SEASONALITY AND POTENTIAL OF *CERANISUS MENES* FOR CONTROL OF THRIPS ON FRENCH BEANS

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ABSTRACT

There are no records of *Ceranisus menes* Walker in Kenya, though its distribution is known to be worldwide. The temporal presence and seasonality of *C. menes* was determined and its potential for use in the control of *Megalurothrips sjostedti* and *Frankliniella occidentalis* in French beans in Kenya evaluated. French bean, *Phaseolus vulgaris* L, cv. Monel was sown monthly throughout the year at Kaguru Farmers' Training Centre, Meru District, Kenya. Densities of *M. sjostedti*, *F occidentalis* and *C. menes* were monitored using blue sticky plates. Development of *C. menes* and percentage parasitism on *M. sjostedti* and *F. occidentalis*, both in the field and laboratory, were assessed. *Ceranisus menes* exhibited a clear seasonality at Kaguru FTC, being present early and towards the end of the year and virtually none in the middle of the year. However their low numbers, when present, did not keep the thrips populations in check. The population of *C. menes* was better synchronised with that of *F. occidentalis* population than with *M. sjostedti.* Linear regression analysis did not show a density-dependent relationship between percentage parasitisation by *C. menes* and thrips larval density. The lowest percent parasitism (3.5%) was recorded in the months of August and September, which coincided with the period of the highest *M. sjostedti* density. The parasitism experiments showed that once *C. menes* completes parasitising *M. sjostedti* or *F. occidentalis* larvae, the developmental periods and percentage mortality in either of the two thrips spp. were not different. *Ceranisus menes* can be explored further alongside other locally available biocontrol agents for possible incorporation into an integrated thrips management on French beans.

Key words: Biocontrol, parasitoid, *Megalurothrips sjostedti*, *Frankliniella occidentalis*

1.0 INTRODUCTION

There have been few attempts to use parasitoids for the control of thrips as compared to predators, despite the fact that the latter are more host-specific (Loomans and van Lenteren, 1995). There is need to explore the possibility of using parasitoids, especially indigenous ones, possibly in conjunction with predators for incorporation into integrated pest management of thrips in French beans. This will hopefully reduce reliance on pesticides, which has been reported to cause low temporal presence and parasitisation rates by *Ceranisus menes* Walker (Hirose *et al.,* 1993).

Many parasitoids are known to attack thrips (Lewis, 1973; 1997; Loomans and van Lenteren, 1995). One such parasitoid that has received a lot of attention and is gaining importance worldwide is the solitary thrips larval endoparasitoid, *C. menes* (Loomans and van Lenteren, 1995). This is partly due to its worldwide distribution and ability to parasitise larvae of many thrips pests in a wide variety of crops. Such thrips include *Thrips tabaci* Lindeman, *Thrips palmi* Karny, *M. sjostedti* and *Frankliniella occidentalis* and *Frankliniella schultzei* Trybom. *C. menes* has been evaluated for the control of *T. tabaci* (Saxena, 1971), *T. palmi* (Hirose *et al.,* 1993; Castineiras *et al.,* 1996) and *F. occidentalis*, (Loomans and van Lenteren, 1992, 1994, 1995 and 1996), in various parts of the world with promising results.

In Africa, attempts to use *C. menes* for the control of *M. sjostedti* has been reported from International Insitute of Tropical Agriculture (IITA) (Tamo *et al* 1993). Recovery of the parasitoid from field-collected thrips larvae was also very low. Low parasitisation rates have also been reported elsewhere (Saxena, 1971). French beans are attacked not only by *M. sjostedti,* but also *F. occidentalis.* There are no records of *C. menes* in Kenya, though its distribution is known to be worldwide (Loomans and van Lenteren, 1995).

The objective of this study was, therefore, to determine the presence and seasonality of *C. menes,* and to evaluate its potential for control of *M. sjostedti* and *F. occidentalis* in French beans in Kenya.

2.0 MATERIALS AND METHODS

Field experiments were carried out at Kaguru Farmers Training Centre (FTC), Meru District (37°30' 0°E), at 1,527 m above sea level and receiving an annual rainfall of 1,765 mm (Jaetzold and Schmidt, 1983), and at Jomo Kenyatta University of Agriculture and Technology (JKUAT) (1°06' 37° 01' E, altitude 1,520 m above sea level. French bean, *Phaseolus vulgaris* L, cv. Monel was grown in 10 x 10 m plots replicated four times. The plots were separated by 1 m-paths. The beans were sown monthly, throughout the year (1998/1999), at a spacing of 60 cm between the rows and 10 cm within the rows. Prior to sowing, bean seeds were treated against attacks by bean flies using mixtures of Imidacroprid (Gaucho®) and Fipronil (Vitavax®) at the rates of 8 g/kg and 4.8 ml/kg seed respectively. At sowing, diammonium phosphate (DAP) fertilizer was applied at the rate of 60 kg/ha, while calcium ammonium nitrate

(CAN) was applied as a top dressing at the rate of 60 kg/ha when the plants were three weeks old (first trifoliate leaf stage). The fields were kept free of weeds and irrigated as necessary.

Densities of *M. sjostedti, F. occidentalis* and *C. menes* were monitored using blue sticky plates (size 17 x 21 cm), placed inside transparent polythene bags. The bags were coated on both sides with insect glue (Temmen Ò, Germany). The traps were fastened to sticks that held them in position 30 cm above the bean canopy. They were placed in the field from the day of sowing, and their heights adjusted as the plants grew and were left in the field for seven days. Two traps per plot, one facing East/West and the other facing North/South directions were placed in the field to trap thrips from all directions. The polythene bags were removed from the plates after one week, then pasted onto two plain printing papers. In the laboratory, each polythene bag was cut into two sheets and a transparency with a squared grid fastened onto each sheet with paper clips. Identification and counting of *M. sjostedti, F. occidentalis* and *C. menes* was done under a dissecting microscope.

For the assessment of percent parasitism in the field, fifteen flowers per plot were sampled twice a week from beans grown at JKUAT. All the flowers from a plot were placed in 100 ml transparent plastic cups and taken to the laboratory for extraction of thrips larvae. The flowers were carefully dissected under a microscope and all first and second instar thrips larvae extracted and placed in cages, in groups of ten larvae per cage. The larvae were provided with fresh bean pod sections or petals and 10% honey/water solution. The cages were placed in an incubator at 25°C. When the thrips larvae became pre-pupae and pupae, the rearing cages were inspected daily for parasitised pre-pupae and pupae and adult parasitoid emergence. The thrips larvae collected from the field were not separated to species due to difficulties in such an exercise (Palmer *et al.*, 1989). Consequently, it was not possible to evaluate percentage parasitism for *M. sjostedti* and *F. occidentalis* on French beans separately.

In the laboratory, percent parasitism and development of *C. menes,* reared separately on *M. sjostedti* and *F. occidentalis* first instar larvae were assessed. *M. sjostedti* and *F. occidentalis* were reared in the laboratory at 25°C in an incubator to provide the first instar thrips larvae for use in the experiments.

Twenty two-day old first instar larvae of *M. sjostedti* or *F. occidentalis* were each separately placed on a bean flower petal or bean pod in a cage using a fine camel hair brush (size 000) and supplied with 10% honey/water solution (Murai, 1990). One female *C. menes,* two to three-days old, obtained from the colony of *C. menes* reared from thrips larvae collected from the field, was placed in a cage with the 20 thrips larvae. The cages were placed in an incubator at 25°C and *C. menes* females removed after 24 hours. Bean flower petals and pods were replaced daily and the tissue paper moistened and supplied with 10% honey/water solution as necessary. Each experiment was repeated ten times.

Parasitisation was observed during the pre-pupal and pupal stages of the thrips, when the immature parasitoids could be seen through the host body wall (Castineiras *et al.*, 1996). This is because it was difficult to recognise parasitisation in the larval instars (Loomans and van Lenteren, 1995), which developed normally (Saxena, 1971). Therefore, only data of thrips larvae surviving to the pre-pupa stage were taken into account. Parasitised pre-pupae were counted daily and transferred to fresh cages and placed in an incubator at 25°C.

Relationships between the densities of adult *M. sjostedti* and *F. occidentalis* with that of *C. menes* in the field were analysed by correlation analysis. The total numbers of larvae parasitised were regressed against the total number of larvae collected. Percentage parasitisation {(number parasitised per 20)100} and percent mortality,{(number of dead parasitoid larvae and pupae per total parasitised larvae)100} were calculated for each of the thrips species. Developmental time data, collected in the larval rearing experiments, were log transformed and analysed using PROC GLM of SAS (SAS Institute, 2000). Means were separated using Student-Newman-Keuls (SNK) grouping. Percentage mortality and percentage parasitisation data were arcsine transformed prior to analysis by t-tests (SAS Institute, 2000).

3.0 RESULTS

Field-collected adult parasitoids were identified as *C. menes* Walker (LaSalle, British Museum of Natural History, Personal comm.) (Plate 1). Only female *C. menes* was collected from the two field sites. They were of two colour-types, brown and yellow abdomen.

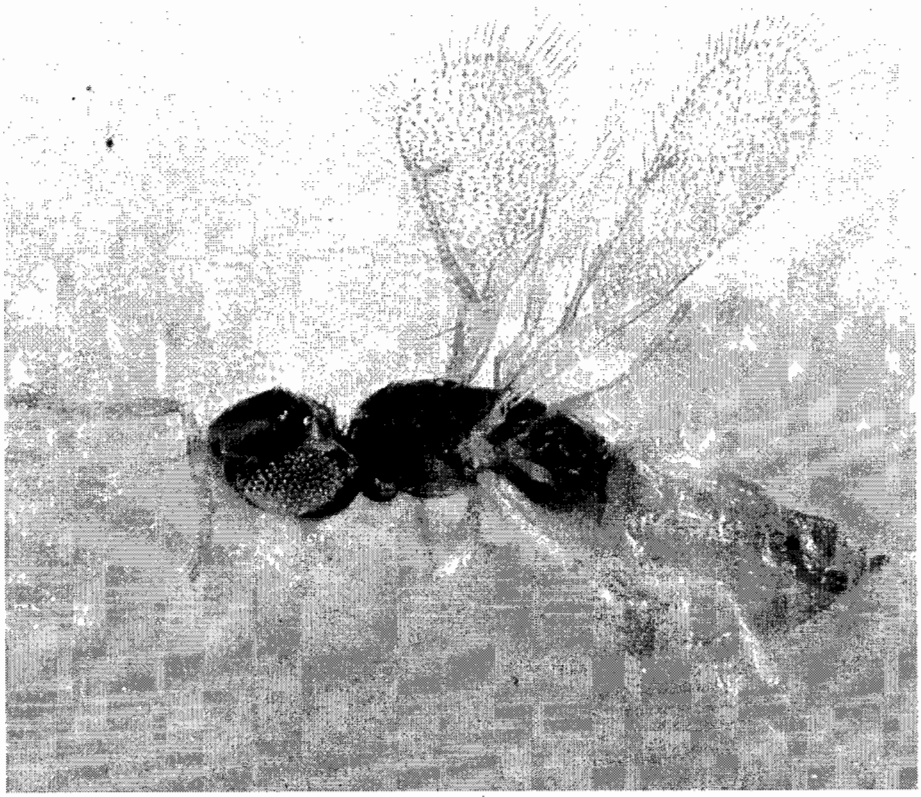

Plate 1: Adult female Ceranisus menes

Ceranisus menes colonised French bean fields naturally at the two localities. The incidence of *C. menes* at two sites and for different plantings at Kaguru is shown in Figure 1. Figures 2 and 3 show the seasonal incidence of *C. menes* together with that of *M. sjostedti* and *F. occidentalis,* respectively, at JKUAT. Of the two sites, JKUAT had the highest densities of *C. menes* for most of the plantings. *Ceranisus menes* exhibited a clear seasonality, being present early and late in the year (Figure 1). The same trend was observed at JKUAT, where the *C. menes* population rose to the highest peak in the late and early months of the year (Figures 2 and 3). At Kaguru, there were virtually no *C. menes* in the middle of the year while at JKUAT, *C. menes* was present in substantial numbers throughout the year. However, the densities were lower in the middle of the year and a few *C. menes* were found on the

French bean flowers in the two localities during the mid months of the year when none were found on the traps. Figure 2 shows that in spite of the extremely high densities of *M. sjostedti* in the crop sown at JKUAT (~1300 / trap) in the crop sown in July, the densities of *C. menes* on the same crop were very low, about 3 / trap at their peak. A little increase in the numbers of *C. menes* was evident at the end of the crop cycle. Noteworthy also is the fact that the crop sown in October had the highest numbers of adult *C. menes* recorded for all the sowings at this site for the duration of the studies. A closer look into the population trends of the parasitoid and the thrips reveals that the parasitoid population was more synchronised with the *F. occidentalis* population than with the *M. sjostedti* population (Figures 2 and 3). However, in none of the sowings was there significant correlation between the densities of *C. menes* and either *M. sjostedti* or *F. occidentalis* ($P > 0.05$).

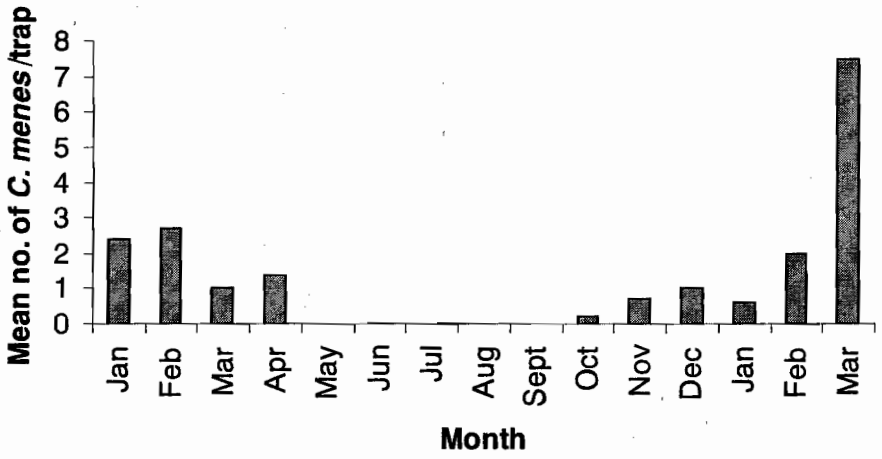

Figure 1: Incidence of Ceranisus menes caught on sticky traps in unsprayed field-grown French beans at Kaguru

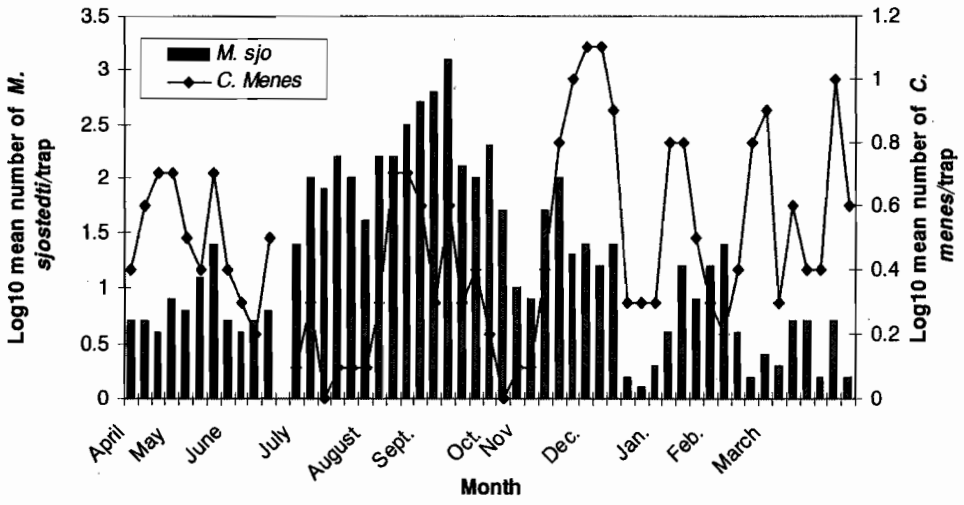

Figure 2: *Densities of Megalurothrips sjostedti and Ceranisus menes in French bean crop at JKUAT*

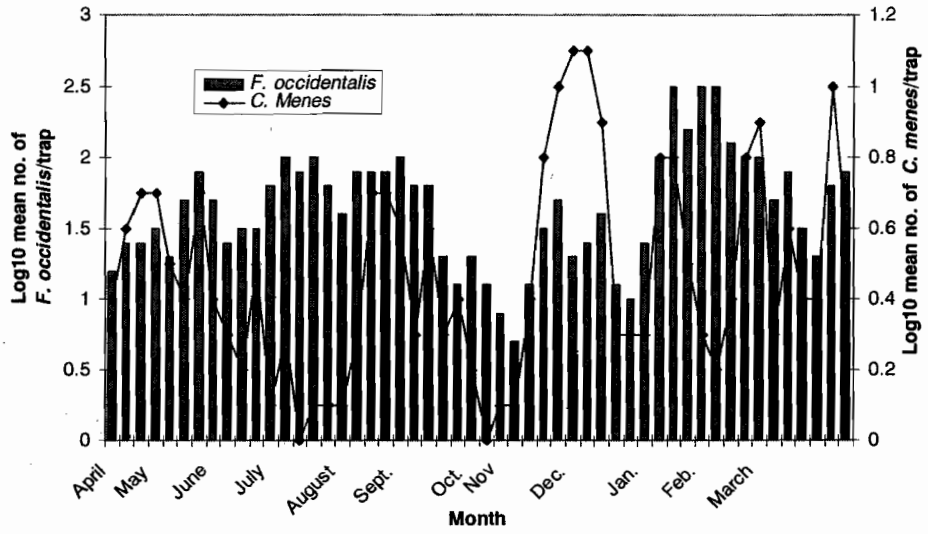

Figure 3: Densities of Frankliniella occidentalis and Ceranisus menes in French bean crops at JKUAT

Table 1 shows percent parasitism of the field-collected thrips larvae. Only mortalities with reference to the parasitoid stage that is visible in the pre-pupa and pupa thrips instars could be accounted for. Percentage parasitism of thrips larvae by *C. menes* ranged from 3.5% to 18.1% for the four plantings at JKUAT, peaking in the months of March and April (Table 1). The lowest percent parasitism (3.5%) was recorded in the months of August and September, which coincided with the period of the highest *M. sjostedti* density. Percentage parasitisation was generally higher during the latter part of the year.

Table 1: Percentage parasitism and adult emergence of Ceranius menes reared from thrips larvae collected from unsprayed French beans at JKUAT

Sampling period	*No. larvae Collected*	*Percentage Parasitism*	*% Adult Emergemce*
August -September	1957	3.5	57.4
November–December	794	8.8	57.1
January-February	571	14.7	61.9
March-April	596	18.1	72.9

Linear regression analysis did not show a density-dependent relationship between percentage parasitisation by *C. menes* and larval density. Results of parasitism experiments in the laboratory are presented in Table 2, which showed that *C. menes* successfully parasitised and completed development in both *M. sjostedti* as well as in *F. occidentalis*. The developmental period of *C. menes* in *M. sjostedti* and in *F. occidentalis* were not significantly different (Table 2). Similarly, percentage mortalities of *C. menes* in *M. sjostedti* and *F. occidentalis* were not significantly different (Table 2). However, percentage parasitisation of *F. occidentalis* by *C. menes* was higher than that of *M. sjostedti* (Table 2).

Table 2. Developmental period, percentage mortality and parasitism of Ceranisus menes on Frankliniella occidentalis and Megalurothrips at 25°C

Developmental period Thrips spp.	*in days(Mean ±SE)*			*% mortality*	*% parasitisatior*
	Egg-Larva	*Pupa*	*Total*	*(Mean ±SE)*	*(Mean ±SE)*
F. occidentalis	9.5±0.15 a	16.8± 0.16a	26.3±0.24a	17.6±3.7a	30.5±2.8a
M. sjostedti	9.6 ± 0.16a	17.2±0.18a	26.8±0.21a	25.3± 4.9a	22.0±1.3b

Means within a column followed by the same letter are not significantly different ($P < 0.05$) mean seperation by SNk procedure.

4.0 DISCUSSION

The finding that only female *C. menes* were collected during the course of these studies agrees with those from elsewhere in Africa and Europe, where only female *C. menes* have been collected. Males of the same species have been reported only from South East Asia (Loomans and van Lenteren, 1995). The parasitoid was of the two colour types reported for *C. menes,* i.e., brown and yellow abdomen types (Loomans and van Lenteren, 1995).

In one of the sites, Kaguru FTC, C. *menes* exhibited a clear seasonality, being present towards the end of the year and early in the year. Such seasonality has been reported elsewhere (Loomans and van Lenteren, 1995) and attributed to diapausing of the parasitoid during cold temperatures. *C. menes* is reported to be present in the field when mean monthly temperatures are above 20°C and remain active up to 37°C. This may be the explanation for the seasonality of *C. menes* in Kenya, since it is absent in the crop during the coldest months of the year (May through to August).

Despite the temporal presence and the increasing numbers of *C. menes* late and early in the year, the parasitoid never managed to keep the population of the thrips low at both localities. This was probably due to its very low numbers, which were thought to be insufficient to act as mortality factor of *M. sjostedti.* High numbers of *C. menes* were found in October at both localities. This more or less coincided with the period when the densities of *F. occidentalis* began to increase. It is therefore possible that the parasitoid responds numerically to *F. occidentalis.* Lewis (1973) however suggests that it is not known whether the increase in percentage parasitism with increase in larval density is due to a numerical (aggregative or reproductive) or a functional response.

The population of *C. menes* was better synchronised with that of *F. occidentalis* population than with that of *M. sjostedti. C. menes,* however, has been observed to parasitise thrips closely related to *M. sjostedti* in South East Asia (Chang, 1990), which may be the reason why these thrips species are not major pests in these localities (Tamo *et al.,* 1993). Moreover, *C. menes* has been reared from *M. sjostedti* larvae (Tamo *et al.,* 1993). The lowest percent parasitism (3.5%) was recorded in the months of August and September, which coincided with the period of the highest *M. sjostedti* density. This was due to the low numbers of *C. menes* recorded in the crop at the time, hence insufficient as a mortality factor for *M. sjostedti.* This is a possible explanation since the populations of the parasitoid were very low, from May. Percentage parasitisation was higher during the latter part of the year and this coincided with the period when the parasitoid was present in higher numbers than in the middle of the year. This period also coincided with the build up of *F. occidentalis* populations.

Only mortalities with reference to the parasitoid stage visible in the thrips pre-pupal and pupal instars could be accounted for, since it is difficult to distinguish

between parasitised and unparasitised first and second instars of thrips larvae (Loomans and van Lenteren, 1995). It is possible, therefore, that percentage mortality of *C. menes* in this study was underestimated.

Both first and second instar thrips larvae were collected from French bean fields because *C. menes* is known to oviposit in both larval instars (Loomans and van Lenteren, 1995), though Saxena (1971) recorded higher parasitisation of second instars. Other authors have recorded higher parasitisation of the first instars (Loomans and van Lenteren, 1995).

In order to evaluate the possibility of using *C. menes* for the biocontrol of *M. sjostedti,* parasitisation and subsequent rearing in the laboratory was carried out. *Ceranisus menes* completed development in the two thrips species. This is an important factor if the use of this parasitoid is to be incorporated into a thrips biocontrol program. The developmental period of *C. menes* was longer than that of the hosts (data not shown). Similar observations have been made in glass house conditions for *C. menes* and other *Ceranisus* spp. such as *C. americensis* (Loomans and van Lenteren, 1996). However, since thrips populations in glass houses are not discrete (Loomans and van Lenteren, 1995), the parasitoids are able to find suitable hosts at all the times. Similarly, populations of thrips also overlap on the French beans. Moreover, thrips have been found in the French bean crop throughout the year, and therefore the parasitoid never lacks hosts.

The parasitism experiments showed that once *C. menes* completes parasitising *M. sjostedti* or *F. occidentalis* larvae, the developmental periods and percentage mortality in either of the two thrips spp. were not different. Loomans and van Lenteren (1994) found that percentage parasitism of *F. occidentalis* by *C. menes* decreased with increase in larval size, because the thrips larvae were able to ward off attacks by the parasitoid. However, it may not be possible to deduce the effects of larval sizes on percentage parasitisation of the two species since the larval sizes for *F. occidentalis* given by Loomans and van Lenteren (1994) and for *M. jostedti*, given by Salifu and Hodgson (1987), are not definitive. Such studies may provide the relevant data on the behavior of *M. sjostedti* larvae towards attacks by *C. menes* needs to be carried out.

In the field, *C. menes* may likely have responded more to *F. occidentalis* and not *M. sjostedti.* This assertion is reinforced by the finding that percentage parasitism was highest during the period when virtually only *F. occidentalis* was present in the crop, despite its actual low numbers. This was unlike the case with *M. sjostedti.* In view of the difficulties encountered in the control of *F. occidentalis*, such as pesticide resistance, this would be a very welcome observation for the development of integrated management of thrips in French beans. However, more research needs to be conducted in this regard. As noted earlier, the high percentage parasitism, when thrips numbers were low, could also have been related to the seemingly higher parasitoid numbers during that time of the year, as compared to the

earlier months, when there were virtually no *C. menes* in the crop, the reasons for which are not clear yet.

This, being the first recorded account of *C. menes* in Kenya, indicates that the parasitoid is locally available. It is present throughout the year. The most appropriate time for sampling *C. menes* is, therefore, evident. The incidence of the parasitoid was low, as compared to that of the thrips species for most of the year. It is possible that this was the reason that they could not keep the thrips populations in check. From the foregoing, it is evident that *C. menes* should be considered for control of thrips alongside the locally available predator, *Orius albidipennis* Reuter (Gitonga *et al.*, 2002 a, b).

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REFERENCES

Castineiras A, Baranowski R. M. and H. Glenn. (1996). Temperature Response of *Ceranisus menes* (Hymenoptera: Eulophidae) Reared on *Thrips palmi* (Thysanoptera: Thripidae). *Flo. Entomolo.*, **79**(1), pp 13 -19.

Chang N. T. (1990). *Ceranisus menes* (Walker) Eulophidae: Hymenoptera), A New Parasite of Bean FlowerThrips *Megalurothrips usistatus* (Bagnal) Thysanoptera: Thripidae). *Plant protection Bull.* ,**32**, pp 237 - 238.

Gitonga L. M. (1999). Bioecology of Thrips in French Bean Growing Agroecosystems in Kenya. PhD Thesis pp176.

Gitonga L. M., Overholt W. A. ., Lohr B., Magambo J. K. and Mueke J. M. (2002a). Functional Response of *Orius albidipennis* (Hemiptera:Anthocoridae) to *Megalurothrips sjostedti* (Thysanoptera:Thripidae). *Biological control*, **24**, pp 1 - 6.

Gitonga L. M, Lohr B., Overholt W. A., Magambo J. K. and Mueke J. M. (2002b). Effects of Temperature on the Development of *Orius albidipennis* (Hemiptera:Anthocoridae), a Predator of the African Legume Flower Thrips, *Megalurothrips sjostedti* (Thysanoptera:Thripidae). *Insect Science and its Application,* **22** (3), pp 215 - 220.

Hirose Y., Kajita H., Takagi M., Okajima S., Napompeth B. and Buranapanichpan S. B. (1993). Natural Enemies of *Thrips palmi* and their Effectiveness in the Native Habitat, Thailand. *Biol. Control,* **3**, pp 1-5.

Jaetzold R. and Schmidt H. (1983). Farm Management Handbook of Kenya: Vol II. Ministry of Agriculture, Nairobi, Kenya, pp 311.

Lewis T. (1973). Thrips, their Biology, Ecology and Economic Importance. Academic Press. London.

Lewis T. (1997). Pest Thrips in Perspective. **In** T. Lewis (Ed.). Thrips as Crop Pests. CAB Oxon UK pp1-13.

Loomans A. J. M. and van Lenteren. J. C. (1994). Evaluation of the Effectiveness of Parasitic Wasps for the Biological Control of Thrips Pests in Protected Crops: State of Affairs. *Bull. I0BC/WPRS,* **17**(5), pp 158-164.

Loomans A. J. M. and van Lenteren J. C. (1995). *Biological Control of Thrips Pests: A review on Thrips Parasitoids.* **In**: Biological Control of Thrips Tests. Wageningen Agricultural University Papers **95** (1), pp 92 -195.

Loomans A. J. M. and J. C. van Lenteren. (1996). Prospects of *Ceranisus americensis* (Girault) (Hymenoptera: Eulophidae) as a potential biological control agent of Thrips Pests in Protected Crops. *Bull. IOBC/WPRS,* **19**(1), pp 95 - 98.

Loomans A. J. M., Silva I. and van Lenteren J. C. (1992). *Ceranisus menes* (Hymenoptera: Eulophidae), a Potential Biological Control Agent of *Frankliniella occidentalis* (Thysanoptera: Thripidae). *Proc. Exper. and Appl. Entomol..*, N. E. V. Amsterdam, **3**, pp 40 - 45.

Murai T. (1990). Rearing method and biology of thrips parasitoid, *Ceranisus menes. Bull. IOBC/WPRS,* **13**(5), pp 142 -146.

Palmer J. M., Mound L. A. and du Heauthe G. J. (1989). IIE Guides to Insects of Importance to Man 2. Thysanoptera. CAB International Institute of Entomology, British Museum Natural History, pp 1-73.

Salifu A. B. and Hodgson C. J. (1987). Dispersion Patterns and Sequential Sampling Plans of *Megalurothrips sjostedti* Trybom (Thysanoptera: Thripidae) in Cowpeas. *Bull. Entomol. Res.* ,**77**, pp 441 - 449.

SAS software. (2000). Changes and Enhancements through Release 6.12. SAS Institute inc. Cary, NC, USA, pp1162.

Saxena R. C. (1971). Some Observations on *Ceranisus* sp. (Hymenotera: Eulophidae) Parasitising *Thrips tabaci* Lind. (Thysanoptera: Thripidae). *Indian J. Entomol.*, **33**(1), pp 91- 92.

Tamo J., . BaumgartnerJ.,Delucchi V. and Herren H. R. (1993). Assessment of Key Factors Responsible for the Pest Status of Bean Flower Thrips *Megalurothrips sjostedti* (Thysanoptera: Thripidae) in West Africa. *Bull. Entomol. Res.*, **83**, pp 251 - 258.

Tagashira E. and Hirose Y. (2001). Development and Reproduction of *Ceranisus menes* (Hymenoptera: Eulophidae), a Larval Parasitoid of Thrips: Effects of Two Host Species, *Frankliniella intonsa* and *Thrips palmi* (Thysanoptera: Thripidae. *Applied Entomology and Zoology,* **36**, pp 237- 241.