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CHARACTERISTICS AND PERFORMANCE OF *Aeschynomene* spp. IN THE TROPICS AND SUBTROPICS

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ABSTRACT

Aeschynomene is a principally tropical genus with native American species distributed from 40°N to 35° along the Atlantic coast and from 28°N to 17°S on the Pacific coast. There are about 160 species but cultivars have been released only from *A. americana* (Aa; 'Glenn') and *A. falcata* ('Bargoo'). Bargoo is a spreading, prostrate, perennial adapted to infertile, well-drained sites. Glenn and Florida common Aa are upright annuals adapted to seasonally-flooded areas. Aa has been evaluated and used commercially to a greater degree than other species. Studies have shown that Aa plant hight at first defoliation is critical, and plant should be clippled or grazed when 30 to 40 cm tall to increase vigor, leafiness, and nutritive value of regrowth. Crude protein and *in vitro* digestibility of 20 and 70% have been observed for the grazed portion of well-managed Aa swards. Over 3 yr in Florida, steers gained 0.7 kg d^{-1} on grass-Aa pastures. Although used commercially in Florida, major limitations of Aa are that it is an annual and drought-induced stand failures are common.

Overview of the Genus

Aeschynomene is a tropical genus consisting of 160 species worldwide (Kretschmer and Bullock, 1980). The 74 species in the Americas are found from 40°N to 35°S on the Atlantic and 28°N to 17°S on the Pacific Coast. Outside of the Americas, most species are found in Africa, where the genus expresses its greataest diversity. Remaining species occur in Southeast Asia and the Pacific Islands.

Aeschynomene species grows at elevations from 0 to 2300 m. The genus contains annuals and perennials, and includes a continuum of plant forms from herbaceous to tree-like. Morphology ranges from erect to prostrate and includes trailing, viney, and rhizomatous forms (Kretschmer and Bullock, 1980). Kretschmer and Bullock (1980) provided a classification of *Aeschynomene* spp. of the Americas consisting of two sections, *Aeschynomene*, the hydrophytes, and *Ochopodium*, primarily xerophytes. About half of the species are hydrophytic and half xeric (Kretschmer and Bullock, 1980).

Species with Agronomic Potential

To date, only two species are planted as forage crops: A. americana and A. falcata. From these species only two cultivars have been released: 'Glenn' (A. americana) (Bishop et al., 1985a) and 'Bargoo' (A. falcata) (Cameron, 1986), both in Australia. A. indica ("budda pea") is naturalized in Australia and persists under heavy grazing (Bishop et al., 1985a). It seems that invasion of A. indica into heavily-stocked pasture in Australia has stimulated the evaluation program for Aeschynomene in that country, but to date A. indica is not cultivated (Bishop et al., 1985a). In Florida (USA), a local ecotype of A. americana, "Florida common" or "Florida commercial" is cultivated on about 5000 ha for hay and grazing (Kretschmer and Snyder, 1981), but no cultivars have been released.

Many of the 160 species are known only as herbarium specimens, but considerable effort has been made to evaluate many species and accessions within species, especially : A. americana. In south Florida, Kretschmer and Bullock (1980) grew and evaluated the total, readily available germplasm (160 accessions, representing 21 species). Quesenberry and Ocumpaugh (1981) evaluated 206 accessions, representing 18 species in north Florida. Bishop et al. (1988) in Australia evaluated 316 accessions, representing 29 species. The following 11 species are ones which these researchers have suggested for further evaluation of their agronomic potential (Table 1). A. americana, except for shrubby types, is not included in Table 1, but will be treated in greater detail later.

Table 1. Aeschynomene species (other than A. americana) of particular interest for further evaluation of their potential for forage crops.

	Researchers +		
	Kretschmer	Quesenberry	
Species	Bishop et al.	and Bullock	and Ocumpaugh
abyssinica	3‡		
americana (perennial only)	21		
brasiliana	10		16
denticulata		4	
elegans	9	10	9
evenia		8	8
falcata			7
fluitans		1	
histrix	9		
paniculata		12	
villosa	49	11	7

+ See references for citations.
‡ Number of accessions tested, not all of which had potential.

Aeschynomene abyssinica is a strong perennial that is recommended for arid areas (Bishop et al., 1988). It is native to Africa (Zimbabwe) and is an erect shrub (1 to 1.2 m tall) with stems 20 to 50 mm in diameter. When evaluated in Australia (21^{o} 10'S), ripe seed were produced by 270 d (Julian). Seed production and retention have been rated as 'fair'.

Aeschynomene americana perennial types appear to be native to Mexico, Panama, Brazil, and Colombia (Bishop et al., 1988). They are generally erect, ascendent shrubs with stems 50 to 100 mm in diameter. Seed production is fair (21^{o} 10' S) and retention good. Seed size and maturity are variable.

Aeschynomene brasiliana is annual or perennial and varies from a semi-erect to prostrate shrub, 0.25 to 2.2 m (Bishop et al., 1988) or 0.1 to 0.4 m tall (Quesenberry and Ocumpaugh, 1981). Flowering has been observed between 48 to 131 d at 21^{o} 10'S (depending on accession) (Bishop et al., 1988) and 258 to 317 d at about 29^{o} 45' N (Quesenberry and Ocumpaugh, 1981). In Gainesville, Florida, three of 16 accessions perennated and none reseeded (Quesenberry and Ocumpaugh, 1981). Most accessions have a sticky exudate on stem hairs that may affect commercial use (Bishop et al., 1988).

Aeschynomene denticulata is an erect herbaceous to suffruticose perennial adapted to marshy habitats (Kretschmer and Bullock, 1980). Plants vary from 0.5 to 1.25 m in height with lowest branches greater than 0.2 m above soil surface. At Fort Pierce, Florida, plants showed relatively little insect damage, and one out of three accessions perennated and produced seed.

Aeschynomene elegans is a perennial, varying from a prostrate-decumbent to erect plant adapted to well-drained soils (Bishop et al., 1988; Kretschmer and Bullock, 1980) and possessing a tap-root system (Quesenberry and Ocumpaugh, 1981). In north Florida, *A. elegans* exhibited both perennality and reseeding ability (Quesenberry and Ocumpaugh, 1981). At Fort Pierce, Florida, two out of 10 accessions perennated, but there was little mature seed produced (Kretschmer and Bullock, 1980). Accessions tested at Fort Pierce had little to no insect damage. This species is one of three suggested for further evaluation in all three reports (Table 1).

Aeschynomene evenia is an erect, perennial shrub (Kretschmer and Bullock, 1980). Two reports from Florida suggest the species has forage crop potential (Table 1). At Fort Pierce, all eight entries flowered (234 to 275 d), seed production was rated as moderate, and there was little insect damage (Kretschmer and Bullock, 1980). At Gainesville, all eight accessions flowered between 258 and 293 d, but none reseeded.

Aeschynomene fluitans is a herbaceous perennial adapted to marshy sites (Kretschmer and Bullock, 1980). The single accession tested by Kretschmer and Bullock (1980) was a short-day plant, which began flowering after 306 d. No seed was produced at this location (about 27° 15'N), but the accession was perennial and appeared as if it could withstand close grazing.

Aeschynomene histrix is a prostrate or sub-erect, herbaceous perennial (Kretschmer and Bullock, 1980). It is adapted to well-drained sites, where additional experimentation has been recommended (Bishop et al., 1988). In Australia (21° IO'S), flowering of nine accessions occurred from 88 to 111 d with mature seed available from 117 to 162 d. Seed set was fair to good, and seed retention was fair. At Ft. Pierce, Florida, A. histrix was found to be leafy in autumn (Kretschmer et al., 1986). Several promising lines of A. histrix are under evaluation by CIAT in Colombia (Pizarro, 1983).

Aeschynomene paniculata is an erect, suffruticose perennial adapted to well-drained sites (Kretschmer and Bullock, 1980). At Ft. Pierce, Florida, four of 12 accessions showed some perennality, but no reseeding.

Aeschynomene villosa contains a wide diversity of types that are annual or perennial with a wide variety of morphologies and site adaptations (Bishop et al., 1988; Kretschmer and Bullock, 1980). Bishop et al. (1988) allocated the 49 accessions they tested to seven groups. A group containing 18 early, annual accessions with good seed set seemed to have promise for moderately dry to dry subtropics. Two A. villosa accessions tested at Ft. Pierce, Florida appeared to have perennality, and seed set was rated 8 on a scale with 10 as maximum (Kretschmer and Bullock, 1980). In north Florida, one A. villosa out of seven showed perennality, and all showed adventitious rooting (Quesenberry and Ocumpaugh, 1981). One out of three accessions tested on the dry-sand ridge area of central Florida appeared to be well adapted and may be valuable for late-season pasture (Williams, 1988). When grown with 'Pangola' digitgrass (Digitaria decumbens), persistence of A. villosa as a perennial during mild winters was considered good after 4 yr at Ft. Pierce, Florida (Kretschmer et al., 1986). At Ona, Florida (27° 55'N), A. villosa failed to reestablish following the first winter when growing in bahiagrass (Paspalum notatum) (Pitman and Kretschmer, 1984).

Species Used Commercially

Aeschynomene falcata consists of ecotypes which are either annual or perennial. Most accessions tested have been prostrate, herbaceous plants adapted to grasslands or savannahs (Kretschmer and Bullock, 1980). The species is indigenous to Florida. It has survived -6°C in north Florida and was recommended for further study there (Quesenberry and Ocumpaugh, 1981). All accessions tested in Florida have flowered before early September, which results in little autumn forage production.

'Bargoo' is a prostrate, perennial cultivar of A. falcata released in New South Wales, Australia in 1973 (Cameron, 1986). It is a hardy, spreading, herbaceous species adapted to low fertility soils of southern Queensland and northern New South Wales.. Thro and Shock (1987) tested Bargoo in Louisiana (30° 50' N) and found 20 to 80% of the plants survived winter (-13°C). Bargoo has little impact on carrying capacity of pastures because of its low forage production. Individual animal performance may be improved because of improvement in diet quality. Average liveweight gains of heifers grazing Bargoo -Glycine tabacina- native grass mixtures were greater than liveweight gains of heifers grazing range without the legumes (Dicker and Garden, 1984).

Aeschynomene americana is a large and variable species consisting of annual or perennial ecotypes, prostrate or erect herbs or shrubs, and some viney, trailing climbers. The species occurs naturally in subtropical America, especially in permanently- or seasonally-wet habitats. Colloquial names include jointvetch (American jointvetch), deervetch, and tamarindillo. Bishop et al. (1988) evaluated 127 accessions of A. americana in Australia and identified six groups. The majority of accessions tested range from early-flowering (mean 79 d) to late-flowering (mean 134 d) annuals. Kretschmer and Bullock (1980) evaluated 98 accessions at Ft. Pierce, Florida (27° 25'N). Eighty-two of the 98 flowered after 246 d, and 44 had some perennality, surviving winter and flowering in April. Quesenberry and Ocumpaugh (1981) evaluated 94 accessions of A. americana in north Florida (29° 45'N). Almost 50% of these plants had adventitious rooting from prostrate stems, which may improve persistence during grazing. As reported by Kretschmer and Bullock (1980), most accessions were short-day flower initiation plants, resulting in little forage production after flowering.

Kretschmer et al. (1986) evaluated 23 A. americana accessions for persistence over a 4-yr trial where the legume was grown with Pangola digitgrass. Two entries (IRFL 1725 and 1726) were found to have fair (25 to 40% plot coverage) persistence compared to all other A. americana accessions which had no plants remaining after 4-yr. These two accessions were compared to Florida common on the dry-sand ridge at Brooksville, FL and neither of the reportedly perennial (IRFL 1725 and 1726) accessions perennated there (Williams, 1988).

Thro and Shock (1987) compared Florida common and two local A. americana entries with 26 species of subtropical forage legumes at two locations in Louisiana (29° 50' N and 30° 50' N) and found that A. americana was the only legume that reseeded. Based on dry-matter productivity, forage nutritive value, and self seeding ability, A. americana had greatest potential as a forage crop compared to other annuals. Thro (1988) collected 67 accessions of A. americana in southern Louisiana (30° 30′ N), which are believed to be introduced rather than native plants, and compared them with Florida common. Some accessions from this collection had yields similar to Florida common. Florida common was compared to 14 cool- and warm-season legumes for mid-June to August forage potential in Mississippi (33° 28′N) (Brink and Fairbrother, 1988). When seeded annually, A. americana had potential to provide greater quantities of high-quality forage than lucerne (Medicago sativa) or red clover (Trifolium pratense) during summer.

'Glenn' jointvetch was collected in 1971 near Tampico, Mexico (22°N) and released in 1983 for use in the tropics and subtropics of Queensland (Bishop et al., 1985a). Ungrazed plants are erect-ascending and shrub-like and grow 1 to 2 m tall. Grazed plants branch close to the ground and have a leafy canopy. It is adapted to low-lying areas where waterlogging during the wet season precludes production of many legumes. Glenn is an annual and must regenerate from seed produced the previous season. Feeding values and animal production aspects will be covered later.

Florida common A. americana, a long-time resident of peninsular Florida, was collected in 1930 in central Florida and substantial quantities of seed were harvested at the Plant Materials Center in Arcadia in the 1950's (Hodges et al., 1982). Kretschmer and Bullock (1980) indicated that Florida common was inferior in yield and other characteristics to several other accessions of A. americana or other Aeschynomene spp. in general. Through most of Florida, Florida common is an annual similar to Glenn jointvetch. Growth for the first 30 to 45 d is slow, during which time Florida common is vulnerable to grass competition In Florida, it is well adapted to sandy, relatively infertile, and often water-saturated soils.

More research has been conducted on Florida common than all other species of Aeschynomene combined. In the subsequent text, reports concerning various aspects of Florida common will be reviewed. Earlier, some potentially useful Aeschynomene spp. were identified, and we hope that the subsequent discussion will provide ideas for parallel research with these species. We also hope that the following will illustrate deficiencies in our knowledge of A. americana.

Nitrogen fixation

Rhizobium bacteria of the "cow pea" group or special Aeschynomene cultures (viz. TAL 309, CIAT 465, etc.) promote early and effective nodule development on jointvetch (Quesenberry et al., 1981). Usually, native Rhizobium are present in sufficient quantities for effective inoculation. In glasshouse studies, jointvetch had a maximum rate of acetylene reduction of 70 (Quesenberry et al., 1981) and 148 (Albrecht et al., 1981) u moles acetylene g -1 dry nodules hr -1. There were differences in nitrogenase activity among A. americana accessions (Albrecht et al., 1981; Quesenberry et al., 1981). Greatest specific nodule activity occurred in 28-d-old plants and decreased when plants were defoliated or when plants were under negative water stress. Flooding for 3 d did not reduce nitrogenase activity. Fourteen-day-old plants grew vigorously and survived flooding for 6 months (Miller and Williams, 1981). Plants rated as 'inferior' lacked nodules, while those with 'superior' shoot development showed good nodulation after flooding for 14 d (Albrecht, et al., 1981). Flooding did not reduce nodule weight, percent nodulation, or nitrogenase activity, whereas soil water deficit did cause reduction in these variables.

Nitrogenase activity and nodule number of field-grown jointvetch were not affected by P and K fertilizer nor 100 kg ha^{-1} of N applied at seeding (Quesenberry et al., 1981). Plant dry matter and N yield were increased by P and K fertilizer.

Diseases and Pests of Aeschynomene spp.

Sonoda and Lenne (1986) describe and discuss the diseases of Aeschynomene. About eight diseases caused by fungi have been reported, most of which have been reported on A. americana (Table 2).

Anthracnose is an important and widely distributed pathogen affecting about six species in at least nine countries (Table 2). As many as 69% of accessions tested in Colombia and 94% of those in Brazil were killed by Colletotrichum gloeospoioides. A combination of C. gloeospoioides and C. truncatum caused slight to moderate damage in 58% of 45 accessions tested in Florida. The disease was observed in plots of Florida common A. americana in Florida (Lenne and Sonoda, 1978), but some resistance to anthracnose was observed in another accession tested.

Calonectria dieback has been observed only in Peru on A. paniculata. Rhizoctonia solani foliar blight has often been reported to cause moderate leaf loss especially in A. americana during periods of frequent rain and warm temperatures, but plants recover quickly. Cercospora leaf spot, Polythrincium leaf blotch and powdery mildew (Oidium spp.) are not important problems. These have been observed when conditions are favorable or when plants are old, such as late autumn.

Florida common A. americana is moderately resistant to root-knot nematode (Meloidogyne spp.) (Quesenberry et al., 1985). Rhoades (1980) observed that Florida common exhibited a high degree of resistance to M. incognita. When Kretschmer et al. (1980) compared yield of Florida common grown on fumigated soil vs. a control, there was no difference at any of four harvests. Quesenberry et al. (1985) evaluated the reaction of 73 accessions of A. americana to M. arenaria, M. incognita, and M. javanica in an effort to develop resistance through breeding, but no accession was resistant to all three Meloidogyne spp.

Table 2. Diseases of Aeschynomene spp.[+]

Disease	Causal agent	Host range
Anthracnose	Colletotrichum gloeospoioides	A. americana
		A. brasiliana DC
		A. histrix
		A. paniculata
		A. sensitiva
		A. virginica
	Collectotrichum truncatum	A. paniculata
		A. sensitiva
Leaf spot	Cercospora sp.	A. americana
Pod and foliage spot	Cercospora sp.	A. americana
Leaf spot	Cercospora aeschynomene	A. falcata
Leaf blotch	Polythrincium sp.	A. brasiliana
		A. indica
		A. brasiliana
Dieback	Calonectria sp.	A. paniculata
Foliar blight	Rhizoctonia solani	A. americana
		A. brasiliana
Powdery mildew	Oidium sp.	A. americana

[+] From Sonoda and Lenne, 1986.

Florida common has been tested in glasshouse and field conditions for reaction to nematodes Belonolaimus longicaudatus, Dolichodorus heterocephalus, Hoplolaimus galeatus, and Paratrichodorus christiei (Rhoades, 1980). The first three nematodes did not build up on jointvetch, but P. christiei increased to relatively large populations. In the field, large populations of B. longicaudatus in the soil did not increase further on jointvetch, and yield of snapbean (Phaseolus vulgaris) was similar after jointvetch compared to field fallow.

Lepidoptera stem boring, defoliation, and leaf binding are problems with Aeschynomena spp. (Kretschmer and Bullock, 1980). Occurrence and management of arthropods found on A. americana in Florida have been summarized (Bullock and Kretschmer, 1982). Several pests, primarily noctuid defoliators, were of economic importance during 2 yr at one location (Table 3). In both years, the caterpillar, Selenis monotropa, was the most prevalent insect pest. Several arthropods and an entomophagous fungus provide some biological control for the insect pests observed.

Effects of insect pests on A. americana are often obvious, such as complete defoliation by S. monotropa. Effects of other pests, such as leafbinders, are insidious. Presence of 25% leaf binding before flower initiation, and its continued high incidence, reduced seed yield to 1.5 g from 30.5 cm of stem, compared to 5.5 g seed when plants were treated with insecticide (diflubenzuron). Kretschmer and Bullock (1980) rated 21 species and 225 accessions in the field for damage by leaf-feeding caterpillars, leaf-binding microlepidoptera and stem-boring insects. Differences were found among species and accessions within species for resistance to the major insect pests S. monotropa and Evippe sp. For example, within A. americana, Florida common was more severely affected than many other accessions from Argentina, Guatemala, Nicaragua, or Honduras. Differences have been observed for resistance to leaf-binding microlepidoptera.

Table 3. Insect pests and biological controls observed in A. americana[+]

Insect pest	Biological control
Leaf chewing	
Looper: Selenis monotropa	Spiders: Misumenops ciler M. bellulus Wasp: Euplelectrus comstockii
Velvet-bean Caterpillar: Anticarsia gemmatalis	Fungus: Nomuraea rileyi
Tobacco budworm: Heliothis virescens	none observed
Leaf binding	
Microlepidopterans: Evippe sp.	none observed
Piercing-sucking	
Aphids: Aphis craccivora	none observed

[+] From Bullock and Kretschmer, 1982.

Establishment of A. americana

Information on establishment of Aeschynomene spp. in pastures is limited almost entirely to Florida common A. americana. Establishment really begins with seed production, harvest, and treatment of seed used for planting. A. americana is an annual legume and stands must regenerate from seed to persist from year to year. Flowering begins in mid- to late September in Florida (Quesenberry and Ocumpaugh, 1981), and mature seed is set within 3 weeks of flowering (Hodges et al., 1982). Reproductive development and seed set continue through early November, with seed harvest occurring after frost. Yield of seed in the pod has exceeded 1000 kg ha^{-1} for ungrazed plants in Australia and Florida (Bishop et al., 1985b; Sollenberger and Quesenberry, 1986) and 300 kg ha^{-1} for grazed pastures in north Florida (Sollenberger and Quesenberry, 1986). In south Florida, commercial seed yields of 600 kg ha^{-1} have occasionally been realized, but yield usually averages about 100 kg ha^{-1} (C.M. Payne, personal communication). Removal of seed from the hull (pericarp) increases germination from about 6 to a maximum of 98% (Ruelke et al., 1974). Hanna (1973) increased germination from 6 to 78% and 2 to 74%, depending on year. Repeated wetting and drying increases germination for both dehulled seed and seed in the hull (Ruelke et al., 1974). Removal of seed from the hull is accomplished with a hammer-mill or carborundum wheel, and resulting yield of dehulled seed is 50% of hulled seed (C.M. Payne, personal communication).

When seeding jointvetch, type of seed planted depends on soil moisture (Hodges et al., 1982). If moisture is good during early establishment, 5.6 kg ha^{-1} of dehulled or 12 kg ha^{-1} or seed in the hull is recommended. Use seed in the hull at 24 to 36 kg ha^{-1} if planting conditions are less than ideal. A mixture of dehulled seed and seed in the hull (viz 1:4 ratio) provides some protection against sudden onset of drought (Kalmbacher et al., 1988)

Jointvetch can be established in a prepared seedbed (Mislevy et al., 1982) or in a perennial-grass sod (Kalmbacher et al., 1988; Sollenberger and Quesenberry, 1986). Generally, jointvetch is established in a perennial grass and managed to allow seed production and natural reseeding. Distribution of seed can be accomplished by aerial spreading on large ranches, use of specialized sod-seeding drills, or by disking and broadcasting. Generally, there is little difference in stands resulting from different drills (Kalmbacher et al., 1977), or for disk and broadcast methods compared to drilling (Kalmbacher and Martin, 1983). If soil moisture is limiting, however, disk and broadcast methods often fail to produce a stand. If establishing jointvetch in perennial grasses, other factors, such as rainfall and grass canopy at seeding, may be much more important than seeding method.

Jointvetch seedlings (compared to Macroptilium atropurpureum) do not have a great deal of drought tolerance (Boman et al., 1988). When planting jointvetch on a commercial basis in areas where it is adapted, the most practical management to ensure adequate soil water for establishment is selection of seeding date. In Florida, it is common to observe jointvetch seedlings in May (before the rainy season) that have germinated and died. Several times in a season there may be enough rainfall for germination, but not enough rainfall for establishment. At Ona, Florida, 17 seedings were made in bahiagrass sod from May to late June 1981 to 1985, and seven of these seedings were failures because of insufficient rainfall (Kalmbacher, unpublished data). Jointvetch failure using dehulled seed usually occurred in May. At this location, by waiting until after 1 June the chance of 12 mm wk^{-1} or more of rain is 95%, and the chance of 25 mm wk^{-1} is 65%.

Effect of bahiagrass canopies on soil water and subsequent jointvetch establishment has been measured (Kalmbacher, unpublished data). Over a 5-yr-period, three bahiagrass canopy leaf area indices (LAI; 2.2, 4.5, and 7.7) were maintained, and both gravimetric and tensiometric soil water were determined during 17 seedings. Out of 209 dates analyzed, canopy LAI affected soil water potential on 41 dates. Evapotranspiration (ET) was measured in each of 2 yr, and ET rate differences ($P<0.05$) between the high (128 mg m^{-2} s^{-1}) and low LAI (100 mg m^{-2} s^{-1}) were found once. Using discriminant analyses, rainfall, rather than any variable indicative of soilwater status, explained success or failure of jointvetch.

Poor seedling vigor in jointvetch is one of the major problems with the species, and this makes management of the perennial grass canopy extremely important. Increasing light to the seedling is likely the major reason why controlling the grass canopy enhances stand establishment. Amount of light that penetrated a bahiagrass canopy was related to jointvetch establishment (Kalmbacher and Martin, 1983). During the first 28-d after seeding where the bahiagrass canopy was 150-mm tall at seeding, photon flux density (PFD) (3-yr avg.) at the soil surface ranged from 7 to 16 einsteins m^{-2} d^{-1} but with grazing, PFD was 21 to 29 einsteins m^{-2} d^{-1}. Three-year average jointvetch yield was 1370 kg ha^{-1} in the check vs. 2300 kg ha^{-1} in the graze treatment.

Grazing is the most practical and economical method of obtaining the degree of canopy control necessary for establishing jointvetch. In limpograss (*Hemarthria altissima*), grazing the grass to an 80-mm stubble and extending the period of grazing during establishment of jointvetch until seedlings reach the two-leaf stage was recommended (Sollenberger, 1987b). This treatment controlled limpograss and maximized jointvetch establishment.

Cost associated with establishing jointvetch in Florida was calculated at \$217 ha^{-1} when overseeding in a perennial grass (Prevatt and Mislevy. 1990). Kalmbacher et al. (1988) estimated \$134 ha^{-1} for initial establishment and \$115 ha^{-1} for annual maintenance. Differences in cost of establishment

($134 vs. $217) were largely due to seed cost used. Establishing jointvetch on cultivated land was estimated to be $245 ha^{-1} (Prevatt and Mislevy, 1990).

Fertilization and Liming

Response of Florida common to lime (L) on Florida's acid, infertile Spodosols is clear-cut. Hodges et al. (1982) recommended soil pH in the range of 5.5 to 6.0. Lime ($CaCO_3$) applied at 0, 2.2, 4.5 Mg ha^{-1} resulted in annual dry matter yields of 0.4, 1.9, and 2.3 Mg ha^{-1} when averaged over five fertilizer treatments (Hodges et al., 1982). Calculated optimum L rate for maximum yield of Florida common grown on a native soil with an initial pH of 4.5 and P concentration of 3 mg kg^{-1} soil was 4.4 Mg ha^{-1} L (Snyder et al., 1985). Six rates of L ranged from 0 to 4 Mg ha^{-1} and six rates of P ranged from 0 to 80 kg ha^{-1} in this study, and no L x P interaction was found for legume yield.

Yield response of Florida common to P and K fertilizer has been less clearly defined than that to L. Moore (1978) reported a response to K (37 kg ha^{-1}), but not P. Hodges et al. (1982) found little response to either P or K alone or in combination when averaged over three rates of L. They recommended 110 and 60 kg ha^{-1} of K and P, for growing jointvetch on Florida soil newly cultivated from the native condition. Snyder et al. (1985), as indicated above, tested L and P together and calculated 73 kg ha^{-1} of P (with 4.4 Mg ha^{-1} L) gave maximum yield. Their recommendation for P fertilization was 75 kg ha^{-1} at planting with additional P fertilization on 2-yr intervals.

Forage Production Potential

Though jointvetch is not considered to be a high-yielding legume, Florida common _A. americana_ has produced up to 8 Mg ha^{-1} of DM when harvested in late September following seeding in early June (Sollenberger and Quesenberry, 1985). At two locations in Louisiana, May seedings of Florida common yielded between 6 and 7 Mg ha^{-1} by mid-September (Thro et al., 1987). Production is less when grazed or clipped at regular intervals and has been reported to be in the range of 1 to 4 Mg ha^{-1} in several Florida studies (Mislevy et al., 1981; Sollenberger et al., 1987b).

A major factor limiting yield in Florida is the relatively short productive period of Florida common. Spring and early-summer drought typically delay establishment until June even though temperatures are adequate for germination in early to mid-April. Grazing may not begin until mid-July (Sollenberger et al., 1987b) or even early August (Chaparro, 1989) in some years. First flower occurs generally from mid- to late September in Florida (Chaparro, 1989; Quesenberry and Ocumpaugh, 1981; Sollenberger and Quesenberry, 1986), and only limited forage production occurs after flowering (Quesenberry and Ocumpaugh, 1981). Other areas of the southern USA may have more favorable weather conditions for jointvetch (Thro, 1988). Spring and early summer rainfall in Louisiana is greater and more uniformly distributed than in Florida. This allows for planting up to 2 months earlier and grazing by late June in Louisiana.

Defoliation Management

Florida common can be used for hay, silage, or grazing. Hodges et al. (1982) indicated that management for hay is difficult because of leaf shattering during drying and harvest. Spicer et al. (1982) harvested mature jointvetch for silage, and they found that herbage was of low forage quality. Harvesting at relatively immature growth stages increases quality but may not be practical in many situations because yields would likely be too low. Thus, in most instances jointvetch is used as a grazed forage.

Commercially-used lines of _A_. _americana_ in Australia and USA are upright in growth habit and have woody stems. Bishop et al. (1985a) observed that defoliation management influences jointvetch growth habit and canopy structure. Ungrazed plants had an erect, shrub-like appearance with height and width of 1 to 2 m, but grazed plants branched close to the ground and presented a leafy canopy. Similarly, Moore and Hilmon (1969) reported that heavy browsing of jointvetch by deer (_Odocoileus virginianus_) resulted in a prostrate growth habit and profuse branching. These observations suggest that defoliation management of _A_. _americana_ is likely to have an important influence on plant persistence, productivity, and nutritive value.

Effect on Plant Persistence and Forage Production

Tang and Ruelke (1976) evaluated plant height at cutting (45 or 90 cm) and stubble height (15 or 30 cm) effects on yield of Florida common in the greenhouse. There were no treatment effects on legume DM harvested, but trends favored defoliation at 45 cm. Regrowth of plants cut first when 90 cm tall was poor. This was attributed to death of shaded axillary buds on the lower part of the stem. Higher stubble height resulted in greater survival and faster regrowth when mature plants were clipped.

Mislevy et al. (1981) studied clipping management of Florida common in the field. Plants were harvested to 8 or 18 cm stubble heights when they were 30, 60, or 90 cm tall. Regrowth was harvested to the same stubble height when 30, 60, or 90 cm tall. Branching was greatest when initial harvest occurred at 30 cm. If 90 cm tall at first harvest, many plants died following defoliation because axillary buds on lower stems had been shaded and were inactive. Dry matter yield was greatest for plants initially harvested when 30 cm tall with regrowth harvested at 60 to 90 cm. Lowest yields occurred for plants harvested first at 90 cm because regrowth was limited, and for plants with regrowth harvests at 30 cm because stem accumulation was minimal. The 8 cm stubble resulted in highest yields in both years, but increasing initial harvest height while maintaining the 8 cm stubble height decreased stand and rate of regrowth.

Albrecht and Boote (1985) measured regrowth characteristics of Florida common cut to a 9 or 18 cm stubble. Plants were 60 cm tall at harvest, and virtually all leaf area was removed by clipping to either stubble height. Plants clipped to 18 cm had more viable axillary buds than did those cut to 9 cm, and recovery of leaf area and canopy carbon exchange rate were greater for the 18 m treatment.

In coastal Ghana, Adjei and Fianu (1985) clipped Florida common to 15 cm heights every 60, 90, or 120 d throughout the year. Annual DM harvested was approximately 3.3, 4.5, and 6.2 Mg ha^{-1} for the three frequencies. Percentage cover of legume increased for each cutting frequency during the year of study, primarily because of large seed yields and subsequent reestablishment.

Gildersleeve et al. (1987) initiated grazing of Florida common when plants were 28, 45, or 54 cm tall. Subsequent defoliation was at 28 d intervals for all treatments, and each was grazed four times during the season. Although plants grazed initially at 28 cm had less leaf accumulation at first grazing, they produced more leaf than did the 45 and 54 cm treatments later in the season. The authors suggested that earlier initial grazing improved seasonal DM production by stimulating axillary bud development and secondary branching.

Sollenberger et al. (1877b) evaluated plant height when Florida common was first grazed (20, 40, 60, and 80 cm). All treatments were grazed every 35 d after the initial grazing. Total-season legume herbage accumulation increased with increasing height when plants were first grazed (Table 4). Little regrowth after first grazing was observed for the 60 and 80 cm treatments, and distribution of legume herbage over the grazing season was much more uniform when grazing was initiated at 20 or 40 cm heights (Table 4). Leaf/stem ratio decreased with increasing plant height when first grazing occurred, and this trend continued in grazings of regrowth. Because plants were so stemmy when they were grazed first at 60 or 80 cm, a smaller percentage of this herbage was actually consumed by grazing cattle. In fact, seasonal totals for herbage (legume plus grass) disappearance during grazing were from 0.4 to 1.0 mg ha^{-1} greater for the 20 and 40 cm treatments compared with 60 and 80 cm heights, despite higher herbage accumulation for the 60 and 80 cm treatments.

Table 4. Effect of height at initiation of summer grazing (HI) on accumulation and seasonal distribution (by grazing cycles, C) of jointvetch herbage.+

	1983				1984			
HI	C1	C2	C3 & 4	TOT	C1	C2	C3 & 4	TOT
cm	Mg ha^{-1}							
20	0.08	0.47	0.44	0.99	0.20	0.50	0.34	1.04
40	0.30	0.23	0.21	0.74	0.53	0.31	0.21	1.05
80,60	2.03	0.04		2.07	1.38	0.04	‡	1.42

\+ Jointvetch overseeded into a limpograss sward.
‡ Jointvetch HI was 80 cm in 1983 and 60 cm in 1984. Only two grazing cycles were completed for these treatments in each year.

Data from these studies suggest that, although total accumulation of jointvetch may be favored with later initiation of clipping or grazing, more uniform seasonal distribution of herbage production and better utilization of herbage under grazing are likely when first defoliation occurs by the time that plants are 40 cm tall. Similarly in Australia, it was recommended that first grazing occur when plants are 30 to 40 cm tall to promote maximum leaf production and pasture quality (Bishop et al., 1985a).

Effect on Nutritive Value

Crude protein (CP) and *in vitro* organic matter digestibility (IVOMD) values in excess of 20 and 70% have been reported for the harvested or grazed portion of well-managed Florida common swards (Brink and Fairbrother, 1988; Rusland et al., 1988; Sollenberger et al., 1987c). In contrast, results reported for mature herbage have ranged from 8 to 10% CP and 40 to 50% IVOMD (Mislevy et al., 1981; Sollenberger and Quesenberry, 1985; Spicer et al., 1982). Thus, nutritive value of jointvetch herbage may vary widely depending upon maturity and the portion of the plant canopy harvested.

Stem of Florida common decreased in CP from 13 to 7% and in IVOMD from 61 to 40% as plant height when first grazed increased from 20 to 80 cm (Sollenberger et al., 1987c). Leaf CP did not change and leaf IVOMD decreased only from 77 to 67% over the same range of plant heights. Mislevy and Martin (1985) reported that IVOMD of Florida common clipped to ground level declined 3.2 percentage units with each 15 cm increase in plant height. Over a wide range of heights at first harvest, these authors found that the top 45 to 60 cm of the plant had an average

IVOMD of 65% and CP of 17%, while IVOMD and CP of the remaining basal portion were 35 and 5%. Characterizing CP concentration of various fractions of a Florida common canopy, Hodges et al. (1982) reported that in the top 15 cm, in the leaves and fine stems, and in the coarse stems, CP was 24, 21, and 6%, respectively.

Based on these observations, it can be concluded that the principal determinant of nutritive value of jointvetch herbage is leaf/stem ratio. Defoliation management can have a major impact on this canopy characteristic. Leaf/stem ratio of total herbage decreased from 1.6 to 0.6 as plant height when first grazed increased from 20 to 80 cm (Sollenberger et al., 1987c). For grazings that occurred at successive 35-d intervals after the first, leaf/stem ratio remained higher for the 20 (1.0) compared to the 80 cm initiation height (0.4). Similarly, Gildersleeve et al. (1987) found that leaf/stem ratio was highest throughout the season when first grazing was initiated at 28 compared with 45 and 54 cm.

Mislevy et al. (1981) reported CP of 17.5% and IVOMD of 70% when Florida common plants were harvested at a 30 cm initial height and 30 cm regrowth height. This compared favorably to 11.9% CP and 52% IVOMD for an initial harvest height of 90 cm with regrowth harvested at 30 cm. Interestingly, 90 cm regrowth of plants that were first cut when they were 30 cm tall had 14.9% CP compared to 11.9% for plants cut first at 90 cm. Stem diameter of the 90 cm regrowth was 50 to 75% smaller than the 90 cm initial growth. Leaf/stem ratio of regrowth harvests was high over a range of regrowth heights if initial harvest occurred when plants were 30 to 60 cm. These data concur with field observations that leafy canopies resulted when initial grazing occurred before plants were overly mature (Bishop et al., 1985a; Moore and Hilmon, 1969).

Mineral concentration was determined in Florida common herbage harvested at 30, 60, or 90 cm initial and regrowth heights (Kalmbacher et al., 1981). Potassium concentration decreased from 2.1 to 1.5% (initial) and 1.8 to 1.3% (regrowth) as height increased from 30 to 90 cm. Phosphorus was unaffected by initial height, but concentration decreased from 0.30 to 0.26% as regrowth height increased from 30 to 90 cm. Magnesium declined from 0.34 to 0.30% with increasing initial height, but regrowth height had no effect. Calcium, Zn, Cu, and Mn changed very little due to height at initial or regrowth harvests. Only Cu was lower than the concentration (4 mg kg^{-1}) recommended by NRC to meet the needs of growing calves (Kalmbacher et al., 1981).

Effect on Seed Production

Sollenberger and Quesenberry (1986) found that height when plants were first grazed did not affect Florida common seed production. Time when autumn grazing was ended (closure date) had a major impact on seed production per plant, with yields decreasing as closure date was postponed. Pitman and Kalmbacher (1983) ended autumn grazing of Florida common when plant growth had ceased (4 November), at first flower (8 October), and during vegetative growth (2 September). Seed yields averaged 12.8, 17.7, and 27.7 g m^{-2} for the respective dates. Jointvetch plant populations in spring of the next year were greater in areas with a shorter autumn grazing period. Chaparro (1989) measured pod yield responses to levels of postgraze stubble height and of closure date. Greatest declines in pod yield occurred when closure date was delayed from 1 wk before initiation of flowering to date of flower initiation (Fig. 1). Increasing stubble height increased pod yield, but closure date had a greater influence on pod yield than did stubble height.

The period of jointvetch seed set is characterized by poor forage quality of perennial grass pastures in Florida, so presence of legume herbage in cattle diets is critical if moderate to high levels of animal performance are to be attained. Several studies (Chaparro, 1989; Pitman and Kalmbacher, 1983; Sollenberger and Quesenberry, 1986) have demonstrated that grazing decreases Florida common seed yield. Thus, the grower must compromise between maximum seed yield and maximum utilization of high quality jointvetch herbage.

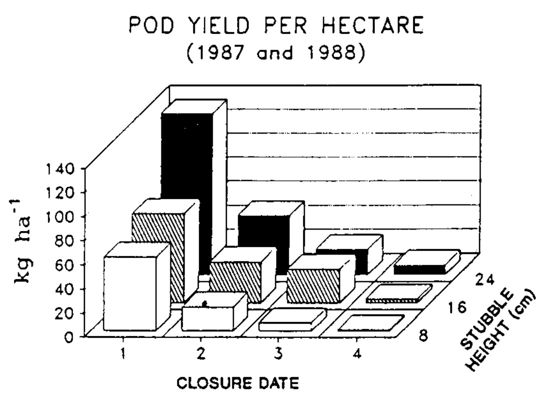

Fig. 1. Influence of closure date of autumn grazing and postgraze stubble height on jointvetch pod yield.

The nature of this compromise was illustrated in the study by Pitman and Kalmbacher (1983) described earlier. Ending autumn grazing of Florida common when plant growth had ceased, at first flower, and during vegetative growth left 84, 153, and 493 g m^{-2} of ungrazed herbage on 1 December, while seedyields were 12.8, 17.7, and 27.7 g m^{-2}, respectively. Thus, higher seed yields were associated with the least utilization of jointvetch herbage. Chaparro (1989) found that amount of standing herbage at season end increased linearly with increasing postgraze stubble height and quadratically with earlier closure. He suggested that a good compromise between greatest seed yield and greatest herbage utilization would be to graze relatively closely (8 to 16 cm) until just before first flower and then restrict access of cattle until seed are mature. In Australia, Bishop et al. (1985a) observed that to maximize Glenn seed set, it may be necessary to lighten stocking or cease grazing when plants are in flower. For normal pasture regeneration, they suggested that sufficient seed was set even when plants were continuously grazed to less than 20 cm high. Hodges et al. (1982) indicated that, under moderate grazing pressure, Florida common produced adequate seed without special management, but heavily-utilized areas required protection from grazing during 15 September to 15 October.

Canopy Characteristics and Ingestive Behavior of Cattle

To appreciate the potential contribution of A. americana to livestock diets, it is important to understand canopy structure of jointvetch-grass pastures and the nature of the interaction between grazing cattle and sward canopies. Bulk density of Florida common in the top 10 to 20 cm of the canopy varied little from that of the whole canopy [16.4 and 17.8 kg OM $(ha \cdot cm)^{-1}$] but limpograss bulk density was 37.3 kg OM $(ha \cdot)^{-1}$ in the upper layer and 91 kg OM $(ha \cdot cm)^{-1}$ in the whole canopy (Moore et al., 1987). This resulted in jointvetch percentage in total DM being greatest at the top of the canopy and least at the base (Moore et al.,1987; Sollenberger et al., 1987a). Morales (1990) reported that percentage jointvetch at the top of a jointvetch-bahiagrass canopy was twice as great as legume percentage in the whole canopy. Similarly, Brown et al. (1987) observed that legume percentage was greater in the top 10 cm layer of jointvetch-stargrass (Cynodon nlemfuensis) pastures than in lower layers. Apparently, percentage jointvetch in the whole canopy of a jointvetch-grass association often underestimates the proportion of legume in the diet because grazing animals are removing herbage from the top of the canopy downward (Sollenberger et al., 1987a). For a jointvetch-limpograss sward, percentage legume in herbage consumed during a grazing period was from 5 to 25 percentage units higher than that in the whole canopy (percentage in herbage consumed 3.17 + 1.47 * percentage in whole canopy, r^2=0.93) (Sollenberger et al., 1987a).

In addition to spatial distribution of jointvetch in the canopy contributing to a higher proportion of legume in the diet than in the whole canopy, selection for jointvetch has been documented in grass-Florida common jointvetch pastures (Moore et al., 1989; Sollenberger, 1987a). Early in a grazing period on rotationally-grazed limpograss-jointvetch swards, esophageally-fistulated steers selected a diet higher in percentage jointvetch than that found in the upper 10 to 20 cm layer of the canopy (Figure 2) (Sollenberger et al, 1987a). Moore et al. (1989) reported that herbage selected by cattle early in a grazing period from 28 and 49-d-old regrowth in limpograss-jointvetch pastures had greater total legume and legume leaf percentages than did herbage in either the upper or upper plus middle horizon. In contrast, over an entire grazing period, percentage jointvetch in herbage consumed was not different from that in the grazed horizon (herbage above the target postgraze stubble height) when pastures were grazed to a 10 to 20 cm stubble (Sollenberger et al., 1987a).

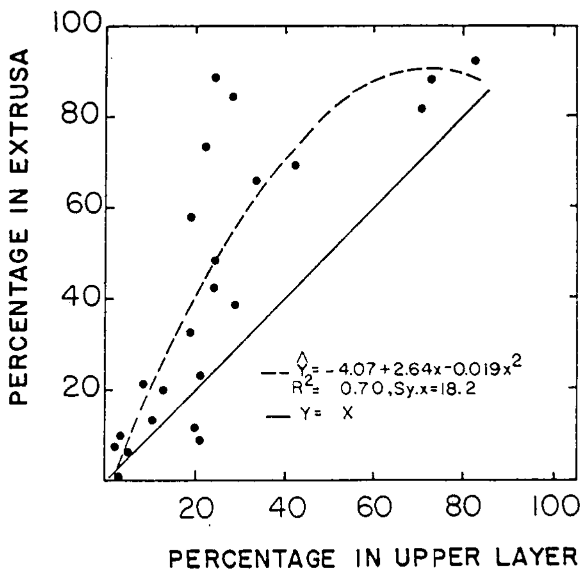

Fig. 2. Relationship between percentage jointvetch in the extrusa of grazing steers and percentage jointvetch in the upper layer of jointvetch-limpograss pastures.

Gildersleeve et al. (1987) reported that cattle grazing pure stands of various Aeschynomene spp. selected leaf, seed, and fine stem material less than 4 mm in diameter. Sollenberger et al. (1987a) suggested that cattle preferred Florida common over limpograss if jointvetch leaf and fine stem were available in the grazed portion of the canopy, but when this herbage was removed from upper layers, cattle altered their grazing patterns and consumed grass and weeds in preference to larger jointvetch stems.

These observations suggest that cattle will select for jointvetch over some associated grasses under light to moderate grazing intensities. If grazing intensity is increased, jointvetch leaf and fine stem will be removed quickly from the canopy. Cattle will then consume other herbage in preference to remaining stem. Because of the vertical distribution of jointvetch in the canopy and selection of herbage by grazing animals, botanical composition of the diet will likely change over a grazing period or with varying levels of grazing intensity. By controlling how close jointvetch-grass pastures are grazed, grazing management can be used to manipulate the proportion of legume in the diet and perhaps match nutrient requirements of grazing animals with pasture nutritive value.

Animal Performance on A. americana Pastures

Hodges et al. (1976) reported average daily gain of steers on Florida common jointvetch-'Pensacola' bahiagrass pastures of 0.34 kg d^{-1} compared to 0.27 kg d^{-1} on Pensacola alone. Grazing of legume pastures was delayed until jointvetch was 60 to 70 cm tall, and this may have limited potential benefit from its use. Gain per hectare was 259 kg for the association and 253 kg for the grass alone. In a 5-yr study with beef breeding herds, Hodges et al. (1974) reported higher weaned-calf percentages for a Florida common jointvetch-bahiagrass system compared to bahiagrass alone (82 vs. 67%). Weaning weights did not differ for the two systems, and calf production per cow was 163 kg for the legume-grass system compared to 155 kg for grass alone. Jointvetch stand failures occurred in 2 out of 5 yr because of below normal June and July rainfall. Requirement for minimizing grazing during legume establishment resulted in more hay feeding for the legume system, and the authors suggested that no more than 25% of a pasture system be planted to jointvetch. One weakness of the management regime in this study was that jointvetch was not grazed until it was taller than 1 m, thus some opportunity for exploiting its high nutritive value was lost.

Calf performance has been evaluated on Florida common pastures used for creep grazing (Ocumpaugh and Dusi, 1981). Using creep pastures that were 10% as large as the cow pasture, calf gains were 0.9 kg d^{-1} in each of two grazing seasons. Under the conditions of this trial, use of jointvetch for creep grazing was profitable over a wide range of calf prices. Use of concentrate ration was not profitable at any calf price considered.

Pitman (1983) compared bahiagrass-Florida common and N-fertilized bahiagrass systems for growing steers. Highest steer average daily gain occurred on the mixed sward (0.58 kg d^{-1}). Gains on bahiagrass receiving 224 and 56 kg N ha^{-1} yr^{-1} were 0.48 and 0.43 kg d^{-1}. Carrying capacity of the mixed sward was similar to bahiagrass receiving 56 kg N ha^{-1} yr^{-1}. Rusland et al. (1988) reported yearling steer gains on limpograss and limpograss-Florida common pastures of 0.39 and 0.70 kg d^{-1} over 3 yr. The N-fertilized grass supported higher average stocking rates than did the mixed sward (2210 vs. 1700 kg liveweight ha^{-1} d^{-1}), but gain ha^{-1} was greater on the association (377 vs. 263 kg). They attributed the 80% greater daily gains for the association to the presence (approximately 20% of the pasture DM) and high nutritive value of jointvetch, which in this study was grazed first at 30 to 40 cm with regrowth grazed at 40 to 50 cm. Hand-plucked jointvetch CP and IVOMD were above 20 and 70% during the majority of the grazing season. In a 2-yr study, Holderbaum (1989) reported steer daily gains of 0.52 kg d^{-1} on limpograss-Florida common pastures managed as described by Rusland et al, 1988). Jointvetch in this study was only 8% of the DM because of early-summer drought. Despite lower legume contribution than obtained by Rusland et al. (1988), daily gains on the association were 79% higher than on N-fertilized grass.

Steer gains on a Glenn jointvetch-*Setaria sphacelata* association in Australia were 0.51 kg d^{-1} from 5 December to 20 June (Bishop et al, 1985a). In a second study, steers gained 0.6 kg d^{-1} on a Glenn-Chloris *gayana* pasture during the period from 28 November to 3 June (Bishop et al., 1985a).

Florida common was planted for grazing by white-tailed deer as a supplement to their natural diet (Keegan et al., 1989). Deer grazed it readily, and it accounted for 32% of DM intake. Diets of deer with access to jointvetch were higher in CP, P, Ca, and IVOMD than natural diets. Keegan and Johnson (1987) reported that weight of 1-yr-old deer grazing jointvetch averaged 64 kg compared to 52 kg for those on a natural diet.

Data from numerous studies have demonstrated the high nutritive value of Florida common jointvetch and the improved forage quality of jointvetchgrass associations compared to the grass alone. Lack of positive animal performance response to jointvetch in some studies may be attributed in part to late initiation of grazing of the legume and low leaf/stem ratio that is associated with maturity. Although total DM production may be reduced by earlier grazing, forage nutritive value is greatly enhanced. Since the purpose of planting jointvetch in pastures is primarily to increase animal performance, initiating grazing when it is 30 to 40 cm tall appears to be warranted.

Summary and Potential of *Aeschynomene*

The world's *Aeschynomene* germplasm has been evaluated and several species and accessions within species have been recognized to have potential. There is some agreement among researchers that the following species, in addition to *A. americana*, may be useful: *A. brasiliana*, *A. elegans*, *A. evenia*, and *A. villosa*. Both perennial types and some other annual accessions of *A. americana* warrant further evaluation. So little is known about these newly recognized plants that no estimation of their potential can be made. We endorse the recommendations of Bishop et al. (1988), Kretschmer and Bullock (1980), and Quesenberry and Ocumpaugh (1981) that sufficient research be conducted to assess their potential.

To date, only *A. americana* and *A. falcata* are planted commercially. Most research conducted has been on *A. americana* (jointvetch). Positive attributes of jointvetch include; it provides nutritious, palatable forage; it is adapted to wet, rather infertile soil; and it is relatively free of disease, insect, and nematode problems. Limitations of jointvetch include; it does not have great seedling vigor; it is not persistent; it must reestablish from seed annually (which does not always occur), and the distribution of forage production is not very good (beginning too late in the growing season and terminating too early due to flowering).

Upon evaluating the literature, we feel there is potential for improvement in jointvetch through selection and possibly breeding efforts. The genus is highly variable, and perhaps desirable traits (e.g., later flowering, larger seed size, less accumulation of woody stem) could be combined into a cultivar through artificial hybridization (Hardy and Quesenberry, 1984). Before attempts are made to overcome the shortcomings of jointvetch or other *Aeschynomene* spp. that have potential to become commercially acceptable, the cost and likelihood of successful improvement efforts need to be weighed against potential for improvement in other legumes.

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