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EFFECT OF VARIOUS CHARCOAL ROT ISOLATES ON AGRONOMIC TRAITS OF EXOTIC SUNFLOWER INBRED LINES

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SUMMARY

Thirteen exotic sunflower inbred lines and eight isolates of Macrophomina phaseolina were studied to observe the genotypic variation for resistance to charcoal rot. The results indicated that significant differences exist among inbred lines for all traits evaluated. Among charcoal rot isolates, significant differences were observed for head weight only. Three inbred lines, namely, HAR 1, HAR 2 and HAR 5 had maximum head diameter and differed significantly from other inbred lines. Among the inbreds, HAR 1 and HAR 2 had maximum head weight, greater number of achenes per head. Hence inbred lines HAR 1 and HAR 2 were resistant/tolerant across charcoal rot isolates while HA 822 was susceptible for disease development and two charcoal rot isolates (MP 9 and MP 21) were virulent in affecting head weight.

INTRODUCTION

Sunflower is a non-conventional oilseed crop in Pakistan and its area under cultivation is increasing rapidly. Thereby plant breeders are continuously paying attention to developing and releasing sunflover cultivars with improved seed yield and quality. However, these desirable traits are mainly affected by insect pests and diseases. Charcoal rot is one of the most important disease of sunflowers in Pakistan. Charcoal rot is caused by *Macrophomina phaseolina (Tassi)* Goid M. *phaseoli* (Mauble, Ashby) and is a potential threat to sunflower growers (Mehdi and Mehdi, 1988).

Orellana (1970) reported that the disease has inflicted significant losses in sunflowers resulting in 18 to 64 percent seed yield reduction. Sunflower cultivars exhibit various levels of resistance to *M. phaseoina* (El-Dahab et al., 1980; El-Zarka et al., 1980). Some interspecific sunflower hybrids derived from *Helianthus tuberosus x H. annuus* were observed to have the highest resistance (Pustovoit et al., 1981). The challenge to modern breeding for disease resistance is to improve the durability as well as the level of resistance in our crops, since breeding for disease resistance is more economic as compared with chemical control of plant diseases. Keeping these facts in view, the present research project was initiated to evaluate thirteen exotic sunflower inbred lines across eight isolates of *M. phaseolina.* The purpose of this study was to determine the amount of genotypic variation for resistance to charcoal rot in the exotic sunflower inbred lines grown in field conditions. This information will be of great help for the future sunflower breeding programmes aiming at resistance to charcoal rot in Pakistan.

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MATERIALS AND METHODS

The present research studies were carried out at Post-Graduate Agricultural Research Station, University of Agriculture, Faisalabad, during spring 1988. The experimental material comprised 13 exotic sunflower inbred lines namely CM 400, DM 1, DM 2, DM 3, HA 306, HA 313, HA 821, HA 822, HAR 1, HAR 2, HAR 3, HAR 4 and HAR 5. Among these, CM 400, DM 1, DM 2, DM 3, HA 821 and HA 822 are oilseedand the remaining ones are non-oilseed inbred lines. Eight different isolates of charcoal rot, *Macrophomina phaseolina (Tassi)* Goid. *M. phaseoli* (Mauble. Ashby), namely MP 1, MP 2, MP 5, MP 9, MP 14, MP 15, MP 16 and MP 21, obtained from National Agricultural Research Centre (NARC), Islamabad, were used for inoculation.

The experimental design used was a randomized complete block design in split-plot layout replicated three times. Main plots consisted of the sunflower inbred lines and the charcoal rot isolates were placed in sub plots. Eight rows of each sunflower inbred line were planted in the main plot. Each row was 3.35 m long and row spaced 76 cm apart with plant to plant distance of 23 cm. The inbred lines were planted with a dabbler on March 5, 1988. Two seeds were dropped per hill and they were thinned to one plant per hill at V_2 stage (Schneiter and Miller, 1981). During flowering, ten plants were randomly selected from each row and inoculated on May 22, 1988 with charcoal rot isolates selected at random by using the toothpick method (Edmunds, 1964; Anahosour, 1983). Toothipicks were inserted 15 cm above soil surface. The inoculated plants were harvested on July 5, 1988 and data on the following agronomic traits were recorded:

1. head diameter (cm),
2. head weight (g),
3. 100-achene weight (g),
4. number of achenes per head,
5. seed yield per plot (g).

The data thus collected were processed by analysis of variance techniques (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

It is evident from Table 1 that highly significant differences existed among sunflover inbred lines for head diameter, head weight, number of achenes per head, 100-achene weight and seed yield per plot. Among the variants of charcoal rot isolates, significant differences existed for head weight. This indicated that variation existed among the isolates in affecting head weight. The inbred line x isolate interaction was non-significant for the plant traits indicated in this study. This indicated that the sunflower inbred lines and the charcoal rot isolates acted independently of each other for agronomic traits. Omran et al. (1979) and El-Zarka et al. (1980) also obtained similar results and stated large differences for seed yield among 25 sunflower introductions from ten different countries. They also indicated variability in agronomic traits for resistance to *M. phaseolina*.

Table 1. Mean squares from the analysis of variance for five indicated traits of 13 sunflower inbred lines inoculated with eight charcoal rot isolates

S.O.V.	df	Head diameter (cm)	Head weight (g)	No. of achenes per head.	100-achene weight (g)	Seed yield per plot (g)
Replications	2	28.964*	445.589	105100.00	0.068	42832.250*
Inbred lines (G)	12	23.627**	1702.579**	439311.50**	11.017**	56626.642**
Error (a)	24	6.354	245.242	74122.635	1.673	10905.209
Isolates	7	2.799	258.841*	36227.143	1.003	7498.500
G x I	84	2.616	98.007	30211.583	0.650	3584.394
Error (b)	182	3.225	120.902	32880.614	0.574	7841.209

*, ** Significant at the 0.05 and 0.01 levels of probability, respectively.

Three sunflower inbred lines, HAR 1, HAR 2, and HAR 5, har a large head diameter as mentioned in Table 2. Out of the three inbreds, HAR 1 and HAR 2 had maximum head weight and number of achenes per head. These lines differed significantly from the other inbred lines whereas the non-oilseed sunflower inbred line HA 306 had the largest 100-achene weight followed by the oilseed inbred line HA 822. Seed yield per plot was highest for HAR 1 and HAR 2. This may be due to their large head diameter, maximum head weight and number of achenes per head. Omran et al. (1979) proved by correlation studies in two sunflower varieties that seed yield per plot was due to both capitulum diameter and 100-achene weight.

Table 2. Mean comparisons of yield and yield components in 13 sunflower inbred lines inoculated across charcoal rot isolates

Inbred lines	Head diameter (cm)	Head weight (g)	No. of achenes per head.	100-achene weight (g)	Yield per plot (g)
CM 400	14.10 d*	29.23 d	494.46 e	5.87 bcd	184.23 c
DM 1	13.71 d	33.94 cd	514.29 de	5.32 de	191.89 c
DM 2	15.00 bcd	33.19 cd	602.08 cde	5.66 bcd	207.65 c
DM 3	14.69 cd	30.58 cd	522.79 de	5.41 de	194.12 c
HA 306	14.86 cd	39.14 bcd	538.33 cde	7.40 a	244.93 bc
HA 313	15.05 bcd	37.04 cd	578.71 cde	6.34 bc	227.55 bc
HA 821	14.89 cd	30.29 cd	544.29 cde	5.51 cd	185.23 c
HA 822	14.42 cd	36.72 cd	513.38 de	6.56 ab	212.91 c
HAR 1	16.68 ab	48.16 ab	835.79 ab	5.74 bcd	286.33
HAR 2	17.24 a	58.74 a	933.13 a	6.14 bcd	348.47 a
HAR 3	15.17 bcd	29.07 d	640.13 cd	4.59 e	175.33 c
HAR 4	14.52 cd	34.69 cd	578.08 cde	5.77 bcd	209.73 c
HAR 5	15.95 abc	40.26 bc	722.88 bc	5.58 cd	246.84 bc

* Means followed by the same letter are not significantly different at the 0.05 probability level as determined by Duncan's multiple range test.

Among the agronomic traits, charcoal rot isolates had a significant effect on head weight. Two isolates, MP 9 and MP 21, affected this trait. Therefore, these two isolates were virulent for head weight (Table 3). The phenotypic coefficients of variation were greater than their respective genotypic coefficients of variation for agronomic traits (Table 4). The genotypic and phenotypic coefficients of variation were smaller in value for head diameter, whereas they were larger for head weight, number of achenes per head and seed yield per plot. The phenotypic standard deviation was greater for number of achenes per head and seed yield per plot. These three traits exhibited maximum variation.

Table 3. Mean comparisons of *Macrophomina phaseolina* isolates across sunflower inbred lines for yield and yield components.

Charcoal rot isolate	Head diameter (cm)	Head weight (g)	No. of achenes per head.	100-achene weight (g)	Yield per plot (g)
MP 1	14.58	41.20 a*	657.97	6.05	246.46
MP 2	15.42	38.37 ab	629.03	5.80	235.78
MP 5	15.15	38.28 ab	605.13	6.13	232.67
MP 9	14.85	34.22 b	604.82	5.70	215.91
MP 14	14.87	36.56 ab	599.82	5.71	211.82
MP 15	14.96	38.14 ab	662.05	5.77	233.35
MP 16	14.95	36.18 ab	598.36	5.74	213.41
MP 21	14.99	33.07 b	577.18	5.81	206.63

* Means followed by the same letter are not significantly different at the 0.05 probability lever as determined by Duncan's multiple range test.

Table 4. Means, range, phenotypic standard deviations (S.D) and coefficients of variation for seed yield, seed yield components and charcoal rot disease symptoms on the stem of sunflower inbred lines inoculated with *M. phaseolina* isolates

Trait	Means	Range	Phenotypic S.D.	Coefficients of tvariation (%)	
				Genotypic	Phenotypic
Head diameter (cm)	15.10	9.00-22.66	0.85	5.72	6.12
Head weight (gm)	37.01	13.34-100.52	7.82	21.22	21.92
Number of achenes per head	616.79	128.00-1478.00	123.78	20.07	20.88
100 achene weight (gm)	5.84	3.07-9.08	0.63	10.64	11.01
Seed yield per plot (gm)	224.25	56.71-529.19	43.93	20.35	21.07

Table 5 indicated that estimates of genetic variance for seed yield and seed yield components were significant. This indicates the existence of sufficient genetic variation among the exotic sunflower inbred lines. El-Zarka et al. (1980) also observed variability in resistance to *M. phaseolina* in 25 introductions for seed yield and oil contents. The estimates of isolate variance were smaller in value compared to their respective genetic variances. Isolate variance was significant for head weight, thus indicating variation among charcoal rot isolates for the said trait. Most of the genetic x isolate variance estimates were negative in value. Thereby the most reasonable value for genetic x isolate variance is zero as indicated by Allard (1960). The phenotypic variances for all the traits evaluated in the present study were greater in value than their respective genetic variances.

Table 5. Estimates of components of variance and broad-sense heritability (h2) for yield, yield components of 13 sunflower inbred lines inoculated with 8 charcoal rot isolates.

Trait	Component of variance					
	62G	62I	62GI	62E	62P	h2
Head diameter (cm)	0.745**	0.01	+0.00	0.134	0.879	0.847
Head weight (gm)	61.676	4.12*	+0.00	5.0387	66.714	0.924
Number of achenes per head.	15327.412**	154.25	+0.00	1370.0260	16697.440	0.918
100-achene weight (gm)	0.386**	0.01	0.02557	0.024	0.413	0.934
Seed yield per plot (gm)	2082.427	100.36	+0.00	326.771	2409.144	0.864

\+ Negative estimates for which the most reasonable value is zero.

*,** Significant at the 0.05 and 0.01 levels of probability, respoecively.

In the present study, the estimates of broad-sense heritability for seed yield and seed yield components were quite high. These estimates were maximum for 100-achene weight (0.934) and minimum for head diameter (0.847). These results are quite different from those obtained by Sharinivasa (1982) who estimated a high heritability for head diameter and a low one for 100-achene weight. This may be due to the effect of charcoal rot disease incidence, environments or the experimental material evaluated. The estimate of heritability are used in predicting the progress from selection. If the heritability of a trait is high, this indicates that the genotype plays a more important role than the environment in determining the phenotype. Therefore, a character with a high heritability is more likely to respond to selection than a charachter and charcoal rot resistance for use in future hybridization programmes.

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EFFET DE DIVERS ISOLATS DE POURRITURE CHARBONNEUSE (*Macrophomina phaseolina*) SUR DES CARACTÉRES AGRONOMIQUES DE LIGNÉES DE TOURNESOL

RÉSUMÉ

Treize lignées de tournesol et huit isolats de *Macrophomina phaseolina* ont été étudiés afin d'observer les variations génotypiques liés à la résistance à la pourriture charbonneuse. Les résultats montrent qu'une différence significative existe parmi toutes les lignées pout tous les caractéres étudiés. Parmi les isolats de pourriture charbonneuse, des différences significatives ont été observées seulement pour le poids des capitules. Trois lignées, HAR1, HAR2 et HAR5 ont un diamétre de capitule maximal et différant significativement des autres lignées. HAR1 et HAR2 ont le poids de capitule maximal et le plus grand nombre d'achénes par capitule.

EFECTO DE VARIOS AISLAMIENTOS DE PODREDUMBRE CARBONOSA SOBRE CARACTERES AGRONOMICOS DE LINEAS PURAS DE GIRASOL EXOTICO.

RESUMEN

Trece líneas puras de girasol de origen exótico y ocho aíslamientos de *Macrophomina phaseolina* fueron estudiados para observar la variación genotípica para resistencia a la podredumbre carbonosa. Los resultados indicaron que existieron diferencias significativas entre líneas puras para todos los caracteres observados. Entre aislamientos de podredumbre carbonosa fueron observadas diferencias significativas solo para peso del capítulo. Tres líneas puras denominadas HAR1, HAR2 y HAR5 tuvieron un diámetro de capítulo máximo significativamente diferente de otras líneas. Entre las líneas, HAR1 y HAR2 mostraron máximo peso de capítulo y mayor número de aquenios por capítulo. Por tanto las líneas puras HAR1 y HAR2 fueron resistentes/tolerantes a los aislamientos de podredumbre carbonosa mientras la línea HA 822 fué susceptible para el desarrollo de la enfermedad y los aislamientos de podredumbre carbonosa (MP9 y MP21) fueron virulentos afectando el peso del capítulo.