SURVIVAL AND DEVELOPMENT OF THE STEMBORER *CHILO PARTELLUS* (SWINHOE) (LEPIDOPTERA : PYRALIDAE) ON SELECTED WILD GRAMINEOUS PLANTS

by

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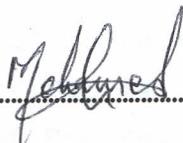
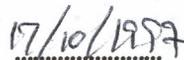MASTER OF SCIENCE (M.Sc.)

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DECLARATION

This thesis is my original work and has not been submitted for a degree to any other university.

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CERTIFICATION

We certify that this work was carried out by Mohamed Hassan Mohamud under our supervision and is being submitted for examination with our approval as supervisors.

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ABSTRACT

A major constraint to increase the production of maize is competition from phytophagous insects. The Lepidopteran stem borer, *Chilo partellus* (Swinhoe) (Lepidoptera:Pyralidae), is considered to be one of the most damaging insect in Eastern and Southern Africa. Understanding the role of wild alternate host plants in sustaining stem borer population is important for development of crop protection strategies.

A comparative study was therefore undertaken to determine the behaviour and biology of *C. partellus* on selected wild and cultivated host plants. The host plants included susceptible maize (Inbred A) and five wild host plant species of family Poaceae (Graminae)-*Sorghum versicolor* Anderss, *Pennisetum purpureum* Schumach, *Panicum maximum* Jacq, *Echinochloa pyramidalis* (Lam.) and *Hyparrhenia rufa* (Nees) Stapf. The aspects investigated were ovipositional behaviour, larval arrest and dispersal, larval feeding, food assimilation and larval growth and development. There was no significant ($P = 0.05$) difference between any of the host plants tested in ovipositional response in no- and multiple-choice tests. In two-choice tests, however, there was significant ($P = 0.05$) difference in number of eggs laid on Inbred A (424 eggs) against *P. purpureum* on which 966 eggs were laid. Larval arrest on leafcuts obtained from test plants in petri dishes at 4 and 24 hours after infestation was not significantly ($P = 0.05$) different among any of the wild grasses tested in no-choice tests; also no significant ($P = 0.05$) differences were found in the number of larvae arrested on Inbred A (8.66 and 5.0) versus

S. versicolor (6 and 4.16) at 1 and 24 hours after infestation in two-choice tests. In multiple-choice tests, the number of first instar larvae arrested on both Inbred A (20.20) and *S. versicolor* (19.10) was significantly (P = 0.001) higher than on the other host plants at 24 hours after infestation. The lowest number of larvae was recorded on *H. rufa* with only 2.70. When whole plants were used the number of larvae arrested was significantly (P =0.001) higher on Inbred A (10.0) and *S. versicolor* (8.33) than on the other host plants. Larval feeding on leaf discs of different host plants was significantly (P = 0.001) higher on Inbred A (45%) than on the wild host plants. There were no significant (P = 0.05) differences among the wild host plants in weight (mg) of stem consumed by larvae. However, there was significantly (P = 0.05) more food assimilated of Inbred A (0.45 mg) leafcuts than on *E. pyramidalis* (0.15 mg), *P. maximum* (0.06 mg) and *H. rufa* (0.03 mg). Larval development was significantly (P = 0.001) faster on Inbred A and *S. versicolor*, than on the other test plants.

S. versicolor was the most suitable wild host plant for survival and development of *C. partellus* larvae, while *P. purpureum* was suitable for oviposition. The wild host plants could be used as a bordering or trap crops for adult oviposition and larval arrest with maize, and cut off after the cultivated crop has passed the susceptible stage. This would have the effect of eliminating high proportion of *C. partellus* egg batches as well as first instar larvae.

CHAPTER ONE

1.0 **INTRODUCTION**

Among several insects that attack maize, stem borers are an ubiquitous and economically important group. The pest importance is often due to the type of damage suffered by the crop (Hill and Waller 1982). These insects infest maize throughout its growth (from seedling stage to maturity). Seventeen species of stemborers belong to family Pyralidae and Noctuidae have been found to attack maize in various parts of Africa (Seshu Reddy, 1983; Bosque-perez and Mareck, 1990; Khan et al., 1991). The most injurious species are *Chilo partellus* (Swinhoe), *Busseola fusca* Fuller, *Sesamia calamistis* Hampson, and *Eldana saccharina* Walker. The spotted stem borer *C. partellus* (Swinhoe), is an important insect pest of maize (*Zea mays* L) in Eastern and Southern Africa. Infestation in maize plants starts during the early whorl stage of the crop (Mathez 1972; Ampofo 1985). Damage symptoms include leaf-feeding which starts in the whorl and results in deadheart formation if the feeding extends to the meristematic region. Severe stem-tunnelling occurs when the larvae bore into the stem and consequently, results in stem-breakage. Yield losses of 18% (Warui and Kuria 1983) and 44% (Mohyuddin and Attique, 1978) have been attributed to this insect in Kenya and Pakistan respectively.

C. *partellus*, indigenous to Asia, is widely distributed in Eastern and Southern Africa (Bleszynski 1970). *C. partellus*, is

most economically important stemborer species in maize in East and Southern Africa at elevations below 1800 m (Seshu Reddy 1983). *C. partellus* was first recorded in Africa by Tams (1932), but was not reported again until some 20 years later in Tanzania (Duerdon 1953). Since that time, the geographic distribution of *C. partellus* has continued to expand with reports from Kenya, Uganda, Rwanda, South Africa, Ethiopia, Sudan, Somalia, Botswana, Malawi, Mozambique, Swaziland, Zimbabwe, and Zaire (Nye 1960; Ingram 1983; Harris 1990). In Madagascar, *C. partellus* was first recorded in 1972, and by 1975 it was considered to be the most damaging stem borer in maize, surpassing the indigenous *Chilo orichalcociliellus* Strand (Delobel 1975). Recent surveys by Overholt et al., (1994) indicate that the exotic *C. partellus* may gradually be displacing the indigenous *C. orichalcociliellus*. Electrophoresis of *Chilo* larvae collected in maize and sorghum fields in the coastal belt of Kenya indicated that 26.8% were *C. orichalcociliellus* and 73.2% were *C. partellus* (Kioko et al., 1995).

In Africa, where the bulk of maize is grown on small plots surrounded by land occupied by wild gramineous plants (Bowden, 1976), stemborers infest cultivated crops in high populations. To understand the population dynamics of stemborers in cultivated crops, knowledge of the ecological relationships between stemborers and native grasses is essential (Bowden, 1954). Unfortunately, very little research work has focused on the role of native grasses in stemborer ecology.

The survival of many herbivorous or phytophagous insect larvae depends on the ability of the adult to select a suitable host plant for oviposition. A basic knowledge of the oviposition behaviour of *C. partellus* in relation to the wild host species is important in identifying the most preferred host plant. This would reduce the number of egg batches which female moths would lay on maize in the absence of preferred wild host plant for oviposition, which in turn could be used in the management of *C. partellus*. One of the objectives of this study was to determine the ovipositional preference of *C. partellus* among five wild host plants in comparison to the susceptible maize cultivar, Inbred A.

The first two instars of *C. partellus* larvae establish within the whorls of the plants where they feed generously on the young leaf tissue. Third instar larvae migrate away from the whorls into other tissues as they become differentiated (Ampofo and Kidiavai, 1987). The ability to recognize and assess various biochemical and/or biophysical characteristics on the plant surface is probably of great value to the larvae. This would facilitate the recognition of acceptable or non-acceptable plants and guide larvae to preferred feeding sites. Schoonhoven (1973) discussed the role of chemoreceptors on the antennae and maxillary palpi of Lepidopteran larvae in discerning various volatiles from the plant surface and host plant recognition. Ampofo and Kidiavai (1987) reported that the movement and development of larvae infesting the plants will differ from one phenological stage to the other. They also reported that the duration the larvae remain in the whorls of plants may vary among cultivars, depending on the plant and its growth characteristics. Growth and development of an insect on its

host plant is one method used to determine the suitability of the plant and mechanisms of resistance of the plant to the insect. Larval growth is related to physical characteristics of the plant, lack of nutrients or presence of toxins or deterrents which influence food intake and digestion by the insect (Soo Hoo and Fraenkel, 1966). It is known that, insect feeding and metabolism are components of insect-plant relationships (Kumar, 1993). Stem borer larvae feed in communities of wild and cultivated grasses that have stems sufficiently large to accommodate stem borer feeding tunnels (Harris, 1990).

Most stem borers of maize are generally polyphagous and attack several gramineous host plants (Tams and Bowden, 1953; Seshu Reddy, 1983). During non-cropping seasons when there is a paucity of cultivated crops in the field, stem borers either aestivate or diapause in crop residues, or they remain active in wild host plants. Maize planting and the termination of *C. partellus* pupal period are both related to the commencement of the rains (Schelters, 1978). Thus, there is synchrony between the early growth stages of maize plants and infestation of the fist generation of *C. partellus*.

Present knowledge of survival and development of *C. partellus* on wild host plants is limited. Information obtained from this study would be important in future for the possible incorporation of wild host plants in the integrated management of the stalk borer.

1.1 Objectives of the study

1.1.1 General objectives

The general objective of this study is to examine the survival and development of *C. partellus* on selected wild host plants and to compare these responses with those on a susceptible maize variety, Inbred A.

1.1.2. Specific objectives

The specific objectives were as follows:

1. To evaluate the ovipositional responses of *C. partellus* to selected wild host plants and on susceptible maize variety Inbred A.

2. To study larval arrest and dispersal on both leafcuts and whole plants of different host plants.

3. To evaluate feeding, assimilation of food, growth and development of *C. partellus* larvae on different host plants.

2.0 **LITERATURE REVIEW**

2.1. <u>Description and Biology of *Chilo partellus*</u>

The spotted stem borer, *C. partellus* (Swinhoe) of the family
Pyralidae is a moth of medium-size and straw-colored. An adult
female lays nearly 500 eggs in masses of 10 - 80 eggs (ICRISAT,
1983), the lower surfaces of the leaves are more preferred
(Ampofo, 1985). The eggs are flattish and oval and tend to
overlap like fish scales. They hatch in 4 - 5 days. The larval
period lasts from 19 - 27 days. Pupation takes place inside the
stem and the adults emerge in 7 - 10 days through the exit holes.
At the end of the rainy season the last instar larvae may enter
into diapause. The diapausing larvae can be found in stubbles and
stalks remaining in the field. As the next rainy season starts,
the diapause is broken and pupation takes place, giving rise to
the first generation of adults (ICRISAT, 1983).

2.2. <u>Alternate hosts</u>

Knowledge of the role of alternative host plants in pest
population dynamics is important in developing pest management
strategies. The presence of alternative host plants in or near a
field can increase survival of the pest during the crop-free
periods, thereby increasing the population that colonizes the crop
once it is planted. In contrast, some alternative hosts may act
as trap plants during cropping periods by decreasing the pest

population on the cultivated crops. Orders of insects, including Lepidoptera have their own different host plants (Le Pelley, 1959). The host range of lepidopteran stemborers that attacks cereals appears limited to grasses (Graminae), sedges (Cyperaceae) and cat-tails (Typhaceae) (Jepson, 1954). *C. partellus* attacks maize as well as wild grasses and its host cereal crops and various wild gramineous plants (Harris, 1990)

Limited information is available on behavioral responses of stemborers to wild host plants and on the importance of wild hosts in population dynamics. Survival of *Sesamia calamistis* Hampson varied markedly between food sources (*Andoropogon* sp., *Pennisetum polystachion, P. purpureum, Panicum maximum, Sorghum arundinaceum,* Maize and artificial diet) (Shanower et al., 1993). When reared on artificial diet, approximately 95% of the larvae successfully pupated. Maize was the next best food source with 30% of larvae pupating. Survival was very low on all five wild grasses. When reared on *S. arundinaceum*, 7% of the larvae pupated, whereas less than 1% of larvae pupated on *P. maximum, P. purpureum, Andropogon* sp and *P. polystachion.*

Bessin and Reagan (1990) reported that the sugarcane borer, *Diatrae saccharalis*, fed on different wild hosts such as *Leptochloa filiformis, Digitaria sanguinnalis, Eulesine indica, Echinochloa colona* and rye grass, *Lolium temulentum*, but maize was considered as the optimal host.

2.3. Ovipositional preference

Neem seed kernel extracts can affect the insect female moths egg oviposition. No egg deposition of the Oriental fruit fly, *Dacus dorsal* Hendel, occurred during 2 days of observation in banana treated with a 1% of neem seed kernel extracts (Schmutterer and Heinz, 1983). Maize plants aged 3-4 weeks after germination have been reported to be preferred by *C. partellus* for oviposition over other plant age groups (Singh and Sandhu, 1978; Dabrowski and Nyangiri, 1984; Ampofo, 1985). Ampofo (1985) found that in all the genotypes and plants at different growth stages, smooth areas of the plant (the lower leaf surface and the midrib concavity) were preferred for oviposition. Among the maize genotypes, Inbred A, the least hirsute, was the most preferred for oviposition . Roome et al., (1977) observed that *C. partellus* moths sometimes oviposited on a non-host surface, even in the presence of host plants. However, the larvae do not establish on non-hosts, but may migrate to nearby host plants.

Chapman et al., (1983) observed differences in the migration of neonate larvae from infested to surrounding sorghum plants, depending on cultivar and plant age. These observations indicated an innate ability of the larvae to determine the suitability of the oviposition plant for feeding, and a tendency to migrate in search of more preferred hosts, if the oviposition plant is not acceptable.

The majority of adult males of *C. partellus* have been reported to emerge within the first 2 hour of scotophase (20 : 00 to 08 : 00h), and females 5 hour later. Mating occurs during the

last 5 hours of the scotophase on the night of eclosion. Oviposition occurs during the first 6 hours of the scotophase of the following night, but the majority of the eggs are laid during the first 2 hours. No eggs have been reported to be laid during daylight (Pats, 1991).

2.4. Dispersal and hatching

The hatching and dispersal of early instars of *C. partellus* on maize had been studied at different initial densities (Pats et al., 1992). These authors reported that approximately 20% of the larvae remained on the oviposition plant one week after hatching. Dispersing larvae made up 25% of the original number of eggs. On average, 50% of potential larvae (eggs) were lost within 14 days after oviposition. The mean number of plants infested from each oviposition plant varied from 2.26 to 4.22. The mean dispersal distance in the field for the larvae was approximately 30-70 cm. Berger (1992) has also reported that four dispersal phases occurred during the larval development of *C. partellus* on young food plants: ballooning of newly hatched larvae when moving from egg batch to plant whorl (phase 1); ballooning of the 1st- & 2nd- instar larvae, which leave the plant whorl in the week after egg eclosion (phase 2); walking period to stem penetration (phase 3); and walking after stem penetration (phase 4).

Six main categories of insect behavioral and physiological responses are considered important during plant / herbivore interactions: (1) Orientation and settling; (2) feeding;

(3) metabolism of ingested food; (4) growth; (5) survival and fecundity; and, (6) oviposition (Saxena, 1969; Saxena, et al., 1974). Interruption of one or more of these insect responses due to unfavourable plant characters would render the plant unsuitable for insect establishment. The extent of insect establishment depends on an interaction of insect responses to various plant characteristics (Saxena, 1969).

2.5. Food consumption and assimilation

The first two instars of *C. partellus* larvae established within the whorls where they fed gregariously on the young maize leaf tissue. Third instar larvae migrated away from the whorls into other tissues as they became differentiated (Ampofo and Kidiavai, 1987).

Kumar et al., (1993) reported that food ingested on maize cultivars indicated a high moderate level of antibiosis in maize variety MP 704 corresponding to its high resistance, a moderate level of antibiosis in V-37 and Poza Rica 7832 corresponding to their moderate resistance to *C. partellus.* Kumar (1993) found that poor food utilization but high relative consumption rate on resistant `MP 704' and low consumption rate but high food utilization on F1 hybrids resulted in slow development and low biomass gained by *C. partellus* and *B. fusca* on these cultivars.

2.6. Growth and Development

The survival rate of tobacco cut worm, *Spodoptera litura* L. larvae
to adult stage, after it has been fed a diet of cabbage leaves
treated with 0.1% neem kernel extracts of the two neem varieties
for two days and then with untreated leaves; was 8.6% with
Thailand neem tree extracts compared with 12.9% with Indian neem
extract (Schmutterer et al., 1983). Kumar et al.,(1993) reported a
faster development of *C. partellus* on susceptible maize cultivars
as compared to resistant ones. It was reported that fifteen days
after infestation, most larvae on resistant maize cultivars V-37,
Mp704 and Poza Rica 7832 were only in their second and third
instars, while those on susceptible cultivars were in fourth and
fifth instars. Shanower et al., (1993) recorded larval survival,
larval pupal period, and pupal weight of *S. calamistis* and
E. saccharina on maize and wild grasses. Larval survival and pupal
weights on wild grasses were significantly lower than on maize
plants. Larval survival, growth and development on the maize
cultivars varied according to the level of resistance in the
plants (**Ampofo and Kidiavai, 1987**).

Growth index (G.I.) has been measured by the ratio of
percentage larvae pupated to the developmental period in days.
The growth index of the insect species on different host plants
has been calculated as the ratio of percentage of larvae
developing into pupae to the mean growth in days (Saxena, 1969;
Saxena et al., 1974). The higher the growth index the more
suitable the plant was for the insect's growth. Using this

method, growth index was the ratio of the percent of larvae becoming pupae to the developmental period in days (Saxena, 1969; Khan and saxena, 1985)

$$G.I. = \frac{\% \text{ Pupation}}{\text{Larval period}}$$

Davis and Williams (1986) reported that resistant maize hybrids caused significant adverse effects on survival, growth and development of the south western corn borer, *Diatraea grandiosella* Dyra. Davis et al., (1989) reported that the feeding and survival of *D. grandiosella* larvae and European corn borer, *Ostrinia nubilalis* (Hübner), on the resistant maize hybrids were significantly less than on a susceptible hybrid.

CHAPTER THREE

3.0 **GENERAL MATERIALS AND METHODS**

3.1. Study site

This study was conducted at Mbita Point Field Station (MPFS) of the International Centre of Insect Physiology and Ecology (ICIPE). MPFS is situated on the shores of Lake Victoria in Western Kenya at a latitude 0° 25'S and 0° 30'S and longitude 34° 10' E and 34° 15'E at an altitude 1240 m above sea level. The area receives an average annual rainfall of 900 mm.

3.2. Plant materials

One susceptible genotype of maize (*Zea mays* L.) Inbred A, and five wild host plants were used in the study. The wild gramineous plants were: *Sorghum versicolor* Anderss, *Pennisetum purpureum* Schumach, *Panicum maximum* Jacq, *Echinochloa pyramidalis* (Lam.) and *Hyparrhenia rufa* (Nees) Stapt (Plate 1). The wild grasses were collected from a nursery maintained at the MPFS and grown in a screen-house, measuring 11.40 m x 7 m, constructed with glass and nylon netting wire of approximately 2 mm^2 mesh size. The two lengths were covered with wire netting materials, while the widths and the roof were of glass. Host plants were at an age of 4 weeks and propagated by transplanting, stem cuttings, root stocks, or planting seeds in the screen house.

Plate 1: Host plants from right: INB A (susceptible maize
cultivar), *P. maximum, S. versicolor, H. rufa,*
E. pyramidalis and *P. purpureum.*

3.3. Source of insects

The test insects were provided by the insect mass rearing unit of MPFS, reared in the laboratory on an artificial diet. This diet was developed at ICIPE's MPFS (Ochieng et al., 1985) and consisted of the following ingredients: Distilled water, Rosecoco bean powder, Brewers yeast, Sorbic acid, Ascorbic acid, Methyl-p-hydroxybenzoate, Vitamin E capsules, Benlate, Maize leaf powder, Formaldehyde (40%), Distilled water, Agar agar of *C. partellus*. First, third and fourth instar larvae of *C. partellus* and mated females were used in the different tests of this study.

3.4. Statistical analysis

Student's t-test was used to compare the means of two treatments and Analysis of variance (ANOVA) was calculated to compare mean of more than two treatments using statistical analysis system (SAS) Programme (SAS , 1987). Tukey's Studentized Range (HSD) test was employed for comparisons between means of more than two treatments. Likewise, Ryan-Einot-Gabriel-Welsch Multiple F (REGWF) was employed for comparisons between means of more than two treatments (where Tukey's Studentized Range (HSD) test, could not work due to several zeros in the data collected during study) and analysis was done using General linear models procedure (GLM).

CHAPTER FOUR

4.0. **THE OVIPOSITIONAL BEHAVIOUR OF *C. PARTELLUS***

4.1. Introduction

The survival of many herbivorous or phytophagous insect larvae depends on the ability of the adults to select a suitable host plant for oviposition. According to the report by Ampong-Nyarko et al., (1994), *C. partellus* moths laid about a third of their eggs on the non-host crops Cowpeas or Cassava. As stated by Pats and Ekbom (1994) *C. partellus* female moths laid eggs in batches on the lower side of the lower leaves of maize. Spotted stemborer *C. partellus* is polyphagous and attack several gramineous host plants (Tams and Bowden, 1953; Seshu Reddy, 1983).

This study investigated the ovipositional responses of *C. partellus* to selected wild gramineous host plants *S. versicolor, P. purpureum, P. maximum, E. pyramidalis* and *H. rufa* and on susceptible maize cultivar Inbred A.

4.2. Materials and methods

4.2.1. Ovipositional behaviour of *C. partellus*

4.2.1.1. No-choice tests

The experiments were conducted in a screen house using four to five weeks old plants of each host plant. A single potted plant was covered with a nylon mesh cage (20 cm dia. x 80 cm height)

(Plate 2) into which three laboratory reared, one day old mated female moths of *C. partellus* were released. The females were allowed to oviposit for 48 hours after which the plants were removed and the number of eggs counted. The experiment was replicated six times.

4.2.1.2. Two-choice tests

The test was conducted in a screen house under a nylon mesh cage (20 cm dia. x 80 cm height) (Plate 2). Maize (Inbred A cultivar) was compared with each wild host plant species. Six mated females were released at the center of the cage. The plants were removed after 48 hours and the total number of eggs oviposited were counted for each host. The experiment was replicated six times.

4.2.1.3. Multiple-choice tests

The tests were conducted in a screen house under nylon mesh chambers measuring 125 x 100 x 80 cm in size, (Plate 3). One pot of each wild host plants along with maize plants, were arranged equidistantly in a circle within the chamber. Eighteen laboratory reared, mated females moths were released at the center of the cage. The plants were removed after 48 hours and the total number of eggs counted for each host plant. The experiment was replicated six times.

Plate 2: *Chilo partellus* female moths ovipositional cage in
no-choice and two-choice tests.

Plate 3: *Chilo partellus* female moths ovipositional cage in
multiple-choice tests.

4.3. Results

4.3.1. Ovipositional behaviour of *C. partellus*

4.3.1.1. No-choice tests

No significant difference was observed among the host species in the number of eggs laid by *C. partellus* female moths during 48 hours (F = 0.79; df = 5; P = 0.056) (Table 1). However, *C. partellus* female moths oviposited more eggs on Inbred A (191 ± 25) compared to the number of eggs laid by female moths on wild host plants. This testifies that in no-choice situation *C. partellus* female moths can oviposit on any available plant (Fig 1).

4.3.1.2. Two-choice tests

In this test, the only significant difference was observed in the number of eggs laid by *C. partellus* female moths on Inbred A versus *P. purpureum* (t = 2.6; df = 10; P = 0.02). More eggs were laid on *P. purpureum* (966 ± 140). The comparisons were not significantly different (P > 0.05) (Table 2). In paired tests, *C. partellus* female moths laid more eggs on Inbred A than on the wild host plants. Except for *P. purpureum,* which had 966 eggs compared to 424 eggs deposited on Inbred A (Fig. 2)

4.3.1.3. Multiple-choice tests

In multiple-choice tests, the tendency of the female moths to oviposit eggs on the different test plants remained almost the same as in no-choice tests. There was no significant difference in oviposition among host plants ($F = 0.84$; $df = 5$; $P = 0.053$) (Table 1). Only 17% of total eggs were laid on Inbred A (susceptible host plant) by *C. partellus* female moths, while on wild host plants were as follows: 24% *S. versicolor*, 23% *P. purpureum*, 13% *E. pyramidalis*, 13% *P. maximum*, and 10% *H. rufa*. This indicates that *C. partellus* female moths are not specific with respect to where they oviposit their eggs (Fig. 1).

Table 1. Ovipositional response / preference of *C. partellus* female moths to different host plants in no-choice and multiple-choice tests

Hosts	No. of eggs laid on different hosts in no-choice test	No. of eggs laid on different hosts in multiple-choice test
Inbred A	191 ± 25 a	102 ± 15 a
S.versicolor	180 ± 22 a	149 ± 15 a
P.purpureum	113 ± 17 a	140 ± 12 a
E.pyramidalis	157 ± 20 a	80 ± 12 a
P. maximum	138 ± 18 a	79 ± 10 a
H. rufa	127 ± 19 a	61 ± 7 a

Means $\pm$ SE. Means in column followed by the same letters are not significantly different at $P > 0.05$ by Tukey's Studentized Range Test.

Table 2. Ovipositional preference of *C. partellus* female moths to susceptible maize cultivar (Inbred A) and wild host plants in two-choice tests

Host Plants		No of eggs laid on Inbred A Vs each wild host	
A	B	A	B
Inbred A	S. versicolor	814 ± 233	372 ± 97 ns
Inbred A	P. purpureum	424 ± 153	966 ± 140 *
Inbred A	E. pyramidalis	555 ± 215	421 ± 118 ns
Inbred A	P. maximum	245 ± 139	127 ± 74 ns
Inbred A	H. rufa	361 ± 73	241 ± 82 ns

Means ± SE. Means value followed by * is significantly different from the corresponding mean value in the same row at P < 0.05, ns = not significant at P > 0.05 by t-test.
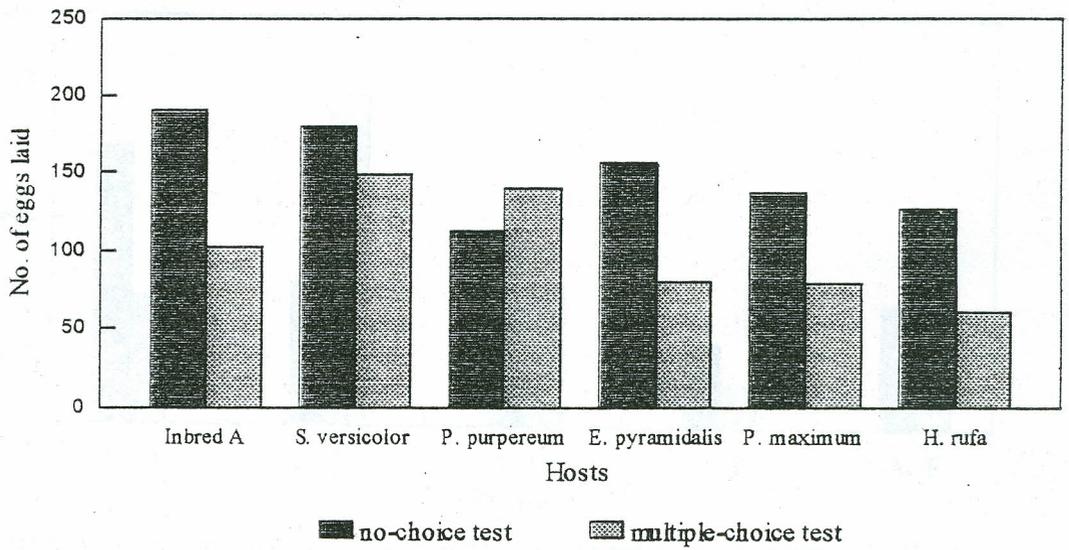
Fig 1: Ovipositional response/preference of *C. partellus* female moths to different host plants in no-choice and multiple-choice tests.
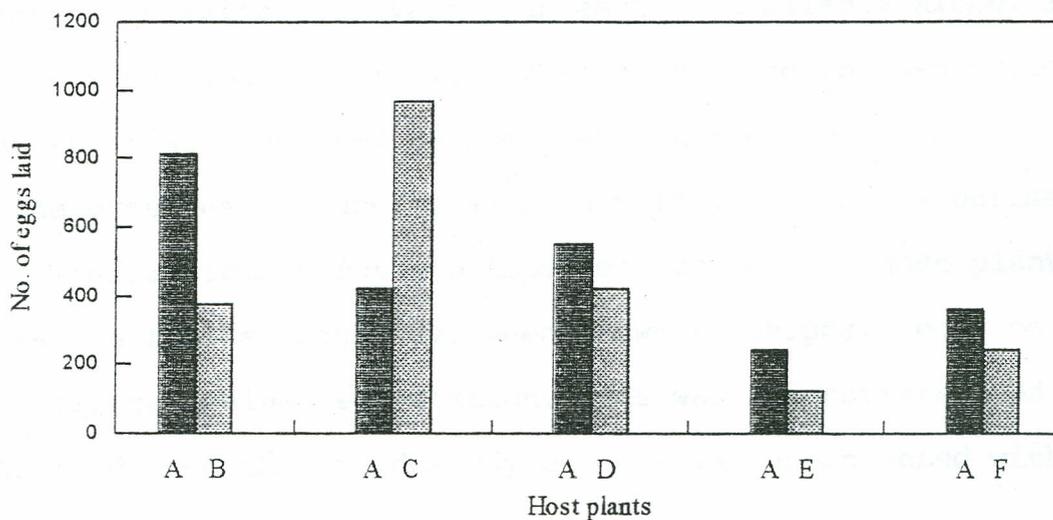
A - Inbred A; B - S. versicolor; C - P. purpureum; D - E. pyramidalis; E - P. maximum; F - H. rufa.

Fig. 2: Ovipositional preference of *C. partellus* female moths to susceptible maize cultivar (Inbred A) and wild host plants in two-choice tests.

4.4. Discussion

Ovipositional behaviour of *C. partellus* showed that there were no significant differences in the number of eggs laid on the host plants in no-choice and multiple-choice tests. This demonstrates that in the absence of main host plant, female moths tended to lay eggs on available host plants. Saxena (1993) reported high ovipositional responses of female moths both on resistant and susceptible maize cultivars when each is available alone. In a no-choice situation *C. partellus* female moths could even oviposit on a non-host as discussed by Kumar and Saxena (1985).

In the presence of host plants in multiple-choice experiments, *C. partellus* female moths oviposited eggs on non-host plants. *C. partellus* female moths have been shown to oviposit eggs on cowpea and cassava against expectation. This was demonstrated and confirmed from the field study on cassava intercropped with sorghum (Ampong-Nyarko et al., 1994).

The two-choice test results showed that *C. partellus* gravid female moths oviposit more eggs on susceptible maize cultivar Inbred A compared to *S. versicolor, E. pyramidalis, P. maximum* and *H. rufa*. There are reports that Inbred A, the least hirsute, was the most preferred for oviposition (Ampofo, 1985). Room et al.(1977) suggested the prevention of desiccation and dislodgment of the egg mass as a factor in the choice of smooth areas for oviposition by *C. partellus*.

CHAPTER FIVE

5.0. THE LARVAL BEHAVIOUR OF *C. PARTELLUS*

5.1. Introduction

Larval dispersal is common character for *C. partellus* first instar larvae. The *C. partellus* larvae do not establish on non-host, but may migrate to nearby host plants. On maize, the small size of *C. partellus* larvae do feed in ears (Overholt et al., 1994). Dass and aggarwal (1993) found that the growth of *C. partellus* on different maize cultivars (CM 600, Basilocal, CM 500, Kisan) varied significantly. There was better consumption and utilization on susceptible maize cultivars CM 600 and Basilocal than on resistant CM 500 and Kisan.

The purpose of this work was to evaluate feeding, assimilation of food, growth and development of *C. partellus* larvae on maize and wild gramineous host plants.

5.2. Materials and methods

5.2.1. Larval settling behaviour

5.2.1.1. No-choice tests

Fresh leafcuts obtained from each host plant were placed singly at the center of petri dishes measuring 9 cm diameter lined with wet filter paper (Plate 4). Ten first instar larvae were released on each leafcut. The petri dish was covered with a lid to prevent larvae from escaping and sealed with a piece of parafilm.

The number of larvae on or under the leafcut was recorded 1, 4, and 24 hours after infestation. The petri dishes were placed in the laboratory dark room, at 27 ^{0}C and a relative humidity of 70%. The experiment was replicated six times.

5.2.1.2. Choice experiments with leafcuts

First instar larvae were provided with a choice of leafcuts of 4-5 weeks old host plant species in separate two-choice and multiple-choice experiments.

For the two-choice tests, two leafcuts of each wild host and two leafcuts of maize Inbred A, were arranged equidistantly along the edge of a petri dish measuring 9 cm in diameter and lined with wet filter paper (Plate 4).

Twenty, first instar larvae of *C. partellus* were released in the center. The petri dish was covered with a lid to avoid the escape of the larvae and sealed with a piece of parafilm. The petri dish was placed in a dark room, in the laboratory and maintained at a constant temperature of 27 ^{0}C and relative humidity of 70%.

The number of larvae found on or under the leafcut were recorded at intervals of 1, 4, and 24 hours after infestation in separate experiments. The experiment was replicated six times.

For multiple-choice tests, leafcuts of different host plants were arranged randomly and equidistantly along the edge of a petri dish measuring 15 cm in diameter lined with wet filter paper (Plate 5). One hundred first instar larvae were released at the center of the petri dish. The rest of the procedure was the same as that described for the two-choice test experiments. The experiment was replicated six times.

Plate 4: Leafcuts of different host plants, in petri dishes of
9 cm diameter for arrest and dispersal of first instar
larvae, in no-choice and two-choice tests.

Plate 5: Leafcuts from all test plants, in a petri dish of 15 cm
diameter for arrest and dispersal, in multiple-choice tests.

5.2.1.3. Larval arrest and dispersal on whole plants

The test plants were planted in pots (25 cm diameter) thinned to two plants per pot, and arranged in randomized complete block design (RCBD) in a screen-house. Four weeks after emergence, 10 neonate larvae of *C. partellus* were released on the outer most leaf of each plant. Seventy-two hours after infestation all the plants were dissected. The number of larvae recovered on each host plant was recorded to reflect the arrest of larvae on the plant. The experiment was replicated six times.

5.2.2. Larval feeding

5.2.2.1. Feeding on leaf discs in no-choice test

Leaf feeding experiments with excised leaves of different host plants were conducted in the laboratory. Leaves of four week-old plants were used. The experiment was carried out in glass vials, lined with wet filter paper to moisten and prevent plant tissue from wilting (Plate 6).

Leaf tissue in the vials was presented to 10 neonate *C. partellus* larvae in the form of discs measuring 2.5 cm in diameter (5 cm square) and of known area (3.14×1.25^2 : 4.9 cm^2) (A1) measured with a graph paper. The vials containing leaf tissues from different host plants were covered with lids, arranged in a randomized complete block design (RCBD) and kept under black cloth, with six replications. After 24 hours of

feeding, the area 4.9 cm^2 (A2) of the leaf disc fed upon by the larvae was measured with a graph paper (mm2).

Control leaf discs obtained from the host plants were kept in separate vials alongside the experimental discs to determine shrinkage caused by water loss. The difference between A1 and A2 after adjustment for weight loss from evaporation indicated the larval feeding response.

5.2.2.2. Feeding on stem segments in no-choice tests

Feeding experiments with excised stems were carried out in the laboratory. Stem segments from a 4-5 week-old plant were used. A pre-weighted, 6 cm long segment (S1) of a host plant was offered to a moulted 4th instar larva in a vial. Vials containing stem segments from different host plants were covered with plastic lids (Plate 6) and arranged in a randomized complete block design (RCBD), with six replications. The larvae were allowed to feed for 48 hours. Thereafter, the uneaten stems (S2) were weighed again after removing the excreta from it. A control of five stem segments of each host plant were placed alongside the experiment to determine the weight loss from evaporation. The differences between (S1) and (S2) after adjustment for weight loss from evaporation indicated stem feeding by the larvae.

Plate 6: Stem segments and leafcuts, of different host plants in a
glass vial used for the feeding tests.

5.2.3. Food assimilation

To determine the area consumed and the amount of food assimilated, third instar larvae were starved (but water- satiated) for two hours, weighed individually on a microbalance. Thereafter larvae were introduced singly into glass vials lined with moist filter paper, and provided with a 6 cm long x 1.5 cm wide leaf cut from each test plant.

The larvae were allowed to feed for 24 hours in a no-choice situation and then starved again for 2 hours so that the green matter was excreted out of the gut. The individual weights of the insect and uneaten food were recorded. To assess the loss in insect body weight due to catabolism, a control was similarly established, in which the larvae were given access to a moist cotton swab to prevent desiccation. The amount of food assimilated by the larvae was determined using the formula previously used by Khan and Saxena (1985) as follows:

Food assimilated = W1 x (C1 - C2) / C1 + W2 - W1

where $W1$ = Initial weight of larvae

$W2$ = Final weight of larvae

$C1$ = Initial weight of control larvae

$C2$ = Final weight of control larvae

Food ingested by each larva was calculated as follows:

Food ingested = Food assimilated + Weight of excreta.

The leaf area consumed by the larvae were measured using a graph paper (mm2). The experiment was replicated six times for each test plant.

5.2.4. Larval growth and development

To understand the effect of host plants on the growth and development of the larvae, two sets of experiments, each with 10 potted plants per host were established. In the first set, each host plant was planted in a plastic pot (20 cm high, 12 cm dia.). Ten potted plants per host species were planted and kept in a screen-house. After five weeks, each test plant was infested with 10 first instar larvae. At fifteen days after infestation, five potted plants of each host were dissected. The number of *C. partellus* larvae recovered from each host and their respective stage at the time of dissection were recorded. In the second experiment, at twenty days after infestation, the remaining five potted plants per host were also dissected and the same parameters were determined. The larvae were allowed to pupate on stem cuttings of same host plants. Fresh stem cuttings were offered on every alternate day. The day on which a larva pupated was recorded. Larval development was measured as a growth index (G.I) which was the ratio of percent larvae becoming pupae to the developmental period in days (Saxena 1969, Khan and Saxena, 1985).

$$G.I. = \frac{\% \text{ Pupation}}{\text{Larval period}}$$

The experiment was replicated six times per set.

5.3 Results

5.3.1. Larval settling behaviour

5.3.1.1. No-choice leafcut tests

There were significantly more larvae settled on leafcuts of Inbred A than on *E. pyramidalis* and *H. rufa* at one hour after infestation (F = 8.23; df = 5; P = 0.001) (Table 3).

Four hours after infestation, significant differences were observed in larval arrest among the different host plant leafcuts. There were significantly more larvae settled on susceptible maize Inbred A than on *P. maximum, H. rufa* and *E. pyramidalis* (F = 5.63; df = 5; P = 0.001) (Table 3).

Twenty-four hours after infestation, significantly more larvae settled on Inbred A than on *P. maximum* and *E. pyramidalis* (F = 3.66; df = 5; P = 0.01) (Table 3).

In no-choice situation, larval settling test, was generally well performed in all the tests (1, 4, and 24 hours after infestation) on Inbred A than wild host plants, particularly on *P. maximum, H. rufa* and *E. pyramidalis.* This shows larval preference to Inbred A (Fig. 3).

Table 3. Arrest response of *C. partellus* neonate larvae to leafcuts of different host plants in no-choice tests

| Host | Mean number of larvae recorded on leaf cuts at hours after infestation (HAI) | | |
	1 HAI	4 HAI	24 HAI
Inbred A	7.60 ± 0.79 ab	8.40 ± 0.75 a	6.00 ± 0.68 a
P. purpureum	7.80 ± 0.51 a	6.70 ± 0.55 ab	4.20 ± 0.82 ab
S. versicolor	6.20 ± 0.66 abc	6.40 ± 0.77 ab	4.10 ± 0.43 ab
P. maximum	5.40 ± 0.65 cbd	4.80 ± 0.41 b	3.00 ± 0.55 b
H. rufa	5.00 ± 0.59 cd	5.70 ± 0.57 b	3.50 ± 0.65 ab
E. pyramidalis	3.70 ± 0.74 d	4.80 ± 0.75 b	2.70 ± 0.42 b

Means ± SE. Means in columns followed by the same letters are significantly different at $P < 0.05$ by Tukey's Studentized Test. HAI: hours after infestation
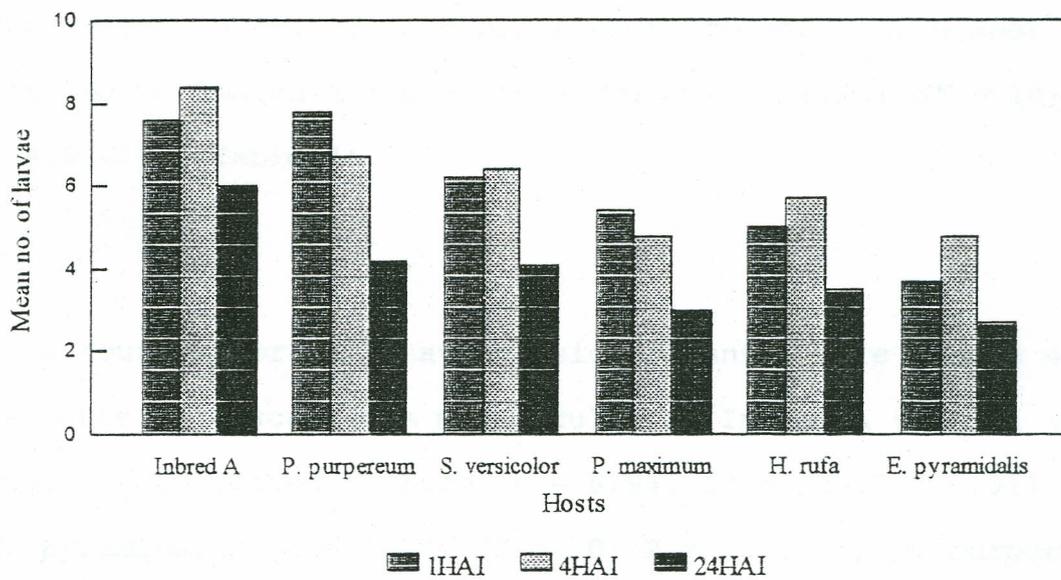
Fig. 3: Arrest response of *C. partellus* neonate larvae to leafcuts of different host plants in no-choice tests.

5.3.1.2. Two-choice leafcut tests

In paired choice tests, larval settling one hour after infestation
was significantly higher on susceptible maize cultivar Inbred A
than on *P. maximum* (t = 4.57; df = 10; P = 0.001), *P. purpureum*
(t = 4.37; df = 10; P = 0.001), *H. rufa* (t = 5.73; df = 10;
P = 0.001) and *E. pyramidalis* (t = 4.62; df = 10; P = 0.001).
There were no significant differences between the number of larvae
settled on Inbred A and *S. versicolor* (t = 1.25; df = 10;
P = 0.024) (Table 4).

Four hours after infestation, significantly more larvae settled on
leafcuts of susceptible maize cultivar Inbred A than on all wild
host plants tested *H. rufa* (t = 6.94; df = 10; P = 0.01),
E. pyramidalis (t = 4.07; df = 10; P = 0.001), *P. purpureum*
(t = 3.83; df = 10; P = 0.01), *P. maximum* (t = 3.10; df = 10;
P = 0.01), and *S. versicolor* (t = 2.19; df = 10; P = 0.05)
(Table 4).

Twenty-four hours after infestation, the tendency of the larval
settling on paired leafcuts remained almost the same as for one
hour after infestation. Significant differences were observed on
Inbred A versus wild host plants *P. maximum* (t = 2.36; df = 10;
P = 0.05), *P. purpureum* (t = 3.19; df = 10; P = 0.01), *H. rufa*
(t = 5.80; df = 10; P = 0.001) and *E. pyramidalis* (t = 3.47;

df = 10; P = 0.01);   except for Inbred A and *S. versicolor* where there was no significant difference (t = 0.62; df = 10; P = 0.055) (Table 4).

In two-choice tests, the number of first instar larvae settled on Inbred A was higher compared to wild host plants, except for *S. versicolor* on which the number of larvae settled was not significantly different compared to Inbred A in 1 and 24 hours after infestation (Fig. 4).

Table 4. Comparison of settling preference of *C. partellus* neonate larvae on leafcuts of susceptible maize and wild host plants in two-choice tests

Host		Mean number of larvae settled at hours after infestation	
A	B	A	B
1 Hour after infestation			
P. purpureum	Inbred A	1.66 ± 0.66	10.83 ± 1.99 **
P. maximum	Inbred A	3.66 ± 0.88	9.50 ± 0.92 **
S. versicolor	Inbred A	6.00 ± 1.50	8.66 ± 1.49 ns
E. pyramidalis	Inbred A	2.16 ± 0.79	8.50 ± 1.11 **
H. rufa	Inbred A	0.66 ± 1.21	9.33 ± 1.42 **
4 Hours after infestation			
P. purpureum	Inbred A	3.50 ± 0.80	7.83 ± 0.79 *
P. maximum	Inbred A	3.00 ± 0.57	5.50 ± 0.56 *
S. versicolor	Inbred A	4.16 ± 1.35	8.16 ± 1.22 *
E. pyramidalis	Inbred A	1.33 ± 0.95	7.66 ± 1.23 *
H. rufa	Inbred A	0.83 ± 0.47	8.66 ± 1.02 **
24 Hours after infestation			
P. purpureum	Inbred A	1.16 ± 0.47	4.83 ± 1.05 *
P. maximum	Inbred A	1.83 ± 0.60	4.50 ± 0.95 *
S. versicolor	Inbred A	4.16 ± 0.54	5.00 ± 1.23 ns
E. pyramidalis	Inbred A	2.00 ± 0.93	7.00 ± 1.09 *
H. rufa	Inbred A	1.00 ± 0.44	5.83 ± 0.70 **

Means ± SE. Means in rows followed by ** or * are significantly different, from the corresponding mean value in the same row at $P < 0.001$ and $P < 0.05$ respectively, ns not significant at $P > 0.05$ by t-test.

1 Hour after infestation

4 Hours after infestation

24 Hours after infestation
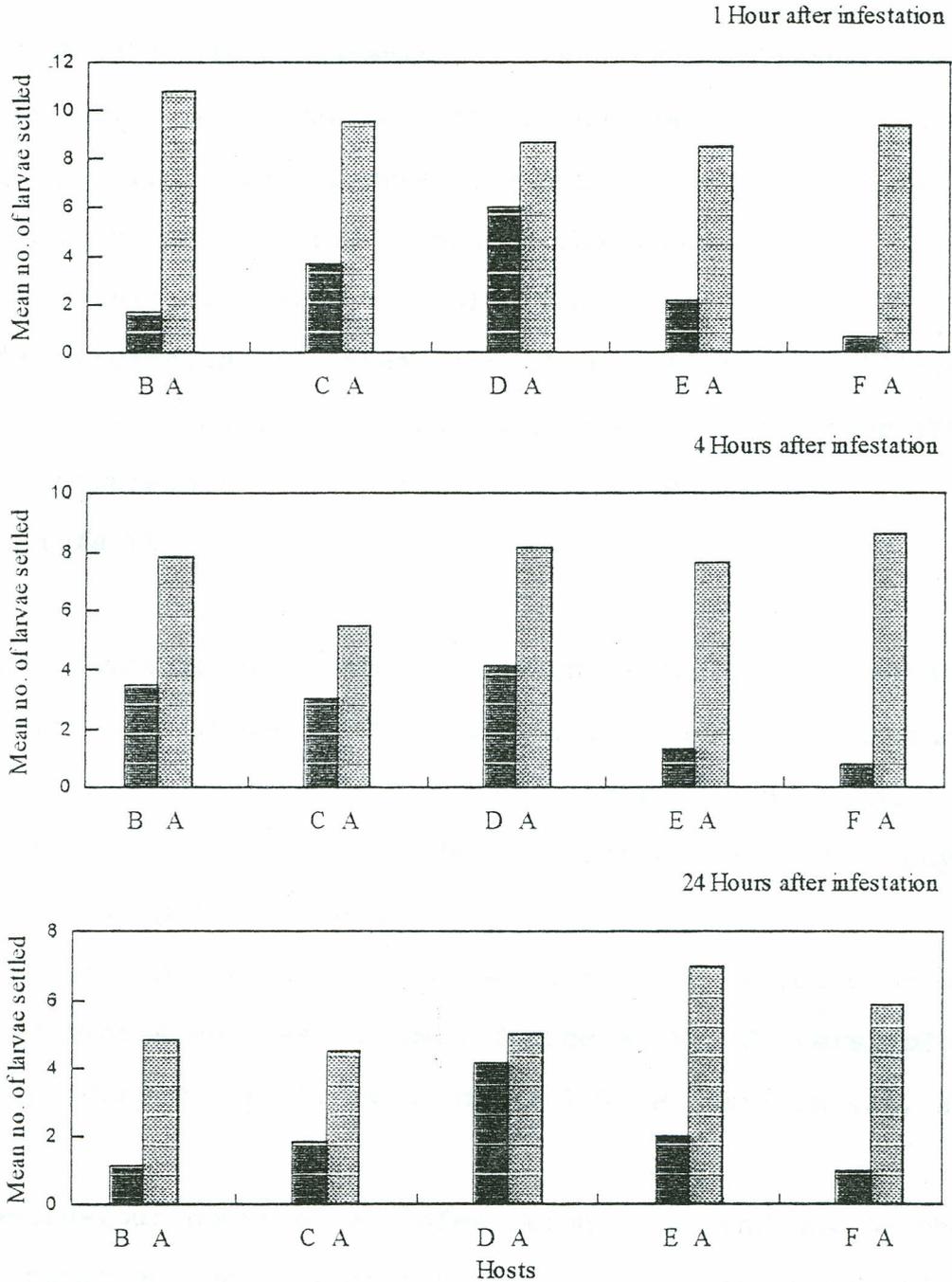
A- Inbred; B- P. purpureum; C- P. maximum; D- S. versicolor; E- E. pyramidalis; F- H. rufa

Fig. 4: Settling preference of *C. partellus* neonate larvae on leafcuts of susceptible maize and wild host plants in two-choice tests.

5.3.1.3. Multiple-choice leafcut tests

One hour after infestation, there were significant differences in the number of larvae settled on the leafcuts of the test plants. Significantly more larvae were settled on leafcuts of susceptible maize cultivar Inbred A than on the other hosts (F = 7.67; df = 5; P = 0.001) (Table 5).

The percentage of larvae settled on leafcuts of different host plants were as follows: Inbred A 30%, *S. versicolor* 17%, *P. purpureum* 15%, *E. pyramidalis* 15%, *P. maximum* 12%, *H. rufa* 9%.

Four hours after infestation, significantly more larvae settled on leafcuts of Inbred A than on *E. pyramidalis, P. maximum* and *H. rufa* (F = 3.8; df = 5; P = 0.05). There was no significant difference between the number of larvae settled on any of the wild host plants (Table 5).

Also, the percentage of larvae settled on leafcuts of different host plants were as follows: Inbred A 27%, *S. versicolor* 18%, *P. purpureum* 17%, *E. pyramidalis* 13%, *P. maximum* 13%, *H. rufa* 12%.

Twenty-four hours after infestation, the tendency of the larval settling on leafcuts of different test plants remained almost the same as in one hour after infestation. Significantly more larvae settled on Inbred A, and *S. versicolor* than on *P. purpureum*, *E. pyramidalis* and *P. maximum*. The lowest number of larvae were observed on *H. rufa* (F = 25.93; df = 5; P = 0.001) (Table 5).

The percentage of larvae settled on leafcuts of different host plants were as follows: Inbred A 29%, *S. versicolor* 27%, *P. purpureum* 17%, *E. pyramidalis* 13%, *P. maximum* 11%, *H. rufa* 3%.

In multiple-choice leafcut tests (1, 4, and 24 hours after infestation), more number of larvae settled on Inbred A (30%, 27%, 27%, respectively) than on wild host plants (Fig. 5).

Table 5. Settling preference of *C. partellus* neonate larvae to leafcuts of different host plants in multiple-choice tests

| Host | Mean number of larvae settled hours after infestation | | |
	1 HAI	4 HAI	24 HAI
Inbred A	24.40 ± 3.30 a	16.80 ± 1.92 a	20.20 ± 1.71 a
S. versicolor	13.80 ± 2.20 b	11.50 ± 2.14 ab	19.10 ± 1.95 a
P. purpureum	12.40 ± 1.72 b	10.70 ± 1.36 ab	12.40 ± 1.19 b
E. pyramidalis	12.10 ± 2.21 b	8.00 ± 1.34 b	9.20 ± 1.29 b
P. maximum	10.50 ± 1.38 b	8.70 ± 1.73 b	8.50 ± 1.31 b
H. rufa	7.80 ± 1.13 b	7.50 ± 1.55 b	2.70 ± 0.81 c

Means ± SE. Means in columns followed by the same letters at 1 HAI 4 HAI and 24 HAI, are significantly different at $P < 0.001$, $P < 0.05$ and $P < 0.001$ respectively by Tukey's Studentized Range Test. HAI: hours after infestation
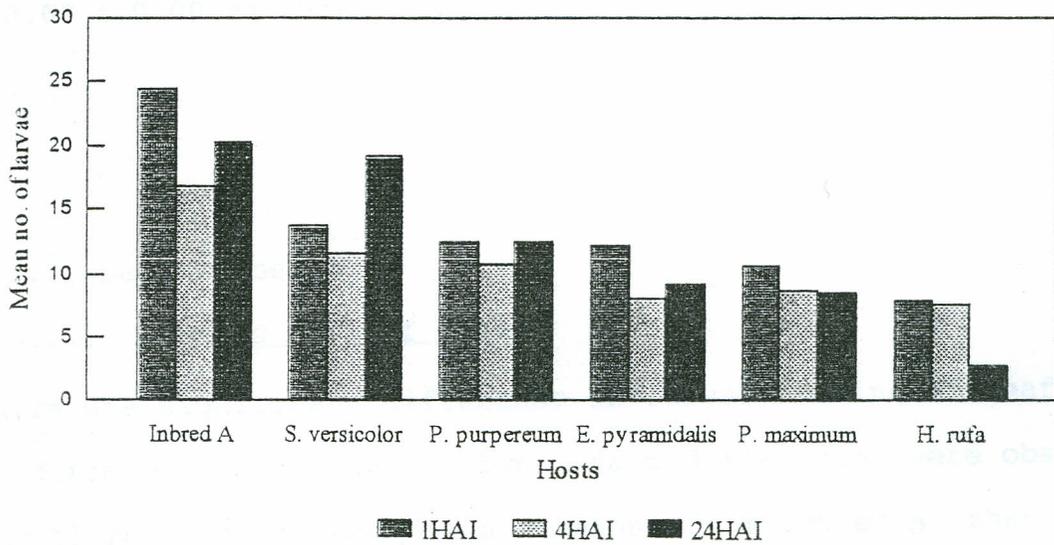
Fig. 5: Settling preference of *C. partellus* neonate larvae on leafcuts of different host plants in multiple-choice tests.

5.3.1.4. <u>Larval arrest and dispersal on whole plants</u>

Significant differences were observed in the number of larvae arrested on the different host plant species used. Significantly more larvae were retained on the susceptible maize cultivar Inbred A and wild sorghum *S. versicolor*, than on the other test plants (F = 26.67; df = 5; P = 0.001) (Table 6).

This shows that, no significant difference on larval retaining between *S. versicolor* (8.33 ± 0.91a) and Inbred A (10.00 ± 0.00 a) (Fig. 6).

5.3.2. Larval feeding

5.3.2.1. <u>Feeding on leaf discs</u>

There was significant difference in larval feeding on leaf discs of different test plants. Significant differences were observed in larval feeding on leaf discs obtained from Inbred A than on the wild host plants (F = 31.98; df = 5; P = 0.001) (Table 7).

C. partellus larvae leaf feeding was higher, on maize leaf discs (45.10 ± 3.27 a) than on the wild host plants. More than 45% of Inbred A leaf discs were fed by *C. partellus* larvae, while the percentage of wild host plants leaf discs fed by the larvae declined from 30% to 4% (Fig. 7).

5.3.2.2. Feeding on stem segments

The results show that feeding on stem segments was significantly
higher on Inbred A than on *E. pyramidalis* and *H. rufa* (F = 2.96;
df = 5; P = 0.021) (Table 8).

Though the data of different host plants stem feeding by
C. partellus larvae was showing that, Inbred A (1.22 ± 0.08 a)
was higher than the wild host plants; there was no significant
difference between weights of stem consumed by the larvae on
Inbred A, *S. versicolor* , *P. purpureum* and *P. maximum.* No
significant difference was also observed between the wild host
plants (**Fig.** 8).

Table 6. Arrest of *C. partellus* neonate larvae on different host plants, 72 hours after infestation

Host	No. of larvae arrested Host on each host plant
Inbred A	10.00 ± 0.00 a
S. versicolor	8.33 ± 0.91 a
E. pyramidalis	2.66 ± 1.02 b
P. maximum	1.50 ± 0.84 b
H. rufa	1.16 ± 0.79 b
P. purpureum	0.83 ± 0.40 b

Means $\pm$ SE. Means in columns followed by the same letter are significantly different at $P < 0.001$ by Tukey's Studentized Range Test.
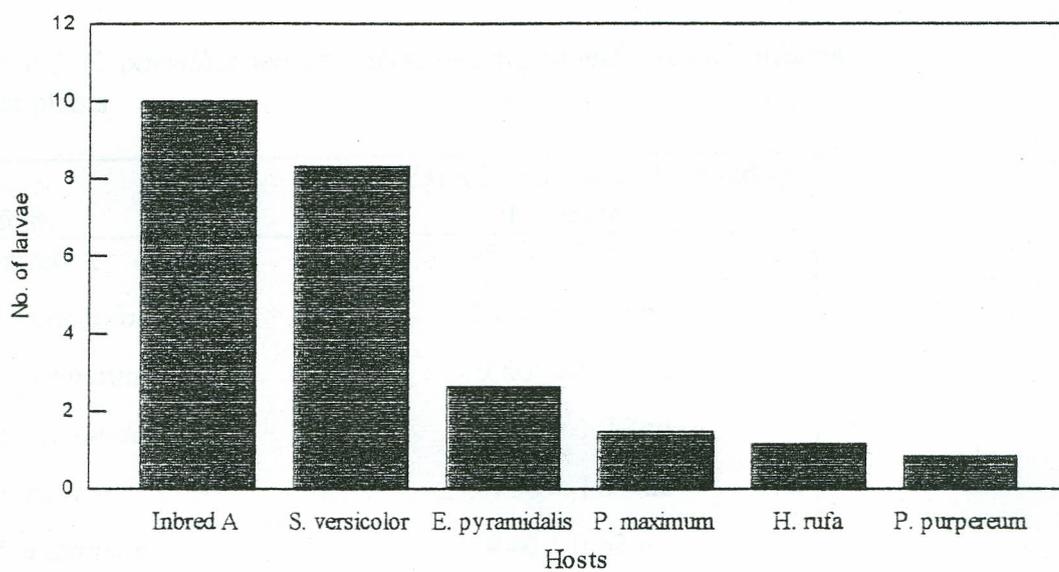
Fig. 6: Arrest of *C. partellus* neonate larvae on different host plants 72 hours after infestation.

Table 7. *C. partellus* neonate larval feeding on leaf discs of different host plants

Host	Percentage of fresh leaf discs fed by the larvae
Inbred A	45.10 ± 3.27 a
S. versicolor	30.70 ± 4.59 b
P. purpureum	19.60 ± 1.72 bc
E. pyramidalis	17.40 ± 1.74 cd
H. rufa	8.30 ± 1.97 de
P. maximum	4.40 ± 0.63 e

Means ± SE. Means in columns followed by the same letters are significantly different at P < 0.001 by Tukey's Studentized Rang Test.

Fig. 7: *C. partellus* neonate larval feeding on leaf discs of different host plants 24 hours after infestation.

Table 8. *C. partellus* 4th instar larval feeding on stem segments
of different host plants, 48 hours after infestation.

Host	stem feeding (mg) larva/48 h
Inbred A	1.22 ± 0.08 a
S. versicolor	1.06 ± 0.02 ab
P. purpureum	1.05 ± 0.03 ab
P. maximum	1.04 ± 0.02 ab
E. pyramidalis	1.02 ± 0.01 b
H. rufa	1.00 ± 0.02 b

Mean $\pm$ SE. Means in columns followed by the same letters are
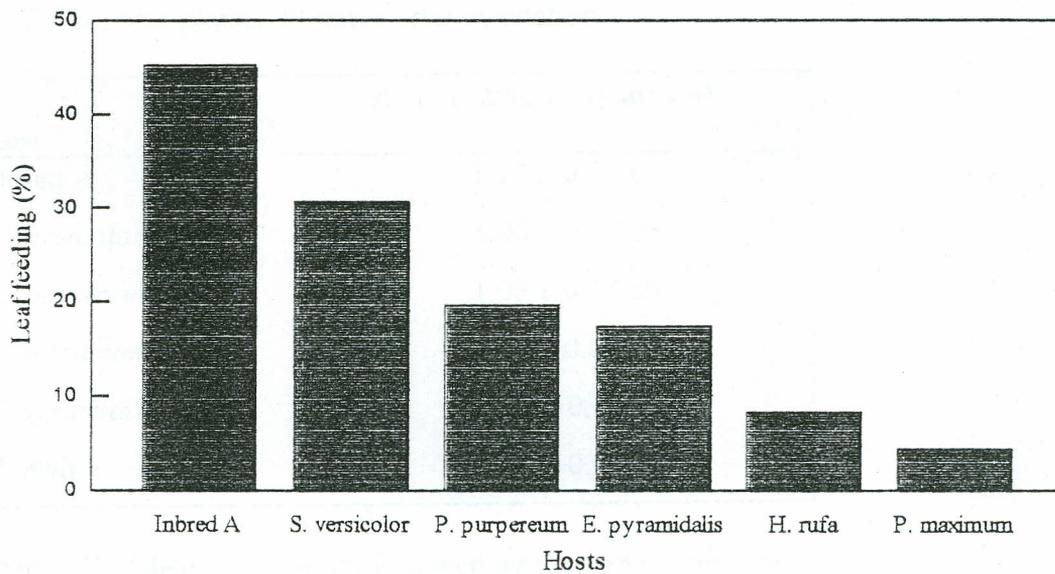significantly different at $P < 0.05$ by Tukey's Studentized Range
Test.
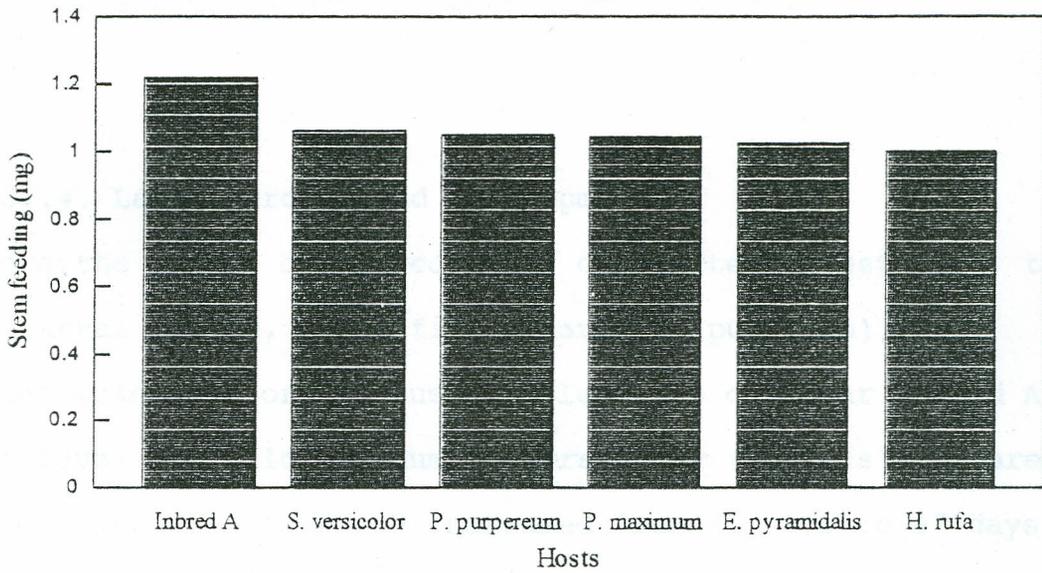
Fig. 8: *C. partellus* 4th instar larval feeding on stem segments of different host plants 48 hours after infestation.

5.3.3. Food assimilation by larvae

There was significantly more food assimilation on susceptible maize Inbred A than on *E. pyramidalis, P. maximum* and *H. rufa* (F = 5.65; df = 5; P = 0.055) (Table 9).

Though the weight of food assimilated by *C. partellus* larvae on wild host plants declined from 0.25 to 0.03 mg, there was no significant difference between them (Fig. 9).

5.3..4. Larval growth and development

Among the plants dissected at 15 days after infestation, the days of larval period, (from first instar to pupation), was significantly short on susceptible maize cultivar Inbred A (25 days) and wild sorghum *S. versicolor* (29 days) compared to the other test plants, which increased from 41 days to 47 days (F = 26.68; df = 5; P = 0.001).

The percentage pupation (percent of larvae become pupa) and growth index were significantly higher on susceptible maize cultivar Inbred A (95.7%, 3.8) than on the wild host plants, which declined from 32% to 10% percent of pupation and 1.1 to 0.1 growth index, at (F = 83.32; df = 5; P = 0.001) and (F = 69.47; df = 5; P = 0.001), respectively (Table 10, Fig. 10).

Among the plants dissected at twenty days after infestation, there were differences in the duration of larval period (Inbred A 26 days, *S. versicolor* 30 days) (F = 17.51; df = 5; P = 0.001), percentage pupation (57% Inbred A, 20% *S. versicolor*) (F = 2.02; df = 5; P = 0.011) and growth index (2.3 Inbred A, 0.7 *S. versicolor*) (F = 1.72; df = 5; P = 0.16) on Inbred A and *S. versicolor* (P < 0.05).   However no larvae were recovered from other host plants (Table 10).

This shows that the wild tested plants *P. maximum, E. pyramidalis, H. rufa* and *P. purpureum* are very poor in promoting *C. partellus* larval growth and development (Fig. 10).

Table 9. Food assimilation by *C. partellus* 4th instar larvae on different host plants, 24 hours after infestation

Host	Food ingested (mg)on different hosts
Inbred A	0.45 ± 0.06 a
S. versicolor	0.25 ± 0.06 ab
P. purpureum	0.23 ± 0.11 ab
E. pyramidalis	0.15 ± 0.02 b
P. maximum	0.06 ± 0.02 b
H. rufa	0.03 ± 0.02 b

Means ± SE. Means in column followed by the same letters are significantly different at $P < 0.05$ by Tukey's Studentized Range Test.
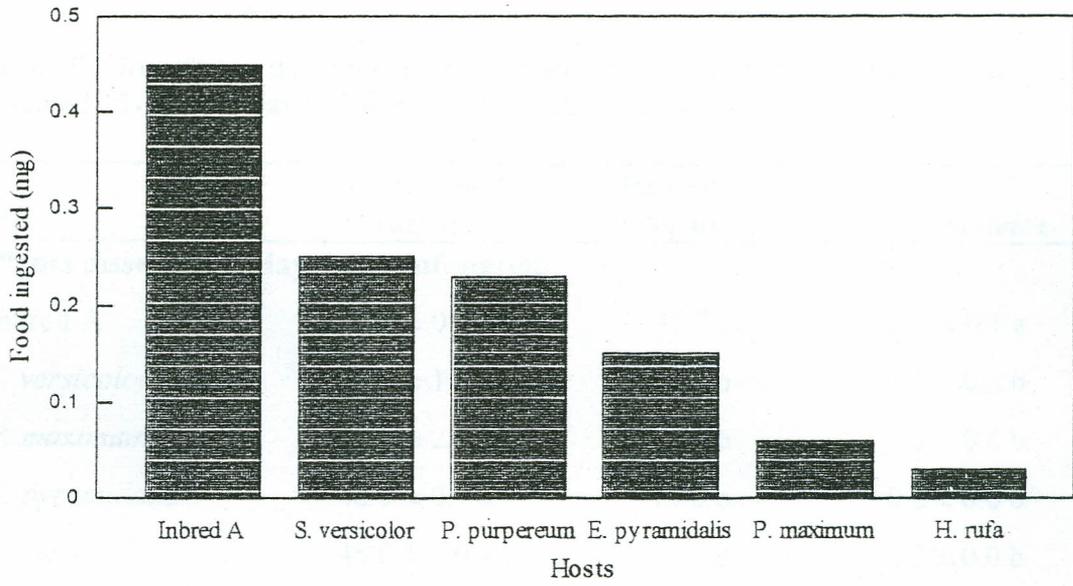
Fig. 9: Food assimilation by *C. partellus* 4th instar larvae on different host plants 24 hours after infestation.

Table 10. Growth and development of *C. partellus* larvae on different host plants dissected 15- and 20-days after infestation with neonate larvae

Host	Larval period (days)	Percentage pupation	Growth Index
Plants dissected 15 days after infestation			
Inbred A	25.6 ± 0.7 b	95.7 a	3.8 ± 0.1 a
S. versicolor	29.0 ± 1.3 b	32.6 b	1.1 ± 0.2 b
P. maximum	41.4 ± 2.1 a	12.0 b	0.3 ± 0.0 b
E. pyramidalis	46.3 ± 0.7 a	10.0 b	0.2 ± 0.0 b
H. rufa	45.0 ± 0.0 a	10.0 b	0.2 ± 0.0 b
P. purpureum	47.0 ± 5.0 a	10.0 b	0.1 ± 0.0 b
Plants dissected 20 days after infestation			
Inbred A	26.0 ± 0.7 a	57.0 a	2.3 ± 0.2 a
S. versicolor	30.0 ± 4.3 a	20.0 a	0.7 ± 0.3 a
P. maximum	_____	_____	_____
E. pyramidalis	_____	_____	_____
H. rufa	_____	_____	_____
P. purpureum	_____	_____	_____

Mean ± SE. Means in column followed by the same letters at 15 and 20 days after infestation, are significantly different at $P < 0.001$ and not significant at $P > 0.05$ by Ryan's Q Test (REGWF).

Plants dissected 15 days after infestation

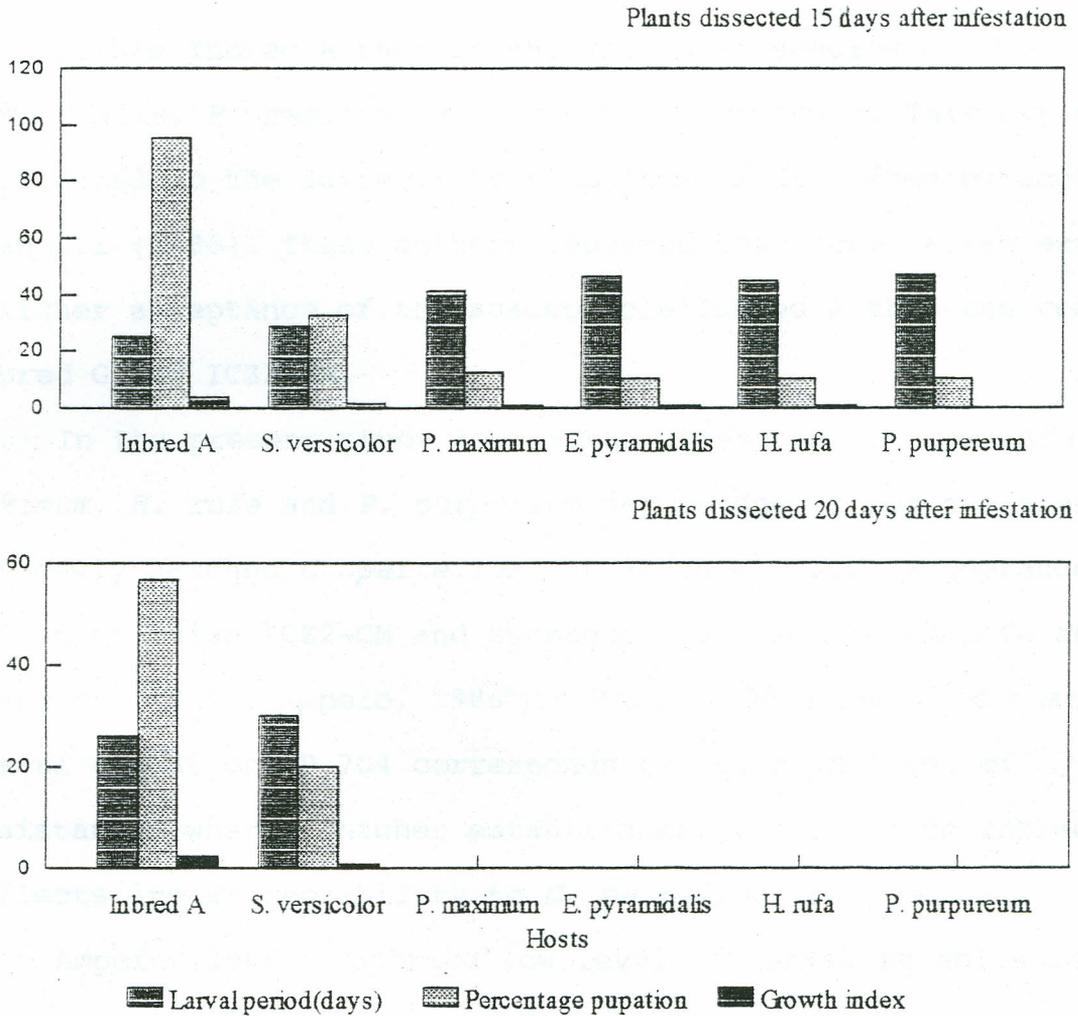Plants dissected 20 days after infestation

Fig. 10: Growth and development of *C. partellus* larvae on different host plants dissected 15- and 20- days after infestation.

5.4. Discussion

The results showed that, significantly more larvae settled on susceptible Inbred A than on the wild host species of *E. pyramidalis, P. maximum, H. rufa* and *P.purpureum.* This may be attributed to the suitability of plants as discussed by Ampofo and Nyangiri (1986). These authors reported that more larvae exhibited a higher acceptance of the susceptible Inbred A than the resistant Inbred G and ICZ2-CM.

In the present study low larval arrest on *E. pyramidalis, P. maximum, H. rufa* and *P. purpureum* may be due to non-preference. The newly hatched *C. partellus* larvae showed poor acceptance of resistant maize ICZ2-CM and subsequently disperse (Ampofo and Nyangiri, 1986., Ampofo, 1986[a]). Kumar (1993) reported that low larval arrest on MP 704 corresponds to its high level of resistance, whereas higher establishment of larvae on Inbred A reflects its susceptibility to *C. partellus.*

Ampofo (1986[b]) reported low level of larval establishment and high larval dispersal from resistant maize cultivars as the result of the presence of plant chemicals. Similar factors may also exist in wild host species used in this study where larval establishment was poor. Plant chemical characteristics are likely to condition the plants for acceptance or rejection by the larvae (Dethier, 1982), and hence require further investigation.

The percentage of insect losses after 72 hours on
P. maximum and *P. purpureum* ranged from 76.6% to 87.7%
respectively. Insect losses could be attributed to the additive
effects of mortality factors, such as predation, excessive rain,
wind or heat and desiccation during movement, natural mortality
and plant chemicals. Ampongo-Nyarko (1994), reported that when
first instar larvae of *C. partellus* were artificially infested on
sorghum about 30% of the larvae established in the whorl of the
plant, 25% were recovered on the surrounding plants within 50 cm
and 45% lost. Berger (1992) reported a high level of larval
dispersal, either by ballooning or crawling. This type of
dispersal for lepidopterous larvae has also been reported by other
workers (Van Hamburg, 1980., Chapman et al., 1983). Dispersal may
have been due to the presence of plant chemicals and/or physical
characters or poor nutrient quality, which lured the larvae of
C. partellus to move from one plant to another.

The number of *C. partellus* larvae found feeding on leaves of
susceptible maize cultivar Inbred A was higher than on the other
host plants. Leaf feeding on susceptible maize cultivar Inbred A
could be due to its susceptibility to *C. partellus*. This is in
agreement with the previous observations by Saxena (1990) that the
level of larval feeding on maize is due to their susceptibility to
the pest. The feeding response to wild species *P. maximum,*
P. purpureum, E. pyramidalis and *H. rufa* suggest that the wild
grasses may have antibiotic properties, or be physically less

suitable for feeding or lack nutrients necessary for optimal stem borer growth.

A high silica content may be one of the factors responsible for stem borer resistance in wild grasses (Mc Naughton et al., 1985; Setamou et al., 1993). Low larval feeding on wild host species may be influenced by plant chemicals, physical and / or anatomical characters such as hairiness or presence of high concentration of waxes on the leaf surface as discussed by Painter (1951) and Norris and Kogan (1979). High density of hairs and trichomes on the leaf surface of wild grasses used in this study could have affected the larval feeding rate. Another physical character which was observed on some of the wild host plants was the toughness of the leaf tissue which could have influenced the feeding on *P. maximum, E. pyramidalis* and *H. rufa*. The results further indicate that larval feeding on leaf discs was significantly lower on wild host plants than on susceptible maize cultivar Inbred A. Similarly stem feeding was significantly lower on *E. pyramidalis* and *H. rufa* than on susceptible maize cultivar. This agrees with Kumar et al., (1993) who reported percentage stem length tunneled by *C. partellus* was significantly lower on resistant MP704, V-37 and Poza Rica 7832 than on the susceptible Inbred A.

Larval developmental rate was faster on the susceptible maize cultivar and wild sorghum *S. versicolor* than on the other hosts. The reason could be either the quality of the nutrient content or the presence of resistant factors in the host species. The resistant maize cultivars MP704, V-37, and Poza Rica 7832 retarded development of *C. partellus* larvae due to resistance through antibiosis (Kumar et al., 1993). Lower development on *P. maximum, E. pyramidalis, P. purpureum* and *H. rufa* also could be due to poor and unbalanced nutrient contents. In that connection, Soo Hoo and fraenkel (1966) reported that even though all the necessary nutrients required for growth may be present, it is conceivable that the insect may still grow poorly as a result of improper nutrient proportions.

The duration of larval period of *C. partellus* was shortest on the susceptible maize cultivar Inbred A and wild sorghum *S. versicolor* compared to the other wild host plants. Significantly longer larval period was recorded on wild host species *P. maximum, E. pyramidalis, P. purpureum* and *H. rufa* which could be due to the resistance. Kumar et al.,(1993) reported that larvae feeding on resistant plants would require a longer period of time to complete a generation than on susceptible cultivars.

At 20 days after infestation, no larvae were recovered from *P. maximum, E. pyramidalis, H. rufa* and *P. purpureum*. It is suggested that these wild hosts induced larvae to leave the plants, and exposed them to natural enemies.

Any plant characteristic which slows larval movement or cause the larvae to leave the plant, exposes them to the dangers of increased predation and elemental factors such as heavy rain, excessive wind and or heat (Singh et al., 1974).

The higher the growth index, the more suitable the plant was for insect's growth. The growth index was significantly higher on susceptible maize cultivar Inbred A than on the other test plants. This can be attributed to its suitability for the development of *C. partellus*.

CHAPTER SIX

6.0 GENERAL DISCUSSION, SUMMARY AND SUGGESTIONS FOR FURTHER STUDIES

Comparative studies on survival and development of *C. partellus* on selected wild host plants and susceptible maize cultivar (inbred A) were conducted under screen house. The results obtained showed that *C. partellus* infests wild gramineous plants *S. versicolor, P. purpureum, P. maximum E. pyramidalis* and *H. rufa*. The results were in agreement with findings by Tams and Bowden (1953) and Seshu Reddy (1983), who reported that most stem borers of maize are polyphagous and attack several gramineous host plants. Of the six host plants Inbred A retained the highest number of first instar larvae (28%) and *H. rufa* was least preferred (3%). This could be due to an innate ability of the larvae to determine the suitability of oviposition plant for feeding, and a tendency to migrate in search of more preferred hosts, if the oviposition plant is not acceptable (Chapman et al., 1983).

Survival and development of *C. partellus* was faster on Inbred A and *S. versicolor* and their consumption was 37% and 24% respectively. This confirms the findings by Shanower et al.,(1993) that survival of *Sesamia calamists* Hampson varied markedly between different food sources (*Andoropogon* sp., *Pennisetum polystachion, P. purpureum, Sorghum arundinaceum,* maize and artificial diet). The four least consumed grasses were *P, maximum, P. purpureum,*

E. pyramidalis and *H. rufa*. The hard, rough and hairy leaf texture may be the cause of low larval feeding. Low larval feeding on wild host species may be influenced by plant physical and /or anatomical characters such as hairiness or presence of high concentration of waxes on the leaves of such plants (Painter 1951; Norris and Kogan 1979).

Wild gramineous plants had comparable number of eggs to Inbred A; except for *P. purpureum* which had two thirds of the total eggs compared to Inbred A. This indicates that *C. partellus* female moths are not specific with respect to where they deposit their eggs. Ampogo-Nyarko et al .,(1994) reported that female moths of *C. partellus* can oviposit on non-host in the presence of host plant. This is borne out by the results of the present study.

The use of the wild grasses can be one of the management practices for control of *C. partellus*, the desired consequence being a decrease in the pest population in maize with a concomitant increase in crop yield.

These results and findings suggest that there may be possibilities for integrating wild host species as a component of pest management of the cereal stem borer *Chilo partellus* (Swinhoe).

Wild sorghum *S. versicolor* which was the most suitable wild host plant for the growth and development of *C. partellus* larvae could be used as a bordering or trap crop in the off season, and cut off after the cultivated crop emergence. This practice may eliminate a high percentage of *C. partellus* first instar larvae.

In suggesting that wild host plants could be used as a bordering or trap crop for adult oviposition and larval arrest; further research on ovipositional preference should analyse foliage chemical content of *P. purpureum*.

A knowledge obtained from such a study may be important from pest control point of view because once this is known the chemical can be used in IPM for interrupting the ovipositional sites. After eggs hatch to first instar larvae, large proportion will probably die before they reach maize, because of predation and abiotic factors such as heavy rain, excessive wind or heat.

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