Forage Potential of Cultivated Peanut (*Arachis hypogaea* L.)[1]

D. W. Gorbet*, R. L. Stanley, Jr., and D. A. Knauft[2]

ABSTRACT

Livestock production enterprises in the southern USA depend primarily on forage for feed. With the development of peanut (*Arachis hypogaea* L.) lines with good late leaf spot (*Cercosporidium personatum* (Berk. & Curt.) Deighton) resistance in the Florida breeding program, studies were initiated in 1983 at Marianna to evaluate their forage potential. Peanut breeding lines were grown without fungicide applications for leaf spot control and cuttings were made to evaluate forage production. Two forage cuttings were compared to a single cutting or harvest for each genotype. Pod yields were taken at the end of each season. Some lines produced dry matter forage yields exceeding 9000 kg ha^{-1} with two cuttings, with some single harvest yields exceeding 7000 kg ha^{-1}. Significant differences were observed among genotypes, years, and forage harvest treatments. Two cuttings always produced the greatest forage yield but reduced pod yields as much as 50% for some entries. Some genotypes produced pod yields of 4000 kg ha^{-1} with the single forage harvest. Crude protein values for the forage were generally higher for two cuttings (14.0 - 19.6%), as compared to the single cutting or harvest (12.5 - 15.1%). *In vitro* organic matter digestibility (IVOMD) ranged from 59.6 - 72% for forage samples. These protein and digestibility values compare favorably to alfalfa (*Medicago sativa* L.) and perennial rhizoma peanut cultivars of *A. glabrata* Benth.

Key Words: Peanut, forage, hay, leaf spot resistance.

Livestock production enterprises in the southern USA depend primarily on forage for feed. Peanuts (*Arachis* spp.) are well adapted to this area and have the potential of producing a high quality forage. The cultivar Florigraze rhizoma peanut (*A. glabrata* Benth.), released by the University of Florida in 1981, is a perennial forage peanut planted from rhizomes and grown for hay and grazing in Florida and several other southeastern states. This variety has produced forage yields and quality similar to alfalfa (*Medicago sativa* L.) in some studies, with dry matter exceeding 5 mT ha^{-1} and *in vitro* organic matter digestibility (IVOMD) of over 60%. However, Florigraze and related perennial peanut cultivars, Ark, Arblick, and Arbrook, are slow to establish, often taking 2 yr or more before forage harvest, and are best adapted to peninsular Florida (10).

Cultivated peanuts (*A. hypogaea* L.) have commonly been grown for seed and forage production, especially during the first half of this century (11). Older cultivars, such as Dixie Runner, usually produced almost twice as much hay as in-shell peanuts (2,11). Recently released peanut cultivars produce greater pod yields and a lower proportion of forage, and hay is not always harvested (2,3,5,7,9,11). Also, most recent cultivars tend to be highly susceptible to leaf spots, caused by *Cercospora arachidicola* Hori (early leaf spot) and *Cercosporidium personatum* (Berk. & Curt.) Deighton (late leaf spot), and require an intensive fungicide program for control. These diseases can cause complete defoliation with resulting lower pod and forage yields. Many studies report that effective leaf spot fungicides increase pod (seed) and forage yields (5,6,9). Susceptible peanut cultivars treated with an effective leaf spot fungicide have produced forage yields from 4-6 mT ha^{-1} (5,9), with corresponding increases in pod yields. Effective fungicide treatment also increased the percentage of forage protein and digestibility. However, these fungicides may not be cleared by the Environmental Protection Agency (USA) for use on forage for livestock feed (5).

With the development of good leaf spot resistant peanut breeding lines in the University of Florida breeding program, studies were initiated in 1983 at Marianna to evaluate the forage potential of some of these lines.

Materials and Methods

Selected peanut breeding lines, plant introductions and cultivars with resistance to late leaf spot were grown in small plot studies without fungicide applications for leaf spot control. Vegetative cuttings were made to evaluate forage production potential. Tests were conducted as a randomized complete block, split-plot design (three reps), with forage harvests (one vs. two seasonal cuttings) as main plot treatments and genotypes as subplot treatments. Subplots were 6.1 x 1.8 m with four rows per plot, planted in a twin-row pattern with the outside rows being 0.9 m apart and the inside rows 22.9 cm apart. Plots were planted at 10-13 seed per M of row in May or early June without irrigation. Each test had 12-16 entries, with 10 genotypes common across all years. Southern Runner was included as a check, since it is the only U.S. cultivar currently available with late leaf spot resistance. All entries were *A. hypogaea* ssp. *hypogaea* and with some resistance to late leaf spot.

Forage harvests were made with a small flail-type forage harvester at:

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[2]Prof. and Assoc. Prof., Univ. of Florida, NFREC, Marianna and Quincy respectively, and Chair, Crop Sci. Dept., North Carolina State Univ., Raleigh, NC.

*Corresponding author.

(a) 75-85 d after planting and again just prior to digging (135-140 d) for the two cutting treatment, or (b) 135-140 d (just prior to digging) only for the single cutting treatment. Vines were removed to leave a 5-10 cm stubble height. Green plot weights were taken and sub-samples used for dry matter determination. Percentage protein and *in vitro* organic matter digestibility (IVOMD) were determined on subsamples in 2 yr. Leaf spot disease ratings were made at the end of the season (135-140 d) just prior to the final forage harvest, using the Florida 1-10 scale (4).

All plots were dug with an inverter digger after the final forage clippings were made. The peanuts were partially dried in windrows for 3-4 d and picked with a plot thresher. In-shell peanuts from each plot were bagged and dried to 8% moisture and weighed. Data were analyzed using MSTAT procedures.

Results and Discussion

All entries in these studies had previously been selected for resistance to leaf spot and had shown to be more resistant to late leaf spot, caused by *C. personatum*, than Southern Runner. Late leaf spot was the dominant disease in all tests, but varied in intensity from year to year. Leaf spot disease ratings were affected ($P \leq 0.01$) by year, forage cutting treatment, and genotype. Most interactions were significant in analyses across years. The late planted test in 1988 had the highest disease levels from late leaf spot with an overall rating of 4.4. In the combined analyses the disease level was significantly higher for the single end-of-season forage harvest (one cutting) than for the two cuttings treatment (3.7 vs. 3.5) (Table 1). Genotype 5 (72x94-12-1) had the lowest disease rating for both forage cutting treatments and Southern Runner had the highest disease level. All genotypes were significantly more resistant to late leaf spot than Southern Runner, which supported previous evaluations.

Forage and pod yields were significantly ($P \leq 0.01$) affected by years, harvests, and genotypes. All interactions were also highly significant ($P \leq 0.01$) in the combined analyses, except for the interaction between genotype and forage harvest treatments.

The mean dry matter forage and pod yields across the 10 genotypes common to all years for each forage harvest (cuttings) treatment are given in Table 2. Data indicate that two cuttings, taken at 75-85 d and again at the end of the season, produced the most total dry matter for forage. Results varied from year to year, with the greatest difference between harvest treatments on forage yields noted in the late planted 1988 test, which also had more leaf spot disease pressure. The first cutting at 75-85 d often produced two to three times as much forage as the second cutting. Disease incidence was very low, with little or no defoliation evident at the 75-85 d harvest. Higher forage yields would be expected with earlier planting dates, as noted for the earlier 1987 planting which had the best forage yield. Moisture appeared to be somewhat limiting in 1986 and 1990, but favorable soil conditions and adequate moisture distribution resulted in good forage yields in 1986.

Table 1. Average leaf spot disease ratings for the peanut genotypes common to all tests, 1985-90.

	Genotype	Disease rating[a] Cutting 1	Cutting 2
1)	UF81206	3.6	3.3
2)	72x32B-3-2-1	3.6	3.4
3)	72x76-6-1-1	3.8	3.8
4)	72x32B-3-2-2	4.0	3.6
5)	72x94-12-1	3.2	2.9
6)	Southern Runner	4.7	4.5
7)	Egret	3.5	3.3
8)	PI 468224 (US29)	3.8	3.6
9)	UF563B	3.7	3.5
10)	PI 475849 (US202)	3.5	3.5
	Avg	3.7	3.5
	LSD (0.05)	0.5	0.6

[a] Leaf spot disease rating on Florida 1-10 scale, where 1 = no disease and 10 = plants dead from leaf spot.

Table 2. Yearly forage dry matter and pod yields across 10 selected genotypes for two forage harvest treatments, 1985-90.

Planting date	Total rainfall	Dry matter forage yields[a] No. cuttings 1	2[b]	Pod yields[a] No. cuttings 1	2
	- cm -	---- kg ha^{-1} ----		----- kg ha^{-1} ----	
5-16-85	55.5	5400	7360	3080	2030
5-21-86	46.2	6640	7970	3030	2390
5-5-87	81.3	7010	8720	1880	1180
6-9-88[c]	50.8	2870	6270	1420	760
5-31-89	71.9	4190	5830	1420	1130
5-24-90	48.8	5420	7070	1870	1370
Avg	59.1	5260	7200	2120	1480
LSD(0.05)	--	260	240	390	400

[a]Data for 10 genotypes common to all tests.

[b]Total forage yield for the two harvests (cuttings).

[c]Heavy leaf spot incidence during the growing season.

Pod yield data were the opposite of the forage yields. The single forage harvest at the end of the season produced higher pod yields than for the two-cutting treatment. Apparently, the first cutting significantly reduced the yield potential, probably by reducing total photosynthetic capacity and reproductive sites. The good pod yields for 1985 and 1986 tests were probably related to a favorable rotation, since these tests followed 25 yr of grass pasture.

Harvest of peanut pods without the vines attached at the time of digging would be very difficult with current harvesting equipment. In this study, plants with pods were retrieved by hand and carried to the thresher for picking, which probably resulted in lower than expected pod yields. A commercial peanut combine could not pick these peanuts efficiently from the windrow if most of the vines were removed.

Data on average annual dry matter forage and pod yields for the ten genotypes that were in all tests indicate that all genotypes produced more forage than in-shell peanuts (Table 3). Southern Runner usually produces more vine growth than most U.S. cultivars but it consistently had the lowest forage yields and one of the highest pod yields in this study. This might be expected since the other genotypes had higher levels of leaf spot resistance than Southern

Table 3. Average annual forage dry matter and pod yields for the two forage harvest treatments for the 10 peanut genotypes common to all tests, 1985-90.

	Genotype	Dry matter forage yields No. cuttings 1	2[a]	Pod yields No. cuttings 1	2
		---- kg ha-1 ----		---- kg ha-1 ----	
1)	UF81206	4800	6450	3530	2400
2)	72x32B-3-2-1	5460	7090	1870	1500
3)	72x76-6-1-1	5420	7300	1620	1300
4)	72x32B-3-2-2	5570	7220	1600	1260
5)	72x94-12-1	5340	7450	1590	1130
6)	Southern Runner	3750	5770	2860	1920
7)	Egret	5810	8150	2190	1290
8)	PI 468224 (US29)	5680	7540	2120	1290
9)	UF563B	4750	7050	2080	1540
10)	PI 475849 (US202)	5990	8060	1730	1120
	Avg	5260	7210	2120	1480
	LSD (0.05)	410	450	250	240

[a]Total for the two cuttings.

Table 4. Percentage crude protein and IVOMD for selected genotypes, 1986.

	Genotype	Harvest treatments[a] Protein H1[b]	H2[b]	1 Cut	IVOMD H1[b]	H2[b]	1 Cut
		---- % ----					
1)	UF81206	15.5	14.9	13.8	70.3	61.1	60.8
2)	72x32B-3-2-1	16.9	17.7	15.2	69.5	63.8	61.3
3)	72x76-6-1-1	17.5	16.6	14.6	71.2	64.4	57.2
4)	72x32B-3-2-2	19.6	17.8	12.8	72.1	63.3	57.7
5)	72x94-12-1	16.0	17.1	14.4	69.8	65.4	61.1
6	Southern Runner	16.0	17.0	12.4	68.4	64.1	61.3
7)	Egret	16.2	14.2	13.6	70.2	62.9	59.3
8)	PI 468224 (US29)	17.0	17.0	12.5	71.7	65.3	55.7
9)	UF563B	16.8	17.3	14.8	70.6	66.2	62.9
10)	PI 475849 (US202)	18.1	16.6	12.8	69.1	63.8	60.5
	Avg	16.9	16.5	13.8	70.4	63.9	59.6
	LSD (0.05)	2.9	3.2	3.4	4.2	4.8	5.6

[a]This test included 15 entries, but data reported on 10 genotypes included in all tests.

[b]H1 = first cutting (76 d); H2 = second cutting of two cutting treatment; 1 cut = single harvest at end of season (135 d).

Runner and were selected for forage potential. Egret, a cultivar from Zimbabwe, and PI 475849 produced the greatest forage yields for both the one- and two-cutting schedule. Both genotypes have significantly better late leaf spot resistance than Southern Runner and a spreading bunch growth habit. UF81206 produced forage yields below the test mean but was clearly the best entry for pod yields and was among the most resistant entries to late leaf spot. However, UF81206, 72x94-12-1, and Southern Runner had the most prostrate growth habits among the genotypes tested. Prostrate growth habit made them more difficult to harvest for forage since branches lying on the soil surface often were not cut for forage. A spreading-bunch growth habit, such as that noted for Egret and PI 475849, would be more desirable for forage production.

Forage yields for some entries in this study were very similar to those reported for Florigraze. Mean dry matter forage yields (1972-76) for Florigraze at Jay, FL for a 1970 planting was 7620 kg ha^{-1} (10). However, results reported in this study were for the same year that the genotypes were planted. Most of the forage yields obtained in this study exceeded those reported for susceptible cultivars sprayed with a leaf spot control fungicide (5,9).

Percentage protein and IVOMD for the 10 genotypes tested are given for 1986, which was the only year with a complete data set (Table 4). Differences were significant for genotypes and forage harvest treatments. Values for protein and IVOMD were higher for both cutting 1 (H1) and cutting 2 (H2) of the two-harvest treatment, compared to the single cutting for all genotypes. H1 was always higher than H2 for IVOMD, but not for protein. Higher leaf spot disease level and associated defoliation, along with maturity, probably contributed to the lower protein and IVOMD for the single cutting treatment.

Data on protein and IVOMD from genotypes compare favorably to Florigraze, which generally averaged 14-15% for protein and 64-69% IVOMD in Florida tests (10). Results from these tests appear to be more favorable than for some reports on spanish cultivars sprayed with a fungicide to control leaf spot (5). This latter study reported 7-10% protein and 57-64% IVOMD. Data on IVOMD from peanut lines in this study compare favorably to those for the alfalfa cultivar Florida 66 in Florida studies (10).

USDA price quotes on alfalfa hay for 1989-92 ranged from $75-94 per t (1). No southeastern state price quotes on alfalfa for 1992 were available, but neighboring state price quotes included: Arkansas - $114, North Carolina - $86, Tennessee - $97, and Texas - $89 per t (1). If comparable pricing can be expected for quality peanut hay, forage value for some of the genotypes in this study could exceed $900 ha^{-1}. In addition to the forage, a producer would have the peanuts (seed), which should be worth more than $300 per t. Another option in harvesting the peanuts (seed) would be by "hogging-off" or using swine to harvest the peanuts, which was a common practice in the first half of this century (11). Swine fed a corn-based diet for half or more of their finishing period (25-105 kg) can overcome the "soft-pork" effect from feeding peanuts, which meat processors discount in price (8).

This study shows that *A. hypogaea* breeding lines have been identified with good potential for high quality forage production. With the continued identification and development of peanut breeding material with good to excellent leaf spot and other disease resistance, fungicides will not be required to produce dry matter forage yields of 8000 kg ha^{-1}, which compares favorably with perennial peanuts and alfalfa.

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