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Overwintering Population of Maize Stem Borer *Chilo partellus* (Swinhoe) at High Altitudes of Kashmir

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Abstract: The present work regarding the overwintering population of maize stem borer *Chilo partellus* (Swinhoe) at larval stage was conducted in order to determine degree of overwintering population and the level of infestation of this pest at different localities of Azad Kashmir. Off 1796 stubbles of maize, present findings showed that over all high population of *C. partellus* (29.1%) larvae was recorded from locality Chota Gala while the lower (18.73%) was from Rawalakot locality. Whereas greater population (27.77%) of overwintering was found on the stubbles of maize genotype "Kashmir Gold" than "Sarhad White" (20.75%). A significant difference in overwintering population was found among all the studied localities. The percentage of infestation (on the basis of exit hole on stubbles) caused by *C. partellus* was significantly ($P < 0.001$) high (27.77%) on "Kashmir Gold" than on the "Sarhad White" (15.99%) in all the studied areas. No clear relationship was found between the stem thickness and the overwintering population of maize stem borer or its infestation.

Key words: *Chilo partellus* (Swinhoe), maize, overwintering population, stubbles

Introduction

Azad Kashmir lies to the north east of Pakistan under the foothills of great Himalayas. It has a variable topography and climate. Major crops grown are maize, potato and wheat. Among these crops, Maize (*Zea mays*) is an important food grain crop all over the world. World maize production in 1977 was 350 million tonnes from nearly 112 million-hectare (Chaudhary, 1983). In Pakistan, maize is annually cultivated on an area of more than 700 thousand hectares. The province of Punjab contributed 96% in area and 98% in total production. The yield in the province was 1340 Kg ha^{-1}in 1977-78 and 1310- Kg ha^{-1} in 1980-81 (Chaudhary, 1983). In Azad Kashmir, maize crop was grown over an area of 1,23,000 hectares each year (Anonymous, 1988). Its yield was 1054 Kg ha^{-1}in Azad Jammu and Kashmir. Three main varieties of maize being cultivated in Kashmir are Kashmir Gold, Meer Alam and Sarhad White.

Maize provides industrial raw material for production of glucose, starch, dextrin, cornflakes, corn oil etc alongwith nutritional needs. Besides a large number of pharmaceutical products, alcoholic beverages are also commercially prepared from maize. The cobs are used for cleaning, brushing, polishing, abrasives for soaps, ceramics, glues and adhesives, as a carrier for insecticides and other pesticides rubber compounds and tyres.

Yield of maize in Azad Jammu & Kashmir is far below as compared with agriculturally advanced countries of world (Anonymous, 1988). Cultivation of this crop is however, handicapped by number of insect pests which heavy toll of its production annually. Among these, maize stem borer *Chilo partellus* (Swinhoe), is notorious pest of this crop and plays havoc role with it all over the world (Atwal, 1976).

C. partellus, is the most destructive pest. Its damage reaches up to 75% and sometimes the crop is totally failed if remains uncontrolled (Latif *et al*., 1960). The young larvae *C. partellus* first feeds on the leaves making a few shot holes and then bore its way downwards through the central whorl reaching the growing tips of the maize plant. As the whorl opens, more shot holes become visible indicating an earlier attack and the plants also show the dead hearts. The full-grown caterpillar of the last generation hibernates in stubble, stalk etc. and remains there till the appearance of the next generation. The plants remained stunted in growth (Atwal, 1976). Kfir (1988) studied hibernation by the lepidopteran stalk borer *C. partellus* and reported that more than 90% of the plants at two sides were infested but as the winter progressed, the proportion of the plant infested and the level of infestation dropped gradually. The larvae hibernated inside the dry stalks, 45% were in the lower third and 50% in the middle third of the stalk whereas 40% of the larvae in 6th instar and 45% of the larvae hibernate in 5th larval instar. Chaudhary and Sharma (1988) worked on the induction and termination of diapause in *C. partellus* and showed that induction of diapause in the pest began from second week of the September up to mid-November, after which all surviving entered diapause. Termination of diapause was found to depend on the favorable environmental conditions. Kfir (1991) reported that diapause has also effect on the development and the reproduction of the maize stem borer. Adesiyum and Ajays (1980) suggested that the partial burning of stalks which results in killing 95% of the larvae still needs to be adopted by west African farmers.

In Azad Jammu & Kashmir, most of the farmers are passive in removing the stubbles after harvesting of the maize crop and it could have been contributing in reduction the pest population in the following crop season. Therefore, maize stem borer, *C. partellus,* the most important pest of the maize crop was selected for the present study. It may be worth mentioning that previously no scientific work has been carried out regarding overwintering population of *C. partellus* in Azad Kashmir. The objective of the study was to observe the extent of overwintering larvae/ population in the different cultivars of maize at different localities of Azad Kashmir and to evaluate the level of infestation due to presence of emergence hole and larvae in the stubbles.

Materials and Methods

The present studies were carried to determine the overwintering population of maize stem borer *Chilo partellus* (Swin.) at high altitudes of Kashmir during 1997. Three localities were selected for present study. Each locality comprises of two sites. The elevation of these localities ranges from 1500 to 1750 meters above the sea level (Table 1). Approximately 1800 stubbles of maize were collected. The road distance between locality Rawalakot and Chota Gala was 12 Km and distance from Rawalakot to Dheerkot was 40 Km. Each locality lies approximately 12-50 Km. whereas each site is located at 1-8 Km. road/walking distance.

Chota Gala (Locality 1): Chota Gala is situated in Distric Rawalakot at the height of 1715 meters above sea level. Two sites Burniar and Tehun were selected from this locality. The road distance between the two sites is one kilometer.

Burniar (Site 1A): At Burniar previously sown variety "Sarhad White" was selected for study purpose from Muhammad Rahim's farm. A total number of 360 maize stubbles were observed. Off these, finally 300 stubbles randomly selected for further observations. The crop was sown on 15th May 1997 and harvested on 1st October 1997. Only urea fertilizer was used. Field was surrounded by kiker (*Acacia arabica*) and populus (*Populus eumericana*) trees on one side and maize crop on the other sides.

Table 1: Genotypes of Maize (*Zea mays*) and number of stubbles observed in different research sites of Azad Kashmir

Localities	Elevation above sea level (m)	Sites	Owner's name	Genotypes	Number of stubbles observed
Chota Gala	1715	Burniar	M. Raheem	Sarhad White	360
		Tehun	M. Akram	Kashmir Gold	302
Dheerkot	1500	Dyar Gali	Abdul Aziz	Sarhad White	300
		Tehaili	Shafi Khan	Kashmir Gold	300
Rawalakot	1615	Kharick	Jamshaid Khan	Kashmir Gold	301
		University	AJK	Kashmir Gold	99
		campus	University	Sarhad White	99
				Meer Alam	99

Tehun (Site 1B): From this site, a total number of 300 maize stubbles of "Kashmir Gold" variety was observed from M. Akram's field. Sowing and harvesting of crop was done on 16th May 1997 and 3rd October 1997, respectively. Only urea fertilizer was used. Maize field and populas trees surrounded maize crop.

Dheerkot (Locality 2): In Distric Bagh, Dheerkot lies at the height of 1500 meters above the sea level. Two sites Diar Gali and Tehaili were selected. The road distance between these two sites is 8 kilometers.

Dyar Gali (2A): At Diyar Gali "Sarhad White" was selected for study purpose from Abdul Aziz's field. A total number of 300 maize stubbles were observed. The crop was sown on 2nd June 1997 and harvested on 20th September 1997. The field was surrounded by apple trees on one side and the maize field on the other sides. No fertilizer was used.

Tehaili (2B): From this site, a total number of 300 stubbles of "Kashmir Gold" was selected from Shafi Khan's field. Sowing and harvesting were done on 13th May 1997 and 5th October 1997. No fertilizer was used. Surrounding habitat consisted of vegetables like; karam, apple trees, kikar plantation and maize fields.

Rawalakot (Locality 3): Distric Rawalakot is situated at the height of 1615 meters. Two sites Kharick and University campus were selected from this locality. The road distance between these two sites is 4 kilometer.

Kharick (Site 3A): From this site (Kharick), maize genotype "Kashmir Gold" was observed. A total number of 300 maize stubbles were observed from Jumshaid Khan's field. According to farmer's statement, date of sowing of crop was 12th May 1997 and harvesting date was 2nd October 1997. The farmer had applied urea fertilizer to this crop. The field was surrounded by maize crop from all the sides.

University campus (3B): At university campus, Rawalakot, three genotypes of maize viz. Kashmir Gold, Meer Alam and Sarhad White were selected from the field experimental plots. A total number of 297 stubbles were observed from the field experimental plots. From each variety, 99 stubbles were selected for the study work. The crop was sown on 24th June 1997 and harvested on 24th October 1997. Sunflowers, cauliflowers and populus trees surrounded the maize field.

Method of sampling: For sequential and accurate sampling, a precise method of estimates was used for overwintering population of *Chilo partellus* as described by Southwood, 1978. A local made quadrate (iron quadrate) measuring 2×2 feet^2 was used as a standard tool to record the number of stubbles per unit area. The presence of larvae in the stubbles was considered as overwintering population.

Quadrate throwing and counting of stubbles: The quadrate was thrown randomly in the field of maize. The maize stubbles per quadrate (–5) were counted. The stubbles, which touched the quadrate border, were taken in to count.

Cutting of the maize plant and measure of diameter of the stubble: The maize plant was cut down at different heights with the help of sickle in order to determine the location of overwintering larvae (if any) in the stalk. The cutting was made at the height of 10, 15 and 20 cm above the ground level at University Campus Rawalakot. Cutting of maize plant was only carried out at University Campus and no such method was applied at any other. The diameter was measured with the help of verniar calliper at the point of cutting in order to determine if there is any relation between stem thickness and the infestation of the *Chilo partellus.* After the removal of the stubbles from the maize field, each stubble was subjected to cutting. The stubbles were carefully cut vertically to determine the presence or absence of larvae inside the stubbles. Presences of exit hole on the stubbles were also considered as the infestation of *C. partellus*.

Recording/ counting of overwintering larvae and statistical analysis: Each stubble, from all sites was thoroughly observed for overwintering larvae and recorded for further analysis. The numbers of exit holes were also recorded for infestation purposes. The presence of larvae and exit holes on stubbles were recorded separately and considered as overwintering population and infestation. All the collected information regarding the overwintering population as well as infestation of *C. partellus* was analyzed statistically using General Linear Model (GLM) on computer. The missing data of Sarhad White variety from University Campus was adjusted by assuming the observed information and added to analysis purposes. Correlation between the overwintering population and diameter of stubbles was also made statistically.

Results and Discussion

The overwintering population and infestation of *Chilo partellus* (Swinhoe) had been previously reported by many research workers like Ampofo (1988); Mohyuddin and Attique (1978); Muzaffar Ahsan (1982); Singh *et al*. (1985); Van Hamburg (1980); Kfir (1988); Ingram (1958) and Kumar (1984) etc. They found that overwintering larvae causing infestation hibernate into the stubble and stalk of maize. The result pertaining to overwintering population and infestation of maize stem borer are discussed as under.

Overwintering population of *Chilo partellus* (Swinhoe): Different scientist like Atwal (1976); Chaudhary and Sharma (1988) and Kfir (1991) had also worked on the hibernation of the *C. partellus.* The present finding show (Table 2) that the overwintering population of *C. partellus* larvae varied in all the three localities

Table 2: Analysis of the variance of the overwintering population of *C. partellus* in maize stubbles at different sites of distric Poonch and Bagh during 1997

Source	DF	SS	MS	F-value	P- value
Locality	2	3.0781	1.5530	8.65	< 0.001
Site	1	0.7799	0.7882	4.39	< 0.001
Locality x Site	2	3.8686	1.9343	10.78	< 0.001
Error	1791	321.4564	0.1795		
Total	1796	306.81			

Significant differences of population density was also found among all the study sites. An interaction between the locality and site was also found.

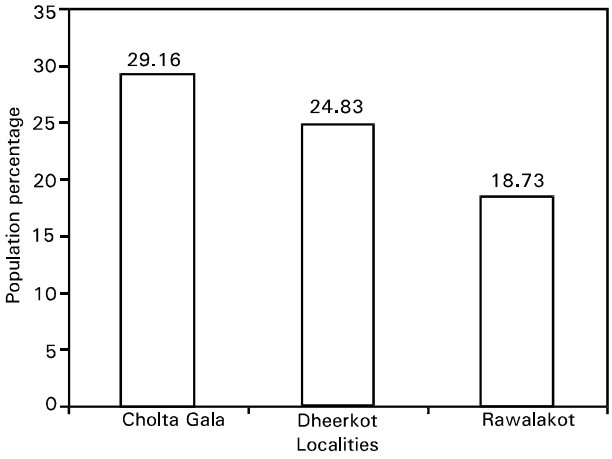

Fig. 1: %age overwintering population of *C. partellus* at different localities of Azad Kashmir.

The higher overwintering population of *C. partellus* was recorded at locality Chota Gala than Rawalakot locality (Fig. 1) Overall, off 1796 stubbles, a total number of 436 overwintering larvae were recorded from the studied maize stubbles (Table 3). Whereas the greater numbers 250 (27.77%) of overwintering larvae were found in the stubbles of Kashmir Gold than "Sarhad White" 186 (20.75%).

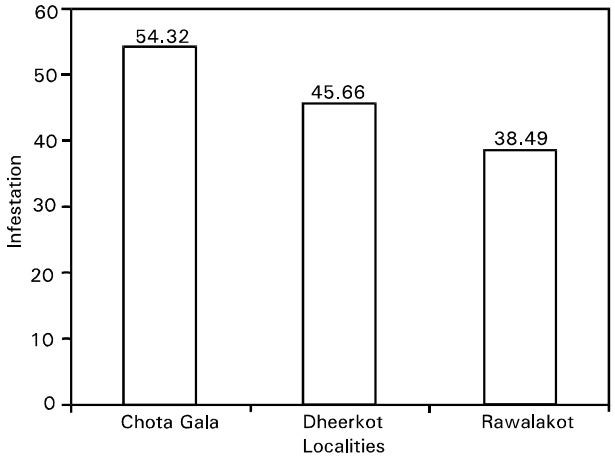

Fig. 2: Combined infestation (larvae + exit hole) of *C.partellus* at different localities of Azad Kashmir

These variation in overwintering larval population at different localities and sites could be due to several reason such as each locality differs in ecological situation, topography, varietal difference etc. For instance, distric Rawalakot lies at higher altitude than the Bagh. A difference in habitat might have played an important role in the insect population. For example, maize crop was sown in small belts than the larger ones at each site, almost all the maize growing areas, were covered by either different types of large trees (mainly apple) or mix crops (sunflower, cauliflower, etc.). Similarly, varietal difference showed a greater difference in overwintering population of *C. partellus* larvae in "Kashmir Gold" than "Sarhad White"

Infestation of *C. partellus* on the basis of exit hole in maize stubbles: The infestation of maize stem borer on the basis of exit hole was highly significant ($P < 0.000$) at all the localities of study sites and a significant ($P < 0.000$) interaction was also found due to the infestation of this pest (Table 4). A total number of 1796 stubbles of different genotypes collected from various localities of Azad Kashmir were observed individually for the presence/absence of exit hole made by larvae. Off these, a total number of 394 stubbles were infested due to the presence of exit holes that contributed an overall 21.92% infestation/ attack. The infestation percentage of *C. partellus* found on genotype "Kashmir Gold" in localities Chota Gala, Dheerkot and Rawalakot was 34.33, 24.66 and 24.33% whereas infestation observed on "Sarhad White" was 16.00, 17.00, 15.20% respectively in these localities (Table 5). The highest percentage (27.77%) of infestation due to the presence of exit hole was recorded in "Kashmir Gold "than "Sarhad White" (15.99%). The infestation of *C. partellus* ultimately causes reduction in grain yield of maize. Mohyuddin and Attique (1978) also reported grain loss of 85.3 kg ha^{-1} in maize for one percent infestation of *C. partellus*. The difference in the degree of infestation could be due to various reasons such as varieties of maize observed, ecological variation, food preference by the pest.

Combined infestation of *C. partellus* larvae (larvae + exit hole): The highest infestation of *C. partellus* was recorded at locality Chota Gala whereas the lower one was at Rawalakot (Fig. 2). The combined infestation was determined by adding the presence of larvae and exit hole in maize stubbles. The analysis of variance (Table 6) for combined infestation showed a significant ($P < 0$) variation in the degree of infestation at all the localities but no difference was found between the sites. The reasons of the variations could be the same as discussed in above lines. It is not known that why there was no difference in combined infestation when all the sites were analyzed.

Correlation between the thickness of maize stem borer and the overwintering of *C. partellus* larvae: The thickness of 1796 stubbles were recorded individually in order to determine the relation between the thickness of maize stem borer and the overwintering *C. partellus* larvae. There was either little correlation ($r = 0.555$, $n = 300$) or weak correlation (Table 7) between the

Table 3: Presence of overwintering *C. partellus* larvae in maize stubbles at different localities of Azad Kashmir during 1997

Locality	Site	Genotype	Number of stubbles		%age of overwintering larvae
			Observed	Larvae found	
Chota Gala	Burniar	Sarhad White	300	83	27.66
	Tehun	Kashmir Gold	300	92	30.66
Dheerkot	Dyar Gali	Sarhad White	300	73	24.33
	Tehaili	Kashmir Gold	300	76	25.33
Rawalakot	Kharick	Kashmir Gold	300	82	27.33
	University campus	Sarhad White	296	30	10.13

Table 4: Analysis of variance for the infestation of *C. partellus* in maize on the basis of exit holes in stubbles at different sites of distric Poonch and Bagh during 1997.

Source	DF	SS	MS	F-value	P- value
Locality	2	3.84	1.92	19.49	< 0.001
Site	1	1.08	1.08	11.00	< 0.001
Localityx Site	2	0.63	0.31	3.24	< 0.001
Error	1791	176.80	0.09		
Total	1796	182.38			

Table 5: Percentage of *C. partellus* larval infestation on the basis of exit hole on maize stubbles at different localities of Azad Kashmir during 1997.

Locality	Site	Genotype	Number of Stubbles		%age of infestation
			Observed	Exit holes	
Chota Gala	Burniar	Sarhad White	300	48	16.00
	Tehun	Kashmir Gold	300	103	34.33
Dheerkot	Dyar Gali	Sarhad White	300	51	17.00
	Tehaili	Kashmir Gold	300	74	24.66
Rawalakot	Kharick	Kashmir Gold	300	73	24.33
	University campus	Sarhad White	296	45	15.20
	Total		1796	394	131.52/6 = 21.92

Table 6: Analysis of variance of combined infestation of *C. partellus* (larvae + exit hole) in maize stubbles at different sites of distric Poonch and Bagh during 1997.

Source	DF	SS	MS	F-value	P- value
Locality	2	0.94	0.47	5.06	< 0.001
Site	1	0.03	0.03	0.40	< 0.525
Localityx Site	2	2.18	1.19	11.74	< 0.001
Error	1791	166.74	0.09		
Total	1796	169.91			

Table 7: Correlation between the stem diameter (cm) and the overwintering population of *C. partellus* larvae in maize stubbles at different localities of Azad Kashmir during 1997.

Locality	Sites	Genotypes	Number of stubbles observed	Stem diameter (cm)		
				Range	Average(± SE)	R-value
Chota Gala	Burniar	Sarhad White	300	1.00-2.0	1.5 ± 0.01	0.577
	Tehun	Kashmir Gold	300	1.00-3.2	1.6 ± 0.01	0.066
Dheerkot	Dyar Gali	Sarhad White	300	1.00-2.6	1.7 ± 0.01	0.105
	Tehali	Kashmir Gold	300	1.00-2.8	1.5 ± 0.01	-0.035
Rawalakot	Kharick	Kashmir Gold	300	0.80-2.4	1.5 ± 0.01	0.288
	University campus	Sarhad White	296	1.10-2.3	1.6 ± 0.01	0.139

Any case of studied variety. It appears that larva hibernates in any genotype irrespective of the stem thickness.

stem diameter and overwintering larval population. It is concluded that stem thickness had no effect on the over wintering population *C.partellus* larva in any case of studied vareity. It appears that larva hibernates in any genotype irrespective of the stem thickness.

The stalk containing larvae and pupae of the stem borer reinfest the young maize plants after adult emergence. The recommended practice of burning stalks completely after the grain has been harvested with view to killing all the diapausing larvae, is seldom followed by farmers who use stalks for variety of purpose (Kumar, 1984)

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