaborators at South China Agricultural University (Jiang et al.., 2000). One Phycomycete (*Synchytrium puerariae* P. Henning) Miyabe (Chytridiaceae) may hold some potential as a biological control agent. This pathogen has been reported on several Pueraria species from Japan, New Guinea, Java, the Phillipines, India, China, and California (specimen at National Fungus Collection, Beltsville, Marlyand (Karling, 1964), but further investigations are necessary to confirm its host specificity.

Host Range Tests and Results

Preliminary host range testing with soybean and peanut were begun in the summer of 2000. As far as

possible, initial host testing will be conducted in China, where quarantine facilities are not required for these native insects. In the later screening stages, extensive testing of American plants and crops will be conducted in U.S. quarantine facilities to ensure host specificity before any insect can be released.

Biological Control Using Pathogens Native to the United States

Pseudomonas syringae* pv. *phaseolicola. This bacterium is the causal agent of “halo blight” of bean and kudzu, causing a small necrotic leafspot surrounded by a bright halo of chlorotic tissue. Zidak and Backman (1996) reported that the bacterium could kill eight- to ten-week-old kudzu seedlings, but produced few, if any, secondary infections under fairly dry conditions in the field.

***Myrothecium verrucaria* (Albertini and Schwein.)** Ditmar: Fr. (Moniliales). This fungus has a fairly broad host range. Yang and Jong (1995) reported good control of leafy spurge, and eight other Euphorbia species using isolates of this fungus. Walker and Tilley found that an isolate from sicklepod (*Senna obtusifolia* [L.] Irwin and Barneby) affected a number of important crops, ornamentals, and weeds, representing six different families. Sprays directed to soybean stems and lower leaves did not reduce soybean dry weight (Walker and Tilley, 1997). It was patented for sicklepod biocontrol, and, although originally isolated from sicklepod, it is even more effective against kudzu. Two years of testing in Mississippi demonstrated that the fungus attacks leaves and stems, with greater activity at 25 to 40°C than at 10 to 20°C. Field tests demonstrated that 95 to 100% control could be achieved within 14 days of inoculation by girdling runner stems with this fungus, which produces asexual spores in a sporodochium, with a matrix suggesting dispersal by splashing rain. In inoculation studies, a surfactant was needed for good infection (Boyette, 2000). A patent for kudzu control has been applied for.

***Colletotrichum gloeosporiodes* (Penz.) Penz. and Sacc. in Penz. (Sphaeriales).** A strain of this widely-distributed pathogen was isolated from kudzu in Houston County, Georgia, and its virulence was increased by repeated selection for growth on Czapek Dox medium amended with kudzu extract. Field inoculations showed a synergistic effect was achieved by inoculations of spores together with 20% of the recommended rate of dicamba. The fungus attacks both leaves and vines, and produces asexual spores in a pycnidium (Farris and Reilly, 2000).

Recommendations for Future Work

For biological control agents from China, no-choice host testing on bean, peanut, and soybean are being initiated in China. Rearing systems need to be developed. In 2001, a wider range of plants common to the United States and China will be tested in China, and a host test list will be submitted to the Technical Advisory Group before United States quarantine tests are planned.

For native fungal pathogens, testing to develop stable formulations and demonstrate efficacy in field situations are recommended.

References

Ahlgren, G. H. 1956. Foreage Crops. 2nd ed. McGraw Hill, New York. 536p.

Boyette, C. D., H. K. Abbas, and H. L. Walker. 2000. Bioherbicidal control of kudzu with Myrothecium verrucaria. Phytopathology 90: S9.

Cope, C. 1949. Front Porch Farmer. Turner E. Smith and Company, Atlanta, Georgia, USA.

Corley, R. N., A. Woldeghebriel, and M. R. Murphy. 1997. Evaluation of the nutritive value of kudzu (Pueraria lobata) as a feed for ruminants. Animal Feed Science and Techology 68: 183-188.

Everest, J. W., J. H. Miller, D. M. Ball, and M. G. Patterson. 1991. Kudzu in Alabama. Alabama Cooperative Extension Service Circular ANR-65, Auburn University, Auburn, Alabama, USA.

Fairchild, D. 1938. The World Was My Garden: Travels of a Plant Explorer. Charles Scribner’s Sons, New York.

Farris, J., and C. C. Reilly. 2000. The biological control of kudzu (Pueraria lobata). Proceeding of the American Association for the Advancement of Science, Washington, D.C. 116: AB2.

Forseth, I. N., and A. H. Teramura. 1987. Field photosynthesis, microclimate and water relations of an exotic temperate liana, Pueraria lobata, kudzu. Oecologia 71: 262-267.

Frankel, E. 1989. Distribution of Pueraria lobata in and around New York City. Bulletin of the Torrey Botanical Club 116: 390-394.

Jiang, Z., P. Xi, J. Sun, and K. O. Britton. 2000. Diseases of kudzu in China. Phytopathology 90: S39.

Karling, J.S. 1964. Synchytrium. Academic Press, New York. 470 p.

Maesen, L. J. G., van der. 1985. Revision of the genus Pueraria DC. with some notes on Teyleria backer. Agricultural University, Wageningen Papers 85-1, Wageningen, The Netherlands.

Maesen, L. J. G., van der, and S. M. Almeida. 1988. Two corrections to the nomenclature in revision of Pueraria DC. Journal of the Bombay Natural History Society 85: 233-234.

Miller, J. H. 1985. Testing herbicides for kudzu eradication on a Piedmont site. Southern Journal of Applied Forestry 9: 128-132.

Mitich, L. W. 2000. Intriguing world of weeds. Kudzu (Pueraria lobata) (Willd.) Ohwi. Weed Technology 14: 231-234.

Moorhead, D. J., and K. D. Johnson. 1996. Controlling kudzu in CRP stands. Georgia Forestry Commission Conservation Reserve Program Note 15.

Pemberton, R. W. 1989. Northeast Asia as a source for biological control agents for North American weeds, pp. 651-657. In Delfosse, E. S. (ed.). Proceedings of the VII International Symposium on Biological Control of Weeds, March 6-11, 1988, Instituto Sperimentale per la Patologia Vegetale, Ministero dell' Agricoltura e delle Foreste, Rome, Italy.

Pemberton, R. W. 1996. The potential of biological control for the suppression of invasive weeds of southern environments. Castanea 61: 313-319.

Shurtleff, W., and A. Aoyagi. 1985. The Book of Kudzu: A Culinary and Healing Guide. Avery Publishing Group, Inc., Wayne, New Jersey, USA.

Sturkie, D. G., and J. C. Grimes. 1939. Kudzu: Its value and use in Alabama. Alabama Agricultural Experiment Station Circular 83, Auburn, Alabama.

Tabor, P. 1942. Seed production by kudzu (Pueraria thunbergiana) in the Southeastern United States during 1941. American Society of Agronomy 34: 389.

Tabor, P., and A.W. Susott. 1941. Zero to thirty mile-a-minute seedlings. Soil Conservation 8: 61-65.

Thornton, M. R. 2001. Arthropod fauna associated with kudzu (Pueraria lobata Willd.) in North Carolina. M. S. thesis, North Carolina State University, Raleigh, North Carolina, USA.

Walker, H. L., and A. M. Tilley. 1997. Evaluation of an isolate of Myrothecium verrucaria from sicklepod (Senna obtusifolia) as a potential mycoherbicide agent. Biological Control 10: 104-111.

Ward, D. B. 1998. Pueraria montana: the correct scientific name of the kudzu. Castanea 63: 76-77.

Wechsler, N. R. 1977. Growth and physiological characteristics of kudzu, Pueraria lobata (Willd.) Ohwi, in relation to its competitive success. M. S. thesis, University of Georgia. Athens, Georgia, USA.

Wiedenmann, R. N. 2001. The siege of invasive species in Midwest ecosystems, pp. 1-5. In Fosbroke, S.L.G. and Gottschalk, K.W. (eds.). Proceedings of the USDA Interagency Research Forum on Gypsy Moth and Other Invasive Species. January 16-19, 2001. Annapolis, Maryland. General Technical Report NE-285. U.S. Department of Agriculture, Forest Service Northeastern Research Station, Newtown Square, Pennsylvania, USA.

Yang, S. M., and S. C. Jong. 1995. Factors influencing pathogenicity of Myrothecium verrucaria isolated

from Euphorbia esula on species of Euphorbia. Plant Disease 79: 998-1002.

Zidak, N. K., and P. A. Backman. 1996. Biological control of kudzu (Pueraria lobata) with the plant pathogen Pseudomonas syringae pv. phaseolicola. Weed Science 44: 645-649.