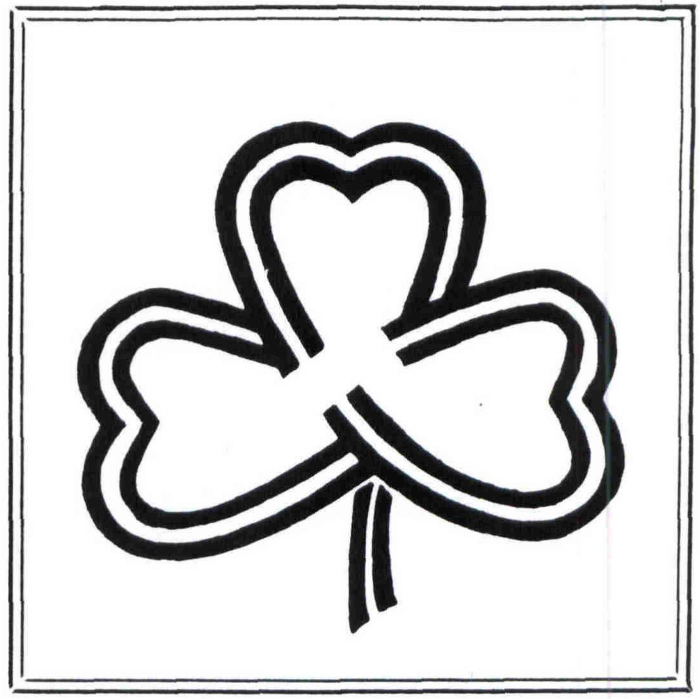
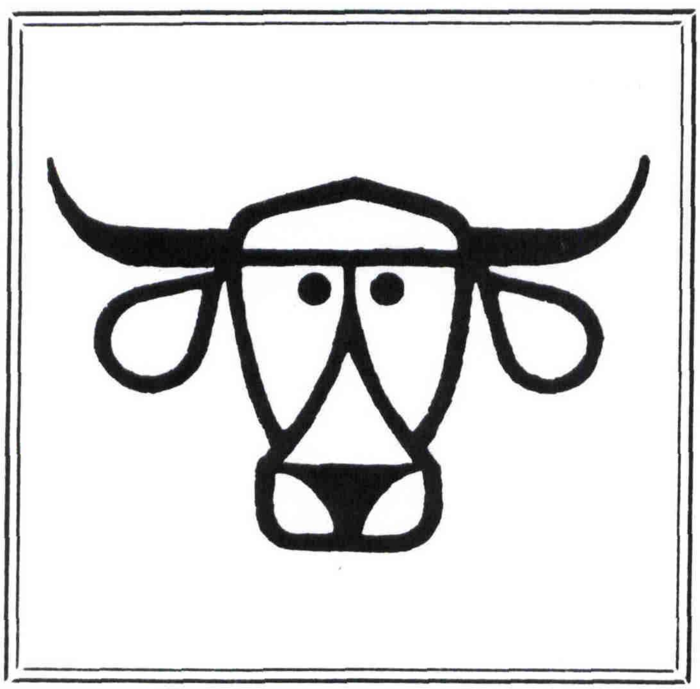
PUBLICATIONS
1984

CPR—4253
October 1984





Forage Research in Texas

1984

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The Growth Pattern and Protein Content of *Amaranthus retroflexus*

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SUMMARY

The project was designed to define the growth pattern and measure the protein content of *Amaranthus retroflexus* (amaranth, redroot pigweed) as well as ascertain its palatability as a feed for dairy goats. Growth followed the classic sigmoidal curve. Analysis of the growth measured by plant biomass exhibited the initial slow start during the lag stage from 0 to 21 days after emergence followed by active growth period during 22 to 49 days after emergence reaching maturity between 50 to 91 days. Maximum protein content (7.86 percent) of top biomass including seed was obtained during the active growth stage. The protein content decreased by 25% as the plants reached maturity. Palatability of the plant measured by the relative consumption of *Amaranthus retroflexus* and *Cynodon dactylon* (Coastal bermudagrass) hay by four dairy goats showed that the goats consumed 7 times more amaranth hay than the bermuda hay. During the relatively short 11 day trial, the results indicated preference for amaranth as a dairy goat feed. However, research must be continued to measure the response to the oxalic acid content of amaranth on animal health and milk production.

INTRODUCTION

One of the leafy plants used as human food in some parts of the tropics is *Amaranthus retroflexus* (Amaranth, redroot pigweed). It is among the C-4 photosynthesizing plants. Its efficiency of converting incident solar energy is greater than that of common cereal plants (Zelitch, 1977). Although amaranth is considered a tropical plant, the plant grows well in the temperate climate of some mid-western areas of the United States. It has limited use as a warm-season substitute for spinach by amateur gardeners. As a farm crop, it is new to traditional American farmers but common among organic farming enthusiasts.

Amaranth grows profusely in South Texas where it is considered a noxious and troublesome weed with the result that

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KEY WORD: Amaranth/ Redroot pigweed/ Dairy goats/ Bermudagrass

little attention has been directed towards its nutritional potentials as a possible livestock feed. Fortunately, research conducted by the Organic Gardening and Farming Research Center (OGFRC) at Rodale Farms, Philadelphia, Pa. has revealed that amaranth leaves synthesize relatively high concentrations of protein. Hill and Rawate (1981) found that the vegetable parts of the plants are high in protein, calcium, potassium, iron and asorbic acid, indicating a high human food potential and feed for livestock. Since amaranth leaves provide a relatively high content of protein and the plant grows so easily in South Texas, it has the potential as a livestock feed. Because this potential has not been exploited, research relative to its use as a feed should be conducted.

Therefore, the objectives of this paper were to determine the growth pattern and protein content of amaranth. In addition, an experiment was conducted to ascertain the comparative palatability of amaranth to bermuda hay utilizing the goat as a test animal.

Experiment I

This study determined the growth pattern and protein content of Amaranth as responses to plant density and harvests conducted at the Prairie View A&M University Agricultural Experiment Station, Prairie View, Texas from May through September, 1983. The soil series is a Hockley fine sandy loam (siliceous, thermic, Plinthic Paleudalf). According to Brams and Anthony (1983) this soil has by a pH of 5.1, with 0.5 percent organic carbon, and a bulk density of 1.56. The soil is 61 percent sand, 25 percent silt and 14 percent clay with kaolinite as the dominant clay species. There was no planting of amaranth plants because they grow as volunteers readily at this station. Therefore, an area 29.8 m^2 located where amaranth plants grew during the last growing season was tilled and treated with 100 lb. 21-8-17 blended fertilizer broadcasted during the month of May, 1983. The amaranth germinated on June 2, 1983, which was noted as the day of emergence. Perennial rye grass (*Lolium perenne* L.) and Coastal bermudagrass (*Cynodon dactylon*) were the outstanding weeds. The dominant parasite observed was black cutworm larvae which pupated on the amaranth.

Experimental Design

The experiment tested the yield response of amaranth to two levels of density and two cutting treatments (none, except at maturity and 2 harvests during growth period) for a total of four treatments. The low density plot averaged 11 plants per M^2 and the high density plot averaged 38 plants per M^2. The experiment was a completely randomized split-plot design of four treatments of four replications per treatment for a total of sixteen experimental units. Main plots were identified as cutting treatments while the subplots were identified as the density of stand.

Experiment II

The experiment to test the palatability of the amaranth plant was conducted at the Prairie View A&M University International Dairy Goat Research Center at Prairie View, Texas. The experiment measured the consumption of amaranth and bermuda hay by allowing the goats to feed free-choice from the two feeds. Four Toggenburn female goats five months old were used for the study.

Each goat was separately housed and each provided with two separate feeders and a container of water. Before the feeding trial was started, each goat was fed 400 gm of amaranth hay and 400 gm of bermuda hay, mixed together each day for 7 days to condition the goats for the forthcoming feed trial. The palatability test was conducted by providing each goat at 7 a.m. a separate weighed amount of amaranth and bermuda hay (450 g. each). Goats were allowed to eat freely from any of the two feeds. At mid-day, the feed containers were switched to prevent goats from becoming use to any feed being kept in a particular feeder. The amount of each feed, (amaranth and/or bermuda) consumed was recorded before a new daily supply was made available. Body weights of the goats were taken on the first and the eleventh day. No supplement was fed.

The analysis of data in Table 1 shows the density of amaranth stand did not influence the dry matter yield (0.05 level of probability) where production averaged 1914 and 1929 kg/ha for both low and high density treatments for all cutting treatments. Production in the maturing plots under the density treatments averaged 1843 and 1718 kg/ha and was not significant (0.05 level). It can be assumed that the reduced number of plants in the low density stand resulted in more biomass per plant whereas the high density stand with a greater number of plants produced less dry matter per plant or thinner more succulent plants per unit area of ground.

The data in Table 2 are measurements of protein concentration in top biomass (including seeds) of amaranth as a function of growth and cutting. The protein concentration of amaranth samples taken 30 days after emergence averaged 7.68 and 7.65% in plots designated under cutting and maturing treatments (Table 2). Analysis of biomass taken 14 days after the first harvest of the cutting plots showed the protein concentration reached only 4.20%. Samples taken after 28 days growth indicated protein percent had increased to 7.40 and began a slow, but not significant decline to 6.78% after 56 days of growth following the first harvest (Table 2). The maturing plots which were not harvested until 86 days after emergence achieved an average protein concentration of 7.39% while the average protein in the plants that were harvested averaged 7.18%, a value not significantly different from the maturing plants.

The curves in Figure 1 show the relative consumption of amaranth and bermuda hay by the test goats. The consumption of amaranth exceeded that of bermuda by a factor of 7-fold during the course of the trial. The marked drop in amaranth consumption between day 3 and 6 could be attributed to an adjustment period to a new feed compared to bermudagrass which was the formal diet prior to the experiment. There also occurred a rise in air temperature during this period which adversely affected feed intake for both amaranth and bermudagrass (Figure 1).

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Table 1. Average Dry Matter Yields/Density Stand for Cutting Plots and Matured Plots

	Cutting Plots Yields Average Kg/Ha			Maturing Plots Yield Average Kg/Ha
	First	Second	Total	
	---Cuttings---		Cutting	
High Density	940	974	1914a	1843b
Low Density	931	998	1929a	1818b

Values with the same letter are not significantly different at the 0.05 level (Duncan Multiple Range Test).

Table 2. Protein Content of *Amaranthus retroflexus* during growth period and after cutting

Treatment	Date of Measurement	Growth Period (Days)	Cutting Plots	Maturing Plots
			----- % Protein -------	
1st Harvest	6/30/83	30[1]	7.68	7.65
	------ Days of Growth After 1st Harvest ------			
	7/14/83	14[2]	4.20[2]	7.87
	7/28/83	28	7.40	7.82
	8/11/83	42	6.87	6.86
2nd Harvest	8/25/83	56	6.78	6.77
Average Means			x = 7.18	x = 7.39

[1] After Emergence

[2] Value not utilized in calculation of mean protein levels of cutting plots.