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Response of Sunflower under Charcoal Rot (*Macrophomina phaseolina*) Stress Conditions

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Abstract: ***Charcoal rot (Macrophomina phaseolina) covered a wide host range and is responsible for causing losses on more than 500 cultivated and wild plant species. So far in Pakistan it has been reported to cause disease on 67 economic hosts including field crops, pulses, flowers and vegetable. It was first reported in 1982 from sunflower field in Pakistan. The fungus is reported to be soil, seed and stubble borne. Twenty four (24) sunflower genotypes were analyzed under charcoal rot (Macrophomina phaseolina) stress conditions. The accessions were planted in a factorial randomized complete block design with three treatments within three replications. Accessions x treatments interaction are significant (P < 0.05) for oil contents and disease incidence. There are three accessions HBRS-5, G-46 and G-54 found highly susceptible to charcoal rot while HBRS-1, A-12 and A-79 are moderately resistance to charcoal rot among the 24 accessions of sunflower. While the remaining accessions have their response from moderate susceptible to susceptible in disease incidence. Due to moderate resistance to charcoal rot HBRS-1, A-79 give high value of yield attributes. These accessions are recommended for high yield production in the field while the other accessions are not recommended due to loss in production regarding their susceptibility to charcoal rot (Macrophomina phaseaolina) disease.***

Keywords: Sunflower; Accessions; *Macrophomina phaseolina*; Charcoal rot; Disease incidence

1. Introduction

Sunflower is a rich source of edible oil. It has a nice fit in the cropping system in Pakistan. It has the ability to meet domestic needs of the country. Sunflower diseases especially head rot followed by charcoal rot are the serious threat to sunflower growers in the country [1, 2]. The causal agent for charcoal rot *(Macrophomina phaseolina)* found the most important pathogen on sunflower and more than 500 plants [3]. It is very serious for sunflower crop throughout the world. Although it is monotypic and no physiological races have been reported, it has high genetic variability resulting in a wide host range, which in turn means that crop rotation is not an effective strategy to combat the disease [4]. In sunflower, losses from charcoal rot can reach 60 to 90% if the conditions are favorable for infection [5]. The present studies were planned to evaluate response to charcoal rot, their heritability and genetic advance in different yield attribute of all sunflower accessions under charcoal rot (*Macrophomina phaseolina*) stress condition. There is evaluated some sunflower genotypes to *Macrophomina phaseolina* [6]. The reaction of genotypes was very different to the agent of disease. Development of resistant varieties is the cheapest source for management. The use of resistant cultivars is considered as one of the most important methods [7]. The present project was under taken with the objective of screening of sunflower germplasms against charcoal rot of sunflower. Seed yield is combination of many traits, where polygenic in nature and it is difficult to make direct selection for these traits. Sunflower breeders reported different types of characters associations [8, 9, 10, 11, 12, 13].

Objective: Screening of disease resistance variety among various genotypes for improving sunflower seed yield under charcoal rot stress conditions

2. Material and Methods

2.1 Experimental Conditions

The experiment was conducted in the research field of the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, Pakistan during 2008. The agro-climatic data on maximum and minimum temperature and total monthly rainfall during the crop season are presented in Figure 1.

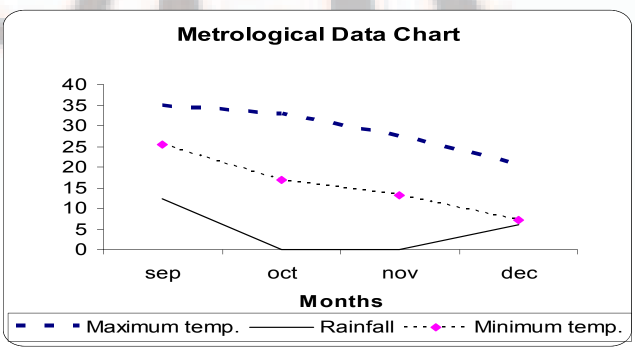

Figure 1: Metrological Data Chart

2.2 Experimental Material

The experiment consisted of 24 sunflower accessions (Table 1) developed and maintained by the Sunflower Research Group, Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, Pakistan during 2008. *Macrophomina phaseolina* inoculum was collected from Department of Pathology, University of the Punjab, Lahore, Pakistan.

Table 1: List of Accessions

S. No	Accessions	Sr. No.	Accessions
1	G-2	13	G-43
2	A-79	14	G-82
3	G-30	15	G-54
4	G-46	16	G-57
5	A-19	17	HBRS-5
6	G-3	18	A-50
7	G-100	19	A-60
8	G-50	20	HBRS-1
9	G-40	21	G-16
10	G-34	22	A-48
11	G-12	23	G-5
12	G-61	24	G-45

2.3 Experimental Layout

The experiment was laid out according to factorial experiment in a randomized complete block design with three replications having following treatments: **(T1)** Application inoculation with fungal isolate (*Macrophomina phaseolina*) at seedling stage of crop along with application of fungicide to control the disease. **(T2)** Application of inoculation with fungal isolate (*Macrophomina phaseolina*) at seedling stage of crop with none use of any fungicide for disease control. **(T3)** Normal/Control (There were no inoculation with fungal isolate at seedling stage and no application of fungicide to control the disease). Identical cultural and agronomic practices were applied to all the experimental units. The experimental unit consisted of single row plot of 3.3 m length with plant to plant and row to row distances of 25 cm and 75 cm, respectively.

2.4 Inoculation Method

Inoculum was applied to the plants before the emergence of heads through flooded method when the field was irrigated. All precautions were taken at the time of inoculation. All recommended agronomic practices were applied to the crop uniformly.

2.5 Data recording

The data were recorded on ten randomly selected plants of each entry from each replication for head diameter, number of achenes per head, head weight, 100-seed weight, seed yield and oil contents. Charcoal rot disease reaction was recorded by carefully examining the external disease symptoms on stem of the inoculated plants. A six point 0-5 (0= no disease symptoms on the external stem to 5= premature death) disease severity rating scale for charcoal rot of sunflower caused by *Macrophomina phaseolina* was used according to the description of James [14] as shown in table 2.

Table 2: Scale for ranking of disease incidence

Grade	Disease Incidence	Status
0	0%	Immune
1	1-9%	Resistant
2	10-24%	Moderate Resistant
3	25-49%	Moderate Susceptible
4	50-74%	Susceptible
5	75% and above	Highly Susceptible

2.6 Biometrical analysis

The data collected for above mentioned characters were statistically analyzed for variance using the method given by Steel [15]. Phenotypic and genotypic correlation coefficients were calculated utilizing the procedure described by Kown and Torrie [16]. This model was extensively used by sunflower researchers [17, 18, 19, 20]. Seed yield was kept as resultant variable and other characters as casual variables.

3. Results and Discussion

A perusal of the results showed (Table 3) that accessions differed significant ($P < 0.05$) for all the characters under study in which 100-seed weight, head weight and oil contents are highly significant. Accessions x treatments interaction are significant ($P < 0.05$) for oil contents and disease incidence only. *Macrophomina phaseolina* has marked effect on different growth and yield parameter of sunflower crops. Charcoal rot cause reduction in plant height and head diameter by 13.77, 75.56 and 10.77 percent infected seeds from infected plants weight 30.46 percent less than healthy plants [21]. Head diameter, Seed yield per plant, 100-seed weight, head weight and number of achenes per plant showed significant differences existed among sunflower accessions under study and high significant differences existed among the treatments and accessions whereas there were non-significant differences among the interaction of accessions and treatments.

Table 3: ANOVA Analysis

Source of Variance	Reps.	Treatments (Tr.)	Accessions (Acc.)	Tr. x Acc.	Error
DF	2	2	23	46	142
HD	3.26*	116.85**	8.51*	0.1	0.94
SY/P	3.27*	11.30*	10.27*	0.061	55.74
100-SW	5.94*	76.75**	19.61**	0.38	0.31
Ach/P	4.80*	3.29*	6.43*	0.86	1331.63
HW	0.73	9104.42**	1815.51**	0.01	2.76
OC	4.03*	1511.88**	446.92**	9.98*	0.73
DI	0.30	210.63**	11.42*	2.04*	0.46

*Significant at 5% level of probability

HD = Head diameter, **SY/P** = Seed yield per plan, **100-SW** = 100-Seed weight, **Ach/P** = Achenes per plant, **HW** = Head weight, **OC =** Oil contents, **DR** = Disease incidence,

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The impact of *Macrophomina phaseolina* for Charcoal rot disease reaction was recorded by carefully examining the external disease symptoms on stem of the plants at the maturity stage of crop in all three treatments. Symptoms suggestive of charcoal rot were observed on oilseed sunflower plants [22]. Symptoms, first observed on plants approaching physiological maturity, consisted of silver-gray lesions girdling the stem at the soil line, premature plant death, and reduced head diameter. The pith in the lower stem was either completely absent or was compressed into horizontal layers. Black, spherical micro-sclerotia were observed in the pith of the lower stem, just underneath the epidermis, and on the exterior of the tap root. Response of sunflower under charcoal rot stress condition are exhibit in Table-4 that all the accessions are variable in response to disease and none of accessions are found to be completely resistant against Macrophomina phaseolina. Study on pathogenicity of *M. phaseolina*indicated high levels of variation in pathogenicity of the fungus [23]. Investigation of *Macrophomina phaseolina* isolates showed great variability in pathogenicity among isolates from different host species [24]. Therefore, HRBS-1, G-12 and A-79 are found moderate resistance to charcoal rot disease because they have the disease incidence amoung the 10-24% according to ranking scale. The accession A-50, G-43, G-5, G-40, G-100, G-61, A-48, G-45, G-2 and G-3 have 25-49% disease incidence are moderate susceptible and G-57, G-30, G-50, G-60, A-60, G-82, G-34 and A-19 showed 50-74% disease incidence are susceptible to disease infection and cause in reduction of yield of sunflower. HBRS-5, G-46 and G-54 have disease incidence more than 75% so these accessions are categorized in high susceptible and strongly not-recommended for the sowing. HBRS-1 was highly resistance in 2006 and moderate resistance during 2007 [25]. During 2008, HRBS-1 exhibits as moderate resistance accession. HRBS-1 is considered as good accession and recommended for sowing. G-100 also showed deviation in resistance during 2006 and 2007 as compared with the results of experiment conducting during 2008 which was moderate susceptible, which cause reduction in yield of sunflower. G-46 was susceptible during 2006 and 2007 and showed highly susceptible disease incidence during 2008. Therefore, G-46 was not recommended as good accession.

4. Conclusion

The current study describes that mostly sunflower accessions are susceptible to charcoal rot (*Macrophomina phaseolina*). However three accessions (HBRS-1, A-79, G-12) showed moderate resistance. It is a challenge for scientists to develop disease resistant, high yielding cultivars with improved oil contents of sunflower.

Table 4: Response of sunflower accessions to charcoal rot (*Macrophomina phaseolina*) disease

Grade	*Disease Incidence*	*Status*	*Remarks*
0	0%	Immune	Nil
1	1-9%	Resistant	Nil
2	10-24%	Moderate Resistant	HBRS-1, A-79, G-12
3	25-49%	Moderate Susceptible	A-50, G-43, G-5, G-40, G-100, G-61, A-48, G-45, G-2, G-3
4	50-74%	Susceptible	G-57, G-30, G-50, G-60, A-60, G-82, G-34, A-19
5	75% and above	Highly Susceptible	HBRS-5, G-46, G-54

References

[1] Mehdi, S.S. and S.A. Mehdi, 1988. Charcoal rot resistance in sunflower cultivars at various plant densities. Pakistan J. Sci. Ind. Res., 31: 786–7

[2] Khan, A., 2001. Yield performance, heritability and interrelationship in some quantitative traits in sunflower. Helia, 24: 35–40

[3] Purkayastha, S., B. Kaur, N. Dilbaghi and A. Chaudthury, 2006. Characterization of *Macrophomina phaseolina*, the charcoal rot pathogen of cluster bean, using conventional techniques and PCR-RAPD basedmolecular markers. Plant pathology, 55: 106-116.

[4] Ijaz S., H.A. Sadaqat and M.N. Khan, 2012. A review of the impact of charcoal rot (Macrophomina phaseolina) on sunflower. J. Agri. Sci., Page 1- 6

[5] Khan, S.N. 2007. Macrophomina phaseolina as causal agent for charcoal rot of sunflower. *Mycopath,* 5:111-118.

[6] Dalili, S.A., S.V. Alavi and V. Ramee, 2009. Response of Sunflower New Genotypes to Charcoal Rot Disease, *Macrophominapheseolina*(Tassi) Goidanch. Journal, 25-1: 155-147.

[7] Mahtab R., D.S.R. Alireza, A. Abasali and S.N.A. Masoud, 2013. Study on Reaction of Sunflower Lines and Hybrids to Macrophomina phaseolina (Tassi) Goid.causal Agent of Charcoal rot Disease. World Appl. Sci. J. 21 (1): 129-133.

[8] Punia, M.S. and H.S. Gill, 1994. Correlations and path-coefficient analysis for seed yield traits in sunflower (Helianthus annuus L.). Helia, 17: 7–12

[9] Patil, B.R., M. Rudaradhya, C.H.M. Vijayakumar, H. Basappa and R.S. Kulkarini, 1996. Correlation and path analysis in sunflower. J. Oilseed Res., 13: 162–6

[10] Lal, G.S., V.S. Bhaderiya and A.K. Singh, 1997. Genetic association and path analysis in elite lines of sunflower. Crop Res. Hisar, 13: 631–4

[11] Teklewold, A., H. Jayaramaiah and B.N. Jagadeesh, 2000. Correlation and path analysis of phasio-marphological characters of sunflower (Helianthus annuus L.) as related to breeding method. Helia, 23: 105–4

[12] Ashok, S., N. Mohamed Sheriff and S.L. Narayanan, 2000. Combining ability studies in sunflower (Helianthus annuus L.). Crop Res. Hisar, 20: 457–62

[13] Khan, A., 2001. Yield performance, heritability and interrelationship in some quantitative traits in sunflower. Helia, 24: 35–40
[14] James, W.C. 1971. An illustrated series of assessment keys for plant diseases, their preparation and usages. Canadian Pl. Dis. Survey. 51(2): 39-65.
[15] Steel, R.G.D. and J.H. Torrie, 1980. Principles and Procedures of Statistics: A Biomaterical Approach. McGraw Hill Book Co. Inc., New York, USA
[16] Kwon, S.H. and J.H. Torrie, 1964. Heritability and interrelationship among traits of two soybean populations. Crop Sci., 4: 196–8
[17] Ivanov, P. and Y. Stoyanova, 1980. Studies on the genotypic and phenotypic variability and some correlation in sunflower (Helianthus annuus L.). Proc. of the 9th Int. Conf. of Sunflower, Pp: 336–42. 8-13 June
[18] Lakshimanrao, N.G., K.G. Shaambulingappa and P. Kusumakumari, 1985. Studies on path coefficient analysis in sunflower. Proc. of the 11th International Sunflower Conference, Pp: 733–5. 10-13 Mathc Mar del plata, Argnetina
[19] Marinkovic, R, 1992. Path-coefficient analysis of some yield components of sunflower. Euphytic, 60: 201–5
[20] Punia, M.S. and H.S. Gill, 1994. Correlations and path-coefficient analysis for seed yield traits in sunflower (Helianthus annuus L.). Helia, 17: 7–12
[21] Raut, J.G. 1985. Effect of charcoal rot caused by *Macrophomina phaseolina* on sunflower plants. Ind. J. Phytopath. 38(2): 345-346.
[22] Gulya Jr, T.J., J.M. Krupinsky, M. Draper and L.D. Charlet. 2002. First report of charcoal rot (*Macrophomina phaseolina*) on sunflower in North and South Dakota. Pl. Dis. 86(8): 923.
[23] Su, G., S.O. Suh, R.W. Schneider and J.S. Russin, 2001. Host specialization in the charcoal rot fungus *Macrophomina phaseolina*. Phytopathology, 91: 120-126.
[24] Femandez, R.B.A., D.E. Santiago, S.H. Delgado and N.M. Perez, 2006. Characterization of Mexican and non-Mexican isolates of *Macrophomina phaseolina* based on morphological characteristics, pathogenicity onbean seeds and endoglucanase gene. J. Pl. Path, 88: 1-12.
[25] HafizUllah, M., M. Aslan Khan, S.T. Sahi and S. Anjum, 2010. Identification of Resistant Sources Against Charcoal Rot Disease In Sunflower Advance Line/Varietes. Pak. J. Phytopathol., 22(2): 105-107.

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