INTRODUCTION

Maize (Zea mays L.) is the most completely domesticated crop among the cereals. Mexico or Central America is most likely being the origin of corn (Martin et al., 2002). In Pakistan, maize is the most important cereal after wheat and rice. Maize is a multipurpose crop, providing food and fuel for human, feed for poultry and livestock and have a great nutritional value. Maize is used as raw product for manufacturing many industrial products (Afzal et al., 2009).

During 2008-2009, maize was sown on 1052.1 ha in Pakistan with an average production of 3415 kg ha⁻¹ and with a total production of 3593 tons (MINFA, 2008-2009).

Maize is most vulnerable to Chilo partellus (Swinhoe) (Lepidoptera: Pyralidae) which causes severe losses to maize crop. It is an important pest in Asian and African countries (Arabjafari and Jalali, 2007).

Maize production is severely affected by maize stem borer to the degree of 15 -60%. A loss of 24-75% has been reported by the attack of this pest alone (Kumar, 2002). Farid et al. (2007) reported 10-50% damage by maize stem borer in Peshawar valley. Yield losses caused by stem borers in Africa are as high as 80% for maize alone, while in Kenya, 18% yield losses was attributed to C. partellus and C. orichalocociliellus in maize and as much as 88% in sorghum by C. partellus. Maximum stalk damage in maize and up to 80% grain yield loss in sorghum by Chilo partellus were reported in 20 days old crops, whereas, similar infestations induced no significant loss when plants were infested soon (6 days) after emergence (Van den berg, 2009).

Various approaches have been made to control maize stem borer including cultural, physical, biological and...
chemical in an uncoordinated manner throughout the country. There is dearth of research regarding the level of infestation in the stubble and particularly in the stalks.

Keeping in view the importance of the crop as well as importance of the maize stem borer, this study was initiated to investigate the level of infestation of the maize stem borer in the stubbles and stalks at farmer’s fields in the main maize growing area of Mardan division of Khyber Pakhtunkhwa, Pakistan.

MATERIALS AND METHODS

To investigate the level of maize stem borer infestation in the stubbles and stalks, two trials were carried out in Mardan during 2012.

Experiment No. 1

In this experiment, two maize varieties (Local white and Hybrid, Pioneer-3025-W) were sown at farmer’s fields at three different locations: Ghowndo, Palo and Baddar in Katlang (Mardan). Farmers were given all the required inputs as well as the produce. After the crops were harvested in October, five samples (considered as replication) each of 50 stubbles in each locality at the selected field were randomly dug out with the help of “Kudal” from both the local white and hybrid maize fields during mid November. The Stubbles were cut open with the help of field knife and examined for stem borer infestation. The presence of larvae, pupae and puparium were considered for infestation.

Experiment No. 2

The second trial was carried out to know the extent of hibernating larvae and pupae in the stalks (dried stalks stored as a heap for fodder purposes) at farmer’s fields in three different locations: village Ghowndo, Palo and Baddar. However, during the month of December and January, five samples (considered as replications) each of 50 stalks in each location were randomly selected from the heaps and cut open with the help of field knife for examination. The presence of larvae, pupae and puparium were considered for infestation.

Data analysis

The data were analyzed statistically and means were separated using LSD test at P<0.005. Mean percentages and standard deviations (SD) was also calculated for all means. T-test was used to compare the mean percent infestation of MSB in stubbles.

RESULTS AND DISCUSSION

The results of percent damage by stem borer in stubbles of maize are shown in Table 1. The data show significant difference at P<0.05 of the main effects of locations and varieties. Highest mean percent infestation of 20.0 in stubbles of MSB was recorded in V1 at L2 whereas the lowest (15.0) mean percent infestation was recorded at L1. Mean percent infestation of 16.7 recorded at L3 is on par with L1. In V2, the highest (33.3) mean percent infestation was recorded at L2 as compared to L3 where the mean percent infestation was recorded lowest, that is, 15.0%. Moreover, the mean percent infestation of MSB recorded in V2 at L1 was 25.0%, which was significantly different from L2 and L3.

Overall mean percent infestation of MSB in stubbles show highest infestation of 26.7 at L2 followed by 20.0 and 15.8% at L1 and L3, respectively. Statistical analysis of the data showed that all the three locations were significantly different at P<0.005 from each other in percent infestation. Significant difference between the two cultivars, that is, V1 and V2 was recorded as P<0.01 (T-test). The data revealed highest MSB infestation (24.4%) in V2, whereas, the lowest (17.2%) mean percent infestation was recorded in V1. The maize stem borer infestation was recorded highest in V2 as compared to V1 where the infestation was recorded lowest and was significantly different from variety V1.

Furthermore, data in Table 2 indicates significant difference between the locations at the mean percent of maize stem borer larvae at P<0.05. In variety V3, the maximum mean percent (6.0%) of hibernating larvae was recorded in L2, whereas the minimum mean percent of 1.0% was recorded in L3. The mean percent of hibernation larvae recorded at L4 was 2.7%, and is paired on with L3. In V5, the maximum mean percent of 17.7% hibernating larvae was recorded at L2 followed by 6.0 and 1.0% at L1 and L3, respectively. The treatments L1, L2 and L3 were significantly different from each other in the mean percent of maize stem borer hibernating larvae.

Overall mean percent of hibernating larvae of maize stem borer in stubbles showed significant difference among the treatments. The maximum mean percent of 11.8% was recorded at L2 followed by L1 and L3, that is, 4.3 and 1.0% respectively. The T-test indicated significant difference between V1 and V2 at P<0.01. The data showed maximum mean percent (8.2) of maize stem borer hibernating larvae at V5 whereas the minimum mean percent was recorded at V1, that is, 3.2%. The data indicated maximum mean percent of hibernating larvae in stubbles at variety V2 as compared to V1 where the mean percent of hibernating larvae was recorded minimum.

Descriptive statistics of the data on MSB damage in stalk of maize at three locations are presented in Table 3. The average infestation show significant differences among the localities, the highest damage occurred at L1 and lowest in L2, the stem borer infestation in maize stalks ranged from
Table 1. Percent infestation of MSB, *C. partellus* (Swinhoe) (Lepidoptera: Pyralidae) in stubbles of two maize cultivars at three locations in Mardan, during 2012

<table>
<thead>
<tr>
<th>Location</th>
<th>V1 (Local white)</th>
<th>V2 (Hybrid)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ghwondo (L1)</td>
<td>15.0 b</td>
<td>25.0 b</td>
<td>20.0 b</td>
</tr>
<tr>
<td>Palo (L2)</td>
<td>20.0 a</td>
<td>33.3 a</td>
<td>26.7 a</td>
</tr>
<tr>
<td>Badder (L3)</td>
<td>16.7 b</td>
<td>15.0 c</td>
<td>15.8 c</td>
</tr>
<tr>
<td>Mean</td>
<td>17.2</td>
<td>24.4</td>
<td>-</td>
</tr>
</tbody>
</table>

Treatments means with common letters are non-significant by LSD test at P<0.05 MSB maize stem borer.

Table 2. Mean Percent of MSB *C. partellus* (Swinhoe) (Lepidoptera: Pyralidae) hibernating larvae in stubbles of two maize cultivars at three locations in Mardan, during 2012

<table>
<thead>
<tr>
<th>Location</th>
<th>V1 (Local white)</th>
<th>V2 (Hybrid)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ghwondo (L1)</td>
<td>2.7 b</td>
<td>6.0 b</td>
<td>4.3 b</td>
</tr>
<tr>
<td>Palo (L2)</td>
<td>6.0 a</td>
<td>17.7 a</td>
<td>11.8 a</td>
</tr>
<tr>
<td>Badder (L3)</td>
<td>1.0 b</td>
<td>1.0 c</td>
<td>1.0 c</td>
</tr>
<tr>
<td>Mean</td>
<td>3.2</td>
<td>8.2</td>
<td>-</td>
</tr>
</tbody>
</table>

Treatments means with common letters are non-significant by LSD test at P<0.05 MSB maize stem borer.

Table 3. Descriptive statistics of *C. partellus* (Swinhoe) (Lepidoptera: Pyralidae) infestation in stalks of maize at three localities in Mardan during 2012.

<table>
<thead>
<tr>
<th>Locality</th>
<th>Total</th>
<th>Average</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Lower Limit</th>
<th>Upper Limit</th>
<th>SD</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ghwondo (L1)</td>
<td>29</td>
<td>7.25</td>
<td>3</td>
<td>10</td>
<td>5.70</td>
<td>8.80</td>
<td>3.10</td>
<td>1.55</td>
</tr>
<tr>
<td>Palo (L2)</td>
<td>23</td>
<td>5.75</td>
<td>2</td>
<td>9</td>
<td>4.31</td>
<td>7.19</td>
<td>2.87</td>
<td>1.44</td>
</tr>
<tr>
<td>Badder (L3)</td>
<td>26</td>
<td>6.5</td>
<td>1</td>
<td>9</td>
<td>4.65</td>
<td>8.35</td>
<td>3.70</td>
<td>1.85</td>
</tr>
</tbody>
</table>

3-10 % at location L1, while the damaged ranged from 2-9 % at location L2 and from 1-9 at location L3.

Mean percent infestation of MSB in stubbles was recorded highest at L2 (Palo) followed by L1 (Ghwondo) and L3 (Badder), respectively. Significant difference between the two cultivars, that is, V1 (Local white) and V2 (Hybrid) was also recorded as P<0.01 (T-test). The maize stem borer infestation was recorded highest in V2 as compared to V1 where the infestation was recorded lowest and was significantly different from variety V1. Mean percent of hibernating larvae of maize stem borer in stubbles was recorded maximum at L2 followed by L1 and L3, respectively. The data indicated maximum mean percent of hibernating larvae in stubbles at variety V2 as compared to V1 where the mean percent of hibernating larvae was recorded minimum. Similar results of differences in hibernating larvae in stubbles of the different varieties were also reported by Ali et al. (2002) in Peshawar valley. An effective control required to destroy old stalks and stubbles in order to reduce the first generation of adult's population. Similar results of observations of MSB in stalks after harvest have been reported by Seshu (1985) and Warui and Kuria (1983) in Africa. Kfir (1990) reported 90,000 to 226,000 larvae over winter ha⁻¹ in South Africa. Slashing maize stubbles destroy 70% of maize borer population and additional plowing and disking destroy additional 19% of the pest population in maize (Kfir, 1990).

Crop residues are crucial for carrying over stem borer larval populations from one growing season to the next. In Kenya, *C. partellus* was reported from stalks after the crop harvest (Seshu, 1985; Warui and Kuria, 1983). Tillage may reduce borer populations through mechanical damage either by burying them deeply into the soil or by breaking the stems and exposing the larvae to adverse weather conditions (Ajayi, 1998), as well as birds, rodents, ants, spiders, and other natural enemies (Seshu, 1988). Control measures have to be applied to manage the pest harmoniously, moths emerging from untreated fields can infest adjacent crops. Currently, this system is not widely adapted in South Africa because of the minimum tillage...
practices and the need for winter grazing beef farmers on
maize (Kfir, 2000).

In rural Africa, maize, sorghum, and millet's dry stems are
used in houses construction as a fencing material, as fuel,
bedding for livestock, boundaries of terraces on slopes, and
as stakes (Sagnia, 1983). Farmers normally stack dry stalks
in the field where they are kept until commencement of
rains before being taken to villages, thus creating a
reservoir for infestation in the following season. To solve
this problem, early cutting of stalks and horizontal position
on the soil surface has been recommended. This was
observed to cause mortality of 97% of stem borers in maize
and 100% in sorghum in Ethiopia, and to reduce the
residual population of borers in millet from 16% in uncut
stems to 3% (Youm et al., 1993). The high level of
mortalities of C. partellus, Chilo orichalcociliellus, and S.
calamisit in horizontally placed stalks was attributed to the
effects of sun and heat, more specifically, the reaching of the
thermal threshold for survival (Päts, 1996). Control of B.
fusca and C. partellus by burning old stalks and other crop
residues immediately after harvest has been recommended.
Almost complete inhibition of C. partellus on maize and
sorghum was achieved in Tanzania by burning stalks
(Duerden, 1953). In Nigeria, about 95% of farmers kept
sorghum stalks and did not follow the practice of burning
them after harvest as per recommendation. As conciliation,
fractal burning was recommended while the leaves are
dry but the stems are not (Adesiyyun and Ajayi, 1980).
Burning leaves generate heat which kills up to 95% of
larvae and the stalks are cured at the same time, making the
stalks stronger as construction materials and more
deployed 45% larvae hibernating inside the dry stalk in the
lower 3rd and 50% in the middle 3rd position of sorghum
grown for grain. Crop residues are the only source of
natural substance added into soils in many small-holding of
farms in African countries but burning crop residues can
cause troubles in farms where the natural content of soils is
low. Burning of crop residues are also creating problems
where soil is eroded by wind and rain is harsh. The base
line is to organize the dry stalks before the next cropping in
order to minimize the emergence of the adults that can
assault the new crop.

CONCLUSION AND RECOMMENDATIONS

In conclusion, the percent infestation of maize stem borer
in stubbles and the mean percent of hibernating larvae
were highest at Hybrid variety at Palo. In stalks, the maize
stem borer infestation was also recorded highest at Palo. In
field conditions, it is necessary to organize the dry stalks
before the next cropping season in order to minimize the
emergence of the adults that can assault the new crop.

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