Tropical and Subtropical Agroecosystems

SHORT NOTE [NOTA CORTA]

EFFECTS OF *Dinarmus basalis* (RENDANI) ON THE POPULATION DENSITY OF *Callosobruchus maculatus* (FABRICIUS) ON STORED COWPEA (*Vigna unguiculata* WALP) SEEDS

[EFECTO DE *Dinarmus basalis* SOBRE LA DENSIDAD POBLACIONAL DE *Callosobruchus maculatus* (FABRICIUS) EN SEMILLA ALMACENADA DE *Vigna unguiculata* WALP]

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SUMMARY

The control of *Callosobruchus maculatus* F. on cowpea seeds was studied in the laboratory using *Dinarmus basalis* as parasitoid. Five males and females adult *C. maculatus* were allowed to oviposit onto ten sets of cowpea seeds each set weighed 5g. Five males and females *D. basalis* were introduced at three days intervals (beginning from the 6th day after oviposition) into each of the nine sets that had been infested with eggs of *C. maculatus* contained in specimen bottles. No *D. basalis* was introduced into the tenth set of cowpea seeds and this served as control. No differences were observed in the number of eggs laid per female *C. maculatus* in all the sets (P> 0.05) and this ranged from 37.80 - 41.20. No differences were observed on adult *C. maculatus* that emerged when *D. basalis* was introduced at the 6th, 9th and 12th day after oviposition (DAO) (P> 0.05). Percent emergence was 0.59, 0.53 and 1.85% at 6, 9 and 12th day, respectively. *C. maculatus* emergence increased from 67.81% in the treatment that was inoculated on the 21st DAO to 74.48 when inoculation was done on the 30th day. The total *D. basalis* per female in each culture was 12.81% on the 6th day to 17.56% on the 15th day and decreased significantly to 11.78% when inoculation was done on the 30th day. The observed percentage mortality of *C. maculatus* increased from 25.03% to 99.41% on the parasitised culture when compared to 25.52 in the control. Introduction of *D. basalis* during the larval stage of *C. maculatus* caused higher mortality of the pest and little or no effect on the adult *C. maculatus*.

Key words: Oviposition, inoculation, mortality, parasitoid.

RESUMEN

Se estudio el control de *Callosobruchus maculatus* F. en semillas de Vigna empleando el parasitoide *Dinarmus basalis.* Cinco hembras y machos adultos de *C. maculatus* fueron depositados para ovipositar en 5g de semillas de vigna. Cinco machos y hembras de *D. basalis* fueron introducidos a intervalos de tres días (iniciando el día 6 posterior a la oviposición) en las semillas infestadas con huevos de *C. maculatus,* se mantuvo un grupo control donde *D. basalis* no fue introducido. No se encontró diferencias (P> 0.05) en el número de huevos ovipositados por cada hembra de *C. maculatus* (rango 37.80 - 41.20). No se encontró difrencias (P > 0.05) en el número de adultos de *C. maculatus* que emergieron cuando *D. basalis* fue introducida en los días 6, 9 y 12 post oviposición (DAO). La emergencia de *C. maculatus* se incrementó cuando *D. basalis* fue inoculado a partir del día 21 DAO. El % de *D. basalis* por hembra en cada cultivo fue 12.81% en día 6, 17.56% día 15 y decremento significativamente (11.78%) cuando la inoculación fue realizada en el día 30. La mortalidad observada en *C. maculatus* incremento de 25.03% a 99.41% en los cultivos parasitados y fue de 25.52% en el grupo control. La introducción de *D. basalis* durante el estadío larval de *C. maculatus* causó una mayor mortalidad y no tuvo efecto en los adultos de *C. maculatus*.

Key words: Oviposición, inoculación, mortalidad, parasitoides.

INTRODUCTION

The bruchid *Callosobruchus maculatus* is an important pest of stored cowpea (*Vigna unguiculata* L. Walp) with ample distribution in tropical and subtropical regions where this crop represents one of the main sources of protein in human diet (Singh *et al*., 2005). It is reported to be the principal storage pest of cowpea grain in sub-Saharan Africa (Taylor, 1981). Infestation of *C. maculatus* starts in the field and continues in storage (Messina, 1984). The insect infests cowpea before harvest and causes quantitative and qualitative losses to seeds in storage facilities (Shade *et al*., 1990). Caswell (1984) and Murdock *et al*. (1997) reported that during traditional post harvest storage in Nigeria, cowpea grain stored in pods for 8 months had 50% of the grain damaged by bruchids but when stored as grain, 82% had one or more holes. Female *C. maculatus* oviposits on the pods and larval development is entirely within the seeds (Messina, 1984, Stoll, 2000).

The Hymenoptera *Dinarmus basalis* is an ectoparasitoid larvophagous species, which is also present in the graineries and represents 80-90% of the bruchid larvophagous parasitoids in the cowpea fields and the stores (Ouedraogo *et al*., 1996). According to *Dugravot et al. (2002), D. basalis* is an efficient natural enemy, which could be used for biological control. The larva of *C. maculatus* is parasitised inside the seeds by *D. basalis (Dugravot et al., 2002*, Gauthier *et al*., 2002). The objective of this study was to manage the population density of *C. maculatus* by introducing *D. basalis* at the time the pest is susceptible to the parasitoid.

MATERIALS AND METHODS

Cowpea seeds that were collected from cowpea store in Uselu market, Benin City were placed in a beaker in an oven at 60^{o} C for one hour to disinfest them (Murdock and Shade, 1991). The experiment was carried out in the University of Benin laboratory under a temperature of $28 \pm 2\,^{o}$C and 70 ± 10 % RH. Cowpea seeds (200g) were infested with five males and females (0-3 days old). The sexes of *C. maculatus* were determined by examining the elytral pattern (Southgate *et al*., 1957). Females are usually dark coloured and possess four elytral spots, while males are pale brown and less distinctly spotted. Furthermore, males have comparatively shorter abdomen and the dorsal side of the terminal segment is sharply curved downwards and inwards. In contrast, females have comparatively longer abdomen and the dorsal side of the terminal segment is only slightly bent downwards (Bandara and Saxena, 1995). The disinfested cowpea seeds were put in five jars with net mesh lids. The seeds in each jar were re-infested with *C. maculatus*. The *C. maculatus* were allowed to oviposit for three days before they were removed.

Cultures of *D. basalis* were reared from the stock collected from parasitised cowpea purchased at the Uselu market, Benin City. Parasitoids were sieved out of the cowpea and the cowpea set aside for new emergence of the parasitoids.

Five grams of the disinfested cowpea seeds were weighed into ten different specimen bottles (labelled A-J) with fine nylon net lids of about 1x1 mm mesh size and these were replicated four times. Cowpea seeds in each of the bottles were infested with five pairs (females and males) of the newly emerged *C. maculatus* (0-3 days old) and were allowed to oviposit for three days.

Introduction of *D. basalis* to cowpea infested with eggs of *C. maculatus*.

Each of the nine bottles containing the infested cowpea except the control was now infested with five pairs (males and females) of *D. basalis* at three days intervals and labeled A-I. No *D. basalis* was introduced into the tenth bottle (labeled J) and this served as the control. Treatments were replicated four times and set-aside on a laboratory bench arranged in completely randomised block design.

Data collection

The number of eggs laid by *C. maculatus* per female was recorded. Emergence of *C. maculatus* and *D. basalis* per female were recorded. The total number of *D. basalis* in each culture was used for analysis. The percentage mortality and emergence (%) was calculated based on the mean number of adult *C. maculatus* per female that emerged relative to the total number of eggs laid per female. Data were taken cumulatively from 20 – 38 DAO and the means were used for analysis of variance. The Fisher's least significant difference (Wahua, 1999) was used to separate the means where applicable.

RESULTS AND DISCUSSION

Emergence of *C. maculatus* was observed from the 20th DAO until 38th day when no emergence was observed. *D. basalis* emergence was observed from the 12th DAO. Results (Table 1) indicated no significant differences ($P > 0.05$) in the mean number of eggs laid per female *C. maculatus*. Significant differences ($P < 0.05$) occurred in adult *C. maculatus* that emerged after inoculation of the parasitoid. The first six days after inoculation, significantly lower *C. maculatus* emerged compared with the cultures that were inoculated later. The highest emergence of *C. maculatus* was observed with the 27th DAO, although there were no significant differences in emergence between the 27th, 30th and the control. Percent mortality was significantly higher in the cultures that were inoculated earlier at the 6th to 18th DAO (i.e. the larval stages) compared with the control or cultures inoculated later at 21st to 30th DAO (when *C. maculatus* has reached adult stage). Results showed that the time when the parasites were introduced affected the parasitism by the parasitoid. This corroborates the report of Ouedraogo *et al*. (1996) and Stoll (2000), which indicated that the eggs hatch in about six days after oviposition. There are four larval instars, which last about twenty days.

The results showed two-phased relationship between the *D. basalis* and *C. maculatus*. The first is from the 6th –18th DAO when mortality of *C. maculatus* was high and this time corresponds to the larval stage of *C. maculatus* while from 21th - 30th DAO, the pest had reached adult stage hence were no more susceptible to the larvophagous parasitoid. This study has confirmed reports by other authors (Ouedraogou *et al*., 1996, Dugravot *et al*., 2002) that *D. basalis is* an efficient parasitoid of *C. maculatus* and can cause significant reduction in the numbers of its prey. The report by Kristina *et al*. *(*2005) that the bean damage can be reduced by approximately by 35–96% using *D. basalis* as control agent has also been confirmed in this study. As shown in the results, up to 99.41% mortality of *C. maculatus* was obtained in this study leaving only about 0.59% to damage the grains.

Table 1. Effect of *Dinarmus basalis* on the population density of *Callosobruchus maculates.*

Inoculation of *Dinarmus basalis* (Days after oviposition) in each sets (A-J)	Number of eggs laid /female *Callosobruchus maculatus*	Emergence of *Callosobruchus maculatus*/Female* (%)	Mortality of *Callosobruchus maculatus*/female* (%)	Total number of *Dinarmus basalis* in each culture*
6 (A)	37. 80	0. 59	99. 41	12. 81
9 (B)	39. 35	0. 53	98. 48	13. 21
12 (C)	41. 15	1. 85	98.15	15. 99
15 (D)	38. 60	3. 67	96. 33	17. 56
18 (E)	39. 50	11. 78	88. 22	14.17
21(F)	41.10	67. 81	32. 20	13. 38
24 (G)	39. 45	69. 78	30. 23	12. 78
27(H)	38. 50	75. 32	24. 68	12. 70
30 (I)	39. 55	74. 48	25. 03	11. 78
Control (J)	39. 90	74. 96	25. 52	-
LSD (P= 0.05%)	NS	4.98	4. 98	0.64

- = No *Dinarmus basalis* was included.
* Each value is mean of cumulative sampling for 19 days.

CONCLUSION

Introduction of *D. basalis* during the larval stage of *C. maculatus* caused higher mortality of the pest and little or no effect on the adult *C. maculatus*.

REFERENCES

Bandara, K.A.N.P and Saxena, R.C. 1995. A technique for handling and sexing *Callosobruchus maculatus* F. adults (Coleoptera: Bruchidae). Journal of Stored Product Research 31: 97-100

Caswell, G.A. 1984. The value of the pods in protecting cowpea seeds from attack from bruchid beetles. Samaru Journal of Agricultural Research 2:49-55.

Dugravot, S., Sanon, A., Thibout, E. and Huignard, J. 2002. Susceptibility of *C. maculatus* (Coleoptera: Bruchidae) and its parasitoid *D. basalis* (Hymenoptera: Pteromalidae) to sulphur- containing compounds: Consequencies of biological control. Journal of Environmental Entomology 31: 550-557.

Gauthier, N., Benedet, F., Tricault Y., Monge, J.P and Huignard, J. 2002. Marking behaviour and discrimination of concealed hosts by the ectoparasitoid, *Dinarmus basalis* Rond. (Hym. Pteromalidae). Journal of Insect Behaviour 15: 589-606.

Kristina, S., Wackers, F., Cardonal, C., and Dorn, S. 2005. Biological control of the common bean weevil by the larval parasitoid *Dinarmus basalis* in on-farm storage systems. http://www.sfiar.ch/documents/posters/dorn.htm. 21/05/2005

Messina, F.J. 1984. Influences of cowpea and pod maturity on the oviposition choices and larval survival of a bruchid beetle *Callosobruchus maculatus*. Entomologia Experimentalist et Applicata 35: 241-248.

Murdock, L.L., Shade, R.E. 1991. Eradication of cowpea weevil (Coleoptera: Bruchidae) in cowpeas by solar heating. American Entomologist 37:228-231.

Murdock, L.L., Shade, R.E., Kitch, L.W., Ntoukam, G., Lowenberg-Deboer, J., Huising, J.E., Moar, W., Chambliss, O.L., Endondo, C. and Wolfson, J.L. 1997. Postharvest storage of cowpea in sub-Saharan Africa. In: Singh, B.B., Mohan Raj, D.R., Dashiell, K.E. and Jackai, L.E.N. (Eds.) Advances in cowpea Research. Ibadan and Japan: IITA and Japan International Research Centre for Agricultural Sciences Tsukuba Ibaraki, Japan. Pp 302-312.

Ouedraogo, P.A., Sou, S., Sanon, A., Monge, J.P., Huignard, J., Tran, B. and Credland, P.F. 1996. Influence of Temperature and Humidity on populations of *Callosobruchus maculatus*.(Coleoptera: Bruchidae) and its parasitoid *D. basalis* (Hymenoptera: Pteromalidae) In two climatic zones of Burkina Faso. Bulletin of Entomological Research 86: 695-702.

Shade, R.E., Furgason, E.S. and Murdock, L.L. 1990. Detection of hidden insect infestations by feeding- generated ultrasonic signals. American Entomologist 36:231-234.

Singh, B.B., Singh, S.R. and Adjadi, O. 2005. Alternation of cowpea genotypes affects the biology of *Callosobruchus maculatus (Fabr.)*(Coleoptera: Bruchidae). Science Agriculture (Piracicaba Braz) 61: 1-10.

Southgate, B.J., Howe R.W., Brett, G.A. 1957. The specific status of *Callosobruchus maculatus* (F.) and *Callosobruchus analis* (F.). Bulletin Entomological Research 48: 79-89.

Taylor, T.A. 1981. Distribution, ecology and Importance of bruchids attacking grain legumes and pulses in Africa. In: Labeyrie, V., Junk, W. (eds.) The ecology of bruchids attacking legumes (pulses). The Hague, Netherlands, pp: 199-203.

Wahua T.A. 1999. Applied Statistics. Afrika- link Books: Ibadan, 356p.

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