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AMARANTH PRODUCTIVITY AND NUTRIENT COMPOSITION IN CENTRAL GEORGIA

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Abstract

Amaranth (*Amaranthus* spp.) may have potential as a forage for summer grazing in the southeastern United States (US). Six accessions of amaranth were harvested at bud stage in two successive growing seasons to evaluate growth characteristics, yield, and forage quality parameters. The accessions, three genotypes of *A. tricolor* (Hinchoy VL, RRC-701, RRC-1186) and one each of *A. hybridus* (RRC-843), *A. cruentus* (RRC-1034), and *A. dubius* (RRC-1186) were evaluated in 1994 and 1995 on a Dothan sandy loam (fine loamy, siliceous, thermic, Plinthic Paleudult) soil at the Fort Valley State University Research Station, Fort Valley, Georgia. The plots were planted in mid-June in each year as a randomized complete block with four replications. Plants were harvested approximately 40 d after germination. Plant height and total dry matter (DM) yield determinations were made at harvest. Percentage leaf and stem were determined by hand separation of 5 randomly-selected plants from each plot. Leaf material for the 1994 growing season was analyzed for neutral detergent fiber (NDF), acid detergent fiber (ADF), and crude protein (CP) content. Protein content ranged from 240-260 g/kg, while NDF and ADF ranged from 523-587 g/kg and 187-293 g/kg, respectively. The accessions ranged in height from 41-74 cm and total DM and leaf DM yield from 0.83-1.30 Mg/ha and 0.52-0.79 Mg/ha, respectively. All the accessions were over 50% leaf. With adequate yields and high leaf protein, amaranth has potential as a summer forage crop for livestock grazing in the southeastern US.

Keywords: Amaranth, yield, forage quality

Introduction

Amaranth (*Amaranthus* spp.) is a hardy, fast-growing pseudo-cereal with C_4 metabolism and wide geographic and environmental adaptability. It is an important grain or vegetable crop in India, Pakistan, Nepal, China, Africa, Southeast Asia, and the Carribean (Robinson, 1986; Stallknecht and Schulz-Shaeffer,1993; Stordahl et al., 1999), but in the United States (US), there was little interest in amaranth until the Rodale Foundation and Rodale Research Center (RRC) began working with the plant in the mid 1970s. Amaranth is now recognized in the US as hardy grain and leafy vegetable that performs well during the summer (Singh and Whitehead, 1996; Stahlknecht and Schulz-Schaeffer, 1993). Amaranth leaves are a good source of dietary fiber and contain high amounts of protein, vitamins, and minerals (Makus and Davis, 1984; Teutonico and Knorr, 1985; Willis et al., 1984). Most of the literature on amaranth concerns it s use in human diets, however, with little information available on the forage value of amaranth for livestock.

Forage production systems for livestock grazing in the southeastern US are traditionally based on perennial warm-season grasses for summer grazing, with overseeded winter annual grasses and legumes for winter grazing (Ball et al., 1996). Warm-season perennial grasses generally have lower feeding value in late summer or early autumn. Amaranth may have potential as a high-protein grazing crop for this period. The objective of this study was to evaluate yield, growth parameters, and forage quality of a number of diverse lines of amaranth in a vegetative state.

Materials and Methods

Field studies were conducted in 1994 and 1995 at the Fort Valley State University Agricultural Research Station in Fort Valley, Georgia, to identify *Amaranthus* genotypes of maximum forage yield and forage quality. The studies were conducted on a Dothan sandy loam (fine loamy, siliceous, thermic, Plinthic Paleudult) soil. A total of six amaranth accessions were evaluated, including three *A. tricolor* (Hinchoy VL, RRC-701, RRC-241) and one each of *A. hybridus* (RRC-843), *A. cruentus* (RRC-1034), and *A. dubius* (RRC-1186). The experimental design was a randomized complete block with four replications. Individual rows consisted of four rows 0.9 m apart and 6.1 m long. During each year, the accessions were planted in mid-June and harvested approximately 40 d after germination. Five randomly-selected plants were collected at time of harvest to measure growth parameters consisting of leaf area, and leaf and stem dry weight. Height of five random plants per plot was measured. Two middle rows were used in the yield determinations. Dry weights were recorded after drying the plant material at 70 °C in a forced air oven. Leaf to stem ratios were calculated based upon leaf and stem dry weights. Dried leaf material was ground to pass a 1 mm screen in a Wiley mill and analyzed for crude protein (CP) using a microkjeldahl technique (Jones and Case, 1990), and neutral detergent fiber (NDF) and acid detergent fiber (ADF) using an Ankom fiber analyzer (Ankom Technology, Fairport, New York, USA).

The data were analyzed as a randomized block using the GLM procedure of SAS (SAS, 1994). Because of a significant interaction between various agronomic parameters and year, each year's data were analyzed separately. When the main effects were significant (P<0.05), means were separated using Duncan's multiple range test.

Results and Discussion

Total DM yield for the six accessions averaged 1.0 and 1.4 Mg/ha in 1994 and 1995, respectively (Table 1). This was similar to reported yields for amaranth cultivars harvested 80 days after planting in Minnesota (Stordahl et al., 1999). The plants in the current study were harvested 40 days after germination. There was no effect of accession on total DM or leaf DM yield in the 1994 season, while there was a significant cultivar effect (P<0.05) in 1995. The two highest yielding accessions in the 1995 season, *A. hybridus* (RRC-843) and *A. cruentus* (RRC-1034), were also the tallest of the six amaranth types evaluated. These accessions had a significantly lower ($P<0.05$) leaf percentage than most of the other types, however. One of the *A. tricolor* accessions, RRC 241, was one of the shortest types we evaluated, but it had similar total and leaf DM yield to the *A. hybridus* and *A. cruentus* accessions due to higher leaf percentage. All of the amaranth cultivars evaluated had between 50 and 70 % leaf in both years of the experiment. These values were somewhat higher than observed by Stordahl et al (1999) in their evaluation of several *A. cruentus* and *A. hypochondriacus* accessions harvested 80 days after planting.

Forage quality data for the six amaranth accessions for the 1994 season are presented in table 2. The NDF and ADF values ranged from 523-587 g/kg and 187-293 g/kg, respectively, which is higher than fiber values reported by Stordahl et al (1999). There were no differences among accessions in their CP content, which ranged from 240-267 g/kg. These values were higher than amaranth leaf CP values reported by Stordahl et al (1999) in plants harvested after 80 days growth.

High leaf percentage and high leaf CP in amaranth suggests that this forage may provide a high-quality alternative summer pasture for grazing livestock in the southeastern US. Animal performance data are currently lacking for *Amaranthus*, however, and further studies are needed to fully evaluate the forage potential of this species.

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Table 1. Yield and vegetative growth parameters of six accessions of amaranth.

Accession number	Year	Plant height (cm)	DM yield Mg/ha	Leaf DM yield, Mg/ha	% Leaf
RRC701	1994	44.5a*	0.83a	0.52a	62.6bc
RRC843	1994	73.8b	0.94a	0.53a	56.2a
RRC1034	1994	65.8b	1.30a	0.77a	58.8ab
RRC8616	1994	40.8a	0.96a	0.65a	66.9cd
HinchoyVL	1994	45.0a	0.86a	0.59a	68.0de
RRC241	1994	40.8a	1.09a	0.79a	72.0e
SE		2.9	0.16	0.10	1.5
RRC701	1995	47.5a	1.18ab	0.70ab	60.0c
RRC843	1995	70.0b	1.80c	0.92c	51.4a
RRC1034	1995	65.0b	1.49bc	0.76abc	52.3ab
RRC8616	1995	44.5a	1.23ab	0.82bc	66.8d
HinchoyVL	1995	45.0a	1.05a	0.60a	57.8bc
RRC241	1995	44.5a	1.42abc	0.89c	63.3cd
SE		4.2	0.12	0.05	2.0

*Within each year, column means with different letters are significantly different, $P<0.05$.

Table 2. Quality parameters for six amaranth accessions.

Accession number	Year	NDF, g/kg	ADF, g/kg	CP, g/kg
RRC701	1994	561ab*	235bc	264a
RRC843	1994	523a	187a	266a
RRC1034	1994	540ab	209ab	260a
RRC8616	1994	568ab	245c	260a
HinchoyVL	1994	587b	240c	267a
RRC241	1994	565ab	293d	240a
SE		16.0	9.4	10.0

*Column means with different letters are significantly different, P<0.05.