# HETEROSIS IN THE GENUS *CYNODON* RICH.

By

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HETEROSIS IN THE GENUS <u>CYNODON</u> RICH.

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# INTRODUCTION

Heterosis, which is defined as hybrid vigor such that an $F_1$ hybrid falls outside the range of the parents with respect to some character or characters, was first reported in the eighteenth century although it was not understood or recognized as such. Since that early beginning plant and animal breeders have tried to explain the phenomenon and utilize its economical potential. The recent increased interest in heterosis results mainly from the superiority of the hybrids over their parents, but also from the fact that hybrid populations represent good experimental material for the study of gene action.

$F_1$ hybrids in many organisms have produced higher yields, phenotypically more uniform populations, and improved quality of the product. Intensive studies however, have not been carried out on hybrids of the genus Cynodon Rich. to measure the amount of heterosis which might be obtained.

The objective of this investigation was to survey the genus Cynodon to determine if heterosis did exist and, if so, to measure its magnitude. Recent workers have expressed heterosis as an increase over the mid-parent value as well as an increase over the high parent value; therefore, both measurements are included in this study.

# REVIEW OF LITERATURE

The beginnings of the heterosis concept were reviewed by Shull (19), and the development of that concept was reviewed by Hayes (12). Review of these areas would serve only to paraphrase their earlier papers and would present no directly pertinent material for this paper. Much of the work on heterosis has been summarized by Whaley (22); therefore, only those aspects which pertain directly to the family Gramineae, and more specifically to the genus Cynodon, will be presented in this paper.

A. Heterosis in the Genus Cynodon Rich.: To date, little work has been done on controlled hybridization in Cynodon. Reports of the amount of heterosis obtained from the hybrids which have been made are even less common. The increasing importance of bermudagrass as a forage and turf plant in recent years has drawn attention to improvement of the species through genetic research.

The plants in the genus Cynodon are divided into two distinct types based upon their agronomic use. The forage type plant exhibits abundant upright growth which is coarse in nature while the turf type plant is low growing and of a finer texture.

Hybrid plants of both types which are markedly better than their parents at least for some characteristic have been either produced or isolated from natural stands. A number of these hybrids have been released as commercial varieties. Burton (5) released the first important hybrid which resulted from a cross between 'Tift' bermuda (a selection of C. dactylon (L.) Pers.) and a C. dactylon introduction from South Africa. He reported that the $F_1$ plant was a faster spreading, more productive individual which was more disease, drought, and frost resistant than either of the parents. When clipped to simulate close grazing the $F_1$ hybrid yielded twice as much as the common bermuda. This variety was released under the name of 'Coastal.'

Harlan, Burton, and Elder (10) reported increased yields and vigor from a cross between Coastal bermuda and a winter-hardy strain from Indiana. The hybrid was released commercially under the varietal name of 'Midland.'

Turf grass hybrids have also been released as commercial varieties. Staten, Watts, and Thurman (20) reported that the Alabama, Arkansas, Oklahoma, and South Carolina Agricultural Experiment Stations jointly released a sterile triploid plant resulting from a natural cross between C. dactylon and C. transvaalensis Burtt-Davy. The $F_1$ hybrid was classified as C. magennisii Hurcombe because of its sterile triploid condition, and was released as 'Sunturf.'

In 1954 Robinson and Latham (18) also reported the release of a new turf hybrid resulting from a cross between C. dactylon and C. transvaalensis. This variety was named 'Tifgreen.' They reported that Tifgreen was a very desirable turf grass for all characteristics and was widely employed on golf courses. A number of other Cynodon hybrids which exhibit heterosis for some desirable characteristic have been made by the Georgia Agricultural Experiment Station.

The first work on controlled hybridization in Cynodon was started by Burton (6) in 1942. Coastal bermudagrass, Star grass (C. plectostachyus (K. Schum.) Pilg.), and a cold resistant C. dactylon from

Indiana were crossed in all possible combinations and the $F_1$ hybrids tested against their parents. Burton reported that the intraspecific hybrids between Coastal bermuda and Indiana bermuda were intermediate in all characters measured; however, the hybrids were more cold tolerant than the Coastal bermuda parent. The best of the Indiana X Star grass hybrids significantly outyielded its most productive parent, demonstrating the existence of heterosis; however, none of the hybrids were as productive as Coastal bermuda. In conclusion of his results, Burton reported that "the limited data from these studies indicate intraspecific hybridization is more effective than interspecific hybridization in the improvement of C. dactylon."

Moll et al. (14), in a study of the relationship between heterosis and genetic divergence in maize, reported that heterosis increased with increased divergence within a restricted range of divergence, but extremely divergent crosses resulted in a decrease in heterosis. This agrees closely with Burton's earlier work on Cynodon.

B. Heterosis in Other Genera of Gramineae: Interspecific and intergeneric hybrids and their cytogenetic characteristics have been reported commonly in the Gramineae. Investigations of this nature involving the cereals, particularly Triticum L. and the related genera Aegilops L. and Secale L., have been reviewed by Aase (1), and studies of hybrids of maize and maize relatives have been summarized by Mangelsdorf and Reeves (13). Carnahan and Hill (7) listed 256 interspecific and 95 intergeneric, of which 17 are considered intertribal, hybrids of the forage grasses. Myers (15) reported that the majority of the forage grass hybrids are artificial or controlled. Most extensive interspecific hybridization has been achieved in Agropyron Gaertn., Bromus

L., and Poa L. Less extensive interspecific hybridization has been achieved in 26 other genera. Similarly, species of three genera, Agropyron, Elymus L., and Hordeum L. have served widely as parents of intergeneric hybrids, while Festuca L.-Lolium L. hybrids constitute most of the so called intertribal hybrids (7).

In interspecific Andropogon L. crosses, Peters and Newell (16) reported that the hybrid clones exceeded the average of the parent types by 20% in height of leaves, 9% in total height of plants, and 59% in total plant yields. The basal spread of the hybrids was intermediate between the two parents.

Burton (4) reported that interspecific Pennisetum L. Rich. hybrids yielded substantially more forage and had a leafier growth habit than either of the parents. The $F_1$ plants were intermediate between the two parents for cold tolerance.

In a study of the hybrid vigor of interspecific Paspalum L. hybrids Burton (3) found that the better hybrids yielded over twice as much dry matter as the best parent. The hybrids were intermediate between the parents for flooding and frost tolerance, but exceeded the parents for disease, heat, and drought resistance.

Bridge (2), reporting on interspecific crosses of Bothriochloa O. Kuntze, found that heterosis was expressed more frequently for plant height, height of leaves, crown width, green weight and dry weight in all crosses relative to the mid-parent value. The hybrids were intermediate between the two parents for winterhardiness. Harlan (11) reported that natural introgression between Bothriochloa species may have occurred in nature. Bridge used this fact of "built-in heterosis" of some parents as the reason $F_1$ individuals of these introgressed parents did not exhibit hybrid vigor.

Chheda and Harlan (8) reported intergeneric hybrids between *Bothriochloa intermedia* (R. Br.) A Camus, and *Dichanthium fecundum* S. T. Bleake, which were generally healthy and vigorous. Some of the hybrids were completely sterile, others set a few seeds, while one hybrid produced abundant seeds when left to open pollinate in the field. On self pollination the hybrids were either completely sterile or set an extremely small number of seeds.

Crowder (9) reported that interspecific and intergeneric progeny of the genera *Festuca* and *Lolium* were agronomically more desirable than the parents. The $F_1$ hybrids were less coarse and the foliage was not as harsh as that of the parents. All progenies, however, were infertile.

It can readily be seen from the above literature review that nearly all of the investigations on hybrids of the Gramineae have been of a cytological nature and have been initiated primarily for two reasons: (a) to serve as an adjunct to morphological data in studies of taxonomy and phylogeny, and (b) to provide fundamental information for the improvement of species by breeding. Most of the investigations have not progressed to the advanced stages of heterosis studies.

## MATERIALS AND METHODS

A. Origin of Parents and Hybrids: The parents involved in the crosses used in this study were accessions in the world collection of *Cynodon* L. C. Rich. with one exception: Parent number one was a hybrid plant produced the previous year. The plants were crossed by the hand emasculation technique described by Richardson (17). All of the hybrids were produced by Mr. Richardson in the fall of 1964, and at the onset of this study the plants had not been identified as true hybrids.

The classification and origin of the parents used in the study are presented in Table I. A great deal of variation existed among these parents. *Cynodon aethiopicus* Harlan et de Wet, *C. validus* var. *afghanicus* Harlan et de Wet, *C. dactylon* var. *coursii* (A. Camus) de Wet et Harlan, *C. validus* var. *validus* de Wet et Harlan, and *C. robustus* de Wet et Harlan are all considered to be forage type grasses. The varieties of *C. dactylon* range from forage to turf types, while *C. transvaalensis* is strictly a turf type plant.

The hybrids which results from crosses between the parents listed in Table I are summarized in Table II. Most of these $F_1$'s were intermediate between the two parents in their morphological characteristics.

B. Cultural Methods: The $F_1$ seeds were individually germinated in small pots and transferred to an observation nursery in the spring of 1965. These hybrids were observed during the summer of 1965 and those hybrids which appeared to be especially vigorous were noted. All hybrids were moved to the greenhouse in the fall of 1965 because many

TABLE I

ORIGIN AND CLASSIFICATION OF PARENTS USED IN *CYNODON* HETEROSIS STUDY, STILLWATER, OKLAHOMA, 1966

| Plant No. | Oklahoma Accession No. | Classification | Origin | 2n |
|---|---|---|---|---|
| 1 | 10308* X 10129 | *C. dactylon* var. *dactylon* | 1963 Hybrid X114 | 36 |
| 3 | 8151 | *C. validus* var. *afghanicus* | Afghanistan | 18 |
| 4 | 8152 | *C. validus* var. *afghanicus* | Afghanistan | 18 |
| 5 | 9219 | *C. dactylon* var. *seleucidus* | Ethiopia | 36 |
| 6 | 9220 | *C. aethiopicus* | Ethiopia | 36 |
| 7 | 9943 | *C. dactylon* var. *dactylon* | Afghanistan | 36 |
| 8 | 9945 | *C. dactylon* var. *seleucidus* | Turkey | 36 |
| 10 | 9953 | *C. dactylon* var. *seleucidus* | Afghanistan | 36 |
| 11 | 9959 | *C. dactylon* var. *seleucidus* | Yugoslavia | 36 |
| 12 | 10020 | *C. validus* var. *palustrius* | India | 18 |
| 13 | 10021 | *C. validus* var. *palustrius* | Malagasy | 18 |
| 14 | 10123 | *C. dactylon* var. *coursii* | Malagasy | 36 |
| 15 | 10127 | *C. dactylon* var. *coursii* | Malagasy | 36 |
| 16 | 10128 | *C. dactylon* var. *coursii* | South Africa | 36 |
| 18 | 10140 | *C. transvaalensis* | South Africa | 18 |
| 19 | 10143 | *C. dactylon* var. *dactylon* | South Africa | 18 |
| 20 | 10144 | *C. dactylon* var. *dactylon* | South Africa | 36 |
| 21 | 10151 | *C. transvaalensis* | South Africa | 18 |
| 22 | 10153 | *C. dactylon* var. *dactylon* | South Africa | 36 |
| 23 | 10160 | *C. dactylon* var. *dactylon* | India | 36 |
| 24 | 10163 | *C. dactylon* var. *dactylon* | India | 36 |

TABLE I (continued)

| Plant No. | Oklahoma Accession No. | Classification | Origin | 2n |
|---|---|---|---|---|
| 25 | 10169 | C. dactylon var. dactylon | South Africa | 36 |
| 26 | 10190 | C. transvaalensis | South Africa | 18 |
| 27 | 10192 | C. dactylon var. dactylon | South Africa | 36 |
| 28 | 10194 | C. dactylon var. dactylon | South Africa | 36 |
| 30 | 10202 | C. dactylon var. dactylon | South Africa | 36 |
| 33 | 10222c | C. dactylon var. laxus | South Africa | 36 |
| 35 | 10234 | C. robustus | Nigeria | 36 |
| 36 | 10251b | C. dactylon var. dactylon | South Africa | 36 |
| 41 | 10287 | C. validus var. validus | Rhodesia | 18 |
| 42 | 10306 | C. dactylon var. coursii | Malagasy | 36 |
| 43 | 10312 | C. validus var. aridus | India | 18 |
| 44 | 10323 | C. validus var. aridus | India | 18 |
| 45 | 10325 | C. dactylon var. coursii | Malagasy | 36 |
| 46 | 10329 | C. dactylon var. dactylon | India | 36 |
| 47 | 10357 | C. dactylon var. laxus | South Africa | 36 |
| 48 | 10429 | C. dactylon var. coursii | Malagasy | 36 |
| 49 | 10480 | C. robustus | Kenya | 36 |
| 50 | 11125 | C. dactylon var. dactylon | Pakistan | 36 |
| -- | *10308 | C. dactylon var. dactylon | India | 36 |

TABLE II

HYBRIDS INCLUDED IN *CYNODON* HETEROSIS STUDY, STILLWATER, OKLAHOMA, 1966

| Plant No. | Progeny of Plant Cross Parent Female X Male | Plant No. | Progeny of Plant Cross Parent Female X Male |
|---|---|---|---|
| 51 | 14 X 22 | 92 | 08 X 15 |
| 53 | 14 X 41 | 93 | 08 X 15 |
| 54 | 14 X 49 | 94 | 08 X 48 |
| 55 | 15 X 20 | 95 | 08 X 45 |
| 57 | 15 X 20 | 96 | 08 X 45 |
| 58 | 15 X 01 | 98 | 08 X 28 |
| 59 | 16 X 24 | 100 | 10 X 22 |
| 60 | 16 X 35 | 101 | 10 X 45 |
| 61 | 12 X 41 | 102 | 11 X 46 |
| 62 | 13 X 04 | 103 | 11 X 46 |
| 63 | 13 X 04 | 104 | 11 X 05 |
| 65 | 24 X 35 | 105 | 11 X 07 |
| 66 | 24 X 35 | 106 | 50 X 23 |
| 67 | 25 X 07 | 107 | 50 X 23 |
| 68 | 36 X 22 | 108 | 50 X 27 |
| 71 | 41 X 06 | 109 | 50 X 27 |
| 72 | 41 X 22 | 110 | 50 X 30 |
| 75 | 42 X 05 | 112 | 18 X 16 |
| 76 | 42 X 35 | 113 | 26 X 16 |
| 77 | 43 X 24 | 114 | 19 X 16 |
| 78 | 43 X 41 | 115 | 19 X 24 |
| 79 | 43 X 41 | 116 | 21 X 41 |
| 81 | 44 X 16 | 117 | 28 X 03 |
| 84 | 47 X 48 | 118 | 28 X 08 |
| 91 | 07 X 03 | 122 | 33 X 05 |

of them were known not to be winter-hardy.

The 50 vigorous hybrids and their parents were planted in the field in the spring of 1966 at the Agronomy Research Station, Stillwater, Oklahoma, on a Bethany silt loam soil. The plants were spaced on two-meter-square centers and planted in a randomized complete block design with six blocks.

The plots were fertilized on June 10 with ammonium nitrate at the rate of 60 pounds of actual nitrogen per acre. Supplemental irrigation was applied when necessary throughout the growing season to keep growing conditions near optimum.

C. Data Collection: Data were collected at plant maturity on an individual plant basis for: plant radius, plant height at center of the plot, plant height at the maximum, distance from center of the plot to the maximum plant height, green weight, dry weight, internode length, and percent moisture. Plant radius, plant height at center of the plot, plant height at the maximum, and the distance from the center of the plot to the maximum plant height were measured in centimeters.

Green weight was obtained by clipping a four-square-foot area to the soil surface at the center of each plant and weighing the plant material in grams. This material was air dried in a drying room for two weeks and a dry weight and percent moisture obtained from this.

Internode length was the average internode length of the fifth internode from the tip of the stolon for five different stolons on each plant and was recorded in millimeters.

D. Analysis of Data: Each $F_1$ hybrid mean was tested against its high parent mean for each response variable by the formula:

$$t = \frac{\overline{F}_1 - \overline{P}_H}{\sqrt{\frac{EMS}{n_1} + \frac{EMS}{n_2}}} = \frac{\overline{F}_1 - \overline{P}_H}{\sqrt{\frac{EMS}{3}}}, \text{ since } n_1 = n_2 = 6.$$

In the above equation:

$\overline{F}_1$ = average of $n_1$ observations for the hybrid;

$\overline{P}_H$ = average of $n_2$ observations for the high parent;

EMS = error mean square obtained in the analysis of variance.

The probability level for the calculated t value was found from "student's t" distribution as given by Steel and Torrie (21).

In like manner, the $F_1$ hybrid was tested against the mid-parent value by the formula:

$$t = \frac{2\overline{F}_1 - (\overline{P}_H + \overline{P}_L)}{\sqrt{\frac{4EMS}{n_1} + \frac{EMS}{n_2} + \frac{EMS}{n_3}}} = \frac{2\overline{F}_1 - (\overline{P}_H + \overline{P}_L)}{\sqrt{EMS}}, \text{ since } n_1 = n_2 = n_3 = 6.$$

In the above equation:

$\overline{F}_1$ = average of $n_1$ observations for the hybrid;

$\overline{P}_H$ = average of $n_2$ observations for the high parent;

$\overline{P}_L$ = average of $n_3$ observations for the low parent;

EMS = error mean square obtained in the analysis of variance.

# RESULTS AND DISCUSSION

The coefficients of variation for each variable in the study are presented in Appendix Table III. The deviation and percent heterosis of hybrid plants from their high parent and mid-parent mean values and the probability levels for significance are presented in Appendix Tables IV through XI for each of the eight variables respectively.

The average percent heterosis of all $F_1$ hybrids for each variable is presented in Appendix Table XIV. The average percent heterosis of the interspecific, intervarietal, and intravarietal crosses are presented in Appendix Table XV.

## Results

Plant Radius: The radius of each of the hybrid plants and both parents are presented in Appendix Table IV. The range of heterosis above mid-parent was from 96.13% for hybrid number 71 to -5.06% for hybrid number 55. Of the 50 hybrids in the study 32 exhibited significant positive heterosis (.50-.001 level of probability) for plant radius. Three of the hybrids exhibited a negative heterosis from mid-parent. The range of the negative heterosis was from -5.06% for hybrid number 55 to -3.78% for hybrid number 58. The average heterosis for all hybrids was 11.77% above high parent and 30.24% above mid-parent (Appendix Table XIV).

When hybrids with a common parent were grouped together (Appendix Tables XII and XIII) to determine which parents produced consistently good or poor $F_1$ individuals, it was found that parent number 6 produced offspring with 96.13% heterosis above mid-parent, while parent number one produced offspring with a -3.78% heterosis for plant radius.

Plant Height at Center: The mean value for the hybrid and both parents and the deviation and percent heterosis from both high and mid-parent values are presented in Appendix Table V for plant height at the center. The range of heterosis from mid-parent was from -27.48% for hybrid 59 to 84.49% for hybrid number 75. A significant percent heterosis above mid-parent value was exhibited in half of the $F_1$ hybrids. A negative heterosis was found in eight of the 50 $F_1$ plants. The average heterosis of all $F_1$ plants for plant height at center was 4.98% above high parent and 23.41% above mid-parent (Appendix Table XIV.)

Plant Height at Maximum: The range of heterosis above mid-parent for plant height at maximum extended from -13.52% for hybrid 77 to 71.42% for hybrid number 102 (Appendix Table VI). Of the 50 hybrids, 38 exhibited a significant heterosis from mid-parent value. Only two plants showed a negative heterosis from mid-parent values. The average heterosis for all hybrids was 7.47% above high parent and 27.82% above mid-parent (Appendix Table XIV).

Parent plant number 46 produced hybrids which showed 78.93% heterosis above mid-parent, while parent 47 produced $F_1$ plants which exhibited -8.54% heterosis for plant height at maximum (Appendix Table XIII). Parent number 47 was the only parent which produced offspring in which the average percent heterosis was a negative value.

Distance from Center to Maximum Height: The range of percent heterosis above mid-parent value extended from -56.59% for hybrid num- 84 to 342.80% for hybrid number 115 (Appendix Table VII). The average heterosis for all hybrids for the distance from the center to the maximum height was 30.10% above high parent and 76.38% above mid-parent.

Green Weight: The deviation and percent heterosis of the hybrid plants from the high parent and mid-parent mean values and the probability levels for significance for the green weight yield of the plants are presented in Appendix Table VIII. The range of heterosis went from -41.98% for hybrid number 76 to 212.67% for hybrid number 112. Seventeen of the $F_1$ plants failed to show a significant amount of heterosis and only five exhibited a negative heterosis. The only hybrid which showed a large negative heterosis was number 76 with a -41.98%. The other four hybrids which showed a negative heterosis ranged from -4.41% to -3.73%. The average percent for all hybrids for green weight yield was 24.11% above high parent and 45.86% above mid-parent (Appendix Table XIV).

Parent number 18 produced $F_1$'s which showed 212.67% heterosis while parent 35 produced $F_1$'s which exhibited a negative percent heterosis of 2.43% (Appendix Table XIII). This was the only parent which produced $F_1$'s with a negative percent heterosis.

Dry Weight: Only 14 hybrid plants failed to show a significant amount of heterosis for dry weight yield when measured from the mid-parent value (Appendix Table IX). Of the 14 which did not show a significant increase only two showed a decrease. In the dry weight yield, as in the green weight yield, hybrid 76 showed a relatively large decrease over the mid-parent value. The range of heterosis above mid-parent was from -38.17% for hybrid 76 to 224.76% for hybrid 112. The average heterosis was 30.63% above high parent and 53.35% above mid-parent (Appendix Table XIV).

All parents produced hybrids which averaged a positive percent heterosis above mid-parent (Appendix Table XIII). Parents number 13 and 4 produced $F_1$'s which exhibited only 5.25% heterosis, while parent number 18 produced $F_1$'s which averaged 224.76% heterosis.

Internode Length: The deviations and percent heterosis for internode length is presented in Appendix Table X. Very little significant heterosis was found for this plant characteristic. Only seven of the hybrid plants exhibited a significant heterosis for internode length and the probability levels of those seven ranged from the .30-.50 level. Heterosis was difficult to detect in this characteristic due to the large amount of variation within the same plants in different replications. The range of heterosis above mid-parent was from -27.00% for plant 59 to 137.93% for plant 102. The average heterosis for all hybrids was 4.99% above high parent and 30.25% above mid-parent (Appendix Table XIV).

Parent number one produced $F_1$ individuals which averaged -3.41% heterosis, while parent number 46 produced $F_1$'s which averaged 86.16% heterosis.

Percent Moisture: Percent moisture would have been the easiest of all variables studied in which to detect heterosis because of the small coefficient of variation. As can be seen from Appendix Table XI almost no significant heterosis was found. Only two plants exhibited a significant heterosis and those were at the .30 and .40 levels of probability. Thirty-three of the hybrids showed a negative heterosis with a range of all hybrids from -28.75% for hybrid 78 to 12.57% for hybrid 95. The average heterosis of all hybrids was -6.68% measured from the high parent and -3.63% measured from the mid-parent value (Appendix Table XIV).

The percent heterosis values of all hybrids for all eight variables in the study were averaged to give the amount of heterosis in the overall study. The total percent heterosis from high parent was 13.42% and from mid-parent was 35.46% (Appendix Table XIV).

The hybrids were grouped into crosses based on the degree of genetic diversity and the amount of heterosis for each of the three groups is tabulated for each and all variables from both the mid-parent and high parent values in Appendix Table XV. The hybrids which were the result of interspecific crosses exhibited 4.10% heterosis from high parent values, while the intervarietal and intravarietal showed 17.52% and 24.88% heterosis respectively.

## Discussion

Heterosis as used in this study is defined as (1) a significant increase in the hybrid population over the mid-parent and (2) a significant increase over the best parent, for the character under consideration. Heterosis would seem to be of little practical value unless the hybrid was significantly better than the best parent at least for some desirable character.

The coefficients of variation (Appendix Table III) were high for each variable except percent moisture. In two of the variables (distance from the center of the plot to the maximum plant height and internode length) the coefficient of variation was entirely out of proportion. The distance from the center of the plot to the maximum plant height was not a good character to measure and probably should not have been included in this study. In some replications the maximum height of a plant was near the periphery of the plant; therefore, the distance from the center to maximum height would be nearly as large as the radius, while in the next replication this same plant might have its maximum height at the center; therefore, this value would be zero. One can readily see this great amount of variability reflected in a coefficient of variation of 67.22%. In essence, this variable served only to distort the averages of the other variables. This character was included in this study so that the plant radius, plant height at the center, plant height at maximum, and distance from center to maximum height could be combined to give a profile of plant growth.

Internode length was thought to be a very constant characteristic of a plant prior to this study; however, a coefficient of variation of 71.77 casts some doubt on this. The author has no explanation for this, but did notice during data collection that internode length seemed to vary widely, and much more so in the hybrids than in the parent plants.

The other coefficients of variation ranged between 20 and 30, which is still high even for biological material. The large degree of variation in this study as expressed by the coefficients of variation is believed to be due more to the plant conditions at the time of data collection than to measurement technique. Because measurements were made only at the end of the growing season and the plants were spaced only two meters apart, many plants were overrun and choked by more vigorous adjacent plants. This also made data collection extremely diff-cult. For these reasons the author feels that measurements should have been made earlier in the growing season or the plants should have been spaced farther apart.

The overall effect of this great amount of variability within the same plants in different replications is it becomes extremely difficult to detect significant differences. This is to say, that an unusually large difference between the $F_1$ mean and the parental mean must exist in any variable before significance can be declared at the levels of probability normally used.

Significant heterosis was obtained in all characters measured with the exception of percent moisture. The hybrids were, almost without exception, exceeded by their parents in percent moisture. This character was included in this study as an indicator of forage palatability. If it is true that as moisture decreases in a plant the palatability decreases, then one might conclude that the hybrid plants would be less palatable than the parent plants. The most striking example of the negative heterosis for percent moisture was hybrid 61, which contained only 46.04% moisture while its parents, 12 X 21, contained 62.51% and 57.30% moisture respectively.

Heterosis was obtained for yield of plant material more than any other character included in this study, with the exception of the distance from the center of the plot to the maximum plant height, which is of questionable value. The average heterosis for dry weight yield was 53.35% as measured above the mid-parent value. Hybrid number 112, which resulted from a cross between C. transvaalensis as the female parent and C. dactylon var. coursii as the male parent, exhibited 224.76% heterosis for dry matter production.

Due to the fact that this study does not constitute a diallel cross and the parents were not selected at random it is not possible to draw inferences about the whole population of Cynodon. The only inferences which can be drawn from this study can only include those hybrids and parents studied. With the above statements in mind one can conclude that in this study and under these conditions hybrid number 102 was probably the best individual plant over all characters. In the same light, parent 46, which is a C. dactylon var. dactylon and the male parent of hybrid 102, was probably the best parent; however, it was used in only one cross. The number of crosses in which each parent was used is presented in Appendix Tables XII and XIII.

In this study, as the genetic diversity increased, the percent heterosis decreased. One might hypothesize that genetic diversity could decrease to the point that heterosis would no longer be exhibited and inbreeding depression might be observed, but this study does not present the data necessary to prove or disprove this hypothesis. This decreased genetic diversity increased heterosis phenomenon agrees closely with

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data from [illegible] hybridization

fective [illegible] improvement of

ylon." C. dactylon." C. dactylon."

## SUMMARY AND CONCLUSIONS

Fifty $F_1$ Cynodon hybrids and their parents were planted in the spring of 1966 and heterosis was measured on the following eight characters: (1) plant radius, (2) plant height at the center, (3) plant height at the maximum, (4) distance from the center to maximum height, (5) green weight, (6) dry weight, (7) internode length, and (8) percent moisture.

Heterosis as measured above both the high parent and mid-parent value was exhibited for all characters measured, with the exception of percent moisture. The hybrids were exceeded by their parents in percent moisture in nearly every cross.

The evidence presented indicates that hybrid vigor is expressed for yield of plant material, plant radius, and plant height in all crosses relative to the mid-parent. It appears that green and dry weight yield will give more consistent increases over the high parent as a result of hybridization, since these characters exhibited a hybrid mean greater than the high parent mean for all crosses more frequently than any other character.

This study indicates that internode length and the distance from the center of the plot to the maximum plant height were not good characters to measure in this study. The large amount of variation between the same plants in different replications limited the usefulness of these characters.

The fact that this study did not constitute a diallel cross, and that parents were not selected at random, limits the inferences which can be drawn from these data. It can be concluded, however, from the data presented that with the parents used in this study, and under the conditions which existed, that as the genetic divergence increased, the percent heterosis decreased, and conversely, as the genetic divergence decreased, the percent heterosis increased.

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APPENDIX

TABLE III

COEFFICIENTS OF VARIATION[1] FOR EACH VARIABLE OF *CYNODON* HETEROSIS STUDY, STILLWATER, OKLAHOMA, 1966

| Variable | C. V. |
|---|---|
| 1. Plant Radius | 25.52 |
| 2. Plant Height at Center | 29.29 |
| 3. Plant Height at Maximum | 20.86 |
| 4. Distance from Center to Maximum Height | 67.22 |
| 5. Green Weight | 31.65 |
| 6. Dry Weight | 29.36 |
| 7. Internode Length | 71.77 |
| 8. Percent Moisture | 9.55 |

[1] $C.\ V. = \frac{100\sqrt{\text{Error Mean Square}}}{\bar{X}}$

TABLE IV

DEVIATION AND PERCENT HETEROSIS[1] OF $F_1$ *CYNODON* PLANTS FROM HIGH PARENT AND MID-PARENT MEAN VALUES AND PROBABILITY LEVELS FOR SIGNIFICANCE FOR PLANT RADIUS (VARIABLE 1)[2], STILLWATER, OKLAHOMA, 1966

| Cross | Plant Number | Hybrid Mean $\bar{F}_1$ | High Parent Mean $\bar{P}_H$ | $\bar{F}_1 - \bar{P}_H$ | Percent Heterosis | Prob. Level for Sign. | Low Parent Mean $\bar{P}_L$ | Mid Parent $\overline{MP}$ | $\bar{F}_1 - \overline{MP}$ | Percent Heterosis | Prob. Level for Sign. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 14x22 | 51 | 118.83 | 111.17 | 7.66 | 6.89 | -- | 88.00 | 99.59 | 19.24 | 19.31 | -- |
| 14x41 | 53 | 156.83 | 184.00 | -27.17 | -14.76 | -- | 111.17 | 147.59 | 9.24 | 6.26 | -- |
| 14x49 | 54 | 191.50 | 174.17 | 17.33 | 9.95 | .40 | 111.17 | 142.94 | 48.56 | 33.97 | .20 |
| 15x20 | 55 | 97.00 | 110.50 | -13.50 | -12.21 | -- | 93.83 | 102.17 | -5.17 | -5.06 | -- |
| 15x20 | 57 | 106.83 | 110.50 | -3.67 | -3.32 | -- | 93.83 | 102.17 | 4.66 | 4.56 | -- |
| 15x01 | 58 | 101.83 | 110.50 | -8.67 | -7.84 | -- | 101.17 | 105.84 | -4.01 | -3.78 | -- |
| 16x24 | 59 | 114.67 | 112.33 | 2.34 | 2.08 | -- | 96.33 | 104.33 | 10.34 | 9.91 | -- |
| 16x35 | 60 | 182.17 | 146.50 | 35.67* | 24.34 | .05 | 112.34 | 129.42 | 52.75 | 40.75 | .10 |
| 12x41 | 61 | 142.67 | 184.00 | -41.33 | -22.46 | -- | 69.33 | 126.67 | 16.00 | 12.63 | -- |
| 13x04 | 62 | 168.33 | 116.50 | 51.83** | 44.48 | .01 | 69.00 | 92.75 | 75.58* | 81.48 | .02 |
| 13x04 | 63 | 132.67 | 116.50 | 16.17 | 13.87 | .40 | 69.00 | 92.75 | 39.92 | 43.04 | .20 |
| 24x35 | 65 | 186.67 | 146.50 | 40.17* | 27.41 | .02 | 96.33 | 121.42 | 65.25* | 53.73 | .05 |
| 24x35 | 66 | 148.17 | 146.50 | 1.67 | 1.13 | -- | 96.33 | 121.42 | 26.75 | 22.03 | .40 |
| 25x07 | 67 | 128.50 | 118.67 | 9.93 | 8.28 | -- | 77.00 | 97.84 | 30.66 | 31.33 | .40 |
| 36x22 | 68 | 122.83 | 109.67 | 13.16 | 11.99 | .50 | 88.00 | 98.84 | 23.99 | 24.27 | .50 |
| 41x06 | 71 | 321.17 | 184.00 | 137.17** | 74.54 | .001 | 143.50 | 163.75 | 157.42** | 96.13 | .001 |
| 41x21 | 72 | 159.83 | 184.00 | -24.17 | -13.13 | -- | 52.33 | 118.17 | 41.66 | 35.25 | .20 |
| 42x05 | 75 | 111.00 | 94.33 | 16.67 | 17.67 | .40 | 65.17 | 79.75 | 31.25 | 39.18 | .30 |
| 42x35 | 76 | 147.33 | 146.50 | 0.83 | 0.56 | -- | 94.33 | 120.42 | 26.08 | 21.65 | .40 |
| 43x24 | 77 | 101.00 | 115.83 | -14.83 | -12.80 | -- | 96.33 | 106.08 | -5.08 | -4.78 | -- |
| 43x41 | 78 | 194.67 | 184.00 | 10.67 | 5.79 | -- | 115.84 | 149.92 | 44.75 | 29.84 | .20 |
| 43x41 | 79 | 197.83 | 184.00 | 13.83 | 7.51 | .50 | 115.84 | 149.92 | 47.91 | 31.95 | .20 |
| 44x16 | 81 | 116.50 | 112.33 | 4.17 | 3.71 | -- | 76.50 | 94.42 | 22.08 | 23.38 | .50 |
| 47x48 | 84 | 148.50 | 125.33 | 23.17 | 18.48 | .20 | 119.50 | 122.42 | 26.08 | 21.30 | .40 |
| 07x03 | 91 | 115.67 | 117.50 | -1.83 | -1.55 | -- | 77.00 | 97.25 | 18.42 | 18.94 | -- |
| 08x15 | 92 | 150.67 | 110.50 | 40.17* | 36.35 | .02 | 88.83 | 99.67 | 51.00 | 51.16 | .10 |
| 08x15 | 93 | 137.00 | 110.50 | 26.50 | 23.98 | .20 | 88.83 | 99.67 | 37.33 | 37.45 | .30 |
| 08x48 | 94 | 156.00 | 125.33 | 30.67 | 24.47 | .10 | 88.83 | 107.08 | 48.92 | 45.68 | .20 |
| 08x45 | 95 | 141.17 | 108.17 | 33.00 | 30.50 | .10 | 88.83 | 98.50 | 42.67 | 43.31 | .20 |
| 08x45 | 96 | 121.17 | 108.17 | 13.00 | 12.01 | .50 | 88.83 | 98.50 | 22.67 | 23.01 | .50 |
| 08x28 | 98 | 92.83 | 88.83 | 5.00 | 5.62 | -- | 66.00 | 77.42 | 15.41 | 19.90 | -- |
| 10x22 | 100 | 98.00 | 100.33 | -2.33 | -2.32 | -- | 88.00 | 94.17 | 3.83 | 4.06 | -- |
| 10x45 | 101 | 115.33 | 108.17 | 7.16 | 6.61 | -- | 100.33 | 104.25 | 11.08 | 10.62 | -- |
| 11x46 | 102 | 139.17 | 93.83 | 45.34** | 48.32 | .01 | 86.17 | 90.00 | 49.17 | 54.63 | .10 |
| 11x46 | 103 | 144.83 | 93.83 | 51.00** | 54.35 | .01 | 86.17 | 90.00 | 54.83 | 60.92 | .10 |
| 11x05 | 104 | 97.17 | 86.17 | 11.00 | 12.76 | -- | 65.17 | 75.67 | 21.50 | 28.41 | .50 |
| 11x07 | 105 | 90.83 | 86.17 | 4.66 | 5.40 | -- | 77.00 | 81.59 | 9.24 | 11.32 | -- |
| 50x23 | 106 | 91.50 | 102.50 | -11.00 | -10.73 | -- | 67.00 | 84.75 | 6.75 | 7.96 | -- |
| 50x23 | 107 | 92.33 | 102.50 | -10.17 | -9.92 | -- | 67.00 | 84.75 | 7.58 | 8.94 | -- |
| 50x27 | 108 | 85.17 | 67.00 | 18.17 | 27.11 | .30 | 67.00 | 67.00 | 18.17 | 27.11 | -- |
| 50x27 | 109 | 94.83 | 67.00 | 27.83 | 41.53 | .20 | 67.00 | 67.00 | 27.83 | 41.53 | .40 |
| 50x30 | 110 | 105.17 | 73.00 | 32.17 | 44.06 | .10 | 67.00 | 69.50 | 35.67 | 51.32 | .30 |
| 18x16 | 112 | 78.83 | 112.33 | -33.50 | -29.82 | -- | 40.83 | 76.58 | 2.25 | 2.93 | -- |
| 26x16 | 113 | 135.50 | 112.33 | 23.17 | 20.62 | .20 | 67.00 | 89.67 | 45.83 | 51.10 | .20 |
| 19x16 | 114 | 128.50 | 112.33 | 16.17 | 14.39 | .40 | 50.83 | 81.58 | 46.92 | 57.51 | .20 |
| 19x24 | 115 | 121.00 | 96.33 | 24.67 | 25.60 | .20 | 50.83 | 73.58 | 47.42 | 64.44 | .20 |
| 21x41 | 116 | 152.67 | 184.00 | -31.33 | -17.02 | -- | 52.33 | 118.17 | 34.50 | 29.19 | .30 |
| 28x03 | 117 | 109.17 | 117.50 | -8.33 | -7.08 | -- | 66.00 | 91.75 | 17.42 | 18.98 | -- |
| 28x08 | 118 | 109.67 | 88.83 | 20.84 | 23.46 | .30 | 66.00 | 77.42 | 32.25 | 41.65 | .30 |
| 33x05 | 122 | 97.33 | 82.67 | 14.66 | 17.73 | .40 | 65.17 | 73.92 | 23.41 | 31.66 | .50 |

[1]Percent Heterosis from High Parent = $\frac{\bar{F}_1 - \bar{P}_H}{\bar{P}_H} \times 100$

Percent Heterosis from Mid-Parent = $\frac{\bar{F}_1 - \overline{MP}}{\overline{MP}} \times 100$

[2]Measurements in centimeters

* significant at .05 level of probability

** significant at .01 level of probability

## TABLE V

**DEVIATION AND PERCENT HETEROSIS[1] OF $F_1$ CYNODON PLANTS FROM HIGH PARENT AND MID-PARENT MEAN VALUES AND PROBABILITY LEVELS FOR SIGNIFICANCE FOR HEIGHT AT PLANT CENTER (VARIABLE 2)[2], STILLWATER, OKLAHOMA, 1966**

| Cross | Plant Number | Hybrid Mean $\bar{F}_1$ | High Parent Mean $\bar{P}_H$ | $\bar{F}_1 - \bar{P}_H$ | Percent Heterosis | Prob. Level for Sign. | Low Parent Mean $\bar{P}_L$ | Mid Parent $\overline{MP}$ | $\bar{F}_1 - \overline{MP}$ | Percent Heterosis | Prob. Level for Sign. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 14x22 | 51 | 31.67 | 25.17 | 6.50 | 25.82 | .30 | 21.83 | 23.50 | 8.17 | 34.76 | .50 |
| 14x41 | 53 | 43.00 | 38.50 | 4.50 | 11.68 | .50 | 25.17 | 31.84 | 11.16 | 35.05 | .30 |
| 14x49 | 54 | 62.50 | 48.83 | 13.67* | 27.99 | .02 | 25.17 | 37.00 | 25.50* | 68.91 | .02 |
| 15x20 | 55 | 48.33 | 34.67 | 13.66* | 39.40 | .02 | 21.33 | 28.00 | 20.33* | 72.60 | .05 |
| 15x20 | 57 | 26.67 | 34.67 | -8.00 | -23.07 | -- | 21.33 | 28.00 | -1.33 | -4.75 | -- |
| 15x01 | 58 | 26.50 | 34.67 | -8.17 | -23.56 | -- | 29.50 | 32.09 | -5.59 | -17.41 | -- |
| 16x24 | 59 | 26.17 | 44.17 | -18.00 | -40.75 | -- | 28.00 | 36.09 | -9.92 | -27.48 | -- |
| 16x35 | 60 | 35.67 | 49.50 | -13.83 | -27.93 | -- | 44.17 | 46.84 | -11.17 | 23.84 | -- |
| 12x41 | 61 | 44.83 | 38.50 | 6.33 | 16.44 | .30 | 29.17 | 33.84 | 10.99 | 32.47 | .30 |
| 13x04 | 62 | 41.83 | 46.33 | -4.50 | -9.71 | -- | 20.67 | 33.50 | 8.33 | 24.86 | .50 |
| 13x04 | 63 | 37.50 | 46.33 | -8.83 | -19.05 | -- | 20.67 | 33.50 | 4.00 | 11.94 | -- |
| 24x35 | 65 | 41.00 | 49.50 | -8.50 | -17.17 | -- | 28.00 | 38.75 | 2.25 | 5.80 | -- |
| 24x35 | 66 | 42.67 | 49.50 | -6.83 | -13.79 | -- | 28.00 | 38.75 | 3.92 | 10.11 | -- |
| 25x07 | 67 | 31.33 | 26.17 | 5.16 | 19.71 | .40 | 24.83 | 25.50 | 5.83 | 22.86 | -- |
| 36x22 | 68 | 18.83 | 21.83 | -3.00 | -13.74 | -- | 20.17 | 21.00 | -2.17 | -10.33 | -- |
| 41x06 | 71 | 50.67 | 47.50 | 3.17 | 6.67 | -- | 38.50 | 43.00 | 7.67 | 17.83 | .50 |
| 41x21 | 72 | 29.33 | 38.50 | -9.17 | -23.81 | -- | 11.67 | 25.09 | 4.24 | 16.89 | -- |
| 42x05 | 75 | 43.67 | 28.17 | 15.50** | 55.02 | .01 | 19.17 | 23.67 | 20.00* | 84.49 | .05 |
| 42x35 | 76 | 32.33 | 49.50 | -17.17 | -34.68 | -- | 19.17 | 34.34 | -2.01 | -5.85 | -- |
| 43x24 | 77 | 28.50 | 45.00 | -16.50 | -36.66 | -- | 28.00 | 36.50 | -8.00 | -21.91 | -- |
| 43x41 | 78 | 53.50 | 45.00 | 8.50 | 18.88 | .20 | 38.50 | 41.75 | 11.75 | 28.14 | .30 |
| 43x41 | 79 | 59.67 | 45.00 | 14.67* | 32.60 | .02 | 38.50 | 41.75 | 17.92 | 42.92 | .10 |
| 44x16 | 81 | 39.00 | 44.17 | -5.17 | -11.70 | -- | 36.83 | 40.50 | -1.50 | -3.70 | -- |
| 47x48 | 84 | 40.83 | 41.83 | -1.00 | -2.39 | -- | 39.16 | 40.50 | 0.33 | 0.81 | -- |
| 07x03 | 91 | 36.50 | 34.16 | 2.34 | 6.85 | -- | 24.83 | 29.50 | 7.00 | 23.72 | .50 |
| 08x15 | 92 | 48.17 | 34.67 | 13.50* | 38.93 | .02 | 34.33 | 34.50 | 13.67 | 39.62 | .20 |
| 08x15 | 93 | 45.66 | 34.67 | 10.99 | 31.69 | .10 | 34.33 | 34.50 | 11.16 | 32.34 | .30 |
| 08x48 | 94 | 54.67 | 41.83 | 12.84* | 30.69 | .05 | 34.33 | 38.08 | 16.59 | 43.56 | .10 |
| 08x45 | 95 | 31.50 | 34.33 | -2.83 | -8.24 | -- | 25.17 | 29.75 | 1.75 | 5.88 | -- |
| 08x45 | 96 | 45.67 | 34.33 | 11.34* | 33.03 | .05 | 25.17 | 29.75 | 15.92 | 53.51 | .20 |
| 08x28 | 98 | 26.67 | 34.33 | -7.66 | -22.31 | -- | 25.00 | 29.67 | -3.00 | -10.10 | -- |
| 10x22 | 100 | 31.83 | 37.00 | -5.17 | 13.97 | -- | 21.83 | 29.42 | -2.41 | -8.19 | -- |
| 10x45 | 101 | 40.83 | 37.00 | 3.83 | 10.35 | -- | 25.17 | 31.09 | 9.74 | 31.32 | .40 |
| 11x46 | 102 | 41.17 | 30.83 | 10.34 | 33.53 | .10 | 23.67 | 27.25 | 13.92 | 51.08 | .20 |
| 11x46 | 103 | 45.33 | 30.83 | 14.50* | 47.03 | .02 | 23.67 | 27.25 | 18.08 | 66.34 | .10 |
| 11x05 | 104 | 49.33 | 30.83 | 18.50* | 60.00 | .01 | 28.16 | 29.50 | 19.83* | 67.22 | .05 |
| 11x07 | 105 | 37.00 | 30.83 | 6.17 | 20.01 | .30 | 24.83 | 27.83 | 9.17 | 32.95 | .40 |
| 50x23 | 106 | 30.33 | 24.17 | 6.16 | 25.48 | .30 | 18.33 | 21.25 | 9.08 | 42.72 | .40 |
| 50x23 | 107 | 24.17 | 24.17 | 0.00 | 0.00 | -- | 18.33 | 21.25 | 2.92 | 13.74 | -- |
| 50x27 | 108 | 36.67 | 24.83 | 11.84* | 47.68 | .05 | 18.33 | 21.58 | 15.09 | 69.92 | .20 |
| 50x27 | 109 | 24.17 | 24.83 | -0.66 | -2.65 | -- | 18.33 | 21.58 | 2.59 | 12.00 | -- |
| 50x30 | 110 | 25.33 | 18.33 | 7.00 | 38.18 | .30 | 17.17 | 17.75 | 7.58 | 42.70 | .50 |
| 18x16 | 112 | 34.17 | 44.17 | -10.00 | -22.63 | -- | 11.33 | 27.75 | 6.42 | 23.13 | -- |
| 26x16 | 113 | 34.33 | 44.17 | -9.84 | -22.27 | -- | 13.83 | 29.00 | 5.33 | 18.37 | -- |
| 19x16 | 114 | 32.33 | 44.17 | -11.84 | -26.80 | -- | 13.33 | 28.75 | 3.58 | 12.45 | -- |
| 19x24 | 115 | 25.00 | 28.00 | -3.00 | -10.71 | -- | 13.33 | 20.67 | 4.33 | 20.94 | -- |
| 21x41 | 116 | 31.50 | 38.50 | -7.00 | -24.56 | -- | 11.67 | 25.09 | 6.41 | 25.54 | -- |
| 28x03 | 117 | 40.83 | 34.17 | 6.66 | 19.49 | .30 | 25.00 | 29.59 | 11.24 | 37.98 | .30 |
| 28x08 | 118 | 30.00 | 34.33 | -4.33 | -12.61 | -- | 25.00 | 29.67 | 0.33 | 1.11 | -- |
| 33x05 | 122 | 39.50 | 34.67 | 4.83 | 13.93 | .40 | 28.17 | 31.42 | 8.08 | 25.71 | .50 |

[1] Percent Heterosis from High Parent = $\frac{\bar{F}_1 - \bar{P}_H}{P_H} \times 100$

Percent Heterosis from Mid-Parent = $\frac{\bar{F}_1 - \overline{MP}}{\overline{MP}} \times 100$

[2] Measurements in centimeters

* significant at .05 level of probability

** significant at .01 level of probability

# TABLE VI

DEVIATION AND PERCENT HETEROSIS[1] OF $F_1$ CYNODON PLANTS FROM HIGH PARENT AND MID-PARENT MEAN VALUES AND PROBABILITY LEVELS FOR SIGNIFICANCE FOR PLANT HEIGHT AT MAXIMUM (VARIABLE 3)[2], STILLWATER, OKLAHOMA, 1966

| Cross | Plant Number | Hybrid Mean $\bar{F}_1$ | High Parent Mean $\bar{P}_H$ | $\bar{F}_1 - \bar{P}_H$ | Percent Heterosis | Prob. Level for Sign. | Low Parent Mean $\bar{P}_L$ | Mid Parent $\overline{MP}$ | $\bar{F}_1 - \overline{MP}$ | Percent Heterosis | Prob. Level for Sign. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 14x22 | 51 | 45.83 | 39.17 | 6.50 | 17.00 | .20 | 22.67 | 30.92 | 14.91 | 48.22 | .10 |
| 14x41 | 53 | 54.33 | 56.83 | -2.50 | -4.39 | -- | 39.17 | 48.00 | 6.33 | 13.18 | .50 |
| 14x49 | 54 | 72.17 | 62.17 | 10.00 | 16.08 | .10 | 39.17 | 50.67 | 21.50* | 42.43 | .02 |
| 15x20 | 55 | 39.33 | 41.17 | -1.84 | -4.46 | -- | 29.17 | 35.17 | 4.16 | 11.82 | -- |
| 15x20 | 57 | 41.33 | 41.17 | 0.16 | 0.38 | -- | 29.17 | 35.17 | 6.16 | 17.51 | .50 |
| 15x01 | 58 | 42.17 | 41.17 | 1.00 | 2.42 | -- | 35.67 | 38.42 | 6.50 | 18.22 | .50 |
| 16x24 | 59 | 46.00 | 51.67 | -5.67 | -10.97 | -- | 31.33 | 41.50 | 4.50 | 10.84 | -- |
| 16x35 | 60 | 58.17 | 55.83 | 2.34 | 4.19 | -- | 51.67 | 53.75 | 4.42 | 8.22 | -- |
| 12x41 | 61 | 53.00 | 56.83 | -3.83 | -6.73 | -- | 33.67 | 45.25 | 7.75 | 17.12 | .40 |
| 13x04 | 62 | 60.17 | 51.83 | 8.34 | 16.09 | .20 | 31.67 | 41.75 | 18.42* | 44.11 | .05 |
| 13x04 | 63 | 57.17 | 51.83 | 5.34 | 10.30 | -- | 31.67 | 41.75 | 15.42 | 36.93 | .10 |
| 24x35 | 65 | 55.17 | 55.83 | -0.66 | -1.18 | -- | 31.33 | 43.58 | 11.59 | 26.59 | .20 |
| 24x35 | 66 | 52.33 | 55.83 | -3.50 | -6.26 | -- | 31.33 | 43.58 | 8.75 | 20.07 | .40 |
| 25x07 | 67 | 39.17 | 37.00 | 2.17 | 5.86 | -- | 28.33 | 32.67 | 6.50 | 19.89 | .50 |
| 36x22 | 68 | 29.50 | 29.83 | -0.33 | -1.10 | -- | 22.67 | 26.25 | 3.25 | 12.38 | -- |
| 41x06 | 71 | 69.83 | 56.83 | 13.00* | 22.87 | .02 | 54.83 | 55.83 | 14.00 | 25.07 | .20 |
| 41x21 | 72 | 38.33 | 56.83 | -18.50 | -32.55 | -- | 12.00 | 34.42 | 3.91 | 11.35 | -- |
| 42x05 | 75 | 50.50 | 32.17 | 18.33** | 56.97 | .001 | 29.00 | 30.59 | 19.91* | 65.08 | .05 |
| 42x35 | 76 | 55.67 | 55.83 | -0.16 | -0.28 | -- | 29.00 | 42.42 | 13.25 | 31.23 | .20 |
| 43x24 | 77 | 35.67 | 51.17 | -15.50 | -30.29 | -- | 31.33 | 41.25 | -5.58 | -13.52 | -- |
| 43x41 | 78 | 65.67 | 56.83 | 8.84 | 15.55 | .10 | 51.17 | 54.00 | 11.67 | 21.61 | .20 |
| 43x41 | 79 | 68.50 | 56.83 | 11.67* | 20.53 | .05 | 51.17 | 54.00 | 14.50 | 26.85 | .20 |
| 44x16 | 81 | 47.17 | 51.67 | -4.50 | -8.70 | -- | 38.33 | 45.00 | 2.71 | 4.82 | -- |
| 47x48 | 84 | 47.33 | 54.83 | -7.50 | -13.67 | -- | 48.67 | 51.75 | -4.42 | -8.54 | -- |
| 07x03 | 91 | 41.00 | 43.17 | -2.17 | -5.02 | -- | 28.33 | 35.75 | 5.25 | 14.68 | -- |
| 08x15 | 92 | 60.50 | 42.83 | 17.67** | 41.25 | .001 | 41.17 | 42.00 | 18.50* | 44.04 | .05 |
| 08x15 | 93 | 61.50 | 42.83 | 18.67** | 43.59 | .001 | 41.17 | 42.00 | 19.50* | 46.42 | .05 |
| 08x48 | 94 | 57.50 | 54.83 | 2.67 | 4.86 | -- | 42.83 | 48.83 | 8.67 | 17.75 | .40 |
| 08x45 | 95 | 46.33 | 42.83 | 3.50 | 8.17 | .50 | 40.17 | 41.50 | 4.80 | 11.55 | -- |
| 08x45 | 96 | 55.50 | 42.83 | 12.67* | 29.58 | .02 | 40.17 | 41.50 | 14.00 | 33.73 | .20 |
| 08x28 | 98 | 42.00 | 42.83 | -0.83 | -1.93 | -- | 31.17 | 37.00 | 5.00 | 13.51 | -- |
| 10x22 | 100 | 33.83 | 42.67 | -8.84 | -20.71 | -- | 22.67 | 32.67 | 1.16 | 3.55 | -- |
| 10x45 | 101 | 48.67 | 42.57 | 6.00 | 14.06 | .30 | 40.17 | 41.42 | 7.25 | 17.50 | .50 |
| 11x46 | 102 | 57.00 | 40.17 | 16.83** | 41.89 | .01 | 26.33 | 33.25 | 23.75** | 71.42 | .01 |
| 11x46 | 103 | 56.67 | 40.17 | 16.50** | 41.07 | .01 | 26.33 | 33.25 | 23.42** | 70.43 | .01 |
| 11x05 | 104 | 51.33 | 40.17 | 11.16* | 27.78 | .05 | 32.17 | 36.17 | 15.16 | 41.91 | .10 |
| 11x07 | 105 | 45.83 | 40.17 | 5.66 | 14.09 | .30 | 28.33 | 34.25 | 11.58 | 33.81 | .20 |
| 50x23 | 106 | 39.83 | 28.00 | 11.83* | 42.25 | .05 | 21.00 | 24.50 | 15.33 | 62.57 | .10 |
| 50x23 | 107 | 34.17 | 28.00 | 6.17 | 22.03 | .30 | 21.00 | 24.50 | 9.67 | 39.46 | .30 |
| 50x27 | 108 | 44.17 | 35.83 | 8.34 | 23.27 | .10 | 21.00 | 28.42 | 15.75 | 55.41 | .10 |
| 50x27 | 109 | 39.50 | 35.83 | 3.67 | 10.24 | .50 | 21.00 | 28.42 | 11.08 | 38.98 | .30 |
| 50x30 | 110 | 34.83 | 26.00 | 8.83 | 33.96 | .10 | 21.00 | 23.50 | 11.33 | 48.21 | .30 |
| 18x16 | 112 | 38.33 | 51.67 | -13.34 | -25.81 | -- | 11.33 | 31.50 | 6.83 | 21.68 | .50 |
| 26x16 | 113 | 42.00 | 51.67 | -9.67 | -18.71 | -- | 14.67 | 33.17 | 8.83 | 26.62 | .40 |
| 19x16 | 114 | 42.17 | 51.67 | -9.50 | -18.38 | -- | 13.33 | 32.50 | 9.67 | 29.75 | .30 |
| 19x24 | 115 | 29.50 | 31.33 | -1.83 | -5.84 | -- | 13.33 | 22.33 | 7.17 | 32.10 | .50 |
| 21x41 | 116 | 44.17 | 56.83 | -12.66 | -22.27 | -- | 12.00 | 34.42 | 9.75 | 28.32 | .30 |
| 28x03 | 117 | 48.50 | 43.17 | 5.33 | 12.34 | .40 | 31.17 | 37.17 | 11.33 | 30.48 | .30 |
| 28x08 | 118 | 43.50 | 42.83 | 0.67 | 1.56 | -- | 31.17 | 37.00 | 6.50 | 17.56 | .50 |
| 33x05 | 122 | 48.00 | 42.67 | 5.33 | 12.49 | .40 | 32.17 | 37.42 | 10.58 | 28.27 | .30 |

[1] Percent Heterosis from High Parent $= \frac{\bar{F}_1 - \bar{P}_H}{\bar{P}_H} \times 100$

Percent Heterosis from Mid-Parent $= \frac{\bar{F}_1 - \overline{MP}}{\overline{MP}} \times 100$

[2] Measurements in centimeters

* significant at .05 level of probability

** significant at .01 level of probability

# TABLE VII

DEVIATION AND PERCENT HETEROSIS[1] OF $F_1$ CYNODON PLANTS FROM HIGH PARENT AND MID-PARENT MEAN VALUES AND PROBABILITY LEVELS FOR SIGNIFICANCE FOR DISTANCE FROM CENTER TO MAXIMUM HEIGHT (VARIABLE 4)2, STILLWATER, OKLAHOMA, 1966

| Cross | Plant Number | Hybrid Mean $\bar{F}_1$ | High Parent Mean $\bar{P}_H$ | $\bar{F}_1 - \bar{P}_H$ | Percent Heterosis | Prob. Level for Sign. | Low Parent Mean $\bar{P}_L$ | Mid Parent $\overline{MP}$ | $\bar{F}_1 - \overline{MP}$ | Percent Heterosis | Prob. Level for Sign. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 14x22 | 51 | 67.00 | 66.33 | 0.67 | 1.01 | -- | 25.67 | 46.00 | 21.00 | 45.65 | -- |
| 14x41 | 53 | 112.17 | 135.17 | -23.00 | -17.01 | -- | 66.33 | 100.75 | 11.42 | 11.33 | -- |
| 14x49 | 54 | 81.83 | 117.50 | -35.67 | -30.35 | -- | 66.33 | 91.92 | -10.09 | -10.97 | -- |
| 15x20 | 55 | 33.33 | 31.00 | 2.33 | 7.51 | -- | 17.67 | 24.34 | 8.99 | 36.93 | -- |
| 15x20 | 57 | 71.67 | 31.00 | 40.67 | 131.19 | .10 | 17.67 | 24.34 | 47.33 | 194.45 | .30 |
| 15x01 | 58 | 62.67 | 52.17 | 10.50 | 20.12 | -- | 31.00 | 41.59 | 21.08 | 50.68 | -- |
| 16x24 | 59 | 77.83 | 49.83 | 28.00 | 56.19 | .30 | 21.67 | 35.75 | 42.08 | 117.70 | .30 |
| 16x35 | 60 | 121.00 | 64.33 | 56.67** | 88.09 | .01 | 49.83 | 57.08 | 63.92 | 111.98 | .10 |
| 12x41 | 61 | 71.00 | 135.17 | -64.17 | -47.47 | -- | 28.67 | 81.92 | -10.92 | -13.33 | -- |
| 13x04 | 62 | 85.17 | 37.50 | 47.67* | 127.12 | .05 | 27.67 | 32.59 | 52.58 | 161.33 | .20 |
| 13x04 | 63 | 87.00 | 37.50 | 49.50* | 132.00 | .05 | 27.67 | 32.59 | 54.91 | 166.95 | .20 |
| 24x35 | 65 | 75.00 | 64.33 | 10.67 | 16.58 | -- | 21.67 | 43.00 | 32.00 | 74.41 | .50 |
| 24x35 | 66 | 85.83 | 64.33 | 21.50 | 33.42 | .40 | 21.67 | 43.00 | 42.43 | 99.60 | .30 |
| 25x07 | 67 | 54.33 | 80.50 | -26.17 | -32.50 | -- | 28.00 | 54.25 | 0.08 | 0.14 | -- |
| 36x22 | 68 | 68.67 | 46.83 | 21.84 | 46.63 | .40 | 25.67 | 36.25 | 32.42 | 89.43 | .40 |
| 41x06 | 71 | 221.83 | 135.17 | 86.66** | 64.11 | .001 | 46.17 | 90.67 | 131.16** | 144.65 | .001 |
| 41x21 | 72 | 97.33 | 135.17 | -37.84 | -27.99 | -- | 3.00 | 69.09 | 28.24 | 40.87 | .50 |
| 42x05 | 75 | 32.50 | 54.50 | -22.00 | -40.37 | -- | 8.83 | 31.67 | 0.83 | 2.62 | -- |
| 42x35 | 76 | 92.33 | 64.33 | 28.00 | 43.52 | .30 | 54.50 | 59.42 | 32.91 | 55.38 | .40 |
| 43x24 | 77 | 47.17 | 22.83 | 24.34 | 106.61 | .30 | 21.67 | 22.25 | 24.92 | 112.00 | -- |
| 43x41 | 78 | 109.83 | 135.17 | -25.34 | -18.74 | -- | 22.83 | 78.95 | 30.88 | 39.11 | .50 |
| 43x41 | 79 | 81.83 | 135.17 | -53.34 | -39.46 | -- | 22.83 | 78.95 | 2.88 | 3.64 | -- |
| 44x16 | 81 | 56.17 | 49.83 | 6.34 | 12.72 | -- | 13.83 | 31.83 | 24.34 | 76.46 | -- |
| 47x48 | 84 | 27.17 | 70.00 | -42.83 | -61.18 | -- | 55.17 | 62.59 | -35.42 | -56.59 | -- |
| 07x03 | 91 | 32.50 | 67.33 | -34.83 | -51.73 | -- | 28.00 | 47.67 | -15.17 | -31.82 | -- |
| 08x15 | 92 | 94.17 | 44.33 | 49.84* | 112.42 | .05 | 31.00 | 37.67 | 56.50 | 149.98 | .20 |
| 08x15 | 93 | 75.33 | 44.33 | 31.00 | 69.93 | .20 | 31.00 | 37.67 | 37.66 | 99.97 | .40 |
| 08x48 | 94 | 33.83 | 70.00 | -36.17 | -51.67 | -- | 44.33 | 57.17 | -23.34 | -40.82 | -- |
| 08x45 | 95 | 75.17 | 73.50 | 1.67 | 2.27 | -- | 44.33 | 58.92 | 16.25 | 27.57 | -- |
| 08x45 | 96 | 68.83 | 73.50 | -4.67 | -6.35 | -- | 44.33 | 58.92 | 9.91 | 16.81 | -- |
| 08x28 | 98 | 65.33 | 44.33 | 21.00 | 47.37 | .40 | 28.00 | 36.17 | 29.16 | 80.61 | .50 |
| 10x22 | 100 | 19.67 | 35.00 | -15.33 | -43.80 | -- | 25.67 | 30.34 | -10.67 | 35.16 | -- |
| 10x45 | 101 | 59.50 | 73.50 | -14.00 | -19.04 | -- | 35.00 | 54.25 | 5.25 | 9.67 | -- |
| 11x46 | 102 | 94.83 | 26.33 | 68.50** | 260.15 | .01 | 25.50 | 25.92 | 68.91 | 265.85 | .10 |
| 11x46 | 103 | 59.17 | 26.33 | 32.84 | 124.72 | .20 | 25.50 | 25.92 | 33.25 | 128.27 | .40 |
| 11x05 | 104 | 12.67 | 26.33 | -13.66 | -51.87 | -- | 8.83 | 17.58 | -4.91 | -27.92 | -- |
| 11x07 | 105 | 53.67 | 28.00 | 25.67 | 91.67 | .30 | 26.33 | 27.17 | 26.50 | 97.53 | .50 |
| 50x23 | 106 | 42.17 | 40.50 | 1.67 | 4.12 | -- | 15.67 | 28.09 | 14.08 | 50.12 | -- |
| 50x23 | 107 | 47.33 | 40.50 | 6.83 | 16.86 | -- | 15.67 | 28.09 | 19.24 | 68.49 | -- |
| 50x27 | 108 | 29.50 | 37.50 | -8.00 | -21.33 | -- | 15.67 | 26.59 | 2.91 | 10.94 | -- |
| 50x27 | 109 | 70.17 | 37.50 | 32.67 | 87.12 | .20 | 15.67 | 26.59 | 43.58 | 163.89 | .30 |
| 50x30 | 110 | 66.00 | 38.00 | 28.00 | 73.68 | .30 | 15.67 | 26.84 | 39.16 | 145.90 | .40 |
| 18x16 | 112 | 25.33 | 49.83 | -24.50 | -49.16 | -- | 0.00 | 24.92 | 0.41 | 1.64 | -- |
| 26x16 | 113 | 90.17 | 49.83 | 40.34 | 82.59 | .10 | 7.17 | 28.50 | 61.67 | 216.38 | .20 |
| 19x16 | 114 | 78.17 | 49.83 | 28.34 | 56.87 | .20 | 0.00 | 24.92 | 53.25 | 213.68 | .20 |
| 19x24 | 115 | 48.00 | 21.67 | 26.33 | 121.50 | .30 | 0.00 | 10.84 | 37.16 | 342.80 | .40 |
| 21x41 | 116 | 101.83 | 135.17 | -33.34 | -24.66 | -- | 3.00 | 69.09 | 32.74 | 47.38 | .40 |
| 28x03 | 117 | 68.00 | 67.33 | 0.67 | 0.99 | -- | 28.00 | 47.67 | 20.33 | 42.64 | -- |
| 28x08 | 118 | 78.33 | 44.33 | 34.00 | 76.69 | .20 | 28.00 | 36.17 | 42.16 | 116.56 | .30 |
| 33x05 | 122 | 49.83 | 40.17 | 9.66 | 24.04 | -- | 8.83 | 24.50 | 25.33 | 103.38 | -- |

[1]Percent Heterosis from High Parent = $\frac{\bar{F}_1 - \bar{P}_H}{\bar{P}_H} \times 100$

Percent Heterosis from Mid-Parent = $\frac{\bar{F}_1 - \overline{MP}}{\overline{MP}} \times 100$

[2]Measurements in centimeters

* significant at .05 level of probability

** significant at .01 level of probability

# TABLE VIII

DEVIATION AND PERCENT HETEROSIS[1] OF $F_1$ CYNODON PLANTS FROM HIGH PARENT AND MID-PARENT MEAN VALUES AND PROBABILITY LEVELS FOR SIGNIFICANCE FOR GREEN WEIGHT (VARIABLE 5)[2], STILLWATER, OKLAHOMA, 1966

| Cross | Plant Number | Hybrid Mean $\bar{F}_1$ | High Parent Mean $\bar{P}_H$ | $\bar{F}_1 - \bar{P}_H$ | Percent Heterosis | Prob. Level for Sign. | Low Parent Mean $\bar{P}_L$ | Mid Parent $\overline{MP}$ | $\bar{F}_1 - \overline{MP}$ | Percent Heterosis | Prob. Level for Sign. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 14x22 | 51 | 405.00 | 365.83 | 39.17 | 10.70 | -- | 364.17 | 365.00 | 40.00 | 10.95 | -- |
| 14x41 | 53 | 560.00 | 427.83 | 132.17 | 30.89 | .20 | 364.17 | 396.00 | 164.00 | 41.41 | .40 |
| 14x49 | 54 | 674.17 | 541.67 | 132.50 | 24.46 | .20 | 364.17 | 452.92 | 221.25 | 48.84 | .20 |
| 15x20 | 55 | 602.50 | 576.67 | 25.83 | 4.47 | -- | 391.67 | 484.17 | 118.33 | 24.43 | .50 |
| 15x20 | 57 | 521.67 | 576.67 | -55.00 | -9.53 | -- | 391.67 | 484.17 | 37.50 | 7.74 | -- |
| 15x01 | 58 | 750.00 | 576.67 | 173.33 | 30.05 | .10 | 570.00 | 573.34 | 176.66 | 30.81 | .30 |
| 16x24 | 59 | 774.17 | 506.67 | 267.50** | 52.79 | .01 | 358.33 | 432.50 | 341.67* | 78.99 | .05 |
| 16x35 | 60 | 631.67 | 701.66 | -69.99 | -9.97 | -- | 358.33 | 530.00 | 101.67 | 19.18 | -- |
| 12x41 | 61 | 676.67 | 427.83 | 248.84** | 58.16 | .01 | 367.50 | 397.67 | 279.00 | 70.15 | .10 |
| 13x04 | 62 | 472.50 | 533.33 | -60.83 | -11.40 | -- | 448.33 | 490.83 | -18.33 | -3.73 | -- |
| 13x04 | 63 | 517.50 | 533.33 | -15.83 | -2.96 | -- | 448.33 | 490.83 | 26.67 | 5.43 | -- |
| 24x35 | 65 | 577.50 | 701.67 | -124.17 | -17.69 | -- | 506.66 | 604.17 | -26.67 | -4.41 | -- |
| 24x35 | 66 | 710.00 | 701.67 | 8.33 | 1.18 | -- | 506.66 | 604.17 | 105.83 | 17.51 | -- |
| 25x07 | 67 | 633.33 | 405.83 | 227.50* | 56.05 | .02 | 244.17 | 325.00 | 308.33 | 94.87 | .10 |
| 36x22 | 68 | 312.50 | 365.83 | -53.33 | -14.57 | -- | 255.83 | 310.83 | 1.67 | 0.53 | -- |
| 41x06 | 71 | 508.33 | 588.33 | -80.00 | -13.59 | -- | 427.83 | 508.08 | 0.25 | 0.04 | -- |
| 41x22 | 72 | 517.50 | 427.83 | 89.97 | 20.95 | .40 | 365.83 | 396.83 | 120.67 | 30.40 | .50 |
| 42x05 | 75 | 550.00 | 384.33 | 165.67 | 43.10 | .10 | 378.33 | 381.33 | 168.67 | 44.23 | .30 |
| 42x35 | 76 | 305.00 | 701.67 | -396.67 | -56.53 | -- | 384.33 | 543.00 | -228.00 | -41.98 | -- |
| 43x24 | 77 | 537.50 | 506.67 | 30.83 | 6.08 | -- | 375.83 | 441.25 | 96.25 | 21.81 | -- |
| 43x41 | 78 | 386.67 | 427.83 | -41.16 | -9.62 | -- | 375.83 | 401.83 | -15.16 | -3.77 | -- |
| 43x41 | 79 | 525.83 | 427.83 | 98.00 | 22.90 | .30 | 375.83 | 401.83 | 124.00 | 30.85 | .50 |
| 44x16 | 81 | 466.67 | 405.00 | 61.67 | 15.22 | -- | 358.33 | 381.67 | 85.00 | 22.27 | -- |
| 47x48 | 84 | 775.00 | 868.33 | -93.33 | -10.75 | -- | 612.50 | 740.42 | 34.58 | 4.67 | -- |
| 07x03 | 91 | 514.17 | 434.17 | 80.00 | 18.42 | .40 | 244.17 | 339.17 | 175.00 | 51.59 | .30 |
| 08x15 | 92 | 768.33 | 576.67 | 191.66* | 33.23 | .05 | 426.67 | 501.67 | 266.66 | 53.15 | .10 |
| 08x15 | 93 | 700.17 | 576.67 | 123.50 | 21.41 | .20 | 426.67 | 501.67 | 198.50 | 39.56 | .30 |
| 08x48 | 94 | 523.33 | 612.50 | -89.17 | -14.55 | -- | 426.67 | 519.59 | 3.74 | 0.71 | -- |
| 08x45 | 95 | 480.83 | 426.67 | 54.16 | 12.69 | -- | 215.83 | 321.25 | 159.58 | 49.67 | .40 |
| 08x45 | 96 | 309.17 | 426.67 | -117.50 | -27.53 | -- | 215.83 | 321.25 | -12.08 | -3.76 | -- |
| 08x28 | 98 | 672.50 | 426.67 | 245.83** | 57.61 | .01 | 357.50 | 392.09 | 280.41 | 71.51 | .10 |
| 10x22 | 100 | 616.67 | 529.17 | 87.50 | 16.53 | .40 | 365.83 | 447.50 | 169.17 | 37.80 | .30 |
| 10x45 | 101 | 526.67 | 529.17 | -2.50 | -0.47 | -- | 215.83 | 372.50 | 154.17 | 41.38 | .40 |
| 11x46 | 102 | 625.83 | 372.50 | 253.33** | 68.00 | .01 | 282.50 | 327.50 | 298.33 | 91.09 | .10 |
| 11x46 | 103 | 580.83 | 372.50 | 208.33* | 55.92 | .05 | 282.50 | 327.50 | 253.33 | 77.35 | .20 |
| 11x05 | 104 | 569.17 | 378.33 | 190.84* | 50.44 | .05 | 372.50 | 375.42 | 193.75 | 51.60 | .30 |
| 11x07 | 105 | 559.17 | 372.50 | 186.67* | 50.11 | .05 | 244.17 | 308.34 | 250.83 | 81.34 | .20 |
| 50x23 | 106 | 717.50 | 370.00 | 347.50** | 93.91 | .001 | 282.50 | 326.25 | 391.25* | 119.92 | .02 |
| 50x23 | 107 | 710.17 | 370.00 | 340.17** | 91.93 | .001 | 282.50 | 326.25 | 383.92* | 117.67 | .02 |
| 50x27 | 108 | 758.33 | 496.67 | 261.66** | 52.68 | .01 | 282.50 | 389.59 | 368.74* | 94.64 | .05 |
| 50x27 | 109 | 723.33 | 496.67 | 226.66* | 45.63 | .02 | 282.50 | 389.59 | 333.74* | 85.66 | .05 |
| 50x30 | 110 | 666.67 | 460.00 | 206.67* | 44.92 | .05 | 282.50 | 371.25 | 295.42 | 79.57 | .10 |
| 18x16 | 112 | 760.83 | 358.33 | 402.50** | 112.32 | .001 | 128.33 | 243.33 | 517.50** | 212.67 | .01 |
| 26x16 | 113 | 584.17 | 421.67 | 162.50 | 38.53 | .10 | 358.33 | 390.00 | 194.17 | 49.78 | .30 |
| 19x16 | 114 | 563.33 | 358.33 | 205.00* | 57.20 | .05 | 215.83 | 287.08 | 276.25 | 96.22 | .10 |
| 19x24 | 115 | 563.00 | 506.67 | 56.33 | 11.11 | -- | 215.83 | 361.25 | 201.75 | 55.84 | .30 |
| 21x41 | 116 | 390.00 | 427.83 | -37.83 | -8.84 | -- | 119.17 | 273.50 | 116.50 | 42.59 | .50 |
| 28x03 | 117 | 490.00 | 434.17 | 55.83 | 12.85 | -- | 357.50 | 395.84 | 94.16 | 23.78 | -- |
| 28x08 | 118 | 619.17 | 426.67 | 192.50* | 45.11 | .05 | 357.50 | 392.09 | 227.08 | 57.91 | .20 |
| 33x05 | 122 | 690.33 | 472.50 | 217.83* | 46.10 | .02 | 378.33 | 425.42 | 264.91 | 62.27 | .20 |

[1]Percent Heterosis from High Parent = $\frac{\bar{F}_1 - \bar{P}_H}{\bar{P}_H} \times 100$

Percent Heterosis from Mid-Parent = $\frac{\bar{F}_1 - \overline{MP}}{\overline{MP}} \times 100$

[2]Measured as grams per four square foot area

* significant at .05 level of probability

** significant at .01 level of probability

# TABLE IX

DEVIATION AND PERCENT HETEROSIS[1] OF $F_1$ *CYNODON* PLANTS FROM HIGH PARENT AND MID-PARENT MEAN VALUES AND PROBABILITY LEVELS FOR SIGNIFICANCE FOR DRY WEIGHT (VARIABLE 6)[2], STILLWATER, OKLAHOMA, 1966

| Cross | Plant Number | Hybrid Mean $\overline{F}_1$ | High Parent Mean $\overline{P}_H$ | $\overline{F}_1 - \overline{P}_H$ | Percent Heterosis | Prob. Level for Sign. | Low Parent Mean $\overline{P}_L$ | Mid Parent $\overline{MP}$ | $\overline{F}_1 - \overline{MP}$ | Percent Heterosis | Prob. Level for Sign. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 14x22 | 51 | 166.67 | 144.17 | 22.50 | 15.60 | -- | 133.33 | 138.76 | 27.91 | 20.11 | -- |
| 14x41 | 53 | 229.17 | 152.33 | 76.84* | 50.44 | .05 | 133.33 | 142.83 | 86.34 | 60.44 | .20 |
| 14x49 | 54 | 271.33 | 185.00 | 86.33* | 46.66 | .02 | 133.33 | 159.17 | 112.16 | 70.46 | .10 |
| 15x20 | 55 | 229.17 | 223.33 | 5.84 | 2.61 | -- | 160.00 | 191.67 | 37.50 | 19.56 | -- |
| 15x20 | 57 | 197.50 | 223.33 | -25.83 | -11.56 | -- | 160.00 | 191.67 | 5.83 | 3.04 | -- |
| 15x01 | 58 | 310.83 | 242.50 | 68.33* | 28.17 | .05 | 223.33 | 232.92 | 77.91 | 33.44 | .20 |
| 16x24 | 59 | 313.33 | 188.33 | 125.00** | 66.37 | .001 | 131.67 | 160.00 | 153.33* | 95.83 | .02 |
| 16x35 | 60 | 247.50 | 249.17 | -1.67 | -0.68 | -- | 131.67 | 190.42 | 57.08 | 29.97 | .40 |
| 12x41 | 61 | 330.00 | 152.33 | 177.67** | 116.63 | .001 | 150.83 | 151.58 | 178.42** | 117.70 | .01 |
| 13x04 | 62 | 198.33 | 211.67 | -13.34 | -6.30 | -- | 185.00 | 198.33 | 0.00 | 0.00 | -- |
| 13x04 | 63 | 219.17 | 211.67 | 7.50 | 3.54 | -- | 185.00 | 198.33 | 20.84 | 10.50 | -- |
| 24x35 | 65 | 229.17 | 249.17 | -20.00 | -8.02 | -- | 188.33 | 218.75 | 10.42 | 4.76 | -- |
| 24x35 | 66 | 279.17 | 249.17 | 30.00 | 12.03 | .40 | 188.33 | 218.75 | 60.42 | 27.62 | .40 |
| 25x07 | 67 | 250.83 | 176.67 | 74.16* | 41.97 | .05 | 85.00 | 130.84 | 119.99* | 91.70 | .05 |
| 36x22 | 68 | 134.17 | 144.17 | -10.00 | -6.93 | -- | 103.33 | 123.75 | 10.42 | 8.42 | -- |
| 41x06 | 71 | 200.83 | 212.50 | -11.67 | -5.49 | -- | 152.33 | 182.42 | 18.41 | 10.09 | -- |
| 41x22 | 72 | 194.17 | 152.33 | 41.84 | 27.46 | .30 | 144.17 | 148.25 | 45.92 | 30.97 | .50 |
| 42x05 | 75 | 198.33 | 138.33 | 60.00 | 43.39 | .10 | 106.67 | 122.50 | 75.80 | 61.86 | .30 |
| 42x35 | 76 | 110.00 | 249.17 | -139.17 | -55.85 | -- | 106.67 | 177.92 | -67.92 | -38.17 | -- |
| 43x24 | 77 | 233.33 | 188.33 | 45.00 | 23.89 | .20 | 150.00 | 169.17 | 64.16 | 37.92 | .30 |
| 43x41 | 78 | 177.50 | 152.33 | 25.17 | 16.52 | .50 | 150.00 | 151.17 | 26.33 | 17.41 | -- |
| 43x41 | 79 | 245.83 | 152.33 | 93.50** | 61.37 | .01 | 150.00 | 151.17 | 94.66 | 62.61 | .20 |
| 44x16 | 81 | 160.83 | 147.50 | 13.33 | 9.03 | -- | 131.67 | 139.59 | 21.24 | 15.21 | -- |
| 47x48 | 84 | 347.50 | 348.33 | -0.83 | -0.23 | -- | 215.83 | 281.67 | 65.83 | 23.37 | .30 |
| 07x03 | 91 | 188.33 | 158.33 | 30.00 | 18.94 | .40 | 85.00 | 121.67 | 66.66 | 54.78 | .30 |
| 08x15 | 92 | 292.83 | 223.33 | 69.50* | 31.11 | .05 | 168.33 | 195.83 | 97.00 | 49.53 | .20 |
| 08x15 | 93 | 277.17 | 223.33 | 53.84 | 24.10 | .20 | 168.33 | 195.83 | 81.34 | 41.53 | .20 |
| 08x48 | 94 | 215.83 | 215.83 | 0.00 | 0.00 | -- | 168.33 | 192.08 | 23.75 | 12.36 | -- |
| 04x45 | 95 | 169.17 | 168.33 | 0.84 | 0.49 | -- | 100.00 | 134.17 | 35.00 | 26.08 | -- |
| 08x45 | 96 | 132.50 | 168.33 | -35.83 | -21.28 | -- | 100.00 | 134.17 | -1.67 | -1.24 | -- |
| 08x28 | 98 | 279.17 | 168.33 | 110.84** | 65.84 | .01 | 147.50 | 157.92 | 121.25* | 76.77 | .05 |
| 10x22 | 100 | 232.50 | 191.67 | 40.83 | 21.30 | .30 | 144.17 | 167.92 | 64.58 | 38.45 | .30 |
| 10x45 | 101 | 198.33 | 191.67 | 6.66 | 3.47 | -- | 100.00 | 145.84 | 52.49 | 35.99 | .40 |
| 11x46 | 102 | 270.00 | 149.17 | 120.83** | 81.00 | .001 | 115.00 | 132.09 | 137.91* | 104.40 | .05 |
| 11x46 | 103 | 221.67 | 149.17 | 72.50* | 48.60 | .05 | 115.00 | 132.09 | 89.58 | 67.81 | .20 |
| 11x05 | 104 | 218.33 | 149.17 | 69.16* | 46.36 | .05 | 138.33 | 143.75 | 74.58 | 51.88 | .30 |
| 11x07 | 105 | 230.83 | 149.17 | 81.66* | 54.74 | .02 | 85.00 | 117.09 | 113.74 | 97.13 | .10 |
| 50x23 | 106 | 313.33 | 158.33 | 155.00** | 97.89 | .001 | 96.67 | 127.50 | 185.83** | 145.74 | .01 |
| 50x23 | 107 | 303.17 | 158.33 | 144.84** | 91.47 | .001 | 96.67 | 127.50 | 175.67** | 137.78 | .01 |
| 50x27 | 108 | 279.17 | 210.00 | 69.17* | 32.93 | .05 | 96.67 | 153.34 | 125.83* | 82.05 | .05 |
| 50x27 | 109 | 265.83 | 210.00 | 55.83 | 26.58 | .20 | 96.67 | 153.34 | 112.49 | 73.35 | .10 |
| 50x30 | 110 | 280.83 | 185.00 | 95.83** | 51.80 | .01 | 96.67 | 141.34 | 139.49* | 98.69 | .02 |
| 18x16 | 112 | 305.83 | 131.67 | 174.16** | 132.27 | .001 | 56.67 | 94.17 | 211.66** | 224.76 | .001 |
| 26x16 | 113 | 250.83 | 193.33 | 57.50 | 29.74 | .10 | 131.67 | 162.50 | 88.33 | 54.35 | .20 |
| 19x16 | 114 | 210.83 | 131.67 | 79.16* | 60.11 | .05 | 97.50 | 114.59 | 96.24 | 83.98 | .20 |
| 19x24 | 115 | 254.17 | 188.33 | 65.84 | 34.95 | .10 | 97.50 | 142.92 | 111.25 | 77.84 | .10 |
| 21x41 | 116 | 180.83 | 152.33 | 28.50 | 18.70 | .50 | 56.67 | 104.50 | 76.33 | 73.04 | .30 |
| 28x03 | 117 | 203.33 | 158.33 | 45.00 | 28.42 | .20 | 147.50 | 152.92 | 50.41 | 32.96 | .40 |
| 28x08 | 118 | 251.67 | 168.33 | 83.34* | 49.50 | .02 | 147.50 | 157.92 | 93.75 | 59.36 | .20 |
| 33x05 | 122 | 254.50 | 193.33 | 61.17 | 31.64 | .10 | 138.33 | 165.83 | 88.67 | 53.47 | .20 |

[1]Percent Heterosis from High Parent = $\frac{\overline{F}_1 - \overline{P}_H}{\overline{P}_H} \times 100$

Percent Heterosis from Mid-Parent = $\frac{\overline{F}_1 - \overline{MP}}{\overline{MP}} \times 100$

[2]Measured as grams per four square foot area

* significant at .05 level of probability

** significant at .01 level of probability

# TABLE X

**DEVIATION AND PERCENT HETEROSIS[1] OF $F_1$ CYNODON PLANTS FROM HIGH PARENT AND MID-PARENT MEAN VALUES AND PROBABILITY LEVELS FOR SIGNIFICANCE FOR INTERNODE LENGTH (VARIABLE 7)[2], STILLWATER, OKLAHOMA, 1966**

| Cross | Plant Number | Hybrid Mean $\bar{F}_1$ | High Parent Mean $\bar{P}_H$ | $\bar{F}_1 - \bar{P}_H$ | Percent Heterosis | Prob. Level for Sign. | Low Parent Mean $\bar{P}_L$ | Mid Parent $\overline{MP}$ | $\bar{F}_1 - \overline{MP}$ | Percent Heterosis | Prob. Level for Sign. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 14x22 | 51 | 74.77 | 60.67 | 14.10 | 23.44 | -- | 30.30 | 45.49 | 29.28 | 64.36 | -- |
| 14x41 | 53 | 81.53 | 120.17 | -38.64 | -32.15 | -- | 60.67 | 90.42 | -8.89 | -9.83 | -- |
| 14x49 | 54 | 108.20 | 118.77 | -10.57 | -8.89 | -- | 60.67 | 89.72 | 18.48 | 20.59 | -- |
| 15x20 | 55 | 51.23 | 57.50 | -6.27 | -10.90 | -- | 28.00 | 42.75 | 8.48 | 19.83 | -- |
| 15x20 | 57 | 62.60 | 57.50 | 5.10 | 8.86 | -- | 28.00 | 42.75 | 19.85 | 46.43 | -- |
| 15x01 | 58 | 48.60 | 57.50 | -8.90 | -15.47 | -- | 43.13 | 50.32 | -1.72 | -3.41 | -- |
| 16x24 | 59 | 42.73 | 74.67 | -31.94 | -42.77 | -- | 42.40 | 58.54 | -15.81 | -27.00 | -- |
| 16x35 | 60 | 91.37 | 107.70 | -16.33 | -15.16 | -- | 74.67 | 91.19 | 0.18 | 0.19 | -- |
| 12x41 | 61 | 105.67 | 120.17 | -14.50 | -12.06 | -- | 41.73 | 80.95 | 24.72 | 30.53 | -- |
| 13x04 | 62 | 108.33 | 90.03 | 18.30 | 20.32 | .50 | 42.37 | 66.20 | 42.13 | 63.64 | .40 |
| 13x04 | 63 | 108.67 | 90.03 | 18.64 | 20.70 | .50 | 42.37 | 66.20 | 42.47 | 64.15 | .40 |
| 24x35 | 65 | 110.17 | 107.70 | 2.47 | 2.29 | -- | 42.40 | 75.05 | 35.12 | 46.79 | .50 |
| 24x35 | 66 | 83.17 | 107.70 | -24.53 | -22.77 | -- | 42.40 | 75.05 | 8.12 | 10.81 | -- |
| 25x07 | 67 | 88.20 | 66.77 | 21.43 | 32.09 | .50 | 58.83 | 62.80 | 25.40 | 40.44 | -- |
| 36x22 | 68 | 45.17 | 39.83 | 5.34 | 13.40 | -- | 30.30 | 35.07 | 10.10 | 28.79 | -- |
| 41x06 | 71 | 164.50 | 120.17 | 44.33 | 36.88 | .20 | 104.93 | 112.55 | 51.95 | 46.15 | .30 |
| 41x22 | 72 | 91.47 | 120.17 | -28.70 | -23.88 | -- | 30.30 | 75.24 | 16.23 | 21.57 | -- |
| 42x05 | 75 | 49.57 | 48.57 | 1.00 | 2.05 | -- | 29.93 | 39.25 | 10.32 | 26.29 | -- |
| 42x35 | 76 | 92.47 | 107.70 | -15.23 | -14.14 | -- | 48.57 | 78.14 | 14.33 | 18.33 | -- |
| 43x24 | 77 | 53.83 | 102.40 | -48.57 | -47.43 | -- | 42.40 | 72.40 | -18.57 | -25.64 | -- |
| 43x41 | 78 | 138.03 | 120.17 | 17.86 | 14.86 | -- | 102.70 | 111.29 | 26.74 | 24.02 | -- |
| 43x41 | 79 | 157.53 | 120.17 | 37.36 | 31.08 | .20 | 102.40 | 111.29 | 46.24 | 41.54 | .40 |
| 44x16 | 81 | 65.50 | 74.67 | -9.17 | -12.28 | -- | 41.40 | 58.04 | 7.46 | 12.85 | -- |
| 47x48 | 84 | 89.77 | 100.97 | -11.20 | -11.09 | -- | 75.53 | 88.25 | 1.52 | 1.72 | -- |
| 07x03 | 91 | 57.57 | 72.43 | -14.86 | -20.51 | -- | 66.77 | 69.60 | -12.03 | -17.28 | -- |
| 08x15 | 92 | 71.87 | 57.50 | 14.37 | 24.99 | -- | 46.43 | 51.97 | 19.90 | 38.29 | -- |
| 08x15 | 93 | 68.07 | 57.50 | 10.57 | 18.38 | -- | 46.43 | 51.97 | 16.10 | 30.97 | -- |
| 08x48 | 94 | 78.73 | 100.47 | -22.24 | -22.02 | -- | 46.43 | 73.70 | 5.03 | 6.82 | -- |
| 08x45 | 95 | 83.47 | 61.36 | 22.11 | 36.03 | .50 | 46.43 | 53.90 | 29.57 | 54.86 | -- |
| 08x45 | 96 | 70.07 | 61.36 | 8.71 | 14.19 | -- | 46.43 | 53.90 | 16.17 | 30.00 | -- |
| 08x28 | 98 | 45.67 | 46.43 | -0.76 | -1.63 | -- | 27.33 | 36.88 | 8.79 | 23.83 | -- |
| 10x22 | 100 | 41.63 | 47.43 | -5.80 | -12.22 | -- | 30.30 | 38.87 | 2.76 | 7.10 | -- |
| 10x45 | 101 | 74.97 | 61.37 | 13.60 | 22.16 | -- | 47.43 | 54.40 | 20.57 | 37.81 | -- |
| 11x46 | 102 | 98.03 | 49.83 | 48.20 | 96.72 | .10 | 32.57 | 41.20 | 56.83 | 137.93 | .30 |
| 11x46 | 103 | 55.37 | 49.83 | 5.54 | 11.11 | -- | 32.57 | 41.20 | 14.17 | 34.39 | -- |
| 11x05 | 104 | 37.00 | 32.57 | 4.43 | 13.60 | -- | 29.93 | 31.25 | 5.75 | 18.40 | -- |
| 11x07 | 105 | 46.40 | 66.77 | -20.37 | -30.50 | -- | 32.57 | 49.67 | -3.27 | -6.58 | -- |
| 50x23 | 106 | 44.53 | 42.57 | 1.96 | 4.60 | -- | 32.87 | 37.72 | 6.81 | 18.05 | -- |
| 50x23 | 107 | 62.20 | 42.57 | 19.63 | 46.11 | .50 | 32.87 | 37.72 | 24.48 | 64.89 | -- |
| 50x27 | 108 | 53.13 | 32.87 | 20.26 | 61.63 | .50 | 27.37 | 30.12 | 23.01 | 76.39 | -- |
| 50x27 | 109 | 46.20 | 32.87 | 13.33 | 40.55 | -- | 27.37 | 30.12 | 16.08 | 53.38 | -- |
| 50x30 | 110 | 48.73 | 32.87 | 15.86 | 48.25 | -- | 26.03 | 29.45 | 19.28 | 65.46 | -- |
| 18x16 | 112 | 50.57 | 74.67 | -24.10 | -32.27 | -- | 20.97 | 47.82 | 2.75 | 5.75 | -- |
| 26x16 | 113 | 80.60 | 74.67 | 5.93 | 7.94 | -- | 20.67 | 47.82 | 32.78 | 68.54 | .50 |
| 19x16 | 114 | 69.73 | 74.67 | - 4.94 | -6.61 | -- | 22.43 | 48.55 | 21.18 | 43.62 | -- |
| 19x24 | 115 | 51.20 | 42.40 | 8.80 | 20.75 | -- | 22.43 | 32.42 | 18.78 | 57.92 | -- |
| 21x41 | 116 | 97.60 | 120.17 | -22.57 | -18.78 | -- | 22.03 | 71.10 | 26.50 | 37.27 | -- |
| 28x03 | 117 | 59.63 | 72.43 | -12.80 | -17.67 | -- | 27.33 | 49.88 | 9.75 | 19.54 | -- |
| 28x08 | 118 | 39.00 | 46.43 | -7.43 | -16.00 | -- | 27.33 | 36.88 | 2.12 | 5.74 | -- |
| 33x05 | 122 | 54.00 | 49.33 | 4.67 | 9.46 | -- | 29.93 | 39.63 | 14.37 | 36.26 | -- |

[1]Percent Heterosis from High Parent $= \frac{\bar{F}_1 - \bar{P}_H}{\bar{P}_H} \times 100$

Percent Heterosis from Mid-Parent $= \frac{\bar{F}_1 - \overline{MP}}{\overline{MP}} \times 100$

[2]Measurements in millimeters

# TABLE XI

DEVIATION AND PERCENT HETEROSIS[1] OF $F_1$ CYNODON PLANTS FROM HIGH PARENT AND MID-PARENT MEAN VALUES AND PROBABILITY LEVELS FOR SIGNIFICANCE FOR PERCENT MOISTURE (VARIABLE 8), STILLWATER, OKLAHOMA, 1966

| Cross | Plant Number | Hybrid Mean $\bar{F}_1$ | High Parent Mean $\bar{P}_H$ | $\bar{F}_1 - \bar{P}_H$ | Percent Heterosis | Prob. Level for Sign. | Low Parent Mean $\bar{P}_L$ | Mid Parent $\overline{MP}$ | $\bar{F}_1 - \overline{MP}$ | Percent Heterosis | Prob. Level for Sign. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 14x22 | 51 | 58.14 | 62.49 | -4.35 | -6.96 | -- | 59.73 | 61.11 | -2.97 | -4.86 | -- |
| 14x41 | 53 | 56.42 | 62.51 | -6.09 | -9.74 | -- | 62.49 | 62.50 | -6.08 | -9.72 | -- |
| 14x49 | 54 | 57.22 | 64.53 | -7.31 | -11.32 | -- | 62.49 | 63.51 | -6.29 | -9.90 | -- |
| 15x20 | 55 | 60.77 | 60.12 | 0.65 | 1.08 | -- | 59.38 | 59.75 | 1.02 | 1.70 | -- |
| 15x20 | 57 | 61.31 | 60.12 | 1.19 | 1.97 | -- | 59.38 | 59.75 | 1.56 | 2.61 | -- |
| 15x01 | 58 | 55.61 | 60.12 | -4.51 | -7.50 | -- | 57.01 | 58.57 | -2.96 | -5.05 | -- |
| 16x24 | 59 | 57.55 | 60.89 | -3.34 | -5.48 | -- | 60.73 | 60.81 | -3.26 | -5.36 | -- |
| 16x35 | 60 | 60.84 | 63.62 | -2.78 | -4.36 | -- | 60.73 | 62.18 | -1.34 | -2.15 | -- |
| 12x41 | 61 | 46.04 | 62.51 | -16.47 | -26.34 | -- | 57.30 | 59.91 | -13.87 | -23.15 | -- |
| 13x04 | 62 | 54.30 | 58.47 | -4.17 | -7.13 | -- | 58.14 | 58.32 | -4.02 | -6.89 | -- |
| 13x04 | 63 | 56.10 | 58.47 | -2.37 | -4.05 | -- | 58.14 | 58.32 | -2.22 | -3.80 | -- |
| 24x35 | 65 | 59.34 | 63.62 | -4.28 | -6.72 | -- | 60.89 | 62.26 | -2.92 | -4.69 | -- |
| 24x35 | 66 | 58.97 | 63.62 | -4.65 | -7.30 | -- | 60.89 | 62.26 | -3.29 | -5.28 | -- |
| 25x07 | 67 | 59.82 | 63.36 | -3.54 | -5.58 | -- | 55.49 | 59.43 | 0.39 | 0.65 | -- |
| 36x22 | 68 | 56.23 | 59.73 | -3.50 | -5.85 | -- | 57.85 | 58.79 | -2.56 | -4.35 | -- |
| 41x06 | 71 | 59.28 | 62.51 | -3.23 | -5.16 | -- | 61.61 | 62.06 | -2.78 | -4.47 | -- |
| 41x22 | 72 | 60.17 | 62.51 | -2.34 | -3.74 | -- | 59.73 | 61.12 | -0.95 | -1.55 | -- |
| 42x05 | 75 | 62.91 | 71.10 | -8.19 | -11.51 | -- | 60.75 | 65.93 | -3.02 | -4.58 | -- |
| 42x35 | 76 | 63.13 | 71.10 | -7.97 | -11.20 | -- | 63.62 | 67.36 | -4.23 | -6.27 | -- |
| 43x24 | 77 | 56.16 | 61.18 | -5.02 | -8.20 | -- | 60.89 | 61.04 | -4.88 | -7.99 | -- |
| 43x41 | 78 | 47.12 | 71.10 | -23.98 | -33.72 | -- | 61.18 | 66.14 | -19.02 | -28.75 | -- |
| 43x41 | 79 | 50.98 | 71.10 | -20.12 | -28.29 | -- | 61.18 | 66.14 | -15.16 | -22.92 | -- |
| 44x16 | 81 | 62.97 | 61.71 | 1.26 | 2.04 | -- | 60.73 | 61.22 | 1.75 | 2.85 | -- |
| 47x48 | 84 | 54.32 | 61.43 | -7.11 | -11.57 | -- | 59.44 | 60.44 | -6.12 | -10.12 | -- |
| 07x03 | 91 | 60.08 | 63.36 | -3.28 | -5.17 | -- | 62.99 | 63.18 | -3.10 | -4.90 | -- |
| 08x15 | 92 | 60.61 | 60.12 | 0.49 | 0.81 | -- | 59.62 | 59.87 | 0.74 | 1.23 | -- |
| 08x15 | 93 | 59.67 | 60.12 | -0.45 | -0.74 | -- | 59.62 | 59.87 | -0.20 | -0.33 | -- |
| 08x48 | 94 | 57.05 | 61.43 | -4.38 | -7.13 | -- | 59.62 | 60.53 | -3.48 | -5.74 | -- |
| 08x45 | 95 | 63.72 | 59.62 | 4.10 | 6.87 | .30 | 53.57 | 56.60 | 7.12 | 12.57 | .30 |
| 08x45 | 96 | 57.37 | 59.62 | -2.25 | -3.77 | -- | 53.57 | 56.60 | 0.77 | 1.36 | -- |
| 08x28 | 98 | 55.63 | 59.62 | -3.99 | -6.69 | -- | 56.90 | 58.26 | -2.63 | -4.51 | -- |
| 10x22 | 100 | 60.98 | 61.08 | -0.10 | -0.16 | -- | 59.73 | 60.41 | 0.57 | 0.94 | -- |
| 10x45 | 101 | 60.81 | 61.08 | -0.27 | -0.44 | -- | 53.57 | 57.33 | 3.48 | 6.07 | -- |
| 11x46 | 102 | 57.18 | 56.84 | -0.66 | -1.14 | -- | 57.03 | 57.44 | -0.26 | -0.45 | -- |
| 11x46 | 103 | 59.27 | 57.84 | 1.43 | 2.47 | -- | 57.03 | 57.44 | 1.83 | 3.18 | -- |
| 11x05 | 104 | 60.04 | 60.75 | -0.71 | -1.16 | -- | 57.84 | 59.30 | 0.74 | 1.24 | -- |
| 11x07 | 105 | 56.18 | 63.36 | -7.18 | -11.33 | -- | 57.84 | 60.60 | -4.42 | -7.29 | -- |
| 50x23 | 106 | 54.26 | 64.17 | -9.91 | -15.44 | -- | 57.29 | 60.73 | -6.47 | -10.65 | -- |
| 50x23 | 107 | 55.66 | 64.17 | -8.51 | -13.26 | -- | 57.29 | 60.73 | -5.07 | -8.34 | -- |
| 50x27 | 108 | 62.66 | 64.17 | -1.51 | -2.35 | -- | 56.41 | 60.29 | 2.37 | 3.93 | -- |
| 50x27 | 109 | 61.84 | 64.17 | -2.33 | -3.63 | -- | 56.41 | 60.29 | 1.55 | 2.57 | -- |
| 50x30 | 110 | 57.39 | 64.17 | -6.78 | -10.56 | -- | 60.00 | 62.08 | -4.69 | -7.55 | -- |
| 18x16 | 112 | 60.55 | 60.73 | -0.18 | -0.29 | -- | 53.60 | 57.17 | 3.38 | 5.91 | -- |
| 26x16 | 113 | 56.36 | 60.73 | -4.37 | -7.19 | -- | 53.70 | 57.17 | -0.81 | -1.41 | -- |
| 19x16 | 114 | 61.15 | 60.73 | 0.42 | 0.69 | -- | 51.51 | 56.12 | 5.03 | 8.96 | .40 |
| 19x24 | 115 | 54.48 | 60.89 | -6.41 | -10.52 | -- | 51.51 | 56.20 | -1.72 | -3.06 | -- |
| 21x41 | 116 | 51.44 | 62.51 | -11.07 | -17.70 | -- | 50.49 | 56.50 | -5.06 | -8.95 | -- |
| 28x03 | 117 | 57.46 | 62.99 | -5.53 | -8.77 | -- | 56.90 | 59.95 | -2.49 | -4.15 | -- |
| 28x08 | 118 | 58.38 | 59.62 | -1.24 | -2.07 | -- | 56.90 | 58.26 | 0.12 | 0.20 | -- |
| 33x05 | 122 | 61.52 | 60.75 | 0.77 | 1.26 | -- | 59.39 | 60.07 | 1.45 | 2.41 | -- |

[1]Percent Heterosis from High Parent = $\frac{\bar{F}_1 - \bar{P}_H}{\bar{P}_H} \times 100$

Percent Heterosis from Mid-Parent = $\frac{\bar{F}_1 - \overline{MP}}{\overline{MP}} \times 100$

TABLE XII

AVERAGE PERCENT HETEROSIS FROM HIGH PARENT OF $F_1$ PLANTS FROM EACH *CYNODON* PARENT FOR EACH AND ALL VARIABLES, STILLWATER, OKLAHOMA, 1966

| Parent Number | Number Crosses Used in | Variable 1 Plant Radius | Variable 2 Plant Height (Center) | Variable 3 Plant Height (Maximum) | Variable 4 Distance Center to Maximum Height | Variable 5 Green Weight | Variable 6 Dry Weight | Variable 7 Internode Length | Variable 8 Percent Moisture | Average |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | -7.84 | -23.56 | 2.42 | 20.12 | 30.05 | 28.17 | -15.47 | -7.50 | 3.30 |
| 3 | 2 | -4.32 | 13.17 | 3.66 | -25.37 | 15.64 | 23.68 | -19.09 | -6.97 | 0.05 |
| 4 | 2 | 29.18 | -14.38 | 13.20 | 129.56 | -7.18 | -1.38 | 20.51 | -5.59 | 20.49 |
| 5 | 3 | 16.05 | 42.98 | 32.41 | -22.73 | 46.55 | 40.46 | 8.37 | -3.80 | 20.04 |
| 6 | 1 | 74.54 | 6.67 | 22.87 | 64.11 | -13.59 | -5.49 | 36.88 | -5.16 | 22.60 |
| 7 | 3 | 4.04 | 15.52 | 11.67 | 2.48 | 41.53 | 38.55 | -6.31 | -7.36 | 12.52 |
| 8 | 7 | 22.34 | 13.03 | 18.15 | 35.81 | 18.28 | 21.39 | 7.71 | -1.82 | 16.86 |
| 10 | 2 | 2.15 | -1.81 | -3.33 | -31.42 | 8.03 | 12.39 | 4.97 | -0.30 | -1.17 |
| 11 | 4 | 30.21 | 40.14 | 31.21 | 106.17 | 56.12 | 57.68 | 22.73 | -2.79 | 42.68 |
| 12 | 1 | -22.46 | 16.44 | -6.73 | -47.47 | 58.16 | 116.63 | -12.06 | -26.34 | 9.52 |
| 13 | 2 | 29.18 | -14.38 | 13.20 | 129.56 | -7.18 | -1.38 | 20.51 | -5.59 | 20.49 |
| 14 | 3 | 0.69 | 21.83 | 9.56 | -19.33 | 22.02 | 37.57 | -5.88 | -9.34 | 7.14 |
| 15 | 5 | 7.39 | 12.68 | 16.64 | 68.23 | 15.93 | 15.09 | 5.17 | -0.88 | 17.53 |
| 16 | 6 | 5.89 | -25.35 | -3.06 | 41.22 | 44.38 | 49.47 | -16.86 | -2.96 | 10.34 |
| 18 | 1 | -29.82 | -22.63 | -25.81 | -49.16 | 112.32 | 132.27 | -32.27 | -0.29 | 10.58 |
| 19 | 2 | 20.00 | -18.76 | -12.11 | 89.19 | 34.16 | 47.53 | 7.07 | -4.92 | 20.27 |
| 20 | 2 | -7.77 | 8.17 | -2.04 | 69.35 | -2.53 | -4.48 | -1.02 | 1.53 | 7.65 |
| 21 | 2 | -15.08 | -24.19 | -27.41 | -26.33 | 6.06 | 23.08 | -21.33 | -10.72 | -11.99 |
| 22 | 3 | 5.52 | -0.63 | -1.60 | 1.28 | 4.22 | 9.99 | 8.21 | -4.32 | 2.83 |
| 23 | 2 | -10.33 | 12.74 | 32.14 | 10.49 | 92.92 | 94.68 | 25.36 | -14.35 | 30.46 |
| 24 | 5 | 8.68 | -23.82 | -10.91 | 66.86 | 10.69 | 25.84 | -17.99 | -7.64 | 6.46 |
| 25 | 1 | 8.28 | 19.71 | 5.86 | -32.50 | 56.05 | 41.97 | 32.09 | -5.58 | 15.74 |
| 26 | 1 | 20.62 | -22.27 | -18.71 | 82.59 | 38.53 | 29.74 | 7.94 | -7.19 | 16.41 |
| 27 | 2 | 34.42 | 22.53 | 16.76 | 32.90 | 49.16 | 29.76 | 51.09 | -2.99 | 29.20 |
| 28 | 3 | 7.33 | -5.14 | 3.99 | 41.68 | 38.52 | 47.92 | -11.77 | -5.84 | 14.59 |
| 30 | 1 | 44.06 | 38.18 | 33.96 | 73.68 | 44.92 | 51.80 | 48.25 | -10.56 | 40.54 |
| 33 | 1 | 17.73 | 13.93 | 12.49 | 24.04 | 46.10 | 31.64 | 9.46 | 1.26 | 19.58 |
| 35 | 4 | 13.36 | -23.44 | -0.88 | 45.40 | -20.75 | -13.13 | -12.45 | -7.40 | -2.41 |
| 36 | 1 | 11.99 | -13.74 | -1.10 | 46.63 | -14.57 | -6.93 | 13.40 | -5.85 | 3.73 |
| 41 | 7 | 2.92 | 5.41 | -1.57 | -15.89 | 14.41 | 40.80 | -0.58 | -17.81 | 3.46 |
| 42 | 2 | 9.12 | 10.17 | 28.35 | 1.58 | -6.72 | -6.23 | -6.05 | -11.36 | 2.36 |
| 43 | 3 | 0.17 | 4.94 | 1.93 | 16.14 | 6.45 | 33.93 | -0.50 | -23.40 | 4.96 |
| 44 | 1 | 3.71 | -11.70 | -8.70 | 12.72 | 15.22 | 9.03 | -12.28 | 2.04 | 1.26 |
| 45 | 3 | 16.37 | 11.71 | 17.27 | -7.71 | -5.10 | -5.77 | 24.13 | 0.89 | 6.47 |
| 46 | 2 | 51.34 | 40.28 | 41.48 | 192.44 | 61.96 | 64.80 | 53.92 | 0.67 | 63.36 |
| 47 | 1 | 18.48 | -2.39 | -13.67 | -61.18 | -10.75 | -0.23 | -11.09 | -11.57 | -11.55 |
| 48 | 2 | 21.48 | 14.15 | -4.41 | -56.43 | -12.65 | -0.12 | -16.56 | -14.35 | -8.61 |
| 49 | 1 | 9.95 | 27.99 | 16.08 | -30.35 | 24.46 | 46.66 | -8.89 | -11.32 | 9.32 |
| 50 | 5 | 18.41 | 21.74 | 26.35 | 32.09 | 65.81 | 60.13 | 40.23 | -9.05 | 31.96 |

# TABLE XIII

AVERAGE PERCENT HETEROSIS FROM MID-PARENT OF $F_1$ PLANTS FROM EACH *CYNODON* PARENT FOR EACH AND ALL VARIABLES, STILLWATER, OKLAHOMA, 1966

| Parent Number | Number Crosses Used in | Variable 1 Plant Radius | Variable 2 Plant Height (Center) | Variable 3 Plant Height (Maximum) | Variable 4 Distance Center to Maximum Height | Variable 5 Green Weight | Variable 6 Dry Weight | Variable 7 Internode length | Variable 8 Percent Moisture | Average |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | -3.78 | -17.41 | 18.22 | 50.68 | 30.81 | 33.44 | -3.41 | -5.05 | 12.94 |
| 3 | 2 | 18.96 | 30.85 | 22.58 | 5.41 | 37.69 | 43.87 | 1.13 | -4.53 | 19.50 |
| 4 | 2 | 62.26 | 18.40 | 40.52 | 164.14 | 0.85 | 5.25 | 63.90 | -5.35 | 43.75 |
| 5 | 3 | 33.08 | 59.14 | 45.09 | 26.03 | 52.70 | 55.74 | 26.98 | -0.31 | 37.31 |
| 6 | 1 | 96.13 | 17.83 | 25.07 | 144.65 | 0.04 | 10.09 | 46.15 | -4.47 | 41.94 |
| 7 | 3 | 20.53 | 26.51 | 22.62 | 21.95 | 75.93 | 81.20 | 5.53 | -3.85 | 31.31 |
| 8 | 7 | 37.45 | 23.70 | 25.39 | 64.38 | 38.39 | 37.77 | 27.22 | 0.68 | 31.87 |
| 10 | 2 | 7.34 | 11.57 | 10.53 | -12.75 | 39.59 | 37.22 | 22.46 | 3.51 | 14.93 |
| 11 | 4 | 38.77 | 54.40 | 54.39 | 115.93 | 75.35 | 80.31 | 46.04 | -0.83 | 58.05 |
| 12 | 1 | 12.63 | 32.47 | 17.12 | -13.33 | 70.15 | 117.70 | 30.53 | -23.15 | 30.52 |
| 13 | 2 | 62.26 | 18.40 | 40.52 | 164.14 | 0.85 | 5.25 | 63.90 | -5.35 | 43.75 |
| 14 | 3 | 19.85 | 46.24 | 35.61 | 15.34 | 33.73 | 50.34 | 25.04 | -8.16 | 27.25 |
| 15 | 5 | 16.87 | 24.48 | 27.60 | 106.40 | 31.14 | 29.42 | 26.62 | 0.03 | 32.82 |
| 16 | 6 | 30.93 | 0.18 | 16.99 | 123.42 | 79.85 | 84.02 | 17.33 | 1.47 | 62.47 |
| 18 | 1 | 2.93 | 23.13 | 21.68 | 1.64 | 212.67 | 224.76 | 5.75 | 5.91 | 62.31 |
| 19 | 2 | 60.98 | 16.70 | 30.93 | 278.24 | 76.03 | 80.91 | 50.77 | 2.95 | 74.69 |
| 20 | 2 | -0.25 | 33.93 | 14.67 | 115.69 | 16.09 | 11.30 | 33.13 | 2.16 | 28.34 |
| 21 | 2 | 32.22 | 21.22 | 19.84 | 44.13 | 36.50 | 52.01 | 29.42 | -5.25 | 28.76 |
| 22 | 3 | 15.88 | 5.43 | 21.38 | 33.31 | 16.43 | 22.33 | 33.42 | -2.76 | 18.18 |
| 23 | 2 | 8.45 | 28.23 | 50.02 | 59.31 | 118.80 | 141.76 | 41.47 | -9.50 | 54.82 |
| 24 | 5 | 29.07 | -2.51 | 15.22 | 149.30 | 33.95 | 48.79 | 12.58 | -5.28 | 35.14 |
| 25 | 1 | 31.33 | 22.86 | 19.89 | 0.14 | 94.87 | 91.70 | 40.44 | 0.65 | 37.74 |
| 26 | 1 | 51.10 | 18.37 | 26.62 | 216.38 | 49.78 | 54.35 | 68.54 | -1.41 | 60.47 |
| 27 | 2 | 34.42 | 40.96 | 47.20 | 87.42 | 90.15 | 77.70 | 64.89 | 3.25 | 55.25 |
| 28 | 3 | 26.84 | 9.66 | 20.52 | 79.94 | 50.07 | 55.70 | 16.37 | -2.82 | 32.04 |
| 30 | 1 | 51.32 | 42.70 | 48.21 | 145.90 | 79.57 | 98.69 | 65.46 | -7.55 | 65.79 |
| 33 | 1 | 31.66 | 25.71 | 28.27 | 103.38 | 62.27 | 53.47 | 36.26 | 2.41 | 42.93 |
| 35 | 4 | 34.54 | -3.45 | 21.53 | 85.34 | -2.43 | 6.05 | 19.03 | -4.60 | 19.50 |
| 36 | 1 | 24.27 | -10.33 | 12.38 | 89.43 | 0.53 | 8.42 | 28.79 | -4.35 | 18.64 |
| 41 | 7 | 34.46 | 28.41 | 20.45 | 39.09 | 30.24 | 53.18 | 27.31 | -14.22 | 27.37 |
| 42 | 2 | 30.42 | 39.32 | 48.16 | 29.00 | 1.13 | 11.85 | 22.31 | 5.43 | 23.58 |
| 43 | 3 | 19.00 | 16.38 | 11.65 | 51.58 | 16.30 | 39.31 | 13.31 | -19.89 | 18.46 |
| 44 | 1 | 23.38 | -3.70 | 4.82 | 76.46 | 22.27 | 15.21 | 12.85 | 2.85 | 19.26 |
| 45 | 3 | 25.65 | 30.24 | 20.93 | 18.02 | 29.10 | 20.28 | 40.89 | 6.67 | 23.97 |
| 46 | 2 | 57.78 | 58.71 | 70.93 | 197.06 | 84.22 | 86.11 | 86.16 | 1.37 | 80.29 |
| 47 | 1 | 21.30 | 0.81 | -8.54 | -56.59 | 4.67 | 23.37 | 1.72 | -10.12 | -2.92 |
| 48 | 2 | 33.49 | 22.19 | 4.61 | -48.71 | 2.69 | 17.87 | 4.27 | -7.93 | 3.56 |
| 49 | 1 | 33.97 | 68.91 | 42.43 | -10.97 | 48.84 | 70.46 | 20.59 | -9.90 | 33.04 |
| 50 | 5 | 27.37 | 36.22 | 48.93 | 87.87 | 99.49 | 107.62 | 55.63 | 4.01 | 58.39 |

## TABLE XIV

**AVERAGE PERCENT HETEROSIS OF ALL $F_1$ CYNODON PLANTS FOR EACH AND ALL VARIABLES AND FOR ALL CROSSES, STILLWATER, OKLAHOMA, 1966**

| Variable 1 Plant Radius | | Variable 2 Plant Height (Center) | | Variable 3 Plant Height (Maximum) | | Variable 4 Distance Center to Maximum Height | | Variable 5 Green Weight | | Variable 6 Dry Weight | | Variable 7 Internode Length | | Variable 8 Percent Moisture | | Average | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| High Parent | Mid Parent | High Parent | Mid Parent | High Parent | Mid Parent | High Parent | Mid Parent | High Parent | Mid Parent | High Parent | Mid Parent | High Parent | Mid Parent | High Parent | Mid Parent | High Parent | Mid Parent |
| 11.77 | 30.24 | 4.98 | 23.41 | 7.47 | 27.82 | 30.10 | 76.38 | 24.11 | 45.86 | 30.63 | 53.35 | 4.99 | 30.25 | -6.68 | -3.62 | 13.42 | 35.46 |

## TABLE XV

**AVERAGE PERCENT HETEROSIS OF $F_1$ CYNODON PLANTS FOR EACH AND ALL VARIABLES FOR INTERSPECIFIC, INTERVARIETAL, AND INTRAVARIETAL CROSSES, STILLWATER, OKLAHOMA, 1966**

| | Number Crosses | Variable 1 Plant Radius | | Variable 2 Plant Height (Center) | | Variable 3 Plant Height (Maximum) | | Variable 4 Distance Center to Maximum Height | | Variable 5 Green Weight | | Variable 6 Dry Weight | | Variable 7 Internode Length | | Variable 8 Percent Moisture | | Average | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | High Parent | Mid Parent | High Parent | Mid Parent | High Parent | Mid Parent | High Parent | Mid Parent | High Parent | Mid Parent | High Parent | Mid Parent | High Parent | Mid Parent | High Parent | Mid Parent | High Parent | Mid Parent |
| Inter-specific | 17 | 6.24 | 33.62 | -11.77 | 18.18 | -7.31 | 20.77 | 25.06 | 100.63 | 14.27 | 40.44 | 24.86 | 50.06 | -12.04 | 21.01 | -6.51 | -3.34 | 4.10 | 35.17 |
| Inter-varietal | 25 | 14.30 | 28.92 | 11.99 | 25.94 | 13.34 | 28.77 | 47.24 | 73.59 | 21.64 | 41.24 | 30.92 | 45.08 | 7.19 | 31.58 | -6.46 | -4.06 | 17.52 | 33.88 |
| Intra-varietal | 8 | 15.64 | 27.61 | 21.83 | 32.60 | 20.54 | 39.85 | 15.34 | 62.62 | 52.62 | 89.37 | 47.76 | 86.08 | 32.53 | 45.73 | -7.23 | -2.81 | 24.88 | 47.63 |

VITA

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