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Effect of date of sowing on the infestation of shoot fly, *Atherigona soccata* (Rondani) in spring maize and their varietal preference

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ABSTRACT

The experiments on maize during spring 2006 and 2007 under natural and artificial conditions respectively showed that *A. soccata* did not discriminate amongst the plants of different inbred and hybrid genotypes while depositing eggs. However in all the inbreds and hybrids the numbers of eggs laid by shoot fly increased from 1st sowing (25th January) to 3rd sowing (24th February) and then decreasing from 4th sowing (11th March) till 6th sowing (10th April) and eggs laid by shoot fly were recorded maximum during 3rd sowing (24th February) in all the inbreds and hybrids during 2006. It clearly indicates that this pest severally attacks the crop sown during this period. Present results clearly indicates that crop planted between last week of February to mid of March get exposed to high *A. soccata* attack. Significantly maximum mean dead heart was recorded when the crop was sown on 24th February as compared to all other dates of sowing and significantly lowest when the crop was sown on 10th April, 2006 in both hybrids and inbreds. Irrespective to date of sowing maximum (26.17 & 48.96%) and minimum (13.71 & 27.72%) head hearts were recorded whereas during different dates of sowing maximum (34.02 & 60.33%) and minimum (2.65 & 3.45%) head hearts were recorded on maize hybrids and inbreds during spring 2006. Dead hearts formed by *A. soccata* in selected maize hybrids and inbreds varied from 9.36-26.06 per cent and 28.74-66.06 per cent respectively during different dates of sowing in spring 2007. On the basis of dead heart formation, the inbred C-78 was observed to be least susceptible as compared to inbred 1348-6-2 and Hybrid 1128x163 was more susceptible as compared to 193-2x161 to the attack of *A. soccata*.

KEY WORDS: D**ead heart, egg laying, hybrid, inbred, maize, shoot fly, natural, artificial.**

INTRODUCTION

Maize is one of the important staple food crops, grown in semi-arid regions of the country. The multiple pest complex of maize crop poses serious limitation in the intensification of maize cultivation in different agro climatic regions of India. More than 250 insect pests cause varying degree of damage to maize crop but only about a dozen of these are quite serious and require control measures. With the introduction of high yielding maize hybrids and continuous cropping of maize in three seasons, namely Kharif, Rabi and spring as well as advancement in farming technology led to the emergence of shoot fly (*Atherigona spp.*) as key pest that destabilize the yield of maize and sorghum crops (Sarup et al., 1984; Rao and Panwar, 2001; Siddique et al., 2011; Aruna et al., 2011). In India, only six shoot fly species that too belonging to the genus *Atherigona*, viz., *A. soccata, A. bidens, A. folcata, A. naqvii, A. orientalis* and *A. punctata* are known to infest maize in the

country. The pattern of distribution of these species differs widely due to different agro-climatic conditions prevalent in India. *A. soccata* known to be a serious pest of sorghum in Africa and Asia. Jotwani et al. (1971) estimated 77.7 per cent losses in fodder yield of CSH-I due to sorghum shoot fly. Chaudhary and Sharma (1975) reported 69 to 97 per cent infestationin maize due to shoot fly and upto 20 per cent loss in grain yield was recorded by Pathak et al., (1971). Tiwana and Arora (2011) recorded the highest green fodder (751.4 q/ha) and dry matter (210.5 q/ha) of sorghum when crop was sown during end-April over mid season (begining of July) and late (mid-August) sown crop. The knowledge regarding time of appearance of a pest on the crop and period of its maximum activity helps in deciding sowing date and timing of control operations against the pest. The peak period of activity of shoot fly, A. saccata was determined by sowing the maize crop at weekly intervals during spring. Keeping in the view, heavy loss in spring maize due to *A. soccata*, these experiments were planned to record peak activity periods of shoot fly and varietal preference of shoot fly for implementation of suitable management tactics of this pest.

MATERIAL AND METHODS

The experiments on "Effect of date of sowing on the infestation of shoot fly, *Atherigona soccata* (Rondani) in maize and their varietal preference" were carried out on 33 hybrids and 43 inbred lines of maize in spring season of 2006 and on four selected germplasm in 2007 at Regional Research Station, CCSHAU, Uchani (Karnal). All the 76 genotypes were sown in a row of 4 meter length at fortnight intervals commencing from 25th January to 10th April, 2006 in a randomized block design with three replications. All the recommended agronomical practices except insecticidal application were adopted to raise the better crop. For recording number of eggs per plants five plants in each row of each genotype at random were marked for counting shoot fly eggs. The eggs per plant were counted in the morning daily and were removed by camel hairbrush to avoid recounting of eggs up to 30 days. In each genotype (excluding 5 selected plants taken for egg count) dead hearts caused by shoot fly were pulled out and counted 20 and 30 days after germination. The dead hearts caused by shoot fly could be easily pulled out and the bases of these dead hearts emitted bad and foul smell. The cumulative figures of each count were used to calculate per cent dead hearts in each genotype and dead hearts percentage was calculated by using the formula given as under.

$$\text{Per cent dead heart} = \frac{\text{Total number of dead hearts per genotype}}{\text{Total number of plants per genotype}} \times 100$$

One most resistant and one most susceptible genotype were selected each from 33 hybrids and 43 inbred on the basis of per cent dead heart caused by shoot fly in spring 2006. In year 2007 two hybrids; 193-2x161(resistant), 1128x163(susceptible) and two inbreds; C-78(resistant), 1348-6-2(susceptible) were sown in spring season at fortnight intervals in three replicated plots each of 2 meter row length and covered with plastic net as per the experiment planned previous year to confirm the resistance of the genotypes. Ten pairs of shoot fly per genotype were released in the caged plants as per procedure adopted by Singh and Verma, 1988. Five plants in each genotype replicated thrice were selected randomly and tagged for the observations on dead heart count. Later square root transformation after adding 0.5 to each original figure ($\sqrt{x+0.5}$) was done before subjecting the data to analysis of variance.

RESULTS AND DISCUSSION

Eggs laid by *A. soccata* on maize hybrids and inbreds under natural conditions (spring, 2006): It is evident from Table 1 that the *A. soccata* did not discriminate amongst the genotypes while laying eggs. However, irrespective of date of sowing the maximum mean number of eggs were laid on the genotype, 1128x163 (3.00 eggs/plant) and minimum (1.83 eggs/plant) on 193-2x161. Among the different dates of sowing, irrespective of hybrid the maximum mean number of eggs (3.61 eggs/plant) were recorded during third sowing (24th February), which was at par (3.12 eggs/plant) with 2nd sowing (9th February) and significantly higher than all other dates of sowing. The minimum mean numbers of eggs (0.90 egg/plant) were recorded in sixth date of sowing (10th April, 2006). The maximum number of eggs (4.50 eggs/plant) were observed during 3rd sowing (24th February, 2006) on hybrids 1343-6-2x1354-2,

1025x1011 and 1128x163 while it was minimum (0.5 egg/plant) during 6th sowing (10th April) on 161x163, 1025x1011, 162x163, HQPM-1, 193-1x161 and 193-2x161 (Table 1).

The data presented in Table 2 revealed that there was no significant difference among different maize inbred lines as regards the egg laying by *A. soccata*. The maximum mean number of eggs were laid on the genotype, 1348-6-2 (3.79 eggs/plant) and minimum (2.39 eggs/plant) on genotype 1011. In case of date of sowing the maximum mean number of eggs (4.61 eggs/plant) were observed during 3rd sowing (24th February) and significantly minimum eggs (0.99 egg/plant) were observed during 6th sowing (10th April). The maximum number of eggs (6.00 eggs/plant) were observed during 3rd sowing (24th February) on inbred line 1348-6-2 while it was minimum (0.5 egg/plant) during 6th sowing (10th April) on inbred C-78.

The results of field experiment on oviposition by shoot fly showed that there was no significant difference between the different inbred and hybrid genotypes in number of eggs laid by *A. soccata*. However in all the inbreds and hybrids the numbers of eggs laid by shoot fly increased from 1st sowing (25th January) to 3rd sowing (24th February) and then decreasing from 4th sowing (11th March) till 6th sowing (10th April). The number of eggs laid by shoot fly were recorded maximum during 3rd sowing (24th February) in all the inbreds and hybrids. It clearly indicates that this pest severally attacks the crop sown during this period.

Dead heart caused by *A. soccata* in maize hybrids and inbreds under natural conditions (spring, 2006): *A. soccata* cause maximum dead hearts when the hybrids were sown on 9th February to 26th March, 2006 at an interval of fifteen days under natural infestation condition (Table 3). Lowest dead heart was observed when the crop was sown on 25th January and 10th March, 2006. Regardless the hybrids, significantly maximum (34.02%) mean dead heart was recorded when the crop was sown on 24th February as compared to all other dates of sowing and significantly lowest (2.65%) when the crop was sown on 10th April, 2006. During the 1st sowing (25th January) significantly maximum (9.93%) dead heart was observed in hybrid 164D3-3x193-1 while minimum (5.81%) in 1344x1354-7. Likewise significantly highest (35.08, 42.30 and 32.81%) dead hearts were recorded during 2nd (9th Feb.), 3rd (24th Feb.) and 5th sowing (26th March), respectively on hybrid 1128x163 while significantly lowest (18.45, 24.65 and 11.32%) during 2nd (9th Feb.), 3rd (24th Feb.) and 5th sowing (26th March) sowing, respectively on hybrid 193-2x161. Significantly highest (35.99%) and lowest (18.89%) dead hearts were recorded on hybrid 164(3-4) 7-2 x 163 and 1344x1354-2, respectively during 4th sowing (11th March). Significantly highest (5.34%) dead heart was recorded in hybrid 1040-7x323 while lowest (0.50%) in 161-x163, 164(3-4)7-2x163, 164(3-4), 7-6x163, 170(1+2)x163, 1348-6-2x1354-2 and 1348-6-2x1354-7 during 6th sowing (10th April). Irrespective of date of sowing significantly highest (26.17%) dead heart was recorded in hybrid 1128x163 while lowest in 193-2x161 (13.71%). The interaction between date of sowing and hybrid was significant.

The perusal of the data presented in Table 4 revealed that irrespective of inbred lines the highest (60.33%) mean per cent dead heart was recorded during 3rd sowing (24th February) and was significantly higher than all other dates of sowing while significantly lowest (3.45%) dead heart was recorded during 6th sowing (10th April). Significantly high percentage of dead heart was observed in inbred 1348-6-2 (32.54, 57.79 and 52.87%) when the crop was sown on 25th January, 11th March and 26th March, respectively while significantly low percentage of dead heart (13.69, 35.23 and 23.46%) was observed in 170 (1+2), 1354-2 and 536 when the crop was sown on 25th January, 11th March and 26th March, respectively. During 2nd (9th February) and 3rd sowing (24th February) significantly higher percentage of dead hearts (62.77 and 83.95%, respectively) were observed in inbred 1348-6-2 while significantly lower percentage of dead hearts (39.22 and 41.44%, respectively) were observed in inbred line C-78. During 6th date of sowing (10th April) significantly high (7.19%) dead heart was observed in 1015WG-8 while significantly low 0.50 per cent dead heart was observed in inbred lines 1352, 150, 413 and 1105. Irrespective of date of sowing significantly higher (48.96%) dead hearts were found in inbred line 1348-6-2 while significantly low (27.72%) dead hearts were observed in C-78. In all the inbred lines the higher percentage of dead hearts were recorded when the crop was sown on 24th February. Seasonal incidence of shoot fly in terms of egg laid and dead heart formation on maize revealed that pest was most active when the crop was sown during 24th February to 11th March, 2006. These results suggests that crop planted between last week of February to mid of March get exposed to high *A. soccata* attack and this information can be used in the development of an effective and reliable screening technique for shoot fly resistance.

Eggs laid by *A. soccata* on maize hybrids and inbreds under artificial conditions (spring, 2007): The results presented in Table 5 revealed that the mean number of eggs on selected resistant and susceptible hybrids on different dates of sowing and within the same date of sowing was non significant. However, irrespective of hybrid number of eggs was recorded maximum when the crop was sown on 7th March than 20th February and 22nd March. The number of eggs during 2nd sowing (7th March) on hybrid 193-2x161 and 1128-163 was 3.00 and 3.50 eggs/plant, respectively, which was again numerically higher than 1st sowing (20th February) and 3rd sowing (22nd March). Irrespective of date of sowing more number of eggs (3.08 eggs/plant) were recorded on susceptible hybrid (1128x163) as compared to resistant hybrid (193-2x161) (2.75 eggs/plant).

The perusal of data presented in Table 5stated that there was no significant difference between selected resistant (C-78) and susceptible (1348-6-2) inbred lines in mean number of eggs/plant laid by *A. soccata* at different dates of sowing and within the same date of sowing. Irrespective of date of sowing more mean number of eggs/plant were recorded on inbred 1348-6-2 (3.66 eggs/plant) than inbred C-78 (3.41 eggs/plant).

Dead heart caused by *A. soccata* in maize hybreds and inbreds under artificial conditions (spring, 2007): The perusal of data presented in Table 6 stated that the hybrid 1128x163 suffered severally and showed significantly maximum (25.02, 26.06 and 23.31%) dead heart when the crop was sown on 20th February, 7th March and 22nd April, 2007, respectively than the hybrid 193-2x161 sown on similar dates of sowing where incidence was observed minimum 9.36, 10.43 and 10.12 per cent, respectively. Dead hearts formed by *A. soccata* in selected maize hybrid varied from 9.36 to 26.06 per cent during different dates of sowing. Irrespective of different dates of sowing, significantly more numbers of dead hearts were observed in hybrid 1128x163 (24.79%) as compared to 193-2x161 (9.97%). It is apparent from Table 6 that irrespective of the hybrids, higher percentage of dead heart (18.24%) was found when the hybrids were sown on 7th March followed by 20th February and 22nd April (17.19 and 16.71%, respectively). However, the dead hearts produced among different dates of sowing were not statistically significant. From this table we can also conclude that hybrid 1128x163 was more susceptible as compared to 193-2x161 in terms of per cent dead hearts. The identified least susceptible material need to be incorporated in future breeding program for developing new maize cultivars.

The data in Table 6 indicated that irrespective of date of sowing significantly more number of dead hearts was observed in inbred 1348-6-2 (63.31%) as compared to C-78 (29.04%). It is apparent from the results that irrespective of inbreds significantly higher parentage of dead hearts (47.44%) were found when the inbreds were sown on 22nd April which was at par with dead heart (46.68%) when the crop was sown on 20th February. Significantly low percentage of dead hearts (44.41%) was observed when the crop was sown on 7th March. Dead hearts formed by *A. soccata* in selected maize inbred varied from 28.74 to 66.06 per cent during different dates of sowing. On the basis of dead heart formation, the inbred C-78 was observed to be least susceptible as compared to inbred 1348-6-2 to the attack of *A. soccata*.

The foregoing discussion made it clear that by and large *A. soccata* did not discriminate amongst the plants of different inbred and hybrid genotypes while depositing eggs during 2006 and 2007 in both natural and artificial conditions, respectively. Similar observations were also recorded by earlier workers in spring sown maize. Rao and Panwar (2001) stated that shoot fly species did not discriminate among the plant of different varieties while laying eggs in the field. During present investigation in all the inbreds and hybrids the numbers of eggs laid by shoot fly increased from 1st sowing (25th January) to 3rd sowing (24th February) and then decreasing from 4th sowing (11th March) till 6th sowing (10th April). Similarly, Marwaha et al. (1984) also reported the peak period of activity of shoot fly species in crop sown from 3rd week of February to 1st week of March on the basis of number of eggs laid and dead hearts formed. These results are in accordance with Sarup et al. (1984) who reported that there was a decline in the shoot fly activity in maize sown after the second week of March and increased activity was noticed in the last week of February. Dhaliwal and Sandhu (1983) reported that early sowing of sorghum resulted in less shoot fly damage as compared to late sowing. Gandhale et al. (1983) observed significantly low percentage of dead hearts due to less number of eggs laid by the fly on early sown sorghum than late sown crop. According to Rao and Panwar (1995), the maize crop sown on 8th March 1993 had significantly more dead hearts (17.9%) caused by shoot fly as compared to dead hearts (6.6%) produced in the crop sown on 5th April.

Table 1: Average numbers of eggs laid per plant by *Atherigona soccata* on maize hybrids sown at fortnightly intervals during spring, 2006

Hybrids	*Mean number of eggs laid/plant						Mean
	25th Jan.	9th Feb.	24th Feb.	11th March	26th March	10th April	
1105×L287	2.00 (1.72)	3.50 (2.11)	3.75 (2.17)	3.25 (2.05)	2.00 (1.72)	1.00 (1.40)	2.58 (1.86)
1344×1354-7	1.25 (1.47)	2.50 (1.86)	3.25 (2.05)	2.50 (1.87)	1.50 (1.58)	1.00 (1.40)	2.00 (1.70)
HM-4	2.00 (1.72)	3.75 (2.15)	3.75 (2.17)	3.25 (2.05)	2.00 (1.72)	1.25 (1.47)	2.66 (1.88)
HM-7	2.50 (1.86)	2.75 (1.93)	4.00 (2.23)	2.75 (1.93)	1.75 (1.65)	1.25 (1.49)	2.50 (1.85)
1344×MBR-139	2.00 (1.72)	2.75 (1.92)	3.75 (2.17)	3.00 (1.99)	1.50 (1.58)	1.00 (1.40)	2.33 (1.80)
1343-6-2×1354-2	2.00 (1.71)	3.25 (2.05)	4.50 (2.34)	2.75 (1.93)	1.75 (1.65)	0.75 (1.31)	2.50 (1.83)
161×163	1.75 (1.65)	3.50 (2.10)	4.25 (2.27)	3.25 (2.05)	2.00 (1.72)	0.50 (1.22)	2.54 (1.84)
1126×163	1.50 (1.58)	3.00 (1.98)	3.50 (2.11)	3.25 (2.05)	1.75 (1.65)	0.75 (1.31)	2.29 (1.78)
164(3-4) 7-2×163	1.50 (1.56)	3.50 (2.11)	3.50 (2.11)	3.00 (1.98)	2.50 (1.84)	1.25 (1.47)	2.54 (1.85)
1348×MBR139	1.50 (1.56)	3.00 (1.99)	3.50 (2.10)	3.25 (2.05)	1.75 (1.62)	1.00 (1.40)	2.33 (1.79)
295×323	1.75 (1.65)	3.00 (1.99)	3.25 (2.05)	2.75 (1.93)	1.75 (1.65)	1.00 (1.40)	2.25 (1.78)
193-2×163	2.00 (1.72)	3.00 (1.99)	3.25 (2.05)	3.00 (1.98)	1.75 (1.65)	0.75 (1.31)	2.29 (1.78)
HHM-1	1.75(1.75)	2.75 (1.92)	3.75 (2.17)	2.75 (1.93)	1.75 (1.65)	1.00 (1.38)	2.29 (1.78)
1344×1348-6-2	2.25 (1.78)	3.75 (2.17)	3.25 (2.05)	2.75 (1.93)	1.75 (1.65)	1.00 (1.38)	2.45 (1.83)
1025×1011	2.25 (1.79)	3.50 (2.11)	4.50 (2.34)	3.00 (1.99)	1.75 (1.65)	0.50 (1.22)	2.58 (1.85)
HM-6	1.50 (1.58)	3.25 (2.05)	3.75 (2.17)	2.50 (1.86)	2.00 (1.71)	1.00 (1.40)	2.33 (1.79)
162×163	2.00 (1.72)	2.75 (1.92)	3.25 (2.05)	3.00 (1.99)	1.75 (1.65)	0.50 (1.22)	2.20 (1.76)
1348(6+8) ×1354-2	1.50 (1.53)	3.25 (2.05)	3.00 (1.99)	3.25 (2.05)	1.50 (1.58)	1.00 (1.40)	2.25 (1.77)
170(1+2) ×193-1	1.75 (1.62)	2.50 (1.86)	3.00 (1.98)	2.50 (1.87)	1.75 (1.65)	0.75 (1.31)	2.04 (1.71)
164(3-4) 7-6×163	2.00 (1.72)	3.00 (1.98)	4.00 (2.22)	2.50 (1.86)	1.75 (1.65)	1.25 (1.49)	2.41 (1.82)
HQPM-1	1.75 (1.65)	3.00 (1.98)	3.25 (2.04)	2.75 (1.93)	1.75 (1.65)	0.50 (1.22)	2.16 (1.74)
170(1+2) ×163	2.00 (1.72)	3.50 (2.11)	3.50 (2.12)	3.25 (2.05)	2.25 (1.78)	0.75 (1.31)	2.54 (1.85)
193-1×161	2.00 (1.72)	3.25 (2.05)	4.00 (2.22)	3.00 (1.96)	1.75 (1.65)	0.50 (1.22)	2.41 (1.80)
1128×163	2.50 (1.86)	3.75 (2.17)	4.50 (2.34)	3.75 (2.17)	2.50 (1.86)	1.00 (1.38)	3.00 (1.96)
413×163	1.50 (1.58)	3.00 (1.99)	3.50 (2.11)	3.00 (1.98)	2.50 (1.84)	1.25 (1.47)	2.45 (1.83)
488-1RG×163	2.00 (1.72)	3.25 (2.05)	3.50 (2.11)	3.00 (1.99)	1.50 (1.58)	1.25 (1.47)	2.41 (1.82)
170(1+2) ×161	1.75 (1.65)	3.00 (1.98)	4.00 (2.23)	2.75 (1.91)	2.25 (1.79)	1.00 (1.38)	2.45 (1.82)
1348-6-2×1354-2	2.00 (1.72)	3.50 (2.12)	3.25 (2.05)	3.25 (2.05)	2.50 (1.84)	0.75 (1.31)	2.54 (1.85)
164D3-3×193-1	1.50 (1.53)	3.75 (2.16)	3.75 (2.17)	3.00 (1.99)	2.00 (1.70)	0.75 (1.31)	2.45 (1.81)
1344×1354-2	1.25 (1.47)	2.75 (1.91)	3.25 (2.05)	2.75 (1.93)	1.75 (1.65)	1.00 (1.40)	2.12 (1.74)
1348-6-2×1354-7	1.50 (1.56)	2.75 (1.93)	3.50 (2.11)	2.50 (1.86)	2.00 (1.72)	1.00 (1.40)	2.20 (1.76)
193-2x161	1.25 (1.49)	2.50 (1.86)	3.00 (1.99)	2.25 (1.79)	1.50 (1.58)	0.50 (1.22)	1.83 (1.65)
1040-7×323	1.50 (1.56)	3.00 (1.99)	3.50 (2.10)	3.25 (2.05)	2.25 (1.78)	1.00 (1.40)	2.41 (1.81)
Mean	1.79 (1.65)	3.12 (2.02)	3.61 (2.13)	2.93 (1.97)	1.89 (1.69)	0.90 (1.36)	

*Average of 15 plants (5 plants per row) ×3 replication
Figures in parentheses are square root transformed values.

C.D. (p=0.05)
Date of sowing (0.12)
Hybrids (N.S.)

Table 2: Average numbers of eggs laid per plant by *Atherigona soccata* on maize inbred lines sown at fortnightly intervals during spring, 2006

Inbreds	*Mean number of eggs laid/plant						Mean
	25th Jan.	9th Feb.	24th Feb.	11th March	26th March	10th April	
193-1	2.25 (1.79)	3.75 (2.17)	4.50 (2.34)	4.25 (2.28)	3.00 (1.99)	1.00 (1.40)	3.12 (2.00)
323	2.00 (1.72)	3.75 (2.15)	4.75 (2.38)	3.50 (2.11)	3.00 (1.98)	0.75 (1.31)	2.95 (1.94)
170(1+2)	2.50 (1.84)	4.00 (2.22)	4.50 (2.33)	4.00 (2.22)	2.50 (1.86)	1.00 (1.40)	3.08 (1.98)
1348-6-2	2.75 (1.92)	5.00 (2.44)	6.00 (2.63)	4.50 (2.34)	3.25 (2.05)	1.25 (1.49)	3.79 (2.14)
209	2.25 (1.78)	3.75 (2.17)	4.50 (2.34)	4.00 (2.22)	2.75(1.91)	1.00(1.40)	3.04 (1.97)
164(3-4) 7-6	2.25 (1.75)	4.25 (2.28)	5.25 (2.49)	3.75 (2.17)	3.00 (1.98)	1.25 (1.47)	3.29 (2.02)
1352-58-9	2.25 (1.79)	3.75 (2.17)	4.50 (2.33)	4.00 (2.23)	2.50 (1.84)	0.75 (1.31)	2.95 (1.94)
1352	2.25 (1.78)	4.00 (2.23)	4.75 (2.39)	3.75 (2.16)	2.75 (1.90)	0.75 (1.31)	3.04 (1.96)
MBR-139	2.25 (1.78)	4.00 (2.22)	5.00 (2.43)	4.00 (2.22)	2.75 (1.93)	0.75 (1.31)	3.12 (1.98)
C-78	1.75 (1.63)	3.75 (2.17)	3.75 (2.17)	3.25 (2.05)	2.50 (1.87)	0.50 (1.22)	2.58 (1.85)
150	2.25 (1.79)	4.00 (2.22)	4.50 (2.33)	3.75 (2.16)	2.75 (1.92)	1.00 (1.40)	3.04 (1.97)
295	2.25 (1.78)	4.00 (2.23)	5.00 (2.44)	3.75 (2.17)	2.75 (1.91)	1.00 (1.40)	3.12 (1.99)
586	2.50 (1.86)	3.75 (2.17)	4.50 (2.34)	3.25 (2.05)	3.00 (1.99)	1.00 (1.40)	3.00 (1.97)
577-1	2.50 (1.86)	4.50 (2.33)	4.50 (2.34)	3.25 (2.05)	2.75 (1.93)	1.00 (1.40)	3.08 (1.98)
586-3	2.50 (1.86)	4.00 (2.23)	4.50 (2.32)	3.50 (2.21)	3.00 (1.98)	1.00 (1.40)	3.08 (1.98)
413	2.75 (1.90)	4.25(2.20)	4.75 (2.30)	3.75 (2.10)	2.75 (1.90)	1.00 (1.40)	3.20 (2.00)
163	2.50 (1.86)	4.25 (2.28)	5.00 (2.44)	3.50 (2.11)	2.75 (1.93)	1.25 (1.49)	3.20 (2.02)
1015WG-8	2.25 (1.78)	4.00 (2.22)	5.00 (2.44)	4.00 (2.22)	3.00 (1.98)	0.75 (1.31)	3.16 (1.99)
1354-2	2.25 (1.79)	3.75 (2.17)	4.50 (2.33)	3.25 (2.05)	2.75 (1.92)	1.00 (1.40)	2.91 (1.94)
1344	2.75 (1.92)	3.75 (2.17)	4.25 (2.27)	3.75 (2.17)	2.25 (1.78)	1.00 (1.40)	2.95 (1.95)
162	2.25 (1.79)	4.00 (2.22)	4.50 (2.34)	3.50 (2.11)	3.00 (1.99)	1.00 (1.40)	3.04 (1.97)
1332	2.50 (1.86)	4.00 (2.23)	4.25 (2.28)	3.75 (2.14)	2.75 (1.91)	1.00 (1.40)	3.04 (1.97)
164(3-4) 7-4	2.50 (1.86)	3.75 (2.17)	4.75 (2.39)	3.50 (2.10)	2.75 (1.91)	1.25 (1.49)	3.08 (1.99)
1105	2.25 (1.78)	4.50 (2.34)	4.75 (2.38)	3.75 (2.17)	2.25 (1.78)	1.25 (1.49)	3.12 (1.99)
139	2.25 (1.78)	3.75 (2.17)	5.25 (2.49)	3.75 (2.17)	2.50 (1.85)	0.75 (1.31)	3.04 (1.96)
335	2.25 (1.78)	4.25 (2.28)	4.00 (2.23)	3.50 (2.11)	2.75 (1.91)	1.00 (1.38)	2.95 (1.95)
326-3	2.25 (1.78)	3.75 (2.17)	3.75 (2.17)	3.75 (2.16)	3.00 (1.98)	1.00 (1.40)	2.91 (1.94)
327D	2.50 (1.86)	4.00 (2.23)	4.75 (2.39)	3.25 (2.05)	3.00 (1.99)	1.00 (1.40)	3.08 (1.99)
46	2.25 (1.78)	4.00 (2.22)	4.25 (2.25)	3.75 (2.17)	3.00 (1.98)	1.00 (1.40)	3.04 (1.97)
335	2.00 (1.72)	4.25 (2.28)	4.50 (2.33)	3.25 (2.03)	2.75 (1.93)	1.00 (1.40)	2.95 (1.95)
1011	2.25 (1.79)	4.00 (2.22)	3.75 (2.16)	3.75 (2.16)	2.75 (1.92)	1.00 (1.40)	2.391 (1.94)
536	2.25 (1.78)	3.75 (2.17)	4.75 (2.39)	4.00 (2.22)	3.00 (1.99)	1.00 (1.40)	3.12 (1.99)
161	2.50 (1.86)	4.00 (2.23)	4.00 (2.22)	3.75 (2.17)	2.75 (1.91)	1.25 (1.49)	3.04 (1.98)
164D-4(o)	2.25 (1.78)	4.00 (2.23)	4.75 (2.39)	4.00 (2.22)	2.50 (1.85)	1.25 (1.47)	3.12 (1.99)
193-2	2.25 (1.79)	3.75 (2.15)	4.25 (2.26)	3.75 (2.15)	2.75 (1.92)	1.00 (1.40)	2.95 (1.95)
1040C2	2.00 (1.72)	4.00 (2.22)	5.75 (2.59)	3.75 (2.17)	2.25 (1.86)	1.00 (1.40)	3.16 (1.97)
1094WG	2.25(1.78)	4.00 (2.22)	4.25 (2.27)	3.50 (2.12)	2.75 (1.91)	0.75 (1.31)	2.91 (1.94)
1025	2.50 (1.86)	4.00 (2.23)	4.75 (2.38)	3.25 (2.05)	2.75 (1.92)	1.00 (1.40)	3.04 (1.97)
488	2.50 (1.86)	4.75 (2.39)	5.25 (2.49)	4.00 (2.23)	3.00 (1.98)	1.00 (1.40)	3.41 (2.06)
1040-5	2.25 (1.78)	4.75 (2.39)	5.00 (2.43)	4.00 (2.23)	3.25 (2.05)	1.25 (1.47)	3.41 (2.06)
170(1+2+3)	2.50 (1.85)	4.50 (2.34)	5.50 (2.54)	3.75 (2.17)	2.75 (1.90)	1.00 (1.40)	3.33 (2.03)
326	2.25 (1.78)	4.00 (2.22)	3.75 (2.17)	3.75 (2.17)	2.25 (1.78)	1.00 (1.40)	2.83 (1.92)
316	2.25 (1.79)	4.00 (2.23)	4.00 (2.22)	3.50 (2.11)	3.00 (1.98)	1.00 (1.40)	2.95 (1.96)
Mean	2.32 (1.81)	4.04 (2.23)	4.61 (2.35)	3.70 (2.15)	2.77 (1.93)	0.99 (1.39)	

*Average of 15 plants (5 plants per row) ×3 replication
Figures in parentheses are square root transformed values

C.D. (p=0.05)
Date of sowing (0.04)
Inbred lines (N.S.)

Table 3: Dead hearts caused by *Atherigona soccata* in maize hybrids sown during spring, 2006

Hybrids	*Mean per cent dead heart*						Mean
	25th Jan.	9th Feb.	24th Feb.	11th March	26th March	10th April	
1105×L287	7.42(15.68)	33.50(35.32)	40.21(39.34)	32.64(34.82)	22.73(28.37)	2.88(9.66)	23.23(27.20)
1344×1354-7	5.81(13.83)	19.74(26.32)	24.83(29.84)	20.26(26.72)	15.00(22.70)	4.03(11.49)	14.95(21.82)
HM-4	7.64(15.95)	31.75(34.20)	37.70(37.81)	31.70(34.24)	28.24(31.95)	2.03(8.01)	23.18(27.03)
HM-7	6.26(14.28)	26.68(30.67)	37.85(37.95)	28.10(31.99)	24.10(29.04)	2.76(9.41)	20.96(25.55)
1344×MBR-139	7.44(15.79)	22.34(27.98)	38.67(38.43)	25.92(30.57)	13.88(21.78)	2.57(2.05)	18.57(23.93)
1343-6-2×1354-2	7.46(15.68)	21.67(27.61)	39.46(38.89)	30.23(33.33)	26.70(30.90)	3.53(10.75)	21.51(26.19)
161×163	7.56(15.91)	35.04(36.27)	41.70(40.20)	30.49(33.48)	30.13(33.19)	0.50(4.05)	24.24(27.18)
1126×163	6.07(14.14)	29.72(33.01)	34.10(35.69)	24.31(29.48)	20.76(27.08)	2.25(8.47)	19.53(24.62)
164(3-4) 7-2×163	7.75(15.98)	24.32(29.50)	34.62(36.01)	35.99(29.27)	24.15(29.06)	0.50(4.05)	19.22(23.98)
1348×MBR139	7.70(15.97)	29.24(32.71)	36.58(37.17)	27.22(31.33)	25.67(30.31)	2.72(9.37)	21.52(26.14)
295×323	6.91(15.03)	19.11(25.78)	26.17(30.74)	19.93(26.49)	11.83(20.01)	2.80(9.52)	14.46(21.26)
193-2×163	7.06(15.35)	23.96(29.21)	36.78(37.31)	28.34(32.14)	20.91(27.02)	4.27(11.69)	20.22(25.45)
HHM-1	7.41(15.71)	19.05(25.77)	26.02(30.61)	19.88(26.45)	14.04(21.95)	1.61(6.71)	14.67(21.20)
1344×1348-6-2	8.64(17.00)	24.63(29.61)	32.70(34.82)	21.01(27.21)	15.04(20.74)	2.83(9.53)	17.47(23.48)
1025×1011	8.60(16.95)	24.28(29.32)	31.95(34.35)	24.81(29.77)	14.26(22.13)	3.28(10.34)	17.86(23.81)
HM-6	8.71(17.12)	26.45(30.90)	37.48(37.72)	24.29(29.44)	18.66(25.50)	2.76(9.41)	19.17(25.01)
162×163	8.97(17.30)	24.24(29.33)	32.62(34.75)	23.49(28.93)	13.80(21.72)	3.06(9.98)	17.70(23.67)
1348(6+8) ×1354-2	7.19(15.44)	21.85(27.72)	31.66(34.19)	25.73(30.43)	15.03(22.72)	4.10(11.59)	17.59(23.68)
170(1+2) ×193-1	6.16(14.23)	20.06(26.51)	25.98(30.62)	20.70(26.99)	15.69(23.30)	4.5(12.27)	15.53(22.32)
164(3-4) 7-6×163	8.49(16.77)	25.73(30.28)	37.15(37.52)	24.22(29.40)	17.99(24.97)	0.50(4.05)	19.01(23.83)
HQPM-1	8.25(16.61)	19.84(26.33)	25.63(30.37)	20.34(26.78)	15.97(23.51)	3.27(10.29)	15.55(22.32)
170(1+2) ×163	8.39(16.73)	34.29(35.81)	40.91(39.74)	32.42(34.68)	31.31(33.96)	0.50(4.05)	24.63(27.50)
193-1×161	8.38(16.73)	29.98(33.09)	31.86(34.28)	22.15(28.02)	20.29(26.73)	2.27(8.52)	19.60(24.56)
1128×163	9.20(17.56)	35.08(36.29)	42.30(40.55)	35.75(35.50)	32.81(34.90)	3.86(11.20)	26.17(29.33)
413×163	8.32(16.46)	30.87(33.73)	33.78(35.50)	26.85(31.17)	27.74(31.73)	3.06(9.98)	21.77(26.43)
488-1RG×163	9.52(17.92)	31.37(34.03)	35.72(36.65)	22.82(28.47)	27.38(31.50)	3.00(9.86)	21.63(26.40)
170(1+2)×161	9.26(17.59)	25.87(34.44)	35.59(36.57)	20.64(27.00)	14.32(22.10)	2.88(9.67)	18.09(23.90)
1348-6-2×1354-2	8.60(16.96)	30.64(33.58)	32.13(34.42)	22.34(28.12)	26.50(30.93)	0.50(4.05)	20.11(24.68)
164D3-3×193-1	9.93(18.32)	33.84(45.54)	41.66(40.18)	32.47(34.72)	28.72(32.36)	3.86(11.25)	25.08(28.73)
1344×1354-2	7.15(15.19)	19.79(26.34)	25.54(30.31)	18.89(25.73)	20.25(26.68)	2.79(9.46)	15.73(22.29)
1348-6-2×1354-7	8.43(16.78)	29.18(32.60)	35.05(36.27)	23.47(28.88)	14.91(22.57)	0.50(4.05)	18.59(23.53)
193-2×161	6.52(14.61)	18.45(32.29)	24.65(29.73)	19.09(25.88)	11.32(19.58)	2.25(8.47)	13.71(20.59)
1040-7×323	9.27(17.62)	28.83(32.31)	35.71(35.45)	21.25(27.42)	21.92(27.87)	5.34(13.26)	20.05(25.65)
Mean	7.89(16.16)	24.96(29.84)	34.02(35.58)	26.41(30.71)	20.67(26.69)	2.65(8.89)	

Figures in parentheses are angular transformed values.

C.D. (p=0.05)

Date of sowing	0.26
Hybrids	0.62
Date of sowing × Hybrids	1.53

Table 4: Dead hearts caused by *Atherigona soccata* in maize inbreds shown during spring, 2006

	Mean per cent dead heart						
Inbreds	25th Jan.	9th Feb.	24th Feb.	11th March	26th March	10th April	Mean
193-1	17.98(24.36)	48.71(44.24)	63.62(53.17)	52.17(46.23)	45.42(42.35)	3.19(10.19)	38.51(36.76)
323	13.99(21.58)	46.69(43.08)	60.64(51.15)	54.49(47.56)	39.07(38.62)	3.12(10.06)	36.33(35.34)
170(1+2)	13.69(21.34)	46.82(43.15)	69.69(56.58)	51.07(45.59)	42.26(40.51)	1.61(6.41)	37.52(35.65)
1348-6-2	32.54(34.65)	62.77(52.40)	83.95(66.73)	57.79(49.46)	52.87(46.62)	3.83(11.21)	48.96(43.52)
209	23.18(27.68)	49.45(44.66)	61.05(51.38)	49.13(44.48)	42.03(40.39)	3.61(10.87)	38.07(36.58)
164(3-4) 7-6	27.43(31.30)	61.53(51.66)	70.32(56.98)	55.15(47.95)	50.70(45.38)	2.79(9.50)	44.65(40.46)
1352-58-9	21.69(27.01)	48.49(42.12)	61.66(51.73)	47.54(43.57)	44.47(41.80)	2.85(9.61)	37.78(36.31)
1352	24.11(28.38)	50.65(45.35)	67.70(55.38)	51.48(45.83)	45.10(42.16)	0.50(4.05)	39.92(36.86)
MBR-139	22.87(27.49)	45.11(42.16)	67.88(55.93)	55.15(47.93)	43.67(41.34)	3.16(10.38)	39.67(37.54)
C-78	15.80(22.91)	39.22(38.73)	41.44(40.05)	37.84(37.94)	29.83(32.93)	2.18(8.33)	27.72(30.15)
150	17.54(23.90)	40.03(39.20)	42.25(40.52)	37.16(37.54)	32.00(34.32)	0.50(4.05)	28.25(29.92)
295	20.44(25.98)	48.51(44.12)	59.89(50.71)	50.07(45.02)	43.10(41.00)	1.61(6.71)	37.27(35.59)
586	23.39(28.24)	48.33(44.02)	59.82(50.73)	46.11(42.75)	46.68(43.07)	3.12(10.06)	37.91(36.48)
577-1	19.43(25.25)	46.73(43.09)	56.17(48.57)	41.62(39.97)	43.55(41.25)	3.70(10.94)	35.15(34.85)
586-3	21.96(27.56)	48.41(44.07)	59.09(50.27)	47.87(43.76)	35.80(36.47)	1.89(7.20)	35.80(34.89)
413	26.32(30.72)	47.01(43.26)	60.67(51.36)	55.26(48.00)	45.41(42.34)	0.50(4.05)	39.19(36.62)
163	22.03(27.71)	49.42(44.64)	65.15(53.83)	54.18(47.38)	41.91(40.30)	3.89(11.31)	39.43(37.53)
1015WG-8	22.74(28.04)	48.27(43.98)	55.36(48.09)	47.52(43.56)	43.45(41.20)	7.19(15.49)	37.42(36.73)
1354-2	18.65(24.98)	41.30(39.96)	44.08(41.58)	35.23(36.37)	31.88(34.26)	4.30(11.90)	29.24(31.51)
1344	18.72(24.75)	41.86(40.29)	43.51(41.25)	37.59(37.79)	34.54(35.93)	1.61(6.72)	29.64(31.12)
162	16.99(23.75)	48.72(44.24)	59.64(50.57)	40.40(39.44)	42.48(40.64)	3.55(10.78)	35.30(34.90)
1332	20.38(26.23)	50.57(45.31)	51.40(45.79)	49.47(44.68)	45.38(42.33)	3.54(10.71)	36.79(35.84)
164(3-4) 7-4	22.58(27.87)	50.45(45.24)	59.73(50.61)	38.32(38.22)	49.80(44.86)	4.00(11.47)	37.48(36.38)
1105	20.88(26.55)	50.00(44.98)	52.89(46.66)	40.14(39.28)	42.36(40.57)	0.50(4.05)	34.46(33.68)
139	22.80(27.68)	50.22(45.11)	59.53(50.53)	46.91(43.21)	43.49(41.23)	3.28(10.34)	37.70(36.35)
335	24.15(29.29)	47.63(43.62)	69.75(56.64)	54.60(47.62)	42.40(40.61)	4.41(12.04)	40.49(38.30)
326-3	25.27(29.15)	53.83(47.20)	60.00(50.78)	53.35(46.90)	49.92(44.93)	4.23(11.73)	41.10(38.45)
327D	25.90(29.87)	47.29(43.42)	59.17(50.31)	46.59(43.02)	44.02(41.54)	3.89(11.30)	37.81(36.58)
46	24.99(29.37)	47.76(43.68)	55.06(47.91)	40.01(39.21)	46.14(42.76)	3.97(11.38)	36.32(35.72)
335	25.89(30.27)	48.06(43.68)	65.57(54.07)	52.59(46.47)	47.04(43.28)	4.67(12.42)	40.63(38.39)
1011	26.81(30.75)	51.14(45.63)	51.97(46.52)	45.25(42.25)	45.10(42.16)	3.16(10.02)	37.24(36.15)
536	23.12(28.27)	48.70(44.23)	59.79(50.57)	52.14(46.21)	23.46(37.02)	2.16(7.63)	37.04(35.66)
161	26.61(30.91)	47.59(43.59)	66.40(54.65)	53.54(47.01)	42.06(40.39)	3.99(11.17)	40.03(37.95)
164D-4(O)	29.60(32.81)	53.26(46.85)	63.51(52.85)	50.10(45.04)	49.05(44.43)	3.71(11.03)	41.54(38.93)
193-2	26.10(30.42)	50.05(45.01)	67.28(55.12)	55.55(48.17)	43.75(41.37)	5.00(12.50)	41.29(38.76)
1040C2	25.10(29.97)	52.56(46.47)	61.04(51.38)	50.47(45.25)	38.61(38.37)	6.17(14.27)	38.99(37.62)
1094WG	19.43(25.66)	52.31(46.31)	49.34(44.60)	38.92(38.57)	458.61(42.46)	7.07(15.38)	35.44(35.50)
1025	23.73(28.72)	49.27(44.56)	59.13(50.26)	49.85(44.89)	36.32(36.93)	3.19(10.17)	36.91(35.92)
488	30.03(32.90)	59.68(50.62)	73.96(59.34)	55.60(48.20)	50.50(45.27)	3.83(11.21)	45.60(41.26)
1040-5	26.00(30.20)	61.33(51.54)	71.27(57.58)	56.54(48.74)	48.70(44.23)	2.30(8.57)	44.35(40.14)
170(1+2+3)	27.23(31.08)	59.07(50.23)	73.59(59.18)	51.52(45.85)	48.90(44.35)	6.58(14.83)	44.48(40.92)
326	20.39(26.24)	51.54(45.47)	56.94(48.95)	46.51(42.98)	37.99(37.90)	5.00(12.87)	36.39(35.80)
316	27.67(31.30)	48.28(43.99)	53.61(47.08)	46.38(42.90)	44.35(41.73)	4.73(12.24)	37.50(36.54)
Mean	22.93(27.98)	48.35(44.02)	60.33(51.11)	49.73(44.8.3)	43.11(40.97)	3.45(10.17)	

Figures in parentheses are angular transformed values.

C.D. (p=0.05)

Date of sowing	0.24
Inbreds	0.65
Date of sowing × Inbreds	1.60

Table 5: Average number of eggs laid by *Atherigona soccata* on selected maize hybrids and inbreds during spring, 2007

Maize germplasm	Mean number of eggs laid/plant			
	20th February	7th March	22nd March	Mean
Hybrids				
193-2×161 (R)	2.75	3.00	2.50	2.75
	(1.92)	(1.99)	(1.86)	(1.92)
1128×163 (S)	3.25	3.50	2.50	3.08
	(2.05)	(2.11)	(1.86)	(2.01)
Inbreds				
C-78 (R)	3.50	3.50	3.25	3.41
	(2.11)	(2.11)	(2.05)	(2.09)
1348-6-2 (S)	3.50	4.00	3.50	3.66
	(2.11)	(2.23)	(2.11)	(2.15)

Figures in parentheses are square root transformed values.
R- Resistant
S- Susceptible

C.D. (p=0.05)
Date of sowing (N.S.)
Hybrids (N.S.)
Inbreds (N.S.)

Table 6: Dead hearts caused by *Atherigona soccata* in maize hybrids and inbreds under artificial caged conditions during spring, 2007

Date of Sowing	Mean per cent dead heart					
	Hybrids			Inbreds		
	193-2×161 (R)	1128×163 (S)	Mean	C-78 (R)	1348-6-2 (S)	Mean
20th February	9.36	25.02	17.19	28.74	64.63	46.68
	(17.76)	(29.96)	(23.86)	(32.39)	(53.59)	(42.99)
7th March	10.43	26.06	18.24	29.56	59.26	44.41
	(18.73)	(30.62)	(24.68)	(32.83)	(50.49)	(41.66)
22nd April	10.12	23.31	16.71	28.83	66.06	47.44
	(18.49)	(28.82)	(23.65)	(32.45)	(54.37)	(43.41)
Mean	9.97	24.79	-	29.04	63.31	-
	(18.33)	(29.80)		(32.56)	(52.80)	

Figures in parentheses are angular transformed values.
R- Resistant
S- Susceptible

C.D. (p=0.05) for hybrids
Date of sowing (N.S.)
Hybrids (0.76)

C.D. (p=0.05) for hybrids
Date of sowing (0.97)
Inbreds (0.79)
Date of sowing × Inbreds (1.38)

REFERENCES

[1]. Aruna, C., Bhagwat, V. R., Sharma V., Hussain T., Ghorade R. B., Khandalkar H. G., Audilakshmi, S. and Seetharama N. 2011. Genotype x environment interactions for shoot fly resistance in sorghum (Sorghum bicolor (L.) Moench): Response of recombinant inbred lines. Crop-Protection, **30**(6): 623-630.

[2]. Chaudhary, R. N. and Sharma, V. K. 1975. Note on the comparative resistance of some elite maize germplasms to shoot fly in spring season. Indian J. Agri. Sci. **45**(11-12): 561

[3]. Dhaliwal, G. S., Sandhu, G. S. 1983. Effects of the dates of sowing and seed rates on the infestation of sorghum shoot fly, *Atherigona soccata* R. and the yield of sorghum fodders. J. Res. Panjab Agric.Univ. **18**(2): 157-162.

[4]. Gandhale, D. N., Salunkhe, G. N., Naik, L. M. 1983. Incidence of shoot fly as influenced by sowing time and a seeds rates of sorghum. J. Maharashtra Agric. Univ. 8(3): 294-295.

[5]. Jotwani, M. G., Dinesh Chandra., Young, W. R., Sukhani, T. R. and Saxena, P. N. 1971. Estimation of avoidable losses caused by the insect complex on sorghum hybrid CSH-1 and percentage increase in yield over untreated control. Indian J. Ent. 33 : 375-383.

[6]. Marwaha, K. K. Siddiqui, K. H., Panwar, V.P.S. and Sarup, P. 1984. Peak period of activity of shoot fly species (*Atherigona soccata* Rondani and A. naqvii Steyskal) in spring sown maize germplasms. J. Ent. Res. **8**(2):199-208.

[7]. Pathak, P. K., Sharma, V. K. and Singh, J. M. 1971. Effect of date of planting of spring sown maize on the incidence of shoot fly, *Atherigona spp.* and loss in yield due to its attack. Annual report, 1971-71. Experimental Station, U.P. Agricultural University, Pantnagar.

[8]. Rao, K. Ramachandra and Panwar, V. P. S. 1995. Efficacy of mixtures of carbosulfan treated and untreated maize seeds for the control of shoot fly species (*Atherigona soccata* and A. naqvii) in spring season. Pesticide Research Journal **7**(2) : 149-150.

[9]. Rao, C. N. and Panwar, V. P. S. 2001. Morpholgoical plant factors affecting resistance to *Atherigona spp.* in maize. Indian J. Genet. **61**(4): 314-317.

[10]. Sarup, P., Siddiqui, K. H., Marwaha, K. K. and Panwar, V. P. S. 1984. Changing pest complex of maize as exemplified by the shoot fly (*Atherigona spp.*) preference for hosts in spring season. J. Ent. Res. **8**(2): 115-119.

[11]. Siddique, S. S., Arif M., Babu R., Yadav U., Bisht S. and Hooda, K. S. 2011. Assessment of some newer insecticides against sorghum shootfly, *Atherigona soccata* Rondani. Journal of Experimental Zoology, **14**(1): 301-302.

[12]. Singh, S. P. and Verma, A. N. 1988. monitoring of shoot fly, *Atherigona soccata* (Rondani) in traps and their periodic incidence in sorghum. Crop Res. 1(1): 76-83.

[13]. Tiwana, U. S. and Arora R. 2011. Evaluation of seed rate and sowing time for management of shoot fly (*Atherigona spp.*) in forage sorghum. Journal of Insect Science. Ludhiana. **24**(4): 402-406.