

Original Research Article

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Impact of Angoumois Grain Moth, *Sitotroga cerealella* (Olivier) (Lepidoptera: Gelechiidae) on the Viability of Maize Seeds

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ABSTRACT

The experiment was conducted to determine the viability of maize seed infested with Angoumois grain moth *Sitotroga cerealella* (Olivier). The objective was to see how different cultivars of maize are resistant to this pest. Seeds of sixteen cultivars of maize (CMH08-287, CMH08-292, CMH08-337, CMH08-381(G), CMH08-381, CMH08-433, CMH08-464, CMH08-3500, Aditiya, CP818, CO6, Dhaanya 8255, Winner, NK6240, Pioneer 3502, and Sun 126) were screened at Insectary, Department of Agricultural Entomology, TNAU, Coimbatore. All the maize hybrids were assessed for the change in the seed quality in terms of germination percentage, hundred grain weight, shoot length, root length, seedling length, dry matter production and vigour index after the damage by *S. cerealella*. There is a significant reduction in the seed quality was observed in all maize hybrids due to *S. cerealella* damage.

Keywords

Maize, Seed quality, *Sitotroga cerealella*, Germination and Hybrids.

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Introduction

Maize is one of the important cereal crops next to wheat and rice in the world. Maize has high production potential compared to any other cereal crop. Besides its use as food, feed and fodder, maize is now gaining increased importance on account of its potential uses in manufacturing of starch, plastic, rayon, textile, adhesive, dyes, resins, boot polish, syrups, ethanol, etc. The crop has very high genetic yield potential; it is called as the “Queen of cereals” and “King of fodder” (Muthukumar *et al.*, 2015). The Angoumois grain moth, *Sitotroga cerealella* (Olivier) is one of the principal insect pest that causes

severe losses at storage. It is carried-over from field to the stores through field infected grains (Muthukumar *et al.*, 2016). Insect infestation in stored seeds directly affects their germination. Grains bored by insects fail to germinate. Germination of stored seed tends to decrease with the increase of insect infestation (Anand Prakash and Jagadiswari Rao, 1986). Agrawal *et al.*, (1981) reported that loss of germination in wheat due to insect infestation was about 77.33% which was stored for maximum of eight months. Gokul Raam (2009) reported significant reduction of seed quality in terms of germination

percentage, 100 grain weight, shoot length, root length, seedling length, seedling dry weight and vigour index after the damage by *S. cerealella*. Keeping this in view, the present investigation was conducted to see how different cultivars of maize are resistant to this pest.

Materials and Methods

All the hybrids were collected and the germination test was conducted. Each test entry was weighed (500 g) and placed in wide mouthed jars (15 cm x 7 cm), covered with porous cloth. Twenty pairs of moths were introduced in all the entries. After about six weeks, adults started emerging and again germination test was conducted.

Germination

The germination test was carried out as per the procedure prescribed by ISTA with four replicates of 25 seeds in roll towel. The test conditions were 25 ± 2 °C and $95 \pm 5\%$ RH maintained in a germination room illuminated with fluorescent light (ISTA, 1999). After seven days, the normal seedlings were counted and expressed as per cent. Germinated seedlings per cent reduction/increase in germination was calculated for each hybrid.

Root length

Ten normal seedlings were selected at random from each replication and used for measuring the root length of seedlings. Root length was measured from the point of attachment of seed to the tip of primary root. The mean values were recorded and expressed in centimeter. Percent reduction / increase in root length were calculated for all the hybrids.

Shoot length

The same seedlings were also used for measuring shoot length. The shoot length was

also measured in the same seedling from the point of attachment of seed to tip of the leaf. The mean values were recorded and expressed in centimeter. Percent reduction/increase in shoot length were calculated for each hybrid.

Dry Matter Production (DMP)

The seedlings used for growth measurement were placed in a paper cover and dried in shade for 24 h and then they were kept in a hot air oven (Memmert) maintained at 85 ± 2 °C for 48 h. The dried seedlings were weighed and the mean values were expressed in g per 10 seedling. Percent reduction / increase in DPM were calculated for all the hybrids.

Vigour index

Vigour index values were computed using the following formula and the mean expressed as whole number (Abdul-Baki and Anderson, 1973). Percent reduction/ increase in vigour index were calculated for each hybrid.

Vigour index = Germination (%) x Total seedling length (cm).

Results and Discussion

Germination percentage

In all the hybrids, germination percentage was reduced significantly due to the infestation damage by larvae of *S. cerealella*. In the hybrids germination varied from 80 to 100%, which got reduced to 15-61.67 % after the feeding. Per cent reduction in germination after the screening period due to damage by *S. cerealella* varied from 20 to 81.67. Before the screening process maximum germination of 96.87-100% was noticed in Winner, Dhannya 8255, CMH08-337, CMH08-381, CMH08-433, Pioneer 3502 and Sun 126 which were on par and significantly different from other hybrids. Lowest germination before the

screening process was observed in CMH08-287 and Aditiya (80%) which were on par and significantly different from other hybrids. After the screening process, maximum germination was noticed in CO6 (61.67), followed by CMH08- 287 (60.00 %) and CMH08- 464 (58.33 %). After the screening process minimum germination was observed in Sun 126 (15 %) followed by Aditiya (18.33 %). However, minimum per cent reduction in germination was recorded in CMH08- 287 (20.00 %), CMH08- 464 and CO6 (28.33 %) and maximum per cent reduction in germination was recorded in Sun 126 (81.67) and Winner (80.00) (Table 1).

Root length

Maize hybrids differed significantly with respect to root length both before and after the screening process. Root length of all the hybrids was reduced significantly after the screening period. Before the screening process the highest root length was noticed in Pioneer 3502 (21.58 cm) and Dhannya 8255

(21.25 cm) which were on par and differed significantly from other hybrids. The lowest root length was recorded in CO6 (15.66 cm) and CMH08- 287 (16.27 cm) which were on par and differed significantly from other hybrids. After the screening period root length of the maize hybrids was reduced and it varied 11.83-15.97 cm. The lowest root length was observed in NK 6240 (11.83 cm) and highest root length was noticed in CMH08-381 (15.97 cm) which were significantly different from other hybrids. CO6 recorded the lowest (1.87%) and Pioneer 3502 the highest (41.62%) reduction in root length (Table 2).

Shoot length

Shoot length of most of the maize hybrids reduced significantly (22.70 – 50.95 %) after the screening, maximum reduction in shoot length was observed in Winner (50.95 %), NK6240 (43.58 %), Dhannya 8255 (35.58 %) and CO6 (35.08 %).

Table.1 Germination percentage of maize hybrids before and after damage by *Sitotroga cerealella*

S. No.	Hybrids	Germination (%)		Per cent reduction in germination
		Before damage	After damage	
1	CMH08-287	80.00 A (63.43) ^f	60.00 B (50.77) ^a	20.00
2	CMH08-292	95.00 A (77.08) ^{bcd}	25.00 B (30.00) ^b	70.00
3	CMH08-337	98.33 A (82.57) ^a	23.33 B (28.88) ^b	75.00
4	CMH08-381(G)	85.00 A (67.21) ^c	21.67 B (27.74) ^b	63.33
5	CMH08-381	96.67 A (79.49) ^{ab}	26.67 B (31.09) ^b	70.00
6	CMH08-433	96.67 A (79.49) ^{abc}	21.67 B (27.74) ^b	75.00
7	CMH08-464	86.67 A (68.59) ^{def}	58.33 B (49.80) ^a	28.33
8	CMH08-3500	88.33 A (70.02) ^{def}	28.33 B (32.16) ^b	60.00
9	Aditiya	80.00 A (63.43) ^f	18.33 B (25.35) ^b	61.67
10	CP818	93.33 A (75.03) ^{cde}	30.00 B (33.21) ^b	63.33
11	CO6	90.00 A (71.57) ^{de}	61.67 B (51.75) ^a	28.33
12	Dhaanya 8255	98.33 A (82.57) ^{ab}	20.00 B (26.57) ^b	78.33
13	Winner	100.00 A (90.00) ^a	20.00 B (26.57) ^b	80.00
14	NK6240	91.67 A (73.22) ^{cde}	26.67 B (31.09) ^b	65.00
15	Pioneer 3502	96.67 A (79.49) ^{abc}	21.67 B (27.74) ^b	75.00
16	Sun 126	96.67 A (79.49) ^{abc}	15.00 B (22.79) ^b	81.67
	SEd	4.18	3.09	-
	CD(p=0.05)	8.51	6.29	-

*Figures in parentheses are arcsine transformed values

Means followed by common letter (s) in a column (lower case) and row (uppercase) are not significantly different by LSD (p=0.05)

Table.2 Root length of maize hybrids before and after damage by *Sitotroga cerealella*

S. No.	Hybrids	Root length (cm)		Per cent reduction in root length
		Before damage	After damage	
1	CMH08-287	16.27 A (4.03) ⁱ	14.03 B (3.81) ^{de}	13.73
2	CMH08-292	19.52 A (4.42) ^{ef}	14.83 B (3.92) ^{bc}	24.02
3	CMH08-337	16.24 A (4.03) ^{hi}	13.87 B (3.79) ^{cd}	14.63
4	CMH08-381(G)	20.12 A (4.49) ^{de}	13.87 B (3.79) ^{cd}	31.07
5	CMH08-381	20.24 A (4.50) ^{cde}	15.97 B (4.06) ^a	21.13
6	CMH08-433	18.88 A (4.35) ^{fg}	13.57 B (3.75) ^{de}	28.16
7	CMH08-464	21.27 A (4.61) ^{ab}	14.33 B (3.85) ^{cd}	32.60
8	CMH08-3500	20.60 A (4.54) ^{bc}	14.03 B (3.81) ^{cd}	31.87
9	Aditiya	18.90 A (4.35) ^{fg}	12.60 B (3.62) ^{fg}	33.33
10	CP818	20.59 A (4.54) ^{bc}	13.70 B (3.77) ^{de}	33.47
11	CO6	15.66 A (3.96) ⁱ	15.37 B (3.98) ^{ab}	1.87
12	Dhaanya 8255	21.25 A (4.61) ^{ab}	13.87 B (3.79) ^{cd}	34.73
13	Winner	18.50 A (4.30) ^g	12.90 B (3.66) ^{ef}	30.28
14	NK6240	16.61 A (4.08) ^h	11.83 B (3.51) ^g	28.77
15	Pioneer 3502	21.58 A (4.65) ^a	12.60 B (3.62) ^{fg}	41.62
16	Sun 126	20.97 A (4.58) ^{ab}	15.50 B (3.94) ^{ab}	26.10
SEd		0.05	0.06	-
CD (p=0.05)		0.09	0.13	-

*Figures in parentheses are square root transformed values

Means followed by common letter (s) in a column (lower case) and row (uppercase) are not significantly different by LSD (p=0.05)

Table.3 Shoot length of maize hybrids before and after damage by *Sitotroga cerealella*

S. No.	Hybrids	Shoot length (cm)		Per cent reduction in shoot length
		Before damage	After damage	
1	CMH08-287	5.55 A (2.45) ^f	3.85 B (2.08) ^b	26.81
2	CMH08-292	6.34 A (2.62) ^{de}	4.64 B (2.27) ^b	26.69
3	CMH08-337	6.37 A (2.62) ^{de}	4.67 B (2.27) ^b	34.07
4	CMH08-381(G)	4.99 A (2.34) ^g	3.29 B (1.95) ^b	28.86
5	CMH08-381	5.89 A (2.53) ^{ef}	4.19 B (2.17) ^b	34.39
6	CMH08-433	4.94 A (2.33) ^{ghi}	3.24 B (1.93) ^b	31.66
7	CMH08-464	5.37 A (2.42) ^{fgh}	3.67 B (2.04) ^b	36.17
8	CMH08-3500	4.70 A (2.28) ⁱ	3.00 B (1.87) ^b	35.20
9	Aditiya	4.83 A (2.31) ^{hi}	3.13 B (1.91) ^b	22.70
10	CP818	7.49 A (2.83) ^b	5.79 B (2.51) ^b	25.35
11	CO6	6.71 A (2.68) ^d	5.01 B (2.35) ^b	35.08
12	Dhaanya 8255	7.13 A (2.76) ^{bc}	4.63 B (2.26) ^b	35.58
13	Winner	7.03 A (2.74) ^{bcd}	4.53 B (2.24) ^b	50.95
14	NK6240	4.91 A (2.33) ^{hi}	2.41 B (1.70) ^b	43.58
15	Pioneer 3502	5.74 A (2.50) ^{ef}	3.24 B (1.93) ^b	25.83
16	Sun 126	12.00 A (3.54) ^a	8.90 B (3.07) ^a	30.65
SEd		0.07	0.16	-
CD (p=0.05)		0.13	0.32	-

*Figures in parentheses are square root transformed values

Means followed by common letter (s) in a column (lower case) and row (uppercase) are not significantly different by LSD (p=0.05)

Table.4 Seedling dry weight of maize hybrids before and after damage by *Sitotroga cerealella*

S. No.	Hybrids	Dry weight (g)		Per cent reduction in dry weight
		Before damage	After damage	
1	CMH08-287	2.75 A (1.80)	2.05 B (1.60) ^a	25.49
2	CMH08-292	2.54 A (1.74)	1.61 B (1.45) ^{cde}	36.57
3	CMH08-337	2.36 A (1.69)	1.43 B (1.39) ^{fgh}	39.41
4	CMH08-381(G)	2.55 A (1.75)	1.62 B (1.46) ^{cde}	36.42
5	CMH08-381	2.47 A (1.72)	1.54 B (1.43) ^{ef}	37.60
6	CMH08-433	2.53 A (1.74)	1.81 B (1.52) ^b	28.46
7	CMH08-464	2.96 A (1.86)	2.01 B (1.58) ^a	32.09
8	CMH08-3500	2.66 A (1.78)	1.76 B (1.50) ^{bc}	33.83
9	Aditiya	2.21 A (1.65)	1.28 B (1.33) ^h	42.17
10	CP818	2.51 A (1.74)	1.63 B (1.46) ^{cde}	35.15
11	CO6	2.60 A (1.76)	1.74 B (1.50) ^{bcd}	32.99
12	Dhaanya 8255	2.24 A (1.66)	1.35 B (1.36) ^g	39.82
13	Winner	2.59 A (1.76)	1.55 B (1.43) ^{ef}	40.10
14	NK6240	2.56 A (1.75)	1.52 B (1.42) ^{ef}	40.63
15	Pioneer 3502	2.60 A (1.76)	1.56 B (1.44) ^{def}	40.00
16	Sun 126	2.52 A (1.74)	1.48 B (1.41) ^{efg}	41.27
	SEd	0.02	NS	0.03
	CD (p=0.05)	0.04		0.07

*Figures in parentheses are square root transformed values

Means followed by common letter (s) in a column (lower case) and row (uppercase) are not significantly different by LSD (p=0.05)

Table.5 Vigour index of maize hybrids before and after damage by *Sitotroga cerealella*

S. No.	Hybrids	Vigour index		Per cent reduction in vigour index
		Before damage	After damage	
1	CMH08-287	1741.00	597.87	65.66
2	CMH08-292	2455.99	486.13	80.21
3	CMH08-337	2225.28	432.80	80.55
4	CMH08-381(G)	2132.65	374.05	82.46
5	CMH08-381	2525.18	540.57	78.59
6	CMH08-433	2303.33	363.73	84.21
7	CMH08-464	2303.82	483.22	79.03
8	CMH08-3500	2232.18	483.02	78.36
9	Aditiya	1912.00	286.90	84.99
10	CP818	2613.10	584.83	77.62
11	CO6	2007.23	341.73	82.97
12	Dhaanya 8255	2778.90	371.67	86.63
13	Winner	2548.00	349.90	86.27
14	NK6240	1959.38	380.87	80.56
15	Pioneer 3502	2621.12	344.77	86.85
16	Sun 126	3167.53	364.68	88.49
	Mean	2345.42	424.17	81.47
	P (T<=t) one-tail		1.46	
	t Critical one-tail		1.75	

Minimum reduction in shoot length was observed in Aditiya (22.70 %) followed by CMH08- 292 (26.69 %), CMH08- 287 (26.81 %) and CMH08- 381 (G) (28.86 %) (Table 3).

Seedling dry weight

Maize hybrids differed significantly for seedling dry weight both before (2.21- 2.96 g) and after (1.28- 2.05 g) the damage caused by larvae of *Sitotroga cerealella* due to screening process. Seedling dry weight of all the hybrids was reduced significantly after the screening process. Before screening, highest seedling dry weight was recorded in CMH08- 464 (2.96 g) and the lowest seedling dry weight was recorded in Aditiya (2.21 g).

There was no significant difference between maize hybrids before screening process. After the screening highest seedling dry weight was recorded in CMH08- 287 (2.05 g) and CMH08-464 (2.01 g) which were on par and differed significantly from other hybrids. Per cent reduction in seedling dry weight varied from 25.49 % (CMH08- 287) to 42.17 % (Aditiya) (Table 4).

Vigour index

All the hybrids before the screening process recorded higher vigour index (1741.00 - 3167.53) which got reduced (286.90 - 597.87) after the screening period. Before screening highest vigour index was recorded in Sun 126 (3167.53), followed by Dhannya 8255 (2778.90), and Pioneer 3502 (2621.12) and the lowest vigour index was recorded in CMH08-287 (1741.00).

After screening, highest vigour index was recorded in CMH08- 287 (597.87), CP 818 (584.83) and CMH08- 381 (540.57) and the lowest was recorded in Aditiya (286.90). Lowest percent reduction in vigour index was recorded in CMH08- 287 (65.66 %) and the highest per cent reduction in vigour index was recorded in Sun 126 (88.49 %) (Table 5).

In conclusion, Maize cultivar CO6 and CMH08-287 have more germination % even after *S. cerealella* damage with lesser reduction in root length and shoot length compared to others. Which indicate its resistance against damages caused by this pest. Thus the cultivars can be used as resistant cultivar to increase quality stored seeds of maize crop.

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