A NOVEL TECHNIQUE TO PRODUCE POLYGENIC RESISTANCE TO ANTHRACNOSE IN *Stylosanthes capitata*

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Abstract

An improved cultivar, based on 17 genotypes of *S. capitata* and six of *S.macrocephala*, was developed at the Embrapa Beef Cattle Research Center, Campo Grande, Brazil. The aim was to create durable, race non-specific resistance to anthracnose controlled by polygenic factors. A mass hybridisation technique was employed to produce a high degree of genetic diversity and sizeable quantities of seed of hybrid-derived progenies of Brazilian and Venezuelan genotypes of *S. capitata*. Outcrossing resulted in a significant improvement in the forage production of progeny of Venezuelan accessions. The multicross was evaluated in multilocational trials, each representing a large tract of country in the Cerrados ecosystem along a north-south transect from lat.6^0 S to 20^0 S. The genetic shift that occurred in *S. capitata* was a key element in the formation of the new cultivar. It is a complex mixture of two species, and a recombination of much desired forage traits of Brazilian x Venezuelan genotypes, high forage and seed yields coupled with anthracnose resistance. The new cultivar with its diverse genetic make-up has a wide application in the acid-soil savannas of tropical America. It was released by Embrapa for the Cerrados in 2000.

Keywords: *Stylosanthes capitata*, hybridisation, cultivar development, Cerrados

Introduction

S. capitata and *S. macrocephala* are natives of the Cerrados ecosystem and they are adapted to low fertility quartz sand that extends over 34 million hectares. The major limitation to using *S. capitata* as a component of legume-based pastures in the Cerrados is anthracnose (*Colletotrichum gloeosporioides* Penz. *et* Sacc.). Brazil is the major center of diversity of *S. capitata*, as well as its specialised pathogen, that affects a high percentage of accessions. Accessions of *S. macrocephala* have proven the most resistant of all *Stylosanthes* species hitherto evaluated in Brazil. Disease restriction by genotype mixtures was highly effective in the *S.capitata* improvement project initiated at Embrapa Beef Cattle Research Center. The first phase of this cultivar development was based on a mixture of *S. capitata* and *S. macrocephala*. The current report deals with the second phase of cultivar development. The aim was to create durable, race non-specific resistance controlled by polygenic factors determined by the cumulative effect of a number of resistance genes.

Material and Methods

Hybrid-derived segregating progenies of Brazilian parental lines of *S.capitata* (BRA 040223) showed resistance to anthracnose. In view of the severity of anthracnose affecting *S.capitata* in Brazil a primary consideration was to protect this basic population from a ”breakdown” of resistance. In one instance, this occurred in the ”pre-release” stage of a promising Brazilian accession established for field-scale seed multiplication.

From 1978 to 1988 some 296 accessions of *S. capitata* have been screened for response to anthracnose at the Cerrados Research Center of Embrapa, Planaltina, DF, (CIAT Ann.Rep. 1988). Twenty-five Brazilian ecotypes were identified as resistant to anthracnose. At Campo Grande, only four of these have shown resistance. Venezuelan accessions of *S. capitata* showed a high level of resistance in Brazil. Outcrossing was much in evidence among components of the basic population of Brazilian origin and Venezuelan accessions. A

mass hybridisation scheme was employed to produce a high degree of genetic diversity and sizeable quantities of hybrid seed. Cultivar development was based on 17 genotypes of *S. capitata* and six genotypes of *S. macrocephala.* Hybridisation among anthracnose resistant genotypes of *S. capitata* was carried out in the field in specially designed crossing blocks, totalling 6000 m^2 .

Three bulked generations of the Brazilian basic population and selected Venezuelan accessions of *S. capitata* were established in crossing blocks of 1700m^2 and 1200m^2, respectively. Seeds of four resistant accessions and the basic population were sown in alternate 50m long rows in randomised complete blocks. Row spacing between treatments was 1.0m, and seeding rates were identical (3.3kg/ha). Consequently, plant populations were relatively similar and thus were provided with a good opportunity for free outcrossing among all components**.**

In a crossing block of 2000m^2, eleven Venezuelan and six Brazilian accessions were seeded in three randomised complete blocks. The selected accessions were planted between rows of the fourth bulked generation of the basic population. Details of sowing were the same as in the previous experiment. The planting pattern, the close proximity of parental lines in long rows, the large crossing blocks and the high population of component lines were designed to maximise the potential for outcrossing among populations. Intercrossing among Venezuelan and Brazilian accessions was repeated in the fifth and sixth generations in separately seeded fields. Superior components were selected from the genepool of the previous four crossing blocks on the basis of agronomic characters and anthracnose resistance The crossing block of the fifth generation was composed of 11 progeny of Venezuelan accessions of *S. capitata* and one from Brazil. The sixth generation crossing block contained eigth Venezuelan progeny and two of Brazilian origin..The pollinators of *S. capitata* were chiefly honeybees (*Apis* sp.), but native insect pollinators were also abundant. The rate of

outcrossing appeared to be exceptionally high which may be attributed to a more effective pollinating fauna within the native distribution of the species (Stace, 1984). The rate of outcrossing ranged from 12.4 to 47.7% in Colombia where the species is an introduced exotic (Miles, 1983).

Results and Discussion

Brazilian ecotypes of *S. capitata* are erect or semi-erect, large leaved plants while those of Venezuelan origin lack vigour and are typically prostrate, with smaller leaves and inflorescences. Brazilian ecotypes produced 21% to 35% more dry matter than Venezuelan accessions. The progeny of outcrossed Venezuelan accessions were large leaved, mostly erect plants, phenotypically indistinguishable from the Brazilian ecotypes. Indeed, the typical Venezuelan ecotypes have disappeared from the synthetic population.

Yields of hybrid-derived progeny of Venezuelan accessions showed a very marked improvement. The top yielding accession that produced 10.6 t/ha dry forage and outyielded eight Venezuelan and six Brazilian ecotypes was the progeny of an outcrossed ecotype from Venezuela. However, the mean values of the two groups of different geographical origin were not significantly different ($P<0.05$). Anthracnose severity rating in this experiment ranged from 0.43 to 2.40 (rating scale: 0-9). The sixth generation multicross proved to be a relatively uniform and standardised product with respect to anthracnose resistance, forage and seed yields. The composition, flowering and maturity dates were further stabilised and synchronised by bulking the generations of 1997, 1998 and 1999. At this point in time, six accessions of *S. macrocephala* were introgressed into the composite by physically mixing these seeds with the multicross population at the rate of 20% by weight of *S. macrocephala* seed.

Agronomic performance of hybrid-derived Venezuelan components was compared with the composite multicross in small-plot cutting trials.

DM yields at Campo Grande ranged from 4.1 to 5.0 t/ha in the wet season, and the multicross yielded 4.3 t/ha. In the dry season the same treatments produced 1.7-2.1 t/ha and the multicross yielded 1.8 t/ha.

Mean values of anthracnose rating at Campo Grande for all components of the multicross were 0.69 and 0.98 (rating scale: 0-9). Mean yields of cleaned, scarified seed ranged from 140.6 kg/ha to 230 kg/ha. Weight of scarified, dehulled seed was 48% to 50% less than that of seed-in-pod.

Stability of disease resistance of the multicross and its adaptation to a wider range of conditions has been assessed in three multilocational trials, each representing a large tract of country in the Cerrados ecosystem along a north-south transect from lat.6^0 09'S to 20^0 27'S. DM yields at three sites ranged from 6.5 t/ha to 12.1 t/ha in the first year of regional evaluation, and from 5.7 t/ha to 13.4 t/ha in the second year. Yields of seed-in-pod ranged from 314 kg/ha to 597 kg/ha in the first year and 245 kg/ha to 614.3 kg/ha in the second year. Anthracnose rating was 1.0 to 3.2 and 1.0 to 4.1, respectively.

The genetic shift was a key element in the formation of the multicross. It is a complex mixture of two species and their ecotypes, it also contains a genetic recombination of forage traits of Brazilian x Venezuelan accessions of *S. capitata.* The hybrid-derived progenies possess the desired forage traits, high dry matter and seed yields coupled with anthracnose resistance. High outcrossing among *S. capitata* components of diverse geographical origin enabled us to produce sizeable quantities of hybrid seed in a relatively short time. This cultivar with its diverse genetic make-up has a wide application in the acid-soil savannas of tropical America. It was released by Embrapa for the Cerrados in 2000.

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