Rodent Bait-AG resulted in higher mortality of pine voles than a ZnP–grain formulation (Table 2). When survivors of the ZnP–grain treatment were re-treated with ZnP–grain, only one of 20 voles was killed; but, when treated with ZP Rodent Bait-AG, seven of 20 voles died. When survivors of the ZnP–grain were held for 30 days and subsequently treated with ZP Rodent Bait-AG, 10 of 20 voles died. The anticoagulant formulation (Rozol) was more efficacious (14 of 20 died) than any ZnP formulation when survivors of the ZnP–corn and oats were re-treated. These results suggest that rotation from a ZnP formulation to an anticoagulant could be important if additional control of a recently ZnP–grain-treated vole population was needed, but if an anticoagulant was not available, ZP Rodent Bait-AG would be a reasonable second choice.

The anticoagulant rodenticide baits Volid and Rozol, when stored together with zinc phosphide or organic phosphates, absorb enough pesticide odor (either zinc phosphide or organic phosphides) to be detected by human olfaction. Volid stored with organic phosphates (but not when stored with zinc phosphide) caused reduced feeding (0.05 level of probability) and mortality (0.1 level of probability) of voles (Table 3, test A). Efficacy of Rozol stored with either ZnP or organic phosphates for 57 days was not affected after storage (Table 3, test B).

The Volid formulation contained activated charcoal as an inert ingredient to blacken the bait (to reduce feeding by ground-feeding birds when used in the field). Efficacy of this formulation was reduced slightly by storage with organic phosphates (Table 3). The efficacy of Volid that was held in a storage building for 4 years and was damaged by insects was not affected. Considering the stringency of the laboratory test, the performance of the stored rodenticides with zinc phosphide or the organic phosphates was impressive.

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HortScience 22(2):241–243. 1987.

Forage Potential of Cowpea in a Double-cropping System Following Green Peas

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Additional index words. forage quality, in vitro digestibility, protein, *Vigna unguiculata*, *Pisum sativum*

Abstract. **Cowpea [*Vigna unguiculata* (L.) Walp] has not been considered as a double-crop alternative in the midwestern United States. Forage potential of cowpea following green peas (*Pisum sativum* L.) was studied in two field experiments in central and southern Minnesota. Dry-matter yield was higher in 1981 than in 1982 for all cowpea cultivars tested. Increasing the plant population improved yields for 'California Blackeye Number 5', 'Alabama Giant Blackeye', 'Freezegreen', and the breeding lines MN 139, MN 150, and Au 704, but not for 'Colossus'. In vitro dry matter digestibility (IVDMD) was >63% for both stems and leaves in all cultivars and was not affected by plant population. Crude protein (CP) in leaves exceeded 20% for all treatments. We conclude that cowpea has excellent potential for supplying high-quality forage from double-cropping systems in the midwestern United States.**

Double-cropping is defined as the growing of two crops in succession on the same land space in one growing season (1). This cultural practice has been promoted in several regions of the United States as a method of increasing land-use efficiency (3). However, it is usually limited to areas having long growing seasons (6). Efforts to improve land-use efficiency on some of the most productive lands in the United States have had varied results (4). Cowpea, a productive crop under Minnesota growing conditions (7), has high protein content (5) and is used in double- and multiple-cropping systems in warm regions of the world (13). Livestock fed with cowpea forage have shown weight gains that have been comparable to those from other legumes (10).

Planting of green peas for processing as a cash crop is a common practice for dairy farmers in Minnesota. Harvest of the peas in late June to early July provides the opportunity for planting a second crop for livestock forage. Accordingly, the objectives of this study were to evaluate the potential yield and forage quality of cowpea as a second crop in a double-cropping system with green peas.

Field studies were conducted in 1981 at the Univ. of Minnesota Sand Plain Experiment Station, Becker (Hubbard sandy loam), and in 1982 at the Southern Experiment Station, Waseca, Minn. (Glencoe clay loam). Fertilizer was applied according to soil test recommendations for green peas. No additional fertilizers were applied for the cowpeas. Temperatures (mean daily maximum) for the 1981 growing period ranged from 29°C at planting to 15° at final harvest, and, for 1982, from 30° to 15°, respectively. Seeds were planted on conventionally prepared seed

Received for publication 17 Sept. 1984. Paper no. 14,108 of the Scientific Journal Series, Univ. of Minnesota Agricultural Experiment Station. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

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Table 1. Dry-matter yields of cowpea cultivars and breeding lines grown under two plant populations in 1981 and 1982 at Becker and Waseca, Minn.

	Forage yield (kg·ha^{-1})			
	Plant population (1000 plants/ha)			
	130		260	
Cultivar[z]	1981	1982	1981	1982
COL	3357	2890	3324	2828
MN139	1956	---	2690	---
Au704	2772	---	4097	---
CB#5	3074	2780	4272	3709
ALGB	2481	---	3544	---
FG	1963	---	2123	---
MN150	---	1790	---	2296
LSD, 5%	496	NS	496	NS

[z]COL = 'Colossus', MN139 = advanced breeding line, Au704 = advance breeding line, CB#5 = 'California Blackeye Number 5', ALGB = 'Alabama Giant Blackeye', FR = 'FreezeGreen', and MN150 = advanced breeding line.
[y]Average of three harvest dates (over both populations).

beds inoculated with Soil Implant, cowpea group *Rhizobium*, prepared by the Nitragin Company (Milwaukee, Wis.). The beds were treated with 2,6-dinirro-*N*,*N*-dipropyl-4-(trifluoromethyl)benzenamine (trifluralin) prior to planting.

In both experiments, two-row plots (12.7 m long × 2.7 m wide) were used with row spacings of 0.914 m. Overhead irrigation water was supplied as needed. At each harvest date, in vitro dry matter digestibility (IVDMD) in rumen fluid was determined on duplicate 125-mg subsamples of dry matter (ground through a 1-mm screen) using a two-stage, direct-acidification technique (8). Crude protein was estimated from Kjeldahl N (2) in 1981 only.

On 3 July 1981, the cultivars Colossus, Alabama Giant Blackeye, California Blackeye Number 5, Freezegreen, and the breeding lines Au 704 and MN 139 were hand-planted at two plant populations (130,000 and 260,000 plants/ha). The experimental design was a randomized complete block with four replicates. Plants contained in a 3-m section of random rows were harvested from each plot at 40 days after emergence (early bloom stage) and at 15 and 30 days after early bloom. The final harvest occurred in mid-September and coincided with the first frost. Dry matter yields at all harvest dates were obtained from oven-dried (70°C for 48 hr) shoots of the 13 plants.

On 14 July 1982, 'Colossus', 'California Blackeye Number 5', and one advanced breeding line, MN 150, were planted with a four-row cone planter at the same plant populations used in Expt. 1. A split-plot experimental design with five replicates was used. Main plots were plant populations and subplots were cultivars. Stage and frequency of harvest was similar to that of Expt. 1.

Statistical analysis showed no significant interaction between harvest date and genotype. The yields obtained at each harvest for each genotype showed similar trends as the final harvest. Thus, the harvest date data were pooled.

Dry matter yields were lower in 1982 than in 1981 as a result of the short growing season in 1982 (Table 1). Increased yields were obtained with the high plant population (260,000 plants/ha). However, yields for 'Colossus' were about equal for both populations in 1981 and 1982. This similarity was attributable to the extensive branching of this cultivar at the low plant population, compensating for the reduced number of plants per unit area. 'California Blackeye Number 5', a vining cultivar, produced the highest dry matter yield both years in the high plant population, but in the low population, its yield was comparable to 'Colossus'. Au 704 and 'Freezegreen' exhibited little or no branching and produced low yields at the low population.

The breeding lines MN 139 (1981) and MN 150 (1982) and 'Freezegreen' (1981) had the lowest yields at both plant populations. The low forage yields of the Minnesota breeding lines may be a result of the developmental characteristics of these lines. Both MN 139 and MN 150 were developed for high grain yields and early maturity, and both lines have determinate growth habit. Therefore, the low forage yield may be a result of sparse vegetative growth.

'Colossus' had greater ($P < 0.05$) IVDMD in leaves, shoots, and stems in 1981 than all other cultivars (Table 2). Due to increased IVDMD of 'Colossus', the yield of digestible dry matter of this cultivar was comparable to that of 'California Blackeye Number 5' in 1982 (Table 2). Stem IVDMD was quite high, contributing to the overall high total shoot digestibility. The IVDMD of cowpea from this study was higher than that reported for some common forage crops, such as sunflower (12), oats, and oats–legume mix (11).

Cultivars differed ($P < 0.05$) in both leaf and stem crude protein in 1981 (Table 2). The crude protein of all entries compared favorably to that of other legume forages (9).

Little relationship existed between plant population and IVDMD. Thus, the different growth habits observed at the two populations had no substantial effect on forage quality.

High forage quality of 'Colossus' and 'California Blackeye Number 5' suggest that these cultivars could be recommended in a double-cropping system with green peas in the upper midwestern United States. However, more animal feeding research is needed before unconditional recommendations can be made.

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Table 2. In vitro dry matter digestibility (IVDMD) and percent crude protein (CP) for cowpea cultivars and breeding lines grown at Becker and Waseca, Minn. in 1981 and 1982, respectively.

	IVDMD[y] (%)						CP[y] (%)	
	1981			1982			1981	
Cultivars[z]	Shoot	Stem	Leaves	Shoot	Stem	Leaves	Stems	Leaves
COL	77.3	75.9	78.5	71.8	66.5	79.4	9.8	23.2
MN139	67.7	63.3	74.8	---	---	---	10.7	22.8
Au704	72.7	69.7	77.3	---	---	---	10.8	22.9
CB#5	67.1	63.3	70.1	70.4	67.1	72.4	9.4	25.0
ALGB	71.4	67.9	77.1	---	---	---	8.1	22.4
FG	71.4	66.5	77.8	---	---	---	9.3	21.8
MN150	---	---	---	75.5	65.2	78.1	---	---
LSD, 5%	1.9	2.0	1.3	NS	NS	2.5	0.9	1.1

[z]COL = 'Colossus', MN139 = advanced breeding line, Au704 = Advanced breeding line, CB#5 = 'California Blackeye Number 5', ALGB = 'Alabama Giant Blackeye', FG = 'FreezeGreen', and MN150 = advanced breeding line.
[y]Average of three harvest dates (over both populations).

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HortScience 22(2):243–244. 1987.

Prepropagation Dips of Acanthaceae Cuttings in Growth Regulators to Retard Subsequent Growth

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Additional index words. *Pseuderanthemum atropurpureum, Sanchezia speciosa, Strobilanthes dyeranus,* purple false eranthemum, Persian-shield, height control, growth retardants, growth inhibitors, morphactins

Abstract. **Total immersion of *Pseuderanthemum atropurpureum* L. H. Bailey, *Sanchezia speciosa* J. Leonard, and *Strobilanthes dyeranus* M. T. Mast. cuttings in aqueous solutions of the morphactins chlorflurecol and chlorflurenethol prior to propagation retarded plant growth 16 weeks after rooting. Height of *Sanchezia* and *Strobilanthes* also was reduced by dips of chlorfluren and dichlorflurecol and chlormequat chloride. Morphactins caused abnormal growth on *Pseuderanthemum* and *Strobilanthes*. Dips of PBA reduced the height of *Pseuderanthemum* and *Strobilanthes*. *Pseuderanthemum* height also was reduced by ancymidol and ethephon dips, and height was reduced on *Strobilanthes* by oxathiin and piproctanyl bromide. Chlorflurecol dips reduced plant dry weight of all species. Plant dry weight of *Strobilanthes* also was reduced by chlorofluren, chloroflurenthol, oxathiin, and PBA immersion. Ethephon, PBA, and chlorflurenthol dips also reduced *Pseuderanthemum* dry weight. Chemical names used: 2-chloro-9-hydroxy-9*H*-fluorene-9-carboxylic acid (chlorflurecol); 2-chlorofluorenecarbonic acid-(9)-methylester (dichloroflurecol); 2-chloro-9-hydroxyfluorene-carbonic acid-(9)-*p*-chlorophenoxyethylester (chloroflurenethol); 2-chloro-*N,N,N*-trimethylethanaminium chloride (chlormequat chloride); *N*-(phenylmethyl)-9-(tetrahydro-2*H*-pyran-2-yl)-9*H*-purin-6-amine (PBA); α-cyclopropyl-α-(4-methoxyphenyl)-5-pyrimidinemethanol (ancymidol); (2-chlorethyl)phosphonic acid (ethephon); 2,3-dihydro-5,6-diphenyl-1,4-oxathiin (oxathiin); 1-(3,7-dimethyloctyl)-1-(2-propenyl)piperidinium bromide, (piproctanyl bromide).**

The *Acanthaceae* contains many colorful tropical shrubs that are occasionally grown as potted plants. Rapid growth, large plant size, and absence of freely branching habit has limited the use of such Acanthaceae as purple false eranthemum (*Pseuderanthemum atropurpureum* L. H. Bailey), sanchezia (*Sanchezia speciosa* J. Leonard) and Persian shield (*Strobilanthes Dyeranus* M. T. Mast.). Growth regulators have been used to adapt the Goldlilocks plant (*Pachystachys lutea* Nees) to pot culture (3, 11). Preliminary work (unpublished data) by us indicated that *Pseuderanthemum, Sanchezia,* and *Strobilanthes* do not respond very well to growth-retardant sprays and drenches.

Other methods of applying growth retardants to ornamentals to increase efficiency include impregnated propagation blocks (13), soaked clay pots (1) and application through irrigation tubing (2), granular formulations (10), plaster of Paris tablets (5), and root dips (4). Treatment of stock plants with growth regulators prior to taking cuttings has yielded variable results (8, 9, 11); however, soaking the basal portion of unrooted cuttings in a growth retardant for 24 hr has been reported to be effective (12). Entire immersion of rooted cuttings in butanedioic acid mono(2,2-dimethylhydrazide) (daminozide) has been successful in controlling the height of chrysanthemum; however, ancymidol dips resulted in excessive height reduction (4). Prepropagation or pretransplanting dips of cuttings are presently used by many chrysanthemum growers to control the height of tall-growing cultivars (14).

Several growth-retarding chemicals were tested as prepropagation dips to control the height of *Pseuderanthemum, Sanchezia,* and *Strobilanthes* plants. Double-eye cuttings of *Pseuderanthemum, Sanchezia,* and *Strobilanthes* were submerged completely for 10 sec in the growth regulators listed in Table 1. The selection of growth regulators and rates was based on previous work by Shu and Sanderson (8, 9) and others (4, 7). Treated cuttings were placed in plastic bags, refrigerated overnight at 7°C, and then propagated under mist (10 sec out of every 100 sec) at 21°. Cuttings were inserted directly into a final growing medium consisting of 1 sand, 1 sphagnum peat, 1 pine bark medium (by volume) amended on a cubic-meter basis with 11.2 kg dolomitic limestone, 2.6 kg Perk minor element additive, 2.8 kg $CaNo_3$, 1.8 kg ureaformaldehyde fertilizer 31N–0P–0K, and 2.1 kg granular Aqua-Gro wetting agent. One cutting was propagated and grown in an 8 × 8-cm round plastic pot as an experimental unit. Two pots were used for each of the 13 treatments, which were replicated four times in a randomized block design. Each species was a separate experiment. Upon rooting (about 3 weeks), the plants were moved from mist into full sun (90 $\mu mol \cdot s^{-1} \cdot m^{-2}$ PAR) and grown at a temperature of 17°. Sixteen weeks after treatment, the plant height and dry weight were determined.

All cuttings rooted and, with the exception of *Pseuderanthemum* treated with chlorflurenethol, produced shoots from the axillary

Received for publication 23 Jan. 1986. Ala. Agr. Expt. Sta. J. Ser. no. 11-85889. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.
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