

In conclusion, the hay-type alfalfa cultivars Florida 77 and Apollo produced higher seed and forage yields than the grazing-type cultivars Travois and Spredor II. The grazing-tolerant germplasm GA-GC produced seed yields equivalent to Florida 77 and forage yields higher than all cultivars. The grazing-tolerant germplasm GA-WCG produced seed and forage yields equivalent to its unselected base population, WC-PI, even though it exhibited a more decumbent growth habit and earlier fall dormancy than WC-PI. The lack of significant biological relationships between morphological traits and seed yields agrees with Singh's (1978) conclusion that it is difficult to predict alfalfa seed yield using a single component of seed yield.

The seed yields produced in this study might encourage alfalfa seed production in Georgia, but unpredictable weather and a premium price for alfalfa hay make seed production economically unfeasible at present. Without data to provide measurements of genotype by environment interaction, the results of this experiment have no direct application to the western seed-producing areas. Given that the control cultivars performed as expected, the seed yields of GA-GC and GA-WCG suggest that grazing-tolerant cultivars can be developed that produce higher seed yields than current grazing-type cultivars.

#### ACKNOWLEDGMENTS

The authors wish to express their appreciation to Mr. Donald Wood, Mr. Jack Rogers, Mr. Richard Smith, Mr. Charles Brummer, and Mr. José DeBattista for their assistance in plot maintenance and data collection and to Dr. Glenn Ware for statistical consultation.

#### REFERENCES

- Barnes, D.K. 1972. A system for visually classifying alfalfa flower color. USDA-ARS Agric. Handb. 424. U.S. Gov. Print. Office, Washington DC.
- Barnes, D.K., E.T. Bingham, R.P. Murphey, O.J. Hunt, D.F. Beard, W.H. Skrdla, and L.R. Teuber. 1977. Alfalfa germplasm in the

- United States: Genetic vulnerability, use, improvement, and maintenance. USDA Tech. Bull. 1571. U.S. Gov. Print. Office, Washington DC.
- Barnes, D.K., D.M. Smith, R.E. Stucker, and L.J. Elling. 1979. Fall dormancy in alfalfa: A valuable predictive tool. p. 34. In D.K. Barnes (ed.) Rep. 26th Alfalfa Improvement Conf., Brookings, SD. 6-8 June 1978. Agricultural reviews and manuals. USDA-SEA, St. Paul.
- Bouton, J.H., C.S. Hoveland, J.F. Newsome, and G.V. Calvert. 1987. Alfalfa seed production in Georgia. Georgia Agric. Exp. Stn. Res. Rep. 522.
- Busbice, T.H., R.Y. Gurgis, and H.B. Collins. 1975. Effect of selection for self-fertility and self-sterility in alfalfa and related characters. *Crop Sci.* 15:471-475.
- Certified Alfalfa Seed Council. 1986. Alfalfa varieties: Currently-marketed varieties approved for certification by an agency of the Association of Official Seed Certifying Agencies. Certified Alfalfa Seed Council, Bakersfield, CA.
- Counce, P.A., J.H. Bouton, and R.H. Brown. 1984. Screening and characterizing alfalfa for persistence under mowing and continuous grazing. *Crop Sci.* 24:282-285.
- Gunn, C.R. 1972. Seed characteristics. In C.H. Hanson (ed.) *Alfalfa science and technology*. Agronomy 15:677-687.
- Heinrichs, D.H. 1963. Creeping alfalfas. *Adv. Agron.* 15:317-337.
- Heinrichs, D.H. 1965. Selection for higher seed yield in alfalfa. *Can. J. Plant Sci.* 45:177-183.
- Kalton, R.R., and D.E. Brown. 1981. Alfalfa seed production potentials for the 1980s. p. 24-26. In D.K. Barnes Proc. 27th Alfalfa Improvement Conf., Univ. of Wisconsin, Madison. 8-10 July 1980. USDA-ARS, Peoria, IL.
- Lowe, C.C., V.L. Marble, and M.D. Rumbaugh. 1972. Adaptation, varieties, and usage. In C.H. Hanson (ed.) *Alfalfa science and technology*. Agronomy 15:391-413.
- Pedersen, M.W., G.E. Bohart, V.L. Marble, and E.C. Klostermeyer. 1972. Seed production practices. In C.H. Hanson (ed.) *Alfalfa science and technology*. Agronomy 15:689-720.
- Rumbaugh, M.D., W.R. Kehr, J.D. Axtell, L.J. Elling, E.L. Sorensen, and C.P. Wilsie. 1971. Predicting seed yield of alfalfa clones. *South Dakota Agric. Exp. Stn. Tech. Bull.* 38.
- Rumbaugh, M.D., W.R. Kehr, E.L. Sorensen, I.T. Carlson, J.D. Axtell, and L.J. Elling. 1972. Predicting seed and forage yields of alfalfa open-pollinated progenies. *South Dakota Agric. Exp. Stn. Tech. Bull.* 40.
- SAS Institute. 1985. SAS user's guide: Statistic. SAS Inst., Cary, NC.
- Singh, S.M. 1978. Genetic basis of seed setting in alfalfa. *Theor. Appl. Genet.* 51:297-304.
- Smith, S.R. 1988. Alfalfa persistence and yield under continuous grazing and seed yield of grazing tolerant germplasms. M.S. thesis. Univ. of Georgia, Athens.
- Teuber, L.R., C.M. Rincker, W.L. Green, and W.R. Sheesley. 1984. Seedling year selection for seed yield in alfalfa. p. 62. In Proc. 29th Alfalfa Improvement Conf., Lethbridge, Alberta, Canada. 15-20 July 1984. Curle Printing Co., Minneapolis, MN.

## Characterization and Inheritance of Dwarfing Genes of Pigeonpea

K. B. Saxena,\* S. M. Githiri, Laxman Singh, and P. M. Kimani

#### ABSTRACT

Pigeonpea [*Cajanus cajan* (L.) Millsp.] cultivars have excessive vegetative growth and are not amenable to efficient crop management practices such as foliar insecticide application and mechanized field production. This study was conducted at the ICRISAT Center in India to characterize three easily distinguishable dwarf pigeonpea phenotypes ( $D_6$ ,  $PD_1$ , and PBNA) with respect to some morphological traits and to study the inheritance patterns for dwarfing genes. Six crosses involving the dwarf lines and tall cultivars were studied. In 1986, the parents,  $F_1$ , and  $F_2$  generations were grown and in the

following year, testcrosses and  $F_3$  progenies were evaluated along with their respective parents. Each population was phenotypically classified relative to parental type as tall or dwarf. The chi-square analyses showed that the dwarf phenotype in each of the three lines was controlled by a single recessive gene in homozygous state. The  $D_6$  and  $PD_1$  lines had similar alleles ( $d_3d_3$ ) whereas PBNA had a different allele ( $d_2d_2$ ) for dwarfness, which was recessive to the  $D_6$ / $PD_1$  allele, thus constituting a multiple allelic series.

K.B. Saxena and Laxman Singh, Legumes Program, ICRISAT, Patancheru, A.P. 502 324, India; and S.M. Githiri and P.M. Kimani, Univ. of Nairobi, Kenya. ICRISAT Journal Article no. JA. 810. Received 24 Oct. 1988. \*Corresponding author.

Published in *Crop Sci.* 29:1199-1202 (1989).

**T**RADITIONAL PIGEONPEA cultivars generally grow to the height of over 2 m. The excessive vegetative growth of pigeonpea not only leads to reduced harvest index but is also not amenable to efficient crop management practices such as insecticide application

Table 1. Phenotypic classification of the F<sub>2</sub> and testcross progenies of six crosses between dwarf and tall pigeonpea lines.

Cross/generation	Total plants	Observed		Expected		Ratio tested	Chi-square	Probability	
		Tall	Dwarf	Tall	Dwarf				
		no.							
D <sub>6</sub> × ICPL 1									
F <sub>2</sub>	545	392	153	408.75	136.25	3:1	2.75	0.05-0.10	
Testcross	34	17	17	17	17	1:1	0	1.00	
D <sub>6</sub> × BDN 1									
F <sub>2</sub>	530	392	138	397.50	132.50	3:1	0.31	0.50-0.75	
Testcross	31	16	15	15.50	15.50	1:1	0.04	0.75-0.90	
PD <sub>1</sub> × ICPL 1									
F <sub>2</sub>	204	153	51	153	51	3:1	0.00	1.0	
Testcross	18	10	8	9	9	1:1	0.22	0.50-0.75	
PD <sub>1</sub> × BDN 1									
F <sub>2</sub>	463	334	129	347.25	115.75	3:1	2.03	0.10-0.25	
Testcross	26	19	7	13	13	1:1	5.54	0.01-0.05	
PBNA × ICPL 366									
F <sub>2</sub>	1445	1124	321	1083.75	361.75	3:1	5.97	0.01-0.05	
PBNA × NP(WR)15									
F <sub>2</sub>	516	372	144	387	129	3:1	2.32	0.10-0.25	

and mechanized field production. Efficient management of pod borer (*Heliothis armigera*) and pod fly (*Melanagromyza obtusa*), the major and widespread pests of pigeonpea, is essential for realizing higher yields. Spence and Williams (1972) suggested that delayed planting can be used to achieve restricted vegetative growth in pigeonpea for improved management. Mohammed and Airyanayagam (1983) argued, however, that since plant height in pigeonpea fluctuates considerably from season to season and planting date, the use of dwarfing genes would be a more desirable approach to reduce plant height and reap the benefits of higher inputs and mechanization.

Krauss (1927), Shaw (1936), and Kolhe and Nayeem (1977) reported incomplete dominance of tall over the short plant stature in pigeonpea. Sen et al. (1966), Sheriff et al. (1975), and Marekar et al. (1978) identified bushy dwarf pigeonpea phenotype that had brittle branches and condensed internodes. They reported that the dwarfness was controlled by a single recessive gene. From the intergeneric crosses of pigeonpea and *Atylosia scarabaeoides*, Saxena et al. (1987) reported the identification of a high-protein dwarf line that was around 60 cm in height. Seven sources of dwarfism in pigeonpea available at ICRISAT Center have been described by Sharma et al. (1989). Of these, genetic studies of D<sub>0</sub> dwarf line were done by Waldia and Singh (1987) and based on F<sub>1</sub> and F<sub>2</sub> data of three crosses, they reported that the dwarf phenotype in the D<sub>0</sub> line was controlled by two nonallelic recessive genes *t*<sub>1</sub> and *t*<sub>2</sub>. The present study was conducted with the objective of characterizing three easily distinguishable dwarf pigeonpea phenotypes with respect to some important morphological traits and to study the inheritance patterns for dwarfing genes.

## MATERIALS AND METHODS

Three dwarf pigeonpea phenotypes, D<sub>6</sub>, PD<sub>1</sub>, and PBNA, were included in this study. The dwarf line D<sub>6</sub> was isolated from an irradiated population of 'BDN 1'. The plants of this line are medium maturing (180 ± 10 d), indeterminate, and grow to the height of over 1 m (117 ± 9 cm). The D<sub>6</sub> dwarf

has fewer and shorter internodes and a greater number of secondary and tertiary branches. The internodes are condensed so that the branches radiate from a narrow region about 10 to 15 cm above the ground level. The main branches are brittle and held at an acute angle, giving the plants a short, compact morphology. This line normally yields three brown seeds per pod with a 100-seed wt. of about 11 g. The dwarf line PD<sub>1</sub> was obtained from Agricultural Research Station, Gulbarga in Karnataka state, India, and resembles the D<sub>6</sub> dwarf line in height (113 ± 10 cm) and in the other morphological traits described above. In contrast, it has small [8 g per 100 seeds], white seeds, averaging 3.6 seeds in each pod. The dwarf line PBNA was obtained from Marthwada Agricultural University, Parbhani in Maharashtra state, India. The PBNA dwarf line is the shortest (98 ± 9 cm) among the dwarfs and, unlike PD<sub>1</sub> and D<sub>6</sub> dwarfs, this line retains most of its green leaves up to maturity. It matures about 10 d later than D<sub>6</sub> and has more secondary and tertiary branches. It has white seeds, weighing around 11 g per 100 seeds. On average, each pod contains 3.2 seeds. Under field conditions, the dwarfs D<sub>6</sub> and PD<sub>1</sub> were phenotypically similar except for seed traits. The PBNA dwarf was easily distinguished from D<sub>6</sub> and PD<sub>1</sub>.

In 1984, the two dwarfs, PD<sub>1</sub> and D<sub>6</sub> were each crossed with the tall cultivars 'ICPL 1' and BDN 1, whereas PBNA was crossed with 'ICPL 366' and 'NP(WR)-15'. A portion of the F<sub>1</sub> seed from each cross was sown in the 1985 rainy season to produce F<sub>2</sub> seed. In the 1986 rainy season, the parents, F<sub>1</sub>, and F<sub>2</sub> progenies were grown to record observations on segregation of tall and dwarf plants and to produce testcrosses and F<sub>3</sub> seeds. Because the F<sub>1</sub> plants wilted at the time of flowering, testcrosses with PBNA dwarf could not be made. In each F<sub>2</sub> population, 11 to 19 dwarf and 48 to 50 tall plants were selected randomly to study the segregation in the F<sub>3</sub> generation. In 1987, testcrosses and F<sub>2</sub> derived progenies were grown along with their respective parents. To study the allelic relationship among the three dwarfing genes, the three dwarf lines were crossed in a diallel in 1985 and a portion of the F<sub>1</sub> seed was grown in 1986 to produce F<sub>2</sub> seed. In 1987, the parents, F<sub>1</sub>, and F<sub>2</sub> progenies of each of the three crosses were grown. In each year the seeds of experimental materials were planted on ridges 60 cm apart, with intrarow spacing of 30 cm, on vertisols at the ICRISAT Center. At the time of flowering, each population of this experiment was phenotypically classified relative to parental type as tall or dwarf and the data were

Table 2. Segregation pattern in F<sub>3</sub> progenies grown from tall random F<sub>2</sub> plants of the crosses between tall and dwarf phenotypes.

Cross	No. of progeny	Observed		Expected		Ratio tested	Chi-square	Probability	
		Segregating	Nonsegregating	Segregating	Nonsegregating				
		no.							
D <sub>6</sub> × ICPL 1	48	31	17	32.0	16.0	2:1	0.09	0.75-0.90	
D <sub>6</sub> × BDN 1	49	37	12	32.7	16.3	2:1	1.70	0.10-0.25	
PD <sub>1</sub> × ICPL 1	50	30	20	33.3	16.7	2:1	0.89	0.25-0.50	
PD <sub>1</sub> × BDN 1	48	29	19	32.0	16.0	2:1	0.84	0.25-0.50	
PBNA × ICPL 366	50	31	19	33.3	16.7	2:1	0.48	0.25-0.50	
PBNA × NP(WR)15	50	31	19	33.3	16.7	2:1	0.48	0.25-0.50	

Table 3. Pooled segregation for tall and dwarf types within the tall F<sub>3</sub> segregating progenies from the six crosses between tall and dwarf phenotypes.

Cross	No. of progeny	Total plants	Observed		Expected		Ratio tested	Chi-square	Probability
			Tall	Dwarf	Tall	Dwarf			
			no.						
D <sub>6</sub> × ICPL 1	31	1076	823	253	807.00	269.00	3:1	1.27	0.25-0.50
D <sub>6</sub> × BDN 1	37	1281	985	296	960.75	320.25	3:1	2.45	0.10-0.25
PD <sub>1</sub> × ICPL 1	30	1036	789	247	777.00	259.00	3:1	0.74	0.25-0.50
PD <sub>1</sub> × BDN 1	29	1032	789	243	774.00	258.00	3:1	1.16	0.25-0.50
PBNA × ICPL 366	31	1066	820	246	799.50	266.50	3:1	2.10	0.10-0.25
PBNA × NP(WR)15	31	1102	845	257	826.50	275.50	3:1	1.66	0.10-0.25

subjected to qualitative genetic analyses, using a chi-square test.

## RESULTS AND DISCUSSION

### Inheritance

The F<sub>1</sub> plants of all the crosses resembled their tall parents, suggesting the recessive mode of gene action for controlling dwarfism in the three different dwarf lines. The F<sub>2</sub> progenies were classified into tall and dwarf parental types. In each cross, segregation of the progeny fit the expected ratio of 3:1, indicating that the phenotype of each dwarf was controlled by a single recessive genetic factor (Table 1). This was further corroborated by phenotypic segregation patterns in the testcross and F<sub>3</sub> progenies. Segregation in the testcross progenies of the crosses showed a good fit to the expected ratio of 1 tall : 1 dwarf (Table 1). As expected for single gene segregation within each cross, all the dwarf F<sub>2</sub> derived progenies bred true for dwarfness and two-thirds of the tall progenies, segregated and the remaining tall bred true for tallness (Table 2). Within each segregating progeny, the data showed a good fit to 3 tall : 1 dwarf. The data pooled over the segregating progenies in each of the six crosses (Table 3) also showed a good expected ratio of 3:1, confirming that dwarfness in each of the three dwarf sources was controlled by a single recessive gene present in the homozygous state.

### Allelic relationship

The allelic relationship was studied in F<sub>1</sub> and F<sub>2</sub> generations of crosses made among the three dwarfs in a diallel scheme. The progenies were classified for parental phenotypes.

The dwarf lines D<sub>6</sub> and PD<sub>1</sub> are morphologically similar and the F<sub>1</sub> and F<sub>2</sub> progenies of their cross appeared phenotypically uniform for dwarfing character, suggesting that both D<sub>6</sub> and PD<sub>1</sub> dwarf lines involved the same allele for dwarfness, although the two dwarf lines had been isolated from unrelated sources. In the

cross D<sub>6</sub> × PBNA, all the F<sub>1</sub> plants phenotypically resembled the D<sub>6</sub> dwarf. Of the 229 F<sub>2</sub> plants grown, 57 resembled the PBNA dwarf and 172 were similar to the D<sub>6</sub> parent. The chi-square test indicated a good fit to the monogenic ratio of 3 D<sub>6</sub> type : 1 PBNA type ( $P = 0.90-0.95$ ). These results showed that one locus with complete dominance was involved in the differences observed in the D<sub>6</sub> and PBNA dwarfs, where the D<sub>6</sub> type of phenotype was dominant. In the cross PBNA × PD<sub>1</sub>, all the F<sub>1</sub> plants were similar to PD<sub>1</sub> and in the F<sub>2</sub> generation, 79 segregants were of the PBNA type and 186 resembled PD<sub>1</sub>. The chi-square test showed a good fit to 3 PD<sub>1</sub> type : 1 PBNA type ( $P = 0.05-0.10$ ), typical of a single locus with complete dominance. These observations showed that this cross segregated in a manner similar to that of the cross D<sub>6</sub> × PBNA. This was expected considering that the two dwarfs, D<sub>6</sub> and PD<sub>1</sub>, have been classified as having the same allele for dwarfness.

In conclusion, the results show that the PD<sub>1</sub>/D<sub>6</sub> phenotype was completely dominant to the PBNA type and both the phenotypes were recessive to the tall phenotype. The genetic relationship among these three dwarfs and the tall parents suggested the presence of one locus with recessive multiple alleles, designated as  $T_3T_3$  for tall type,  $t_3t_3$  for PD<sub>1</sub>/D<sub>6</sub> phenotype, and  $t_3^h t_3^h$  for the PBNA phenotype. For the expression of PD<sub>1</sub>/D<sub>6</sub> type of phenotype, the presence of the  $t_3$  allele, either in the homozygous ( $t_3t_3$ ) or heterozygous ( $t_3t_3^h$ ) condition, is essential. On the other hand, the expression of PBNA phenotype requires the presence of  $t_3^h$  allele in the homozygous ( $t_3^h t_3^h$ ) condition. The genetic relationships of these dwarfs with those reported earlier (Sen et al., 1966; Sheriff et al., 1975; Saxena et al., 1987; Waldia and Singh, 1987), needed for complete characterization of dwarfing systems in pigeonpea, has not been reported.

### ACKNOWLEDGMENTS

We would like to thank Dr. A.K. Singh and Dr. Jagdish Kumar of ICRISAT for their helpful comments.

## REFERENCES

1. Kolhe, A.K., and K.A. Nayeem. 1977. Genetic investigation in pigeonpea I. Dwarf  $\times$  Creamy white flower. Maharashtra Agric. Univ. J. 2: 109-113.
2. Krauss, F.G. 1927. Improvement of Pigeonpea. Genetic analysis of *Cajanus indicus* and the creation of new varieties through hybridization and selection. J. Hered. 18: 227-232.
3. Marekar, R.V., K.V. Nayeem, and P.R. Chopde. 1978. Inheritance of branching habit, stem condition and colour in pigeonpea. Indian J. Agri. Sci. 48:563-567.
4. Mohammed, M. El S., and R.P. Ariyanayagam. 1983. The effect of photothermal environment on growth and flowering in dwarf pigeonpea (*Cajanus cajan*) and *Atylosia sericea* Benth. ex bak. Euphytica 32: 777-782.
5. Saxena, K.B., R.V. Kumar, D.G. Faris, and Laxman Singh. 1987. Breeding for special traits. Pigeonpea breeding progress report 9. ICRISAT, Patancheru, A.P. India.
6. Sen, S., S.C. Sur, and K.S. Gupta. 1966. Inheritance of dwarfness in pigeonpeas (*Cajanus cajan* (L.) Millsp.). Zuechter 36: 379-380.
7. Sharma, D., K.B. Saxena, L.J. Reddy, and K.C. Jain. 1989. Sources of dwarfness in pigeonpeas. Indian J. Genet. Plant Breed. (in press).
8. Shaw, F.J.F. 1936. Studies in Indian pulses. The inheritance of morphological characters and of wilt resistance in arhar (*Cajanus indicus* Spreng). Indian J. Agric. Sci. 6: 139-189.
9. Sheriff, N.M., W.M. Alikhan, and R. Veeraswamy. 1975. Studies on the inheritance of certain plant characters in red gram (*Cajanus cajan*). Madras Agric. J. 62: 64-65.
10. Spence, J.A., and S.J.A. Williams. 1972. Use of photoperiod response to change plant design. Crop Sci. 12:121-122.
11. Waldia, R.S., and V.P. Singh. 1987. Inheritance of dwarfing genes in pigeonpea. Indian J. Agric. Sci. 57: 219-220.

## CROP ECOLOGY, PRODUCTION, &amp; MANAGEMENT

## Plot Configuration in Corn Yield Trials

D. T. Bowman\*

## ABSTRACT

It is generally assumed that bordered plots are efficient for reducing error variance and the associated bias from border effects. Conflicting results in the literature regarding use of borders in corn (*Zea mays* L.) grain trials and limited information on use of borders in corn silage (herbage) trials prompted studies on the most efficient plot size and the need for bordered plots in corn grain and silage yield trials. The studies encompassed five and six environments over a span of 4 yr for silage and grain, respectively. Silage trials included from 24 to 28 hybrids each year. Grain trials included three different maturity groups with 18 to 64 entries. Four-row plots were used with the center two rows representing bordered two-row plots and the outside two rows considered as unbordered two-row plots. Bordered two-row plots were 1.06 and 1.02 as efficient in reducing error variance as unbordered two-row plots for silage and grain, respectively. The hybrid by border interactions generally were not significant, and highly significant yield and rank correlations suggest that very little border bias was occurring. Four-row unbordered plots were only 1.30 and 1.48 as efficient as the two-row bordered plots for silage and grain trials, respectively. The greatest gain in efficiency, while not compromising estimation of relative hybrid yields (1.89 and 2.26) came from using two-row unbordered plots and doubling the number of replicates for silage and grain yield trials, respectively, vs. the two-row bordered plots.

THE NEED for guard rows in yield trials to avoid border effects has been established for such crops as soybean [*Glycine max* (L.) Merr.] by Hartwig et al. (2) but has been found unnecessary in other crops, e.g., grain sorghum [*Sorghum bicolor* (L.) Moench] by Ross (8). In corn grain yield trials, there is literature to both support and oppose the use of borders. Early

maturing hybrids were found to be less competitive than late-maturing hybrids and border influence was evident in the study by Genter (1). He suggested grouping hybrids by maturity to avoid the border influence resulting from maturity differences. Kiesselbach (5) in an earlier study noticed a competitive effect between corn hybrids by measuring grain yield in border rows. However, Olson (6), after measuring yields in each row of three-row plots in 1928, concluded that there was no competition between an open-pollinated cultivar and a hybrid.

The North Carolina Official Variety Testing Program began using four-row corn plots in 1984 at the request of seed companies that had entries in the trials. The corn grain trials had been grouped by maturity since 1978 so there should have been very little competitive influence between adjacent hybrids due to maturity differences. Any competitive effects would have been due to plant height and vigor differences. Research by Pendleton and Seif (7) suggested that corn hybrid tests should be grouped by plant height, thus four-row plots may be necessary if there are competitive differences from plant height within maturity groups. With this idea in mind, a study was conducted to determine the need for bordered plots and the best configuration of plots to maximize testing precision in corn grain trials.

Corn silage (herbage) yield trials normally are not grouped by maturity in North Carolina because of fewer entries as compared to corn grain yield trials. Differences in plant height, vigor, and maturity may affect silage yield and one would assume that bordered plots are necessary (9). Keng and Hall (4) found dry matter yield to be significantly different with the use of border rows for late hybrids as compared to single row plots, but concluded that comparison of hybrids in single row plots would lead to the same conclusions as those from two- or three-row plots.

Dep. of Crop Science, Box 8604, North Carolina State Univ., Raleigh, NC 27695-8604. Paper no. 11563 of the Journal Series of the North Carolina Agric. Res. Ser., Raleigh, NC 27695-7601. Received 12 May 1988. \*Corresponding author.

Published in Crop Sci. 29:1202-1206 (1989).