EFFECT OF VARIOUS CHARCOAL ROT ISOLATES IN THE DEVELOPMENT OF CHARCOAL ROT DISEASE IN EXOTIC SUNFLOWER INBRED LINES

Maqbool Ahmad* and Syed Sadaqat Mehdi**

ABSTRACT

Eight isolates of *Macrophomina phaseolina* and thirteen exotic sunflower inbred lines were studied to observe the effect of isolates in the development of charcoal rot disease and the reaction of inbred lines. The results indicated that significant differences were observed for disease symptoms on external and internal stem. Among inbreds HAR 1 and HAR 2 had minimum disease symptoms on internal stem while HA 822 inbred line was susceptible for disease symptoms development both on external and internal stem. Almost all isolates except MP 14 were virulent in affecting the disease development symptoms on external stem. Five charcoal rot isolates (MP 2, MP 5, MP 15, MP 16 and MP 21) were aggressive in disease development symptoms on internal stem.

INTRODUCTION

High yield is the dominant objective of plant breeding and is achieved by maximizing biomass and partition ratio and minimizing loss of biomass. Plant diseases are a major cause of minimizing loss of biomass. The objective of most disease resistance breeding of crop plant is protection of yield and quality and it acts as an insurance when the environmental conditions for the crop are unfavourable. Among diseases, charcoal rot is one of the most important disease of sunflower in Pakistan. Charcoal rot disease

* Scientific Officer, Oilseed Programme, National Agricultural Research Centre, Islamabad.

** Assistant Professor, Department of Plant Breeding & Genetics, University of Agriculture, Faisalabad.

is caused by *Macrophomina phaseolina* (Tassi) Goid *M. phaseoli* (Mauble. Ashby) and is a potential threat to sunflower growers (Mehdi and Mehdi, 1988).

Charcoal rot affected plants are characterized by a grey-to-black discolouration at the base of the stem, which extends upward thus hollowing the interior portions of the stem. Later the pith become shriveled and discoloured (Ilyas et al., 1982; Baumer and Hajdu, 1984). The disease causes root or basal stem rot and premature ripening and drying of stalks (Mirza et al., 1984). The occurrence of this disease also appeared to be related to the extremely hot and dry weather conditions (Alabovette and Marty, 1977; Pustovoit et al. 1981; Baumer and Hajdu, 1984). On the basis of field observations, it was suggested that charcoal rot could be controlled genetically (Mihaljecevic, 1978). Therefore, the present studies were aimed to know the effect of different isolate on the development of disease symptoms in exotic sunflower inbred lines under the field conditions.

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 was comprised of 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 3, HA 821, HA 822,

are oilseed and remaining are non oilseed inbred lines. Eight different isolates of charcoal rot pathogen {*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 repeated three times. Main plots consisted of sunflower inbred lines and charcoal rot isolates were placed in sub plots. Eight rows of each sunflower inbred line were planted in the main plot. Each row was of 3.35 m long and row spaced 76 cm apart with plant to plant distance of 23 cm. The inbred liens were planted with a dibbler 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 were inoculated on May 22, 1988 with charcoal rot isolates selected at random by using tooth pitch method (Edmunds, 1964; Anahosour, 1983) at 15 cm above soil surface. The inoculated plants were harvested on July 5, 1988 and data on the following disease symptoms were recorded.

1. External disease symptoms on stem

Charcoal rot disease reaction was recorded by carefully examining the external disease symptoms on the stem of the inoculated plants. A disease rating scale of 0 to 5 (0=no disease symptoms on external stem to 5= premature death) was used for recording the data.

2. Internal disease symptoms on stem

Charcoal rot disease reaction was recorded by carefully splitting the inoculated stem at the height of 15 cm from soil surface, with the help of a sharp knife and data on internal disease reaction were recorded a 0 to 5 scale as mentioned in trait No.1.

The data obtained were subjected to analysis of various techniques(Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Among sunflower inbred lines and as well as among charcoal rot isolates, significant differences existed for charcoal rot disease symptoms both on external and internal stem (Table 1). However, the inbred line x isolate interaction for charcoal rot disease symptoms on external and internal stem were non-significant. This revealed that the exotic sunflower inbred lines and charcoal rot isolates act independently of one another for reaction to charcoal rot disease. According to Van Der Plank (1963) resistance was said to be horizontal if its variation was independent of pathogen variation, and vertical if variation in the pathogen was associated qualitatively with variation in the host. Therefore a non significant interaction effect in our study due to isolates and inbred lines indicates that the resistance is horizontal. Horizontal resistance is polygenic, pathotype-non-specific and generally graded in expression (Van Der Plank, 1968; Robinson, 1969).

Table 1. Mean squares from the analyses of variance for disease symptoms on stem of thirteen sunflower inbred lines inoculated with eight charcoal rot isolates.

S.O.V.	df	Disease symptoms on External Stem.	Disease symptoms on Internal Stem.
Replications	2	3.954	2.837*
Inbred lines (G)	12	14.876**	6.567**
Error (a)	24	1.506	0.608
Isolates (I)	7	1.284*	1.729**
G X I	84	0.402	0.310
Error (b)	182	0.623	0.310

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

Table 2. Mean disease symptom development of *M. phaseolina* on the stem of thirteen sunflower inbred lines across *Macrophomina phaseolina* isolates.

Inbred lines	Mean disease symptom development+ External stem	Internal stem
CM 400	3.16 bc*	4.22 abc
DM 1	2.53 cd	3.89 cde
DM 2	3.19 bc	4.19 abc
DM 3	2.99 c	4.01 bcd
HA 306	3.89 ab	4.47 ab
HA 313	3.03 c	3.85 cde
HA 821	2.46 cd	3.79 cde
HA 822	4.13 a	4.56 a
HAR 1	1.28 e	2.83 g
HAR 2	1.89 de	2.95 fg
HAR 3	1.99 de	3.37 ef
HAR 4	2.46 cd	3.65 de
HAR 5	2.49 cd	3.89 cde

+ Individual plants were rated for disease symptom development on a 0 to 5 scale, with 0=no symptoms and 5=premature death.

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

HAR 1 and HAR 2 inbred lines were less affected by the infection of charcoal rot disease on their stem (Table 2) . Hence they indicated resistance against this pathogen. An inbred line HA 822 was susceptible to disease symptoms development both on external and internal stem. Almost all the charcoal rot isolates except MP 14 were virulent in making infection on external stem (Table 3) whereas five charcoal rot isolates namely MP 2, MP 5, MP 15, MP 16 and MP 21 were aggressive in causing disease development symptoms on the internal stem.

The estimates of genetic variance for charcoal rot disease symptoms development on internal stem were significant (Table 4) which indicate the existence of sufficient genetic variation among the exotic sunflower inbred lines. The estimates of isolate variance were significant for disease development symptoms on both external and internal stem, thus indicating variation among charcoal rot isolates for the said traits. Broad sense heritability estimates for disease symptoms both on external and internal stems were almost equal and quite high. This suggests that disease rating eighter on the external or internal stem of the inbred lines across charcoal rot isolates is effective for selection purposes. Therefore, charcoal rot disease rating on the external stem of these inbred lines will save the cost and time. The estimates of heritability are used in predicting the progress from selection. If the heritability of a trait is high, this indicates that the genotype play a more important role than the environment in

Table 3. Mean disease symptoms produced by eight charcoal rot isolates on the stem of sunflower inbred lines.

Charcoal rot Isolates	Disease Symtoms on +	
	External Stem	Internal Stem
MP 1	2.59 ab	3.62 bcd
MP 2	2.92 a	4.03 a
MP 5	2.65 ab	3.75 abc
MP 9	2.61 ab	3.73 bc
MP 14	2.48 b	3.47 d
MP 15	2.74 ab	4.00 ab
MP 16	2.99 a	3.98 ab
MP 21	2.88 a	3.99 ab

+ Individual plants were rated for disease symptom development on a 0 to 5 scale with o=no symptoms and 5=premature death

Table 4. Estimates of components of variance and broad-sense heritability (h^2) for disease symptoms on stem of 13 sunflower inbred lines inoculated with 8 charcoal rot isolates.

Traits	Components of variance					
	6^2G	6^2I	6^2GI	6^2E	6^2P	h^2
External disease symptoms on stem.	0.566	0.02*	0.00+	0.026	0.592	0.956
Internal disease symptoms on stem.	0.248**	0.04**	0.717^{-05}	0.013	0.261	0.951

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

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

determining the phenotype. Hence, among the inbred lines it is quite easy to select parents for charcoal rot disease resistance for the future hybridization programmes in Pakistan.

REFERENCES

1. Alabouvette, C. and J.R. Marty. 1977. Influence of climatic and cultural factors on some sunflower diseases. Ann. Phytopath., 9(4):487-493.

2. Anahosour, K. H. 1983. Comparison of toothpick and sick plot methods on the incidence of charcoal rot in sorghum. Newesl. 26:108-109 (Pl. Br. Abst.555(7):5306:1985)

3. Baumer, J.S. and F. Hajdu. 1984. Occurrence of charcoal rot in Minnesota 1983. Proc. Sunflower Res. Workshop, Natl. Sunflower Assoc., Fargo, North Dakota, USA, p.15.

4. Edmunds, L.K. 1964. Combined relations of plant maturity, temperature and soil moisture to stalk rot development in grain sorghum Phytopath. 54(5):514-517.

5. Ilyas, M.B., M.A. R. Bhatti and M.A. Randhawa. 1982. Biology Host Parasite relationship and control of charcoal rot fungus (*Macrophominia phaseolina*). Tech. Bull. No.1 Soc. Adv. Agric. Sciences Pakistan, Univ. of Agric. Faisalabad.

6. Mehdi, S.S. and S. A. Mehdi. 1988. Charcoal rot resistance in sunflower cultivars at various plant dencits. Pak. J. Sci. Ind. Res. 31(11):786-787.

7. Mihaljecevic, M. 1978. Choosing a suitable technique for screening sunflower for resistance to charcoal rot in climatic conditions of Yugoslavia. Proc. 8th Inter. Sunfl. Conf. p.258-264. Minneapolis, Minnesota, USA.

8. Mirza, M.S., W. Manzoor, M. Rashid and S.T. Ali Khan, 1984. Screening sunflower cultivars for resistance to charcoal rot, *Macrophomina phaseolina* (Tossi) Goid . Proc. Natl. Sunflower Workshop, Barani Agri. Res. Dev. Project, PARC, Islaambad pp.36-38.

9. Pustovoit, G.V., S.G. Borodin and N.A. Belousova. 1981. Breeding sunflower for resistance to *Macrophomina phaseolina*. Maslichnye kul'tury. 5 : 35-36 (Pl.Br. Abst. 54(1) : 325 : 1984).

10. Robinson. R.A. 1969. Disease resistance terminology. Rev. Appl. Mycol. 48:593-606.

11. Schneiter, A.A. and J.F. Miller. 1981. Description of sunflower growth stages. Crop Sci. 21(6):901-903.

12. Steel, R.G.D. and J.H. Torrie. 1980. Principles and Procedures of Statistics. McGraw Hill Book Co., New York.

13. Van Der Plank, J.E. 1963. Plant diseases: Epidemics and Control. Academic Press, New York. p. 349.

14. Van Der Plank, J.E. 1968. Disease resistance in plants. Academic Press, New York. p.206.