Subtropical Plant Science, 49: 42-45.1997

Macrophomina phaseolina Resistance, Adaptation and Stability of Different Sesame Genotypes in Tamaulipas, Mexico.

Jorge Elizondo-Barron

Campo Experimental Sur de Tamaulipas, P.O. Box C-1 Sucursal Aeropuerto 89339 Tampico, Tamaulipas

ABSTRACT

During 1990 and 1991, 10 early and 11 medium maturity genotypes of sesame (*Sesamum indicum* L.) were evaluated to determine their response to *Macrophomina phaseolina* (Tassi) Goid, adaptation and stability under diverse environments in the municipalities of Llera and Padilla Tamaulipas. The early maturity Peludo Canastilla and Iguala 200-SI-R77 and the medium maturity Criollo de Llera showed general environmental adaptability. The medium maturity Iguala 267-T72 had the best adaptability to favorable environments. In addition, the early maturity Chino II and the medium maturity Instituto 7 consistently performed best in unfavorable conditions.

RESUMEN

Se evaluaron 10 genotipos tempranos y 11 de maduración intermedia de ajonjolí (*Sesamum indicum* L.) para determinar su respuesta a *Macrophomina phaseolina* (Tassi) Goid, y su adaptación y estabilidad bajo diversos medios ambientes en los municipios de Llera y Padilla, Tamaulipas durante 1990 y 1991. Los cultivares tempranos Peludo Canastilla e Iguala 200-SI-R77 y el cultivar de madurez intermedia Criollo de Llera mostraron adaptabilidad en general al medio ambiente. El cultivar de madurez intermedia Iguala 267-T72 tuvo la mejor adaptabilidad en ambientes favorables. Asimismo, el cultivar temprano Chino II y el intermedio Instituo 7 consistentemente se comportaron mejor en condiciones desfavorables.

Additional Index Word: Sesamum indicum, charcoal rot resistance, adaptation.

Sesame (*Sesamum indicum* L.) is cultivated mainly in the municipality of Llera Tamaulipas on 500 ha, where the average annual grain yield production is 748 kg ha^{-1}. In the past years, a considerable amount of sesame grain produced in this region was exported to the United States of America, which represents a stable market to this product. Sesame production in Mexico usually is confined to small farms where inputs such as fertilizers, pesticides and improved cultivars are seldom used. These factors, when combined with the susceptibility to Macrophomina phaseolina (Tassi) Goid, and edaphic and seasonal variation of the region, often result in low grain yields. Therefore, growers need sesame cultivars resistant to charcoal rot, that can perform predictably across a range of environmental conditions.

Charcoal rot, caused by Macrophomina phaseolina is the primary disease of sesame in Mexico (Urdaneta, 1980; Urdaneta and De Bauer, 1981; Mendoza and Pinto, 1983; De la Garza, 1989). The use of resistant or tolerant genotypes is one of the best ways to control this disease (Martinez and Oscar, 1978; Urdaneta, 1980). However, one common problem faced in genetic improvement programs is the evaluation and recommendation of new varieties based solely on yield, without examination of genotype-environment interaction and performance stability when cultivated across several environments.

Several techniques have been developed to determine genotype-environment interaction. The regression approach, first suggested by Yates and Cochran (1938), employs regression of genotypic means upon an environmental index. The regression technique of measuring genotype-environment interaction developed by Finlay and Wilkinson (1963) and later improved by Eberhart and Russell (1966), and Perkins and Jinks (1968) suggested statistical parameters for the assessment of cultivar stability in plant breeding programs. Many researchers have used this method to investigate genotype-environment interactions in different species (Carballo, 1970; Jowett, 1972; Perkins and Jinks, 1971). Eberhart and Russell (1966) defined a stable genotype as one having an average response in performance to environments of varying levels of productivity with minirnum deviations from regression. Marquez (1970) reviewed the stability concept proposed by Eberhart and Russell and defined genotype-environment interaction as the relative differential behavior shown by genotypes when evaluated across different environments. He suggested that the value of one in the regression coefficient indicated a lack of genotype-environment interaction. A deviation from regression equal to zero indicated a higher degree of predictability.

The objectives of this research were to determine the adaptation and stability of 10 early maturity and 11 medium maturity sesame genotypes and their reaction to Macrophomina phaseolina in the State of Tamaulipas, Mexico.

MATERIALS AND METHODS

The studies were conducted under irrigated conditions in the municipalities of Llera (1990 and 1991) and Padilla Tamaulipas (1991). Testing for disease incidence was

Table 1. Mean yield and stability parameter estimates (b, s^2d) for grain yield of 10 early maturity genotypes tested in three environments (1990-91) of the State of Tamaulipas, Mexico.

Genotype	Mean Yield	b	s^2d
	Kg ha $^{-1}$		
Chino II	1242 cd	0.61*	-12981
Chino II-1	1236 cd	0.86	-8564
Ciano 16-Sel 1	1176 cd	0.84	6552
Iguala 200-SI-R77	1550a	1.38	-7764
Iguala 199-SI-R77	1358abc	0.99	-11435
Padilla 605	1199 cd	1.18	-10266
Peludo Canastilla	1457ab	0.65	-542
Llano	1142 d	0.65	57637*
Colecta Regional	1306 bcd	1.01	-1243
Instituto 15	1278bcd	1.01	13536
Mean	1294		
LSD (0.05)	206		

* Significantly ($P \leq 0.05$) different from 1.0 for the regression coefficient and from 0.0 for the deviation from regression.

Table 2. Mean yield percent of infected plants of early maturity genotypes studied in a field naturally infested with *Macrophomina phaseolina*, at Tablero Experimental Station in 1991.

Genotype	Mean Yield	Disease incidence
	Kg ha^{-1}	%
Peludo Canastilla	1204 a	20.7 a
Llano	1012 ab	25.0 ab
Chino II	943 bc	31.4 ab
Iguala 200-SI-R77	871 bcd	29.7 ab
Iguala 199-SI-R77	869 bcd	44.7 c
Chino II-1	721 cde	32.7 b
Colecta Regional	678 de	57.0 d
Ciano 16-Sel 1	613 e	60.0 d
Instituto 15	607 e	51.0 cd
Padilla 605	526 e	54.0 cd
Mean	804	40.7
LSD (0.05)	236	11.6

conducted only in 1991 in Padilla at the Tablero Experimental Station on a clay soil naturally infested with *Macrophomina phaseolina*.

Standard sesame agronomic practices and recommended procedures for fertility and weed control were used in each study. Seeds were drilled into three-row plots between April 15 and April 30. Rows were 6 m long and 80 cm apart. Spacing within rows was 6.6 cm (seeding rate was 2.5 kg h^{-1}). Experimental design at each location was a randomized complete block design with three replications. Ten early (90 days to maturity) and 11 medium maturity (105 days to maturity) genotypes were tested. Each of these groups constituted a separate experiment. Three rows, 4 m long, were hand-harvested at maturity and reported measured cleaned seed yield was adjusted to 12% moisture.

To investigate genotype-environment interactions for grain yield, two methods of analysis were used. The first method was based on the standard model for analysis of variance, and in the second method, a simple linear regression was used to estimate the regression coefficient (b) and the deviation from regression(s^2d). The model for stability proposed by Eberhart and Russell (1966) was then applied.

To evaluate *Macrophomina phaseolina* resistance, samples of infected plants were taken and the disease was confirmed under the microscope in the laboratory. The number of infected plants in each plot was counted at crop maturity.

RESULTS AND DISCUSSION

Analysis of the early maturity germplasm:

The grain yield analysis of variance indicated significant differences ($P \leq 0.05$) between genotypes and genotype-environment interaction. Mean genotype yield ranged from 1142 to 1550 kg ha^{-1} with Iguala 200-SI-R77 producing the greatest yield.

In the stability analysis, (Table 1), the regression of genotype mean yield on the environmental index resulted in regression coefficients ranging from 0.61 to 1.38. Only one genotype, Chino II had a b value significantly ($P \leq 0.05$) different from 1.0. Deviation from regression was significant for the genotype Llano only.

For grain yield production, the best genotypes were Iguala 200-SI-R77, Peludo Canastilla and Iguala 199-SI-R77. These genotypes are suitable because their grain yield is greater than

Table 3. Mean yield and stability parameter estimates (b, s^2d) for grain yield of 11 medium maturity genotypes tested in three environments (1990-91) of the State of Tamaulipas, Mexico.

Genotype	Mean Yield	b	s^2d
	Kg ha^{-1}		
Iguala 267-T72	1751 a	1.24 *	-11470
Instituto 103-4-3-22	1263 b	1.36 *	-12772
Felicidad 1 vara	1287 b	1.24 *	-12978
Ciano 27 Sel 1 x Calentana	1350 b	1.20	2646
Renner 1-7-Sel 588	1331 b	0.97	19889
Veracruz 2 x Iguala 243-T72	1495 ab	0.76 *	39585 *
Ciano 95	1335 b	0.89	63832 *
Instituto 7	1369 b	0.67 *	-5710
Criollo de Liera	1435 b	0.97	-14350
CD247-5-OY-R87-1Y-OY	1369 b	0.83	70618 *
C343-1-1-1Y-OY-R87-1Y-OY	1308b	0.81*	-8743
Mean	1390		
LSD (0.05)	264		

* Significantly ($P \leq 0.05$) different from 1.0 for the regression coefficient and from 0.0 for the deviation from regression.

Table 4. Mean yield and percent of infected plants of medium maturity genotypes studied in a field naturally infested with *Macrophomia phaseolina*, at Tablero Experimental Station in 1991.

Genotype	Mean Yield	Disease incidence
	kg ha^{-1}	%
CD247-5-OY-R87-1Y-OY	915 a	26.4 a
Instituto 7	867 ab	30.7 ab
Ciano 95	817 ab	44.7 cd
Criollo de Llera	722 bc	42.0 bc
Iguala 267-T72	616 cd	47.7 cd
Veracruz 2 x Iguala 243-T72	614 cd	53.7 cd
C343-1-1-1Y-OY-R87-1Y-OY	525 d	55.7 d
Renner 1-7-Sel 588	310 e	68.0 ef
Ciano 27 Sel 1 x Calentana	181 ef	80.4 f
Felicidad 1 vara	173 ef	56.0 e
Instituto 103-4-3-22	110 f	80.4 f
Mean	531	53.3
LSD (0.05)	153	12.5

the average in 19, 12 and 5%, respectively, (however, only Iguala 200-SI-R77 is significantly higher than the average). In addition, according to their b and s^2d values, those three genotypes possess stability over environments. Chino II was consistently the best genotype under unfavorable conditions (b value smaller than 1.0 and s^2d value equal to zero).

Genotypes differed for yield response and disease incidence when grown on *M. phaseolina* infested soils (Table 2). Disease incidence ranged from 20.7 to 60.0%, with Peludo Canastilla being the least susceptible. The four least susceptible genotypes also produced greater yields than three of the more susceptible genotypes. A high negative correlation coefficient ($r=-0.867$, $P=0.0011$), was found between grain yield and disease resistance.

Analysis of the medium maturity germplasm:

The grain yield analysis of variance indicated significance ($P \leq 0.05$) in the genotype-environment interaction. Mean yield ranged from 1263 to 1751 kg ha^{-1}, with Iguala 267-T72 producing greater yields than nine of the ten other genotypes (Table 3).

In the stability analysis, the regression of genotype mean yield on the environmental index resulted in regression coefficients ranging from 0.67 to 1.36. Six genotypes had b values significantly ($P \leq 0.05$) different from 1.0 (Iguala 267-T72, Instituto 103-4-3-22, Felicidad 1 vara, Veracruz 2 x Iguala 243-T72, Instituto 7, and C343-1-1-1Y-OY-R87-1Y-OY). Deviation from regression was significantly different from zero for three (Veracruz 2 x Iguala 243-T72, Ciano 95, and CD247-5-OY-R87-1Y-OY), of the 11 evaluated genotypes.

Based on grain yield production, the best genotypes were Iguala 267-T72, Veracruz 2 x Iguala 243-T72, and Criollo de Llera, which yielded 25, 7 and 3%, respectively, more than the average. Of these three genotypes, Criollo de Llera may be more desirable, due to its slightly above average yield, and its stability parameters which indicated it as a stable genotype.

Instituto 7 and C343-1-1-1Y-OY-R87-1Y-OY were consistently the best genotypes across unfavorable conditions (b value smaller than 1.0 and s^2d value equal to zero). Disease incidence differed among genotypes (Table 4), with CD247-5-OY-R87-1Y-OY, Instituto 7, and Criollo de Llera, with 26.4, 30.7 and 42.0%, respectively, of disease incidence. These genotypes were less susceptible than five of the tested genotypes. Yields of the less susceptible genotypes were generally greater than the more susceptible genotypes. Grain yield was negatively correlated ($r=-0.916$, $P=0.000l$) with disease incidence.

CONCLUSIONS

Parameters, such as regression coefficient, deviation from regression and *Macrophomina phaseolina* resistance, should assist in selecting sesame genotypes with good general adaptability and greater yield potential. In this study the more stable, high yielding genotypes include: the early maturity Peludo Canastilla and Iguala 200-SI-R77 and the medium maturity Criollo de Llera. These selections are suitable for planting in the central region of the State of Tamaulipas, Mexico. Additionally, the early maturity Chino II and the medium maturity Instituto 7 appear better suited for areas where unfavorable conditions due to Macrophomina phaseolina incidence exist.

LITERATURE CITED.

Carballo, C.A. 1970. Comparación de variedades de maíz de el Bajio y de la Mesa central. Tesis M.C. Colegio de Postgraduados Chapingo, Mexico.

De la Garza, J.L. 1989. Fundamentos de Fitopatologia. Ed. Trillas, Mexico D.F.

Eberhart, S.A. and W.A. Russell. 1966. Stability parameters for comparing varieties. Crop Sci. 6:36-40.

Finlay, K.W. and G.N. Wilkinson. 1963. The analysis of adaptation in a plant breeding programme. Austr. J. Agric. Res. 14:742-754.

Jowett, D. 1972. Yield stability parameters for sorghum in East Africa. Crop Sci. 6:314-317.

Marquez, S.F. 1970. El problema de la interacción genético ambiental en genotecnia vegetal. Colegio de Postgraduados Chapingo, Mexico.

Martinez, S.A. and G.A. Oscar. 1978. Evaluación de lineas de ajonjolí a la pudricion del cuello y tallo causada por *Macrophomina phaseolina*. VIII Congreso Nal. de Fitopatologia, Oaxtepec Morelos, Mexico.

Mendoza, C. and B. Pinto. 1983. Principios de fitopatologia y enfermedades causadas por hongos. Departamento para Agricultura. Universidad Autonoma de Chapingo, Mexico.

Perkins, J.M. and J.L. Jinks. 1968. Environmental and genotype environmental components of variability. III. Multiple lines and crosses. Heredity 23:339-356.

Perkins, J.M. and J.L. Jinks. 1971. Specificity of the interaction of genotypes with contrasting environments. Heredity 26:463-474

Urdaneta, R. 1980. Estudio de algunos hongos que afectan al ajonjoli en diferentes regiones de Mexico, con enfasis en Macrophomina phaseoli. Tesis M.C. Colegio de Postgraduados, Chapingo, Mexico.

Urdaneta, R. and L.I. de Bauer. 1981. Pudricion del cuello y tallo del ajonjoli por Macrophomina phaseoli en diferentes regiones de Mexico. Agrociencia 43:71-79.

Yates, F. and W.G. Cochran. 1938. The analysis of groups of experiments. J. Agric. Sci. 28:556-580.