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Inoculation of *Macrophomina phaseolina* at three stages in sunflower plant and its effect on yield components of different sunflower varieties

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Abstract

Yield loss studies were conducted by growing the seeds of five sunflower hybrid/varieties, i.e. SC-83, SC-92, SF-187, SF-177 and HO-1. Plants inoculated with dry culture of *Macrophomina phaseolina* at sowing, flowering (60 days after emergence) and ripening time (75 days after emergence). The plant height and 1000-grain weight were significantly reduced in HO-1 variety for plants inoculated at late flowering stage to early ripening than the sowing in plots. The plants of all varieties inoculated at flowering stage also matured earlier than the uninoculated plants. The percent oil and protein content also decreased in inoculated plants of HO-1 followed by SC-92 and SC-83 as compared to SF-187 and SF-177 sunflower varieties/hybrid. The sclerotia of the fungus multiplied very rapidly when plants inoculated at flowering stage as compared to other two stages. The maximum yield (kg) per hectare was recorded in SF-177 (2130.00 and 2120.00) followed by SF-187 (2067.00 and 2049.00) sunflower plants inoculated at sowing time and ripening stage than the flowering stage. The yield losses were significantly increased in HO-1, SC-92 and SC-83 sunflower varieties. The overall yield loss in all varieties inoculated at flowering stage was (7.58-45.0%) at ripening (6.59-41.85%) and at sowing (5.54-37.97%) respectively.

Key word: Plant stage, Sunflower, Yield components, *Macrophomina phaseolina*.

Introduction

Charcoal rot caused by *Macrophomina phaseolina* (Tassi) Goid. is considered as one of the most important diseases affecting the crop throughout the world (Sackston, 1981), reducing 1000-seed weight, germination percentage, seedling vigour index and oil content respectively (Kumar, *et al*. 1994, Bhutta *et al*, 1997). *M. phaseolina* infects more than 500 hosts, including wide range of cultivated crops (Sinclair, 1982). The disease has been reported on many economically important host crops in arid and semi-arid zones of the world and has been isolated from cultivated and non-cultivated soils (Young and Alcon, 1982). The maximum disease incidence occurred in un-irrigated plots than the irrigated.

Sunflower is very sensitive if inoculated with the fungus in the post emergence phase and later stage of the growth of the crop (Ahmed, *et al*, 1994). Suriachandraselvan and Seetharaman (2003) tested 25 geographical isolates of *M. phaseolina* and found that isolate MP-8 causing charcoal rot of sunflower was most virulent. The objectives of this study were to see the effect of the fungus on plant age and to determine, if varietal preference existed in population of *M. phaseolina*.

Materials and Methods

Field planting

Yield loss studies were conducted during autumn growing season of the crop. The experiment was conducted on the plot size 3x5m with factorial arrangement in a RCBD with four replications. Thirty seeds of each variety, SF-177, SF-187, SC-83, SC-92 and HO-1 were planted in an 80 cm row with 50 cm a part.

Field inoculation

The plants were inoculated with 1-2 week old culture of *M. phaseolina* at different growth stages i-e at flowering (60 days after emergence), at ripening (75 days after emergence). Plants were also inoculated with dry culture of the fungus in the root zone area with toothpick inoculation method (Dhingra and Sinclair, 1985). Plants were rated for disease incidence (%) and time of maturity was also determined. After harvesting, the following parameters were studied:

a) Plant height: The height for inoculated and un-inoculated plants were recorded in cm.

b) 1000-seed weight: Three samples of 1000 seeds, each from sunflower varieties/hybrid were taken randomly and weight of each sample was recorded in grams.

c) Oil and protein content: Three seed samples of 50g each were taken from each variety and

samples were dried in oven at 130^{O}C for 1 hr. The experiment was done at NIA, Tandojam.

d) Yield per hectare (kg): Yield per hectare was obtained as per the standard method and yield loss (%) was calculated as under:

$$\text{Yield loss (\%)} \frac{\text{Yield in un - inoculated plot - yield in inoculated plot}}{\text{Yield in un - inoculated plot}} \text{ x } 100$$

Results

Effect of plant stage on disease incidence and maturity of plants

The disease incidence was higher in HO-1 plants inoculated at flowering stage or ripening followed by SC-92 and SC-83 (Table 1). The plants also matured earlier when inoculated with *M. phaseolina* at flowering or ripening time (Table2).

Effect of *M. phaseolina* on different yield parameters of sunflower varieties

a) **Plant height and 1000-grain weight:** The plant height was significantly decreased in HO-1 followed by SC-93 varieties inoculated at flowering stage than at ripening stage (Table3). The maximum 1000-seed weight was recorded in SF-177 and SF-187 for plants inoculated at sowing time. The weight was significantly reduced in HO-1 plants followed by SC-92 and SC-83 at flowering stage as compared to control (Table 3).

b) **Percent oil and protein content:** Percent oil and protein content were significantly decreased in HO-1 followed by SC-92 and SC-83 as compared to other varieties/hybrid (Table 4).

c) **Seed yield per hectare of different sunflower varieties:** The maximum yield per hectare was recorded in SF-177 followed by SF-187 (Table 5). The minimum yield was obtained in HO-1 followed by SC-92 and SC-83 plants inoculated at flowering stage than ripening.

The yield loss was significantly decreased in SF-177 followed by SF-187. The maximum yield loss was recorded in HO-1 at flowering stage (45.0%) than ripening (41.85%) followed by SC-92 (24.14%), and SC-83 (14.92%) at flowering stage (Table 5).

Table 1: **Effect of plant stage at inoculation on the disease incidence of sunflower varieties to *Macrophomina phaseolina*.**

Variety	Plant stage	Incidence %		Length of necrotic lesion on stem (cm)	
		Inoculated	Uninoculated	Inoculated	Uninoculated
SF-177	Flowering	19.70	--	3.00	--
	Ripening	11.75	--	2.25	--
	Sowing	6.50	2.00	2.00	1.75
SF-187	Flowering	22.25	--	3.25	--
	Ripening	17.25	--	3.00	--
	Sowing	9.75	2.50	2.25	2.25
SC-183	Flowering	31.25	--	4.00	--
	Ripening	24.50	--	3.25	--
	Sowing	12.75	4.25	3.25	2.50
SC-92	Flowering	39.25	--	5.50	--
	Ripening	30.75	--	5.00	--
	Sowing	16.50	5.75	3.75	2.75
HO-1	Flowering	60.25	--	5.75	--
	Ripening	40.50	--	5.75	--
	Sowing	26.50	6.25	5.00	3.25
LSD (P<0.05)		1.90	0.39	0.65	0.23

Table 2: **Effect of plant stage on maturity of sunflower varieties inoculated with *Macrophomina phaseolina*.**

Variety	Plant stage	Maturity of plants (Days)	
		Inoculated	Uninoculated
SF-177	Flowering	79.75	100.25
	Ripening	99.00	102.75
	Sowing	99.75	107.00
SF-187	Flowering	97.25	100.00
	Ripening	98.25	101.50
	Sowing	98.50	106.00
SC-183	Flowering	93.50	98.00
	Ripening	97.50	100.00
	Sowing	98.50	103.00
SC-92	Flowering	93.50	95.75
	Ripening	95.50	97.75
	Sowing	96.00	102.00
HO-1	Flowering	91.50	92.25
	Ripening	92.25	97.75
	Sowing	94.00	100.00
LSD (P<0.05)		1.47	1.06

Table 3: **Effect of plant stage on plant height and 1000 seed weight of sunflower varieties inoculated with *Macrophomina phaseolina*.**

Variety	Plant height (cm)			1000 seed weight (g)		
	Flowering	Ripening	Sowing	Flowering	Ripening	Sowing
SF-177	160.5	162.0	164.0	42.70	48.25	49.75
SF-187	159.0	160.0	163.0	40.25	47.50	48.50
SC-183	124.5	128.0	129.5	39.25	45.50	41.75
SC-92	120.0	126.0	127.5	37.75	43.25	44.00
HO-1	112.0	122.0	125.5	35.00	41.25	43.25
LSD (P<0.05)	1.45	1.40	13.5	1.25	1.21	1.23

Table 4: **Effect of plant stage on oil and protein content of sunflower varieties/hybrid inoculated with *Macrophomina phaseolina*.**

Variety	Plant stage	Oil (%)		Protein content	
		Inoculated	Uninoculated	Inoculated	Uninoculated
SF-177	Flowering	25.25	32.75	40.00	41.25
	Ripening	27.00	33.75	41.75	42.75
	Sowing	27.25	35.00	41.75	44.50
SF-187	Flowering	23.00	30.50	38.50	40.50
	Ripening	24.00	32.00	39.50	41.50
	Sowing	25.20	32.75	40.75	42.75
SC-183	Flowering	22.00	31.00	37.00	39.00
	Ripening	23.00	31.75	38.50	40.50
	Sowing	25.25	33.50	39.00	41.50
SC-92	Flowering	20.75	30.25	35.00	38.75
	Ripening	21.25	31.50	37.00	39.25
	Sowing	24.25	33.25	38.00	40.75
HO-1	Flowering	19.75	29.50	35.00	37.00
	Ripening	21.25	30.25	36.50	37.75
	Sowing	22.75	32.25	37.25	38.75
LSD (P<0.05)		1.28	1.27	1.43	1.45

Table 5: **Effect of plant stage on seed yield per hectare of sunflower varieties/hybrid inoculated with *Macrophomina phaseolina*.**

Variety	Plant stage	Grain yield (kg/h)	Yield loss (%)
SF-177	Flowering	2120.00	7.58
	Ripening	2123.00	6.59
	Sowing	2130.00	5.54
SF-187	Flowering	2040.00	12.10
	Ripening	2049.00	10.99
	Sowing	2067.00	9.81
SC-183	Flowering	2012.00	14.92
	Ripening	2025.00	13.64
	Sowing	2030.00	11.93
SC-92	Flowering	1753.00	24.14
	Ripening	1759.00	23.55
	Sowing	1764.00	20.18
HO-1	Flowering	1212.00	45.00
	Ripening	1224.00	41.85
	Sowing	1231.25	37.97
LSD (P<0.05)		1.35	--

Discussion

The disease incidence was higher in plants inoculated at flowering stage and also plants matured earlier inoculated at flowering stage than at ripening time. The varietal specificity was related to growth stage of plants inoculated with *M. phaseolina*. Blanco-Lopez and Jimenez-Diaz (1983) also reported that plant maturation is enhanced by inoculating them at flowering under drought conditions. The plant height and 1000 seed weight were significantly decreased in HO-1 followed by SC-92. The results are in accordance with Kumar *et al*.(1994). Percent oil and protein content were significantly reduced in HO-1 followed by SC-92 and SC-83 inoculated at flowering than ripening and sowing time.

The yield per hectare was significantly decreased in HO-1 at flowering stage than inoculated at ripping and sowing time. The yield losses were also higher in HO-1 followed by SC-92 and SC-83 than SF-187 and SF-177 varieties. The results showed that the yield losses increased in HO-1, SC-92 and SC-83 as compared to SF-187 and SF-177 respectively. Pineda and Avila (1993) reported that charcoal rot reduced the yield in sunflower from 36-79%. The similar results have been obtained by Young and Alcon (1982).

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