OIL CONTENT AND FATTY ACIDS OF EXOTIC SUNFLOWER INBRED LINES AS INFLUENCED BY DIFFERENT CHARCOAL ROT ISOLATES

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ABSTRACT

Thirteen exotic sunflower inbred lines were evaluated against charcoal rot disease by using eight different isolates. The analyses of variance indicated significant differences among inbred lines for oil content, oleic acid, linoleic acid and palmitic acid. The differences among isolates were significant for linolinic acid. However, inbred line x isolate interaction was only significant for oleic fatty acid. This indicated that the inbred lines acted independently against the charcoal rot isolates except oleic acid. In general the oleic and linoleic fatty acids were affected by charcoal rot disease.

The linoleic acid percentage of sunflower inbred lines were smaller than their respective oleic acid percentage. Differences among charcoal rot isolates for oil contents percentage and all the fatty acids except linolinic acid were non-significant. Mean linolinic acid percentage was maximum for MP 1 and MP 9 isolates. Maximum variation was present for the two principal fatty acids namely, oleic acid and linoleic acid followed by oil contents and minimum variation was observed for arachidic and linolinic acid concentrations. The estimates of broad sense heritability for quality traits were maximum for oil contents and minimum for linolinic acid.

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INTRODUCTION

The oil extracted from the cultivated sunflower (*Helianthus annuus* L.) is a premium oil on world markets because of its high percentage of polyunsaturated fatty acids (Oleic and linoleic). The popularity of sunflower oil in European and East Asian countries for margarine, salad oil, and cooking is based on the oil composition and for the absence of cholesterol. Because of the degree of monounsaturation, sunflower oil with a high oleic acid content is less susceptible to oxidative changes during refining, storage, and frying. The oil can be heated to a higher temperature without smoking, so that food is cooked faster and absorbs less oil. Furthermore, the quality of the oil is retained longer during storage of both the processed oil and the seed (Robertson and Thomas, 1976). A recent report indicated that a diet rich in monounsaturated fatty acids reduced low density lipoprotein cholesterol in blood plasma (Grundy, 1986). It is therefore, suggested that diets with a fat content containing a large percentage of oleic acid could be used to effectively reduce plasma cholesterol, which is a risk factor for coronary heart disease. The storage inverse relationship between linoleic and oleic acid content is greatly influenced by environment, particularly temperature during seed maturation.

Kharchenko (1979) studied the effect of high temperature on the synthesis of linoleic and oleic acids in achenes of Peredovik (Vanguard), a selection from Peredovik (family 268) and Pervents (Firstborn). Beside these research findings, no work has so far been

made on the effect of charcoal rot disease on the sunflower quality traits. Therefore, the objectives of this investigation were to determine if oil composition of different sunflower inbred lines was affected by charcoal rot isolates. Also to determine the effect of different isolates of charcoal rot on the oil contents of various sunflower inbred lines.

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 of 13 exotic sunflower inbred lines namely CM 400, DM 1, DM 2, DM 3, HA 306, HA 313, HA 821, HA8 22, HAR 1, HAR 2, HAR 3, HAR 4 and HAR 5. Among these CM 400, DM 1, DM 2, 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 were obtained from National Agricultural Research Centre (NARC), Islamabad 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 lines 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 lines 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 toothpick method (Edmunds, 1964; Anahosour, 1983) at 15 cm above soil surface. The inoculated plants were harvested on July 5, 1988 and data on oil contents and fatty acids were recorded.

Oil content determination was made with Nuclear Megnatic Resonance (NMR) apparatus from Oil Quality Laboratory, National Agricultural Research Centre (NARC), Islamabad. Where as the concentration of different fatty acids (palmitic acid, stearic acid, oleic acid, linoleic acid, linolinic acid and arachidic acid) present in the sunflower oil were obtained from inoculated plants of each plot and were analyzed by GC-9A Fatty Acid Analyzer from Oil Quality Laboratory, National Agricultural Research Centre, Islamabad. The data thus collected were subjected to analysis of variance techniques (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The differences among inbred lines were highly significant for oil contents, oleic acid, linoleic acid and palmitic acid (Table 1). Similarly among charcoal rot isolates, highly significant differences existed for linolinic acid. The inbred line

x isolate interaction for the oil contents and all the fatty acids except oleic acid were non-significant. This implied that the sunflower inbred lines and the charcoal rot isolates were not independent of one another for oleic acid. These results are in agreement with El- Zarka et al. (1980), Piskov (1980), Chmeleva et al. (1981) and Seiler (1983) as they observed appreciable differences among sunflower cultivars for the oil contents.

Table 1. Mean squares from analyses of variance for oil contents and fatty acids of 13 sunflower inbred lines inoculated with eight charcoal rot isolates.

S.O.V.	df	Oil Content (%)	Fatty acids (%)					
			Oleic acid	Linol-eic acid	Linoli-nic acid	Palmi-tic acid	Stearic acid	Arachi dic acid
Replications	2	50.272	33.525	35.618	0.058	0.338	3.006	0.001
Inbred lines	12	198.134**	364.833**	308.936**	0.311	2.491**	2.181	0.033
Error (a)	24	30.458	66.488	61.196	0.188	0.640	1.129	0.031
Isolates (I)	7	17.738	45.410	46.515	0.717**	1.039	1.212	0.032
G x I	84	17.512	98.211**	34.507	0.289	0.687	1.118	0.029
Error (b)	182	17.663	26.726	43.113	0.256	0.746	1.287	0.025

** Significant at the 0.01 level of probability.

The average oil contents among inbred lines across isolates ranged from 25.41 to 36.23% for HA 306 (non-oilseed inbred line) and HA 822 (oilseed inbred line), respectively (Table 2). Chmeleva et al. (1981) detected appreciable differences in sunflower genotypes for oil contents. Similarly, the average achene oil content for the sunflower populations studied by Seiler (1983) was 25.76% and ranged from 17.2 to 34.2%. Our results indicated that the oil contents of the inbred lines have been affected by charcoal rot isolates. This is evident by comparing the oil contents of the same lines estimated by Shah (1988) in the absence of charcoal rot disease. Beside these, the differences

in the inbred lines for oil contents may be due to different environments as well.

The percentage of oleic acid was greater than the linoleic acid percentage in all the inbred lines evaluated across charcoal rot isolates. Five sunflower inbred lines namely HAR 1, HAR 2, HAR 3, HAR 4 and HAR 5 had maximum percentage of oleic acid ranging from 59.76 to 62.67%. Sunflower oil is highly regarded and is in demand by the food processing industry due to the high level of polyunsaturated linoleic acid (Seiler, 1986). Inbred line CM 400 had the minimum oleic acid (50.70%) and maximum linoleic acid (40.96%). Seed oil and fatty acid concentrations of sunflower varies greatly depending on the genotype and environmental conditions under which it develops (Seiler, 1983).

The ratio of main fatty acids is disturbed by different environments.Of the environmental factors, it is doubtless that temperature has the most influence on the oil components (Silver et al., 1984). The degree of desaturation of sunflowef oil rises as the temperature falls. The main shift within the fatty acid pattern arises from an increase in the linoleic acid content and a reduction in oleic acid. When temperature rises this pattern of fatty acids become reverse (Kharchenko, 1979). Hence increased oleic acid percentage in the inbred lines evaluated in his study may be due to an increase in the temperature or due to the effect of charcoal rot isolates.

Table 2. Mean comparison of thirteen sunflower indbred lines inoculated across Macrophomina phaseolina isolates for quality traits.

Inbred lines	In percentage						
	Oil contents	Oleic acid	Linoleic acid	Linolinic acid	Palmitic acid	Stearic acid	Arachidic acid
CM 400	34.10 ab*	50.70 e	40.96 a	0.43	6.31 a	1.94	0.16
DM 1	31.12 bcd	56.78 bcd	35.62 abc	0.23	5.69 bcd	1.40	0.14
DM 2	32.88 abcd	55.40 cde	36.29 abc	0.64	5.65 bcde	1.75	0.17
DM 3	33.88 ab	55.09 cde	36.95 ab	0.27	5.74 bc	1.72	0.23
HA 306	25.41 e	52.51 de	38.80 a	0.41	5.78 ab	2.31	0.16
HA 313	33.10 abc	53.97 de	38.03 a	0.38	5.36 bcde	1.83	0.21
HA 821	31.19 bcd	54.05 de	37.83 a	0.22	5.64 bcde	1.69	0.17
HA 822	36.23 a	54.10 de	38.87 a	0.25	5.46 bcde	1.09	0.14
HAR 1	28.41 cd	61.59 ab	31.02 cd	0.20	5.35 bcde	1.57	0.17
HAR 2	29.43 cd	62.67 a	30.05 d	0.29	5.19 cde	1.56	0.16
HAR 3	29.13 d	59.76 abc	32.07 bcd	0.39	5.49 bcde	2.05	0.27
HAR 4	32.15 bcd	61.19 ab	31.66 bcd	0.23	5.13 e	1.58	0.15
HAR 5	34.44 ab	60.48 abc	32.08 bcd	0.39	5.15 de	1.63	0.20

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

Two inbred lines namely CM 400 and HA 306 had the highest palmitic acid of 6.31 and 5.78%, respectively. The lowest value for palmitic acid was recorded in HAR 4(5.13%). These results are in contrast to Ivanov (1985) as they obtained upto 25% palmitic acid as against 7% in Peredovik. Analysis of variance among inbred lines for linolinic acid, stearic acid and arachidic acid were non-significant. This suggested that these components of sunflower oil were not affected by the incidence of charcoal rot disease. These results were in contrast to Seiler (1983) who obtained significant differences for palmitic acid and stearic acid between original and common sunflower populations.

Among quality traits, charcoal rot isolates had significant effect in affecting the linolinic acid (Table 3). The percentage of linolinic acid was maximum for two charcoal rot isolates namely MP 1 and MP 9. Therefore, these two isolates were less aggressive in affecting this fatty acid.

Table 3. Mean comparisons of eight M. phaseolina isolates across sunflower inbred lines for quality traits.

Charcoal rot Isolates	In percentage						
	Oil contents	Oleic acid	Linoleic acid	Linolinic acid	Palmitic acid	Stearic acid	Arachidic acid
MP 1	32.47	57.21	34.91	0.66 a*	5.43	1.67	0.15
MP 2	31.57	56.32	35.71	0.31 b	5.64	1.72	0.23
MP 5	32.02	56.15	36.18	0.32 b	5.46	1.45	0.17
MP 9	31.77	58.72	33.74	0.42 ab	5.28	1.61	0.20
MP 14	31.78	56.99	34.62	0.26 b	5.82	2.02	0.16
MP 15	32.51	57.45	34.74	0.30 b	5.55	1.83	0.20
MP 16	31.21	56.45	36.18	0.31 b	5.47	1.55	0.17
MP 21	30.45	55.06	37.13	0.25 b	5.62	1.77	0.14

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

The estimates of genetic variance for oil contents and all the fatty acids except linolinic, stearic and arachidic acid were significant (Table 4). These significant genetic variances indicated the existence of sufficient genetic variation among the exotic sunflower inbred lines. The estimates of isolate variance were smaller in value compared to their respective genetic variances. Isolate variances were significant for linolinic acid, 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 indicted by Allard (1960). The estimates of phenotypic variances for all the traits evaluated were greater in value than their respective genetic variances.

Table 4. Estimates of components of variance and broad-sense heritability (h^2) for oil contents and fatty acids of 13 sunflower inbred lines inoculated with eight charcoal rot isolates.

Quality traits (%)	Components of variance $					
	6^2G	6^2I	G^2GI	6^2E	6^2P	h^2
Oil Contents	6.99**	0.01	+0.00	0.74	7.73	0.905
Fatty acids:						
Oleic acid	9.45**	-1.35	23.83**	1.11	13.85	0.683
Linoleic acid	10.68**	0.31	+0.00	1.80	12.48	0.856
Linolinic acid	0.004	0.01**	0.01	0.01	0.02	0.233
Palmitic acid	0.08**	0.01	+0.00	0.03	0.11	0.719
Stearic acid	0.05	0.01	+0.00	0.05	0.11	0.487
Arachidic acid	-1.0^{-04}	7.87^{-05}	1.36^{-03}	0.001	0.00	+0.00

$ 6^2G= genetic variance, 6^2I= isolate variance, 6^2GI= genetic x isolate variance, 6^2E= environmental variance, 6^2P=phenotypic variance.

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

The estimates for broad-sense heritability for oil contents were maximum (0.905) among quality traits. These results are somewhat similar to Sharinivasa (1982) as he estimated moderate heritability for oil contents. The estimates of heritability for fatty acids ranged from 0.233 to 0.856 for linolinic and linoleic acid, respectively. However, the estimates of heritability were zero for a arachidic acid due to the negative estimates of genetic variance. Therefore, the environments (charcoal rot isolates) may have biased these estimates. 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 determining the phenotype. Therefore, a character with a high heritability is more likely to respond to selection than a character with a low heritability. Hence among the inbred lines it is quite easy to select parents for oil contents and fatty acids for the future hybridization programmes aiming at charcoal rot resistance.

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