

Effect of seed borne fungi on seed quality of sunflower (*Helianthus annuus*)

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ABSTRACT An experiment was conducted to study the effect of *Alternaria helianthi* on seed quality attributes of sunflower (*Helianthus annuus* L.) cultivars. *Alternaria* blight infected seeds were thin, pale black, shrivelled, wrinkled, ill filled and showed discolouration on seed coat. Morden and Local cultivars of Ranga Reddy and Nizamabad districts recorded highest total seed-borne fungi (53 and 55%). The samples of Nalgonda district recorded maximum occurrence of seed-borne fungi (49%), whereas occurrence of *A. helianthi* was recorded with a range of 2.5-4.5%. Significant differences in seed germination (44-60%) and seed vigour index (470-797) was recorded. The germinability was far below the minimum seed certification standard of <75% in infected sunflower seed samples. Moisture content in seed samples varied from 6-7%. Seed rot and seedling blight were high in morden cultivar (24 and 15 %) and least in Pioneer hybrid of Medak district (10 and 4%). *A. helianthi* and seed borne fungi present in the sunflower seeds drastically reduced seed quality parameters, viz. germination, seed vigour and oil content, over healthy seed samples.

Key words: Sunflower, seed quality, seed borne fungi, *A. helianthi*, oil content.

Sunflower (*Helianthus annuus* L.) is one of the most important oilseed crops grown all over the world. Presently, India has the fourth largest area under sunflower (2.16 M ha), and accounts for 10% of the world acreage. However, yield (567 kg/ha) is lowest among major sunflower-producing countries [1]. Despite rapid spread of crop, a disheartening trend is that productivity is going down in recent years. The full potential of the crop is far from being exploited and the yield levels of the country are the lowest in the world due to biotic and abiotic factors. Among biotic stresses, diseases caused by seed-borne fungi results in considerable yield loss. Of these, leaf spot or blight (*A. helianthi*) is one of the important foliar diseases [2]. The disease incidence and severity is more in *kharif* season and is reported to reduce seed yield and oil content by 27-80% and 17-33%, respectively, besides leading to germination losses varying from 23-32% [3]. Almost all popular cultivars and hybrids of sunflower are susceptible to this disease. The

pathogen is also transmitted through seeds either externally [4] or internally [5] with seed transmission up to 22.9% and reduces the quality of sunflower seeds, germination and vigour of seedlings besides causing pre- and post-emergence seedling blight. Sunflower seeds infected with *A. helianthi* are light in weight and contain less oil and protein content than healthy seeds [6]. The disease causes a reduction of 7 kg/ha in yield with every 1% disease incidence. Keeping this in view, present study was taken up to find out the implications of seed-borne *A. helianthi* and associated seed mycoflora on seed quality attributes of sunflower genotypes.

MATERIALS AND METHODS

Two hundred seed samples were collected from *Alternaria* spot/blight affected sunflower plants at the time of seed maturity stage during *kharif* season of 2009-10. These samples includes varieties and

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hybrids, namely Morden, Nizamabad local, Sunbred 275, Sungold, DRS 1, ASF 100, Kargil, Sunrise, Siri 4427, M 7, KBSH 1, Kaveri, Ganga Kaveri, Pioneer, Nagarjuna, SHR 1, and PAC 41, which were collected from major sunflower-growing areas of Andhra Pradesh (Ranga Reddy, Mahboobnagar, Kadapa, Nizamabad, Nalgonda, Kurnool, Ananthapur and Medak districts). The seed samples were shade dried and stored in paper bags at ambient storage temperatures of $28 \pm 2^\circ\text{C}$. The occurrence of seed-borne fungi (total fungal colonies), seed rot, seedling blight (blotter method), germination and seed vigour paper towel method were evaluated at Department of Seed Science and Technology, College of Agriculture, ANGRAU, Hyderabad.

Seed health status of sunflower cultivars was estimated by using standard blotter method of ISTA [7]. Petri-plates of 90 mm diameter and discs of blotter paper of the same diameter were used. Blotter discs were dipped in beaker containing sterile distilled water with the help of forceps and placed at the bottom of each sterilized Petriplate. Four hundred seeds of each treatment were tested in 40 plates of 10 seeds each per plate were labelled and incubated at $25 \pm 1^\circ\text{C}$ under alternating cycles of 12 hr light and 12 hr darkness for 7 days in BOD incubator. The plates were examined under stereo binocular microscope on 7 day of incubation in standard blotter method. Per cent *A. helianthi* in sunflower seed samples was assessed. The per cent total fungal colonies per 400 seeds were calculated. Seed rot and seedling blight were recorded.

The germination test was conducted with four replications of 100 seeds each sample and was randomly counted and tested for laboratory germination as per the procedures of ISTA [7]. The vigour index of seedling was calculated by multiplying germination percentage with total seedling length [8]. The moisture content in sunflower seeds was estimated by using Steinlite Electric Moisture Meter and expressed in percentage. The oil content of sunflower seed samples (infected and healthy) were analysed using Nuclear Magnetic Resonance Spectrometer (NMRS) at Directorate of Oilseeds Research, Hyderabad. The data were statistically analysed as per Gomez and Gomez [9].

RESULTS AND DISCUSSION

The results showed that *Alternaria* blight infected seeds were thin, pale black, shrivelled, wrinkled, ill filled and showed discolouration on seed coat. Hiremath *et al* [10] and Srinivas [11] also made similar observation.

In blotter method, a total of six fungi belonging to four genera were observed (Table 1 and Fig. 1). Three pathogenic fungi, viz. *A. helianthi*, *A. alternata* and *F. moniliforme* and storage/saprophytic fungi, viz. *A. flavus*, *A. niger* and *R. stolonifer* were observed. The occurrence of seed-borne *A. helianthi* was noticed with a range of 2.5-4.5%. The cultivar Morden of Ranga Reddy district and Local cultivar of Nizamabad district recorded highest per cent of *A. helianthi* (4.5 %). Similar type of variation in the occurrence of seed borne *A. helianthi* was noticed in infected sunflower seed samples to an extent of 0.2-0.6 % [12], 20-46% [10], 9-27% in the control sunflower seed samples [11, 13]. With respect to the total fungal colonies, Morden and Local cultivars of Ranga Reddy and Nizamabad districts recorded maximum total fungal colonies (53% and 56%). Occurrence of seed-borne fungi was high in seed samples of Nalgonda district (49%), followed by samples of Ranga Reddy district (48%). Least occurrence of seed-borne fungi was recorded in Sunrise hybrid of Ananthapur district (23%). This variation in occurrence of seed mycoflora among sunflower seed samples collected from different locations might be attributed to moisture content and genetic make-up of genotypes. These results were in accordance with Rajeswari *et al.* [14] who reported the variation in seed mycoflora in different castor seed samples collected from different locations of Andhra Pradesh. In addition to *A. helianthi*, occurrence of *A. alternata* (13-28%), *R. stolonifer* (1-17%), *Fusarium* spp. (2-8%) was observed. Due to highest occurrence of *A. alternata*, the proliferation of *A. helianthi* was prevented in sunflower seed samples. Similar findings were reported by several workers in sunflower [11, 12]. The occurrence of saprophytic /storage fungi, viz. *A. flavus* (1 to 15 %) and *A. niger* (2.1 to 7.5%) was observed. The involvement of these seed-borne fungi might be one of the reasons for reduction in seed germination percentage and seedling vigour in sunflower seed lots [11, 15, 16, 17, 18].

Table 1. Occurrence of seed-borne fungi and their incidence (%) detected from seeds of 17 sunflower genotypes

District	Genotype	Number of samples	<i>Alternaria helianthi</i>	<i>Alternaria alternata</i>	<i>Fusarium</i> spp.	<i>Aspergillus flavus</i>	<i>Aspergillus niger</i>	<i>Rhizopus stolonifer</i>	Total fungal colonies (%)
Ranga Reddy	Sunbred-275	11	3.50 (10.76)	25.50 (30.31)	4.30 (12.01)	6.00 (4.15)	4.60 (12.36)	4.50 (12.23)	48.40
	Sungold	4	0.00 (0.00)	23.00 (28.65)	7.30 (15.67)	4.80 (12.65)	7.00 (15.33)	2.50 (9.06)	44.60
	Morden	5	4.50 (12.23)	28.00 (31.96)	3.00 (9.95)	7.50 (15.87)	5.60 (13.67)	5.20 (13.18)	53.80
	DRSH-1	5	3.00 (9.95)	21.60 (27.72)	5.20 (13.73)	7.90 (16.32)	4.20 (11.80)	4.40 (12.09)	46.30
	Mean		2.75	24.53	4.95	6.55	5.35	4.15	48.28
			Pathogen (A)		Genotypes (B)				
	SEm±		0.22		0.18				A × B
	CD (0.05)		0.62		0.51				0.44
Ananthapur	ASF-100	13	4.00 (11.52)	19.90 (26.49)	2.40 (8.88)	3.70 (11.08)	6.00 (14.15)	5.80 (14.02)	41.80
	Kargil	3	0.00 (0.00)	14.70 (26.49)	2.50 (8.91)	6.00 (11.08)	4.00 (14.17)	4.70 (13.93)	31.90
	Sunrise	9	0.00 (0.00)	15.60 (23.26)	2.20 (8.52)	1.00 (5.61)	2.70 (9.45)	1.30 (6.53)	22.80
	Mean		1.33	16.73	2.37	3.57	4.23	3.93	32.17
			Pathogen (A)		Genotypes (B)				
	SEm±		0.20		0.14				A × B
	CD (0.05)		0.59		0.41				0.35
									1.02

District	Genotype	Number of samples	<i>Alternaria helianthi</i>	<i>Alternaria alternata</i>	<i>Fusarium</i> spp.	<i>Aspergillus flavus</i>	<i>Aspergillus niger</i>	<i>Rhizopus stolonifer</i>	Total fungal colonies (%)	
Mahboobnagar	Siri-4427	6	0.00	15.30 (0.00)	3.70 (23.03)	3.30 (11.08)	3.70 (10.45)	13.60 (11.08)	39.60 (21.64)	
	Sunbred-275	16	3.30	16.70 (10.46)	4.10 (24.12)	14.70 (11.67)	5.90 (22.54)	5.90 (14.06)	50.60 (14.06)	
	M-7	3	0.00	14.50 (0.00)	4.50 (22.38)	4.60 (12.24)	4.70 (12.37)	6.20 (12.51)	34.50 (14.12)	
	Mean		1.10	15.50	4.10	7.53	4.77	8.57	41.57	
Kurnool			Pathogen (A)		Genotypes (B)			A × B		
	SEm±		0.13		0.09			0.23		
	CD (0.05)		0.38		0.27			0.67		
	Sunrise	10	0.00	13.50 (0.00)	6.30 (21.55)	6.30 (14.53)	6.60 (14.53)	12.50 (14.88)	45.20 (20.68)	
	KBSH-1	3	3.90	15.50 (11.34)	5.60 (23.12)	14.80 (13.67)	2.90 (22.61)	4.30 (9.80)	47.00 (18.99)	
	Kavery	6	0.00	15.00 (0.00)	4.20 (22.74)	8.30 (11.82)	4.30 (16.74)	10.60 (11.96)	42.40 (18.99)	
	Ganga Kaveri	6	3.50	14.70 (10.71)	2.50 (22.54)	3.50 (9.06)	6.70 (10.76)	3.50 (14.98)	34.40 (10.76)	
	Mean		1.85	14.68	4.65	8.23	5.13	7.73	42.25	
				Pathogen (A)		Genotypes (B)			A × B	
	SEm±		0.27		0.22			0.55		
	CD (0.05)		0.78		0.64			1.57		

District	Genotype	Number of samples	<i>Alternaria helianthi</i>	<i>Alternaria alternata</i>	<i>Fusarium</i> spp.	<i>Aspergillus flavus</i>	<i>Aspergillus niger</i>	<i>Rhizopus stolonifer</i>	Total fungal colonies (%)
Medak	Pioneer	9	0.00	13.30 (0.00)	4.10 (21.35)	4.30 (11.68)	5.00 (11.96)	4.50 (12.92)	35.70 (12.24)
	Nagarjuna	12	2.50	14.20 (9.07)	5.30 (22.14)	5.60 (13.29)	5.10 (13.68)	14.80 (13.05)	45.00 (22.62)
	SHR-1	4	0.00	13.80 (0.00)	2.90 (21.80)	2.80 (9.79)	2.10 (9.62)	1.50 (8.33)	23.10 (6.96)
	Mean		0.83	13.77	4.10	4.23	4.07	6.93	34.60
Kadapa			Pathogen (A)		Genotypes (B)		A × B		
	SEm±		0.19		0.13			0.33	
	CD (0.05)		0.55		0.39			0.95	
	Ganga Kaveri	7	3.00	17.40 (9.95)	6.40 (24.65)	5.50 (14.65)	5.60 (13.55)	14.50 (13.68)	49.40 (13.67)
	Kargil	7	0.00	20.10 (0.00)	3.10 (26.64)	6.60 (10.14)	5.60 (14.87)	5.60 (13.68)	41.00 (13.68)
	Sunrise	11	0.00	15.00 (0.00)	3.80 (22.76)	3.20 (11.19)	5.90 (10.30)	14.70 (14.03)	42.60 (22.54)
	Mean		1.00	17.50	4.43	5.10	5.70	11.60	44.33
			Pathogen (A)		Genotypes (B)		A × B		
	SEm±		0.24		0.17			0.42	
	CD (0.05)		0.69		0.49			1.21	

District	Genotype	Number of samples	<i>Alternaria helianthi</i>	<i>Alternaria alternata</i>	<i>Fusarium spp.</i>	<i>Aspergillus flavus</i>	<i>Aspergillus niger</i>	<i>Rhizopus stolonifer</i>	Total fungal colonies (%)
Nizamabad	Local	16	4.50	22.70 (12.23)	3.80 (28.43)	3.60 (11.23)	6.20 (10.93)	14.90 (14.41)	55.70 (22.70)
	Siri	9	0.00	14.00 (0.00)	4.70 (21.92)	5.70 (12.50)	5.40 (13.79)	4.30 (13.43)	34.10 (11.96)
	Mean		2.25	18.35	4.25	4.65	5.80	9.60	44.90
Nalgonda	SEM + CD (0.05)		Pathogen (A)		Genotypes (B)		A × B		
			0.36		0.21				0.52
			1.07		0.62				1.52
	Ganga Kaveri	4	0.00	15.80 (0.00)	7.60 (23.40)	5.40 (15.98)	5.80 (13.43)	14.30 (13.93)	48.90 (22.21)
	Kavery	4	0.00	22.50 (0.00)	4.10 (28.31)	4.00 (11.68)	7.50 (11.53)	17.00 (15.89)	50.20 (24.35)
	Sunbred-275	13	3.40	15.00 (10.51)	5.30 (22.78)	12.60 (13.29)	3.70 (20.78)	5.50 (11.08)	45.50 (13.55)
	PAC-41	4	0.00	23.80 (0.00)	5.20 (29.19)	4.30 (13.18)	3.50 (11.96)	13.70 (10.76)	50.50 (21.76)
	Mean		0.85	19.28	5.55	6.58	5.13	12.63	48.78
	SEM ± CD (0.05)		Pathogen (A)		Genotypes (B)		A × B		
			0.18		0.14				0.36
		0.51		0.42				1.03	

Figures in parentheses are angular transformed

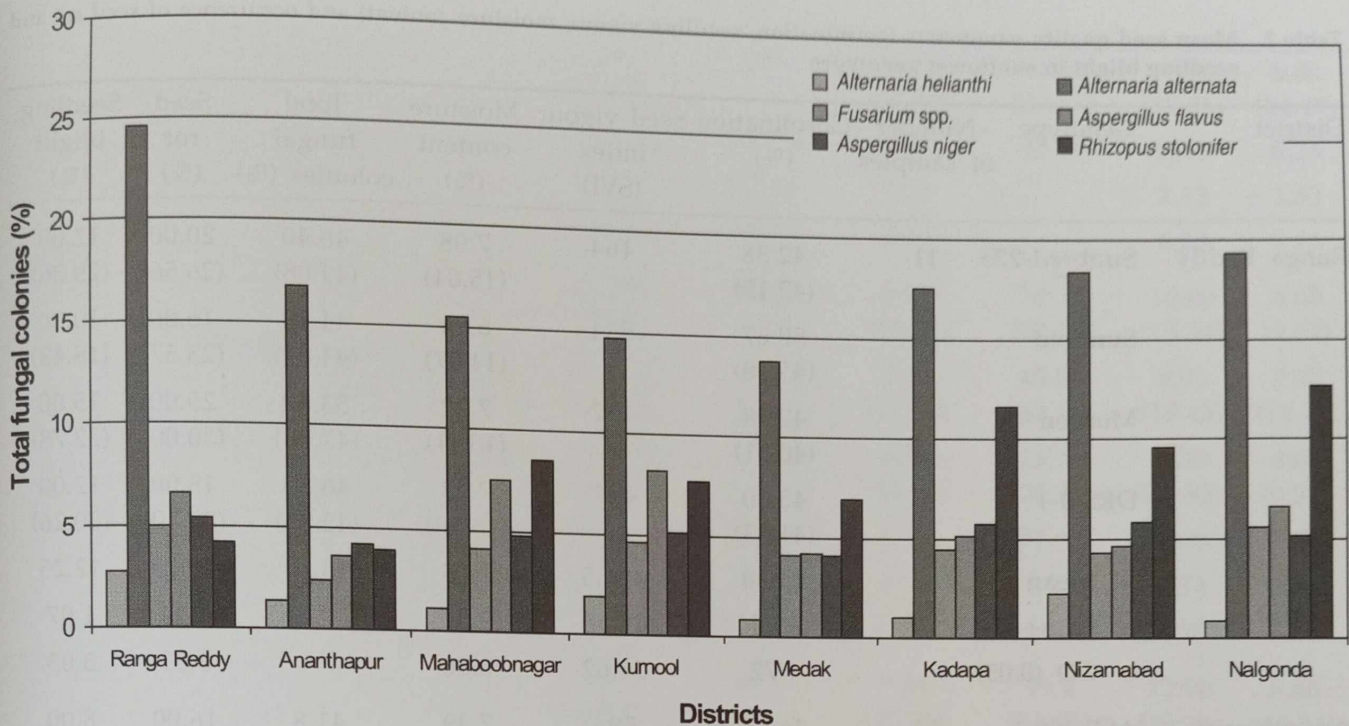


Fig. 1. Occurrence of seed borne fungi and their % incidence detected from the seeds of 17 sunflower genotypes

Irrespective of cultivar and locations, germination of seeds gradually decreased with increased number of total fungal colonies. The germination was far below minimum seed certification standard ($< 75\%$) in all the samples (Table 2 and Fig. 2). Among genotypes, Sunrise hybrid recorded significantly higher germination (69%), followed by Siri hybrid of Nizamabad district (67%). Sunflower hybrids (Pioneer, Kargil and M 7) recorded germination of 60-65%. The germination declined in Morden (42%) and Local cultivar (43%) due to high total number of fungal colonies (54-56%). Sunflower genotypes *viz.* Sungold (Rangareddy district), Siri-4427 (Mahboobnagar district), Sunrise and Ganga Kaveri (Kurnool district), Nagarjuna hybrid (Medak district) recorded germination of above 50%. In remaining samples *viz.* Sunbred-275, DRS 1, ASF 100, Kaveri, Ganga Kaveri and PAC 41, germination of 40-46% was recorded. Irrespective of genotypes, mean germination was low in samples of Nalgonda district (44.21%), followed by samples of Ranga Reddy district (45%).

Irrespective of cultivars and production areas, seedling vigour index gradually decreased with

increased number of total seed-borne fungi. Among cultivars, Morden variety of Ranga Reddy and Local variety of Nizamabad districts recorded less seedling vigour (437-450), whereas Siri hybrid of Nizamabad district (1010) followed by Pioneer hybrid of Medak district (984) and Kargil hybrid of Ananthapur district (876) recorded higher seedling vigour. Among different districts, mean seed vigour index was low in the samples of Nalgonda and Ranga Reddy districts (448-470). Mean seed vigour index was high in the samples of Ananthapur and Medak districts (775-797). Similar type of decreased seed germination and seedling vigour was reported by several workers in sunflower [10, 19]. This reduction in seed germination due to *A. helianthi* in sunflower was reported to an extent of 29-35% over healthy seeds [15], Hiremath *et al.* [10] and Prasad and Kulshrestha [13] reported that sunflower seeds naturally infected with *A. helianthi* showed reduction in seed germination and seedling vigour index. Chander Rao [20] also confirmed that seed germination and seedling vigour was reduced drastically due to *A. helianthi* infection in sunflower. Santha lakshmi Prasad *et al.* [21] reported that sunflower heads infected with Alternaria blight

Table 2. Mean seed quality parameters (germination, seedling vigour, moisture content) and occurrence of seed rot and seedling blight in sunflower genotypes

District	Genotype	Number of samples	Germination (%)	Seed vigour index (SVI)	Moisture content (%)	Total fungal colonies (%)	Seed rot (%)	Seedling blight (%)
Ranga Reddy	Sunbred-275	11	42.38 (42.15)	464	7.08 (15.04)	48.40 (44.08)	20.00 (26.56)	12.00 (20.26)
	Sungold	4	50.67 (45.38)	534	6.94 (14.97)	44.10 (41.61)	16.00 (23.57)	10.00 (18.43)
	Morden	5	42.38 (40.61)	437	7.22 (15.11)	53.60 (47.06)	25.00 (30.00)	15.00 (22.78)
	DRSH-1	5	43.10 (41.03)	447	7.08 (15.10)	46.30 (42.87)	18.00 (25.10)	12.00 (20.26)
	Mean		45.30	470.5	7.08	48.10	19.75	12.25
	SEm±		0.61	10.48	0.51		1.24	1.07
	CD (0.05)		1.72	31.62	0.86		3.51	3.03
Ananthapur	ASF-100	13	46.87 (41.42)	594	7.39 (15.77)	41.8 (41.43)	16.00 (23.57)	8.00 (16.42)
	Kargil	3	63.61 (50.76)	876	6.15 (15.16)	31.90 (34.68)	15.00 (22.78)	9.00 (17.45)
	Sunrise	9	68.95 (53.69)	922	6.95 (15.28)	22.80 (28.52)	12.00 (20.55)	6.00 (16.21)
	Mean		59.81	797	6.83	32.16	14.33	7.67
	SEm±		0.92	72.8	0.20		1.24	1.16
	CD (0.05)		2.63	203	0.57		3.48	3.17
Mahboobnagar	Siri-4427	6	56.66 (48.82)	685	7.25 (15.66)	39.60 (41.32)	14.00 (22.78)	5.00 (15.34)
	Sunbred-275	16	43.95 (41.32)	478	7.04 (15.44)	50.60 (47.69)	17.00 (25.10)	9.00 (17.45)
	M-7	3	60.39 (50.99)	701	6.81 (15.12)	34.50 (39.07)	10.00 (20.26)	3.00 (12.92)
	Mean		53.67	621.33	7.03	41.57	13.67	5.67
	SEm±		1.74	21.69	0.17		1.62	1.81
	CD (0.05)		4.94	61.59	0.47		4.61	5.13
Kurnool	Sunrise	10	58.19 (50.48)	702	6.52 (14.76)	45.20 (42.24)	12.00 (20.26)	5.00 (12.92)
	KBSH-1	3	43.91 (42.07)	469	7.17 (15.42)	47.00 (43.28)	14.00 (19.36)	9.00 (14.17)
	Kavery	6	46.72 (44.83)	562	7.20 (15.34)	42.40 (39.20)	10.00 (18.43)	5.00 (12.65)
	Mean		46.27	577.67	6.96	44.87	12.00	6.33

	Ganga Kaveri	6	52.86 (47.21)	650	6.31 (14.54)	34.40 (35.66)	11.00 (19.36)	6.00 (14.17)	
	Mean		50.42	595.75	6.80	42.25	11.75	6.25	
	SEm±		2.01	45.68	0.26		2.22	1.83	
	CD (0.05)		2.84	129.72	0.73		6.30	5.21	
	Medak	Pioneer	9	65.44 (53.99)	984	6.84 (15.16)	35.70 (34.23)	10.00 (15.34)	4.00 (9.97)
		Nagarjuna	12	50.49 (45.78)	667	7.12 (15.60)	45.00 (42.13)	9.00 (17.45)	7.00 (14.17)
		SHR-1	4	54.09 (47.34)	675	6.70 (15.12)	23.10 (28.72)	8.00 (12.92)	4.00 (9.97)
Mean			56.67	775.33	6.90	34.60	9.00	5.00	
SEm±			2.77	39.81	0.21	1.28	1.53	2.89	
CD (0.05)			7.87	108.00	0.66	4.17	5.38	8.34	
Kadapa		Ganga Kaveri	7	42.86 (40.89)	465	7.34 (15.71)	49.4 (44.65)	12.00 (20.26)	5.00 (15.34)
	Kargil	7	46.17 (42.80)	548	6.95 (15.28)	41.00 (42.71)	10.00 (18.43)	4.00 (13.18)	
	Sunrise	11	50.79 (45.54)	650	6.59 (14.87)	42.60 (40.74)	9.00 (19.87)	6.00 (15.34)	
	Mean		46.60	554.33	6.96	44.33	10.33	5.00	
	SEm ±		1.74	21.96	0.35		1.83	1.53	
	CD (0.05)		4.89	61.95	0.41		1.93	1.78	
	Nizamabad	Local	16	42.64 (39.00)	464	7.04 (15.34)	55.70 (46.71)	24.00 (29.33)	5.00 (12.29)
Siri		9	67.08 (53.15)	1010	6.95 (14.17)	34.1 (35.72)	9.00 (21.90)	7.00 (13.56)	
Mean			54.86	730	6.99	44.90	16.5	6.00	
SEm±			2.00	82.7	0.26		2.12	1.90	
CD (0.05)			5.9	217.90	0.58		5.03	1.12	
Nalgonda		Ganga Kaveri	4	43.56 (41.87)	452	7.05 (15.43)	48.90 (44.49)	10.00 (18.43)	4.00 (11.53)
	Kavery	4	42.70 (41.38)	460	6.99 (15.27)	50.20 (45.24)	11.00 (19.63)	2.00 (11.53)	
	Sunbred-275	13	45.57 (43.03)	499	7.11 (15.58)	45.50 (42.54)	14.00 (20.26)	5.00 (12.92)	
	PAC-41	4	45.00 (42.98)	500	7.10 (15.43)	50.50 (45.41)	17.00 (22.78)	4.00 (12.92)	
	Mean		44.20	477.75	7.06	48.78	13.00	3.75	
	SEm±		0.87	19.87	0.16		2.53	0.751	
	CD (0.05)		3.01	73.43	5.53		10.57	3.30	

Figures in parentheses are angular transformed

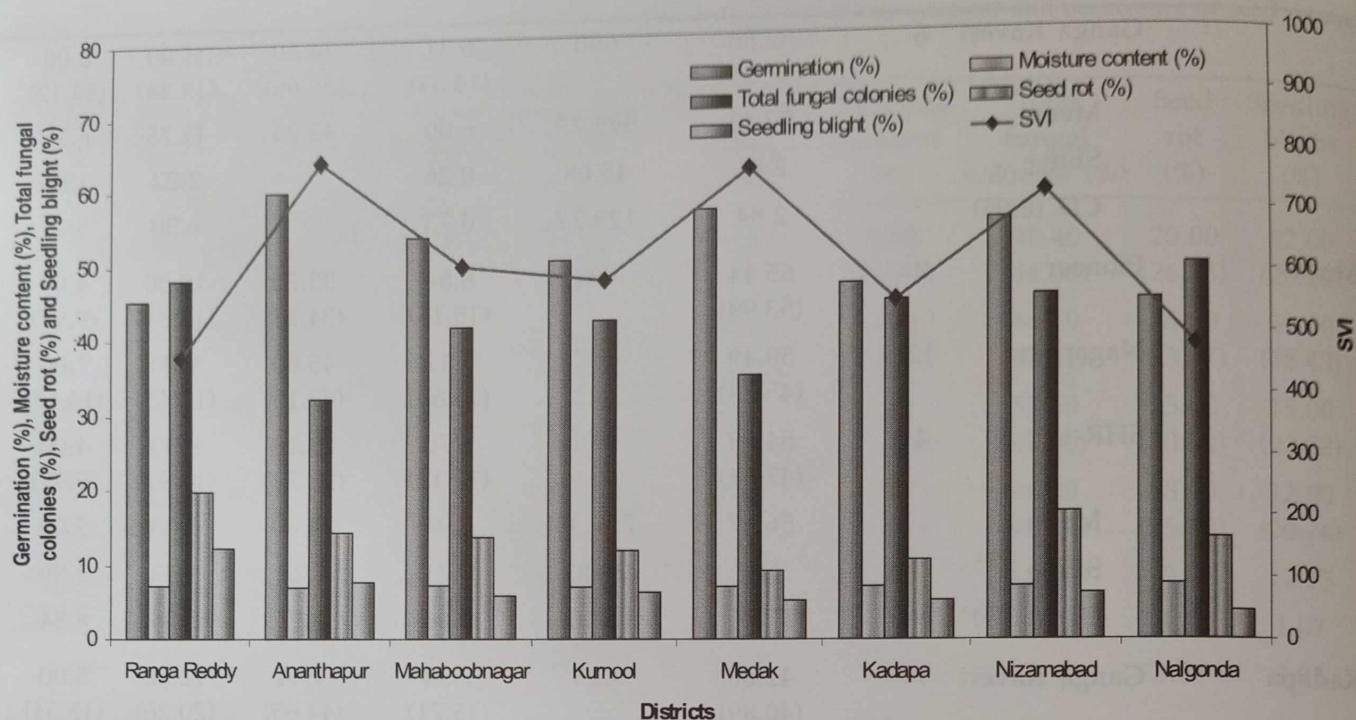


Fig. 2. Mean seed quality parameters (Germination, seedling vigour, moisture content) and mean seed rot % and seedling blight(%) in sunflower

reduced seed germination in Morden variety and DRSH 1 sunflower hybrid.

Significant differences in seed rot and seedling blight were observed in different sunflower genotypes. Seed rot and seedling blight were high in Morden variety (24 and 15%, respectively) and Sunbred 275 hybrid (20 and 12%, respectively) of Ranga Reddy district. Least occurrence of seed rot and seedling blight was noticed in Pioneer hybrid of Medak district (10 and 4%, respectively). Seed rot varied from 8-25% and seedling blight from 2-15%. The occurrence of *A. helianthi* in different sunflower cultivars viz. Sunbred 275 (69 to 75%), Morden (100%), DRSH 1 (60%), ASF 100 (85%), KBSH 1 (67%), Ganga Kaveri (67-71%), Nagarjuna (50%) and Local (94%) was recorded. *A. helianthi* infection was not observed in sunflower genotypes viz. Sungold, Kargil, Sunrise, Siri 4427, M 7, Kaveri, Pioneer, SHR 1, Siri, Ganga Kaveri and PAC 41 (Table 3). It was observed that *A. helianthi* produced various symptoms like germination failure, seed rot, seed discolouration, root rot and seedling blight which decrease the quality and quantity of sunflower seeds. Similar findings were reported earlier [11 and 9]. The results were in confirmity

with Viswanathan [15] who reported that seed-borne fungi reduced seed germination and seedling vigour and increased seed rots and seedling blights in sunflower.

Moisture content in sunflower seed samples ranged from 6-7%. High moisture content in ASF 100 (7.4% of Ananthapur district was accompanied with maximum number of total fungal colonies (42%). Moisture content was less in Kargil hybrid (6%) of Ananthapur district. The difference in occurrence of seed mycoflora in different sunflower seed samples may be attributed to moisture content of seed and other factors like temperature, humidity and light conditions that prevailed at the time of seed maturity of the sunflower crop. Similar findings were reported earlier by Rajeswari *et al.* [14] in soybean.

A. helianthi infection in sunflower seed samples exerted a significant effect on oil content of infected (6%) and healthy seeds (11%). Low oil content in Morden and Local cultivars accompanied maximum occurrence of *A. helianthi*. Similar findings in reduction in oil content due to *A. helianthi* was observed to an extent of 5% [3, 20, 19] (Table 4 and Fig. 3).

Table 3. % Occurrence of *Alternaria helianthi* in seeds of sunflower genotypes collected from various locations of Andhra Pradesh

District	Name of the genotype	No. of samples	No. of samples infected by <i>A. helianthi</i>	Per cent <i>Alternaria helianthi</i> infection
Ranga Reddy	Sunbred-275	11	8	72.73
	Sungold	4	0	0
	Morden	5	5	100
	DRSH-1	5	3	60
Ananthapur	ASF-100	13	11	84.6
	Kargil	3	0	0
	Sunrise	9	0	0
Mahaboobnagar	Siri-4427	6	0	0
	Sunbred-275	16	12	75
	M-7	3	0	0
Kurnool	Sunrise	10	0	0
	KBSH-1	3	2	66.6
	Kavery	6	0	0
	Ganga Kaveri	6	4	66.66
Medak	Pioneer	9	0	0
	Nagarjuna	12	6	50
	SHR-1	4	0	0
Kadapa	Ganga Kaveri	7	5	71.4
	Kargil	7	0	0
	Sunrise	11	0	0
Nizamabad	Local	16	15	93.75
	Siri	9	0	0
Nalgonda	Ganga Kaveri	4	0	0
	Kavery	4	0	0
	Sunbred-275	13	9	69.23
	PAC-41	4	0	0
Total		200	80	40.0

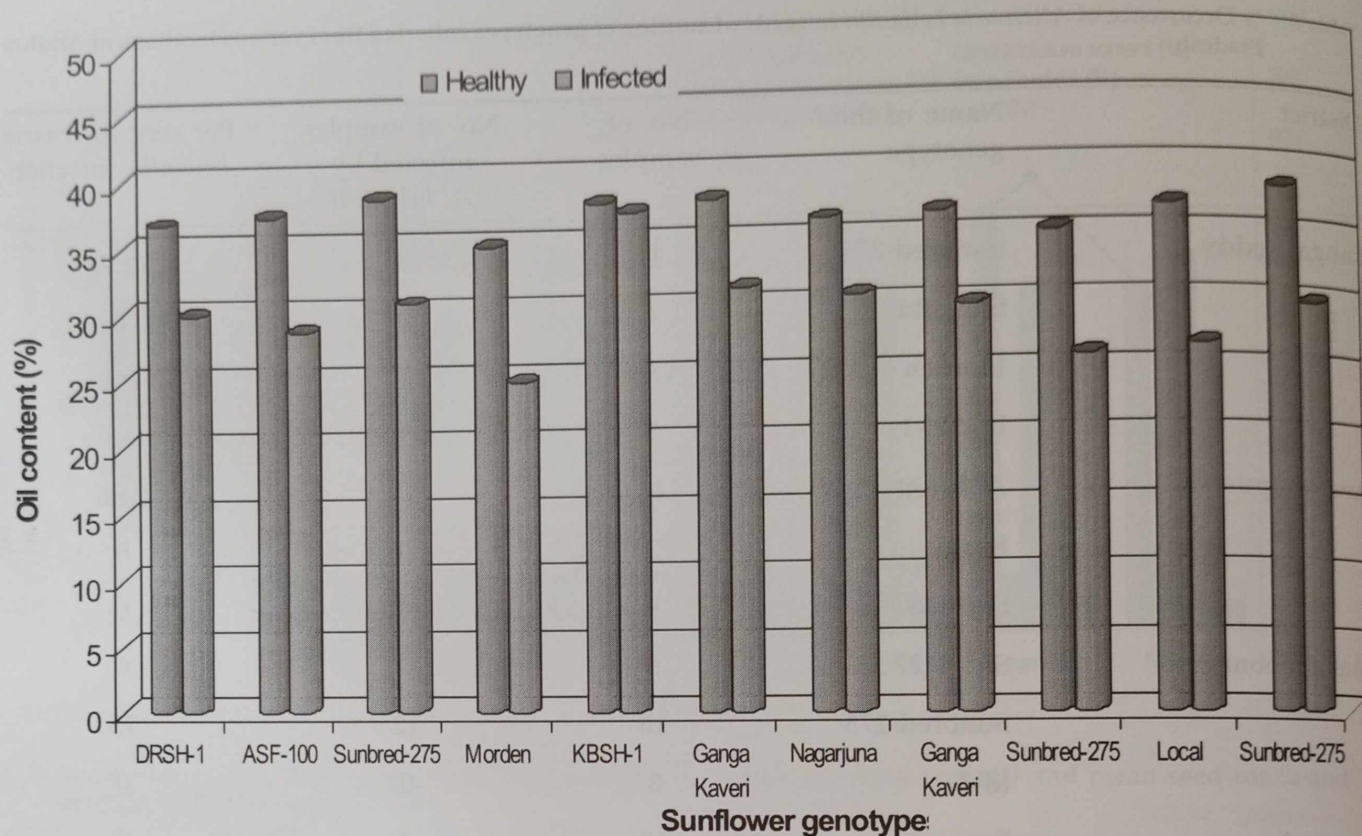


Fig. 3. Oil content in infected and healthy seed samples of sunflower genotypes

Table 4. Oil content in infected and healthy sunflower seed samples of various genotypes

District	Sunflower genotype	Oil content (%)			
		<i>Alternaria helianthi</i> (%) on SLEM	Healthy	Infected	Reduction in oil content over healthy seeds (%)
Ranga Reddy (DOR)	DRSH-1	19.8	36.83	29.95	6.88
Ananthapur	ASF-100	20.8	37.36	28.73	8.63
Mahaboobnagar	Sunbred-275	16.5	38.65	30.77	7.88
Ranga Reddy (SR&TC)	Morden	21.0	34.92	24.75	10.74
Kurnool	KBSH-1	18.2	38.02	37.27	7.56
Nandyal	Ganga Kaveri	12.4	38.20	31.54	6.68
Medak	Nagarjuna	10.2	36.56	30.89	5.67
Kadapa	Ganga Kaveri	12.8	36.96	30.03	6.93
Ranga Reddy	Sunbred-275	20.0	35.41	26.21	9.20
Nizamabad	Local	19.0	37.16	26.87	10.29
Nalgonda	Sunbred-275	18.8	38.54	29.96	8.58
Mean		17.23	37.05	29.01	8.09
SEm±			0.42	0.40	
CD (0.05)			1.24	1.18	

Thus, it was concluded that *A. helianthi* and seed-borne fungi present in sunflower seed samples drastically reduced seed quality in terms of germination, seed vigour and oil content. Therefore to increase the production of sunflower qualitatively and quantitatively, farmers require healthy quality seeds. Hence, it is imperative that seeds must be treated and tested before they are sown in the field. Another adverse effect of seed-borne pathogen is that it contaminates the areas which are disease-free previously. So, it necessitates the eradication of seed-borne inoculum through various seed treatments and through the enforcement of proper domestic and international quarantine acts and procedures.

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