Agricultural Journal 1 (4): 328- 334, 2006

Variations of Flower Thrips (*Megalurothrips sjostedti*) and Pod Borer (*Maruca vitrata*) Pests and Cowpea Flower Abortion Under Caging and Deltamethrin ® Spray Conditions

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Abstract: Experiments were conducted in the field to determine the effect of caging and Deltamethrin ® on abortion of cowpea flower and the population of Megalurothrips sjostedti and Maruca vitrata pests. Caging and complete protection of plants with Deltamethrin ® contributed to a substantial reduction of adults and larvae of *M. sjostedti*, as well as larvae of *M. vitrata* in the Sudano-sahelian and the monomodal Humid-forest rainfall zones. The aborted flowers were greater in the Sudano-sahelian than the monomodal Humid-forest rainfall zone. Contrary to the expectations, flower abortion was greater in caged-Deltamethrin than uncaged-Deltamethrin and uncaged-unsprayed treated plants. The flower abortion attributed to *M. sjostedti* was low and estimated to 2% in the Sudano-sahelian zone in 2001, 2 and 5% in the monomodal humid-forest rainfall zone. The caging effect was 2% in the Sudano-sahelian zone in 2001, 23 and 17%, respectively during the first and the second seasons of 2004 in the monomodal humid-forest rainfall zone. Uncaged-Deltamethrin treated plants produced more pods per plant than caged-Deltamethrin and uncaged-unsprayed plants. This study demonstrates that the flower abortion of cowpea mostly occur naturally; it also suggests that although caging and Deltamethrin ® can considerably reduce *M. sjostedti* and *M. vitrata* pests in field grown cowpea, it can also contribute to increase flower abortion in caged cowpea, thus a reduction of yield in a given agroecosystem.

Key words: Agroecological zones, caging, cowpea, Deltamethrin ®, flower abortion, *Maruca vitrata*, *Megalurothrips sjostedti*

INTRODUCTION

Most plants are not able to provide the necessary resources to develop mature fruits from all of the flowers they produce. Immature fruits abort when the number of pollinated flowers exceeds the resources available for fruit production[1]. The large scale flower abortion and immature fruits is thus a common phenomenon. The proportion of flowers that develop into immature fruits varies considerably among species, ranging from one to hundred percent[2]. Many causes of flower and fruit abortion have been reported, all of which are stress related and include: Heavy deleafing, loss of roots due to rot diseases or other factors, high rate of pesticide applications, lack of successful pollination, insect pests and diseases[1,3].

Anyone observing a cowpea crop closely will notice that many of the flowers abort and do not develop into mature pods containing seeds. Cowpea, *V. unguiculata* (L.) *Walp*. is a major food legume throughout the semi-arid regions of the tropics[4]. However, a complex of insects caused severe damages to this crop and losses of up to 100% of seed yields[5,6]. Studies in Cameroon have shown that despite the attributes of the crops, insect attack under field and storage conditions is responsible of severe losses in yield which drastically limit the amount of crop available to the need of people[7-9]. The cowpea flower thrips, *Megalurothrips sjostedti* and the pod borer *Maruca vitrata* are among the major pests attacking the reproductive structures of cowpea[10-12]. They prefer to attack floral parts and pods causing abortion of flowers

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and pods. Although the natural flowers abortion accounts for about 40% yield losses, the contribution of these pests to cowpea flower abortion is not well known. To increase the production of this food crop, we believe that researchers and farmers must monitor the flower abortion issue.

To address the flowers abortion problem, experiments were conducted in the Sudano-Sahelian and the monomodal humid-forest rainfall zones of Cameroon, which are two of the major cowpea growing areas. In theses zones, investigations were focused on the effects of caging and spraying cowpea with Deltamethrin ® on the populations of *M. sjostedti* and or *M. vitrata*, then assessed the flowers abortion caused by *M. sjostedti* to plants.

MATERIALS AND METHODS

The work was conducted at IRAD, Maroua, Far North Province, Cameroon, in the Sudano-sahelian zone (Zone-I) during the August to November cropping season of 2001. It was repeated in Buea, South West Province, Cameroon, in the monomodal Humid-forest rainfall zone (Zone-IV) during the first (April-August) and second (August-November) cropping seasons of 2004.

In this study, cowpea plants were protected from *M. Sjostedti* and *M. vitrata* infestation by the use of 30×75 cm cages covered with 1.5×1.5 m cloth mesh or by spraying the plants with the insecticide Deltamethrin ®. The experimental design was a complete randomized block comprising three treatments and four replicates. Each replicate consisted of fifteen randomly selected plants per plot, five of which were labelled from 1 to 5 per treatment. The three treatments were:

- Caged plants completely protected from thrips and other insects by spraying three times (two days interval) with Deltamethrin ® under natural conditions (caged-Deltamethrin);
- Uncaged plants, but sprayed three times with Deltamethrin ® under natural conditions (uncaged-Deltamethrin);
- Uncaged and unprotected plants (uncaged-unsprayed).

The five plants of each treatment within a replicate were respectively labelled with yellow, green and red flags to facilitate identification of plants and sampling. Immediately after the caging process, caged-Deltamethrin and uncaged-Deltamethrin plants were sprayed with Deltamethrin ® to keep as much as possible their flowers free from *M. sjostedti* and or *M. vitrata*.

Assessment of the population density of *M. sjostedti* and *M. vitrata* under caging and deltamethrin ® spray conditions: Two days after establishment of cages, one opened flower per labelled plant was collected in 10 mL plastic tubes containing 5 mL 50% alcohol[13]. Flowers were sampled between 8:00 and 10:30 A.M, to minimize loss of thrips flying off after disturbance[14]. Sampling was done after every two days until less than a flower was observed on a plant. Cages were temporarily removed from protected plants during flower collection, then, plants were quickly covered after Deltamethrin ® spray. A total of 5 randomly selected flowers were sampled from labelled plants in replicated plots before Deltamethrin ® spray. Flowers were dissected in the laboratory, the insects identified and counted separately under a binocular stereomicroscope. The population density of each pest species was evaluated, respectively for the whole flower sampling period and for at least eight sets of flower collection two days before the first spraying and two days after each application. The incidence of *M. sjostedti* (adult and larvae) and *M. vitrata* (larvae) populations was determined by counting the number of adults and larvae per opened flower.

Assessment of cowpea flower abortion due to feeding damages by *M. sjostedti*: During flowering that varies from 45-79 DAP, the number of opened flowers as well as growing pods per labelled plant were counted on alternate days. Flower abortion was assessed to have an indication on the degree of natural flower abortion in cowpea and assess any possible adverse effect of caging on the flowering and podding of caged plants. The followings parameters were considered:

The total number of flowers produced per plant = Tfl
The total number of pods produced per plant = Tpd
The number of flowers aborted per plant: Afl = (Tfl-Tpd)
The% aborted flowers per plant = (Afl/Tfl)×100
Flower abortion attributed to damages by thrips = % abortion on unprotected plants minus% abortion on uncaged but completely protected plants.
Caging effect = % abortion on caged plants minus % abortion on uncaged but completely protected plants. At maturity the pod yield expressed in number and dry weight per plant was assessed and recorded for different treatments.

Statistical analysis: Data were analyzed by ANOVA using a Statgraphic plus, version 5.0, SIGMA-PLUS computer program. Means were compared between treatments using the Bonferroni's multiple comparison procedure at 5% level of significance.

Table 1: Effect of caging cowpea and treating with deltamethrin on the occurrence of *M. sjostedti* and *M. vitrata* in zone-I in 2001 and zone-iv in 2004

		Treatments and population of *M sjostedti* and *M vitrata*		
Zone/year	Parameters	Caged-deltamethrin	Uncaged-deltamethrin	Uncaged-unsprayed
Zone-I (2001)	Adults of thrips	0.22±0.04a	0.17±0.03a	2.52±0.21b
	Larvae of thrips	0.28±0.07a	0.31±0.08a	3.36±0.34b
	Larvae of *Maruca*	0.03±0.01a	0.01±0.00a	0.31±0.04b
Zone-IV (2004 st)	Adults thrips	0.83±0.09a	4.06±0.47b	9.65±1.28c
	Larvae of thrips	0.06±0.03a	4.48±0.42b	11.26±0.82c
	Larvae of *Maruca*	0.06±0.02a	0.86±0.13a	5.12±0.49b
Zone-IV (2004 ^{2nd})	Adults of thrips	0.00±0.00a	1.6±0.16b	2.95±0.23c
	Larvae of thrips	0.00±0.00a	0.34±0.07b	0.78±0.10c
	Larvae of *Maruca*	0.05±0.00a	0.26±0.01b	0.47±0.01c

Caged Deltamethrin: plants caged and treated with Deltamethrin after every two days, Uncaged Deltamethrin: plants not caged and treated with Deltamethrin spray every two days, Uncaged unsprayed: plants not caged and not treated with Deltamethrin, Values are means from 20 flowers per treatment (four replicates per treatments), Values with different letter within a row are significantly different at p<0.05

RESULTS AND DISCUSSIONS

Effect of caging and Deltamethrin ® on the population density of *M. sjostedti* or *M. vitrata* in the Sudano-Sahelian and monomodal Humid-forest rainfall zones: There was a highly significant difference (p = 0.00) in adults and larvae of *M. sjostedti* recorded from caged Deltamethrin treated and uncaged Deltamethrin treated plants on one hand and those from uncaged Deltamethrin treated and uncaged unsprayed plants on the other hand (Table 1). The average number of *M. vitrata* larvae from uncaged and unsprayed plants was significantly greater (p = 0.00) than those of caged or uncaged Deltamethrin treated plants. There was no significant difference (p>0.05) between the population of *M. vitrata* recorded in caged Deltamethrin treated and uncaged Deltamethrin treated plants. Caged plants were not only sprayed with Deltamethrin, but also, they were caged shortly before flowers set to maintain as much as possible plants free from *M. sjostedti* and *M. vitrata*.

Caging and treating cowpea plants with Deltamethrin, contributed to 91% reduction of larvae and adult of thrips in Zone-I during the 2001 cropping season compared to uncaged and unsprayed treatment. In the same agroecological zone larvae of *M. vitrata* were 90% reduced by caging and Deltamethrin, whereas Deltamethrin alone contributed to 97% reduction compared to uncaged and unsprayed treatment. The first and second instars larvae of *M. vitrata* have been reported to feed on flowers, while the fourth and fifth were found on pods[12]; this may account for their low number on flowers. Cages may favour *M. vitrata* multiplication because they provide hiding places for larvae from predators. In agreement to this, *M. vitrata* larvae were found hidden in dense cowpea canopies[15]. During the first cropping season of 2004 in zone-IV, adult and larvae of thrips and larvae of *M. vitrata* were respectively reduced by 91, 99 and 98%. The effects of Deltamethrin alone were 58, 60% for adult and larvae of *M. sjostedti* and 83% for larvae of *M. vitrata*. There was a 100% reduction of adult and larvae of *M. sjostedti* by caged Deltamethrin treatment during the second cropping season in Zone-IV, while their respective reductions were 46 and 56% by Deltamethrin alone. The larvae of *M. vitrata* were reduced to 89 and 45% by caged Deltamethrin and uncaged Deltamethrin treatments respectively. It is possible that the lower population of *M. sjostedti* observed was related partly to their redistribution on the neighbouring alternative hosts and secondary to the number of flowers available in the cowpea field[16]. Climatic conditions differed completely among the two agroecological zones and these differences could have influenced the population changes of *M. vitrata* and *M. sjostedti*. Recent works have reported much lower number of adults of *M. sjostedti* than larvae, with large rainfall events being associated with a decline in adult numbers[17]. This was explained by the behaviour of *M. sjostedti* when subjected to the rainfall. The simplest starting point for the explanation is to assume that when *M. sjostedti* are randomly dispersed and exposed to the surface of flowers, they are likely to be knocked off by direct rainfall hits[18]. Significant relationships were observed between the pod borer incidence and the cumulative rainfall[12]. Our results indicate that *M. sjostedti* commonly occurring in agroecological zones of Cameroon has different seasonal population patterns, similar to what was reported on Frankiniella thrips in Florida[19]. The above results indicate that agroecological factors may participate in the population changes of *M. vitrata* and *M. sjostedti*[20].

Effect of caging and Deltamethrin ® on aborted cowpea flowers and flower abortion caused to cowpea by *M. sjostedti* or *Maruca vitrata* in Zone-I in 2001 and Zone-IV in 2004: The aborted flowers were higher in Zone-I than in zone-IV. Within agroecological zone, caging increased the number of aborted flowers more than in uncaged Deltamethrin treated plants in Zone-I, or more than in uncaged plants in Zone-IV (Table 2). There were 53% aborted flowers in caged Deltamethrin treated plants, 55% in uncaged Deltamethrin treated and 57% in uncaged-unsprayed plants in zone-I. In zone-IV, caging and complete protection of plants from infestation by thrips and other insects with Deltamethrin contributed to an increase of flower abortion. During the first cropping season, the flower abortion that was 25% in uncaged-unsprayed plants, 29% in uncaged Deltamethrin treated plants and to 53% in caged Deltamethrin treated plants.

Table 2: Effect of caging and deltamethrin treated plants on aborted cowpea flowers and flower abortion in zone-I during the 2001 cropping and zone-IV during the first (a) and second (b) cropping seasons of 2004

Zone/Year	Treatments	Tfl	Tpod	No. aborted flowers	Aborted flowers (%)	Abortion due to thrips (%)	Caging effect (%)
	Caged-Deltamethrin	40	19	21	53		
Zone-I (2001)	Uncaged-Deltamethrin	52	23	28	55		
	Uncaged-unsprayed	32	14	18	57	+2	-2
	Caged-Deltamethrin	19	9	10	53		
Zone-IV (2004 1st)	Uncaged-Deltamethrin	23	16	7	29		
	Uncaged-unsprayed	13	10	3	25	-5	+23
Zone-IV (2004 2nd)	Caged-Deltamethrin	17	8	9	50		
	Uncaged-Deltamethrin	24	16	8.0	33		
	Uncaged-unsprayed	17	11	6.0	35	+2	+17

Caged-Deltamethrin: plants caged and treated with Deltamethrin after every two days; Uncaged-Deltamethrin: plants not caged and treated with Deltamethrin spray every two days; Uncaged-unsprayed: plants not caged and not treated with Deltamethrin; Zone-I:Soudano-Sahelian zone; Tpod: Total number of pods produced per plant; Zone-IV: Monomodal Humid-forest-rainfall zone Tfl: Total number of flowers produced per plant

Similarly, flower abortion was 50, 33 and 35% in caged Deltamethrin treated, uncaged Deltamethrin treated and in uncaged-unsprayed plants during the second cropping season. The flower abortion attributed to thrips was low and estimated to +2% in Zone-I in 2001, -5 and +2% in Zone-IV during the first and second cropping season in 2004. The caging effect remained low in Zone-I (2%), but was 23 and 17% in Zone-IV during the first and the second cropping seasons.

The number of opened flowers was higher in plants that were caged and treated with Deltamethrin and those that were uncaged and treated with Deltamethrin, as compared to those from plants that were not caged and not prayed. The number of opened flower per plant at each sampling date was always higher in caged or uncaged Deltamethrin treated plants than in uncaged-unsprayed ones. The peak of opened flowers per plant was recorded at 53 DAP with 7 and 8 flowers in protected plants against 4 in unprotected plants (Fig. 1). When the variation of flowering was assessed as a function of DAP, it was found that caging and complete protection of plants with Deltamethrin resulted in decreasing flower set than uncaged Deltamethrin treated plants alone, or the uncaged-unsprayed plants during the first and second cropping seasons in Zone-IV (Fig. 1a,b) and during the 2001 cropping season at Guering-Maroua (Fig. 1c). The fact that opened flowers from plants that were caged-Deltamethrin were not as higher as those of plants of other treatments may be due to limitation of photosynthetic light caused by the presence of cages. In agreement to this, increased yield potential may result from increased efficiency of light captured by plants during photosynthesis and concerted into biomass[21]. Although uncaged-unsprayed plants always had more adult of *M. sjostedti* than uncaged or caged Deltamethrin treated plants, flower abortion was more important in caged Deltamethrin treated plants, suggesting that factors other than thrips *M. sjostedti* were involved in abortion of cowpea plants. Contrary to our expectations, caging and Deltamethrin did not always reduce the flower abortion in zone I and IV. Caging and complete protection of plants with Deltamethrin contributed to an increase of flower abortion in Zone-IV. There was no clear difference

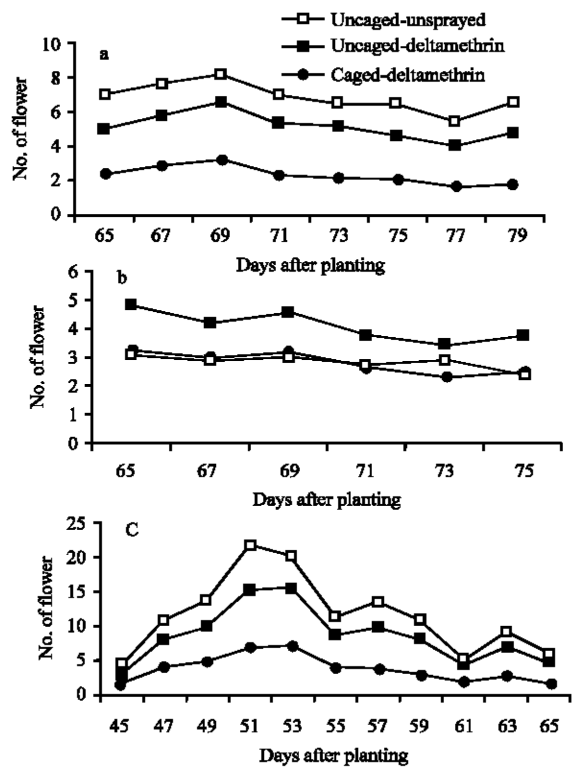

Fig. 1: Number of flowers/cowpea plant protected by caging or Deltamethrin in Zone-IV during the first (a) and second (b) cropping seasons of 2004 and Zone-I during the 2001 cropping season (c). Caged-Deltamethrin: plants caged and treated with Deltamethrin after every two days; Uncaged-Deltamethrin: plants not caged and treated with Deltamethrin spray every two days; Uncaged-unsprayed: plants not caged and not treated with Deltamethrin; Zone-I:Soudano-sahelian zone, Zone-IV: Monomodal Humid-forest-rainfall zone

Table 3: Effect of caging and treating cowpea plants with deltamethrin on the number of pods/plant in zone-iv during the first and second seasons of 2004 and in zone-I during the 2001 cropping season

Zone/Year	Treatments	No. of pods $plant^{-1}$	Dry weight of pods +$plant^{-1}$(mg $plant^{-1}$)
Zone-I (2001)	Caged- Deltamethrin	9.95±0.43a	10.91±0.42a
	Uncaged- Deltamethrin	14.53±0.67b	16.72±0.61b
	Uncaged-unsprayed	10.50±0.30a	12.72±0.62a
Zone-IV (2004 1st)	Caged-insecticide	15.15±0.83a	14.69±0.63a
	Uncaged-Deltamethrin	20.80±1.30b	20.05±0.41b
	Uncaged-unsprayed	18.15±0.68a	16.77±0.53a
Zone-IV (2004 2nd)	Caged- Deltamethrin	13.75±0.68a	26.96±1.92a
	Uncaged-Deltamethrin	21.85±1.43b	52.54±3.21b
	Uncaged-unsprayed	17.73±0.75c	38.91±2.83c

Values with different letter within a column of the same year in a zone are significantly different at $p<0.05$, Caged-Deltamethrin: plants caged and treated with Deltamethrin after every two days; Uncaged-Deltamethrin: plants not caged and treated with Deltamethrin spray every two days, Uncaged-unsprayed: Plants not caged and not treated with Deltamethrin; Zone-I:Soudano-Sahelian zone; Zone-IV: Monomodal Humid-forest-rainfall zone

between treatments in Zone-I as far as flower abortion is concerned. This may be attributed to increased adverse environmental conditions such as drought and temperature in Zone-I compared to Zone-IV. Similar to this, a high percentage of flower abortion and progressive reduction in seed yield was reported for pea grown under high temperature conditions[22]. The excess humidity was also reported to favour flower abortion of *Canavalio ensiformis* (L.) plants[23]; this may account for the increment of aborted flowers and flower abortion in caged cowpea plants. Flower and pod abortion have been reported to be a part of crop production[24]; thus, producing too many flowers is actually an advantage because it means that yield will not be limited by a lack of flowers; taking this point of view, flower abortion is not bad; it simply represents the plant's adjustment to its environment.

Effect of caging and treating cowpea plants with Deltamethrin ® on cowpea yield in pods (mg/plant) in Zone-I in 2001 and in zone-IV in 2004: Caged and unprotected plants had the same number of pods per plant with an average of 10 (Table 3). In contrast, uncaged Deltamethrin treated plants produced more pods than caged Deltamethrin treated and uncaged-unsprayed plants: 14 pods against 10 pods per plant in Zone-I in 2001; 20 pods against 15 and 18 pods per plant in Zone-IV during the first cropping season in 2004; 21 pods against 13 and 17 pods per plant in Zone-IV during the second cropping season in 2004. The dry weight of pods in Deltamethrin treatment was grearter than in caged Deltamethrin treatment in Zone-I in 2001 and in Zone-IV during the first and the second cropping season in 2004. The reduction of yield in the second relative to the first cropping season in Zone-IV could be attributed to increase flower abortion associated to reduction of higher air temperature prevailing in the second growing season. The lower pods number obtained in the second season evidenced this and is in agreement with findings that extreme temperature could influence flowering and fruit set in plant[25]. Reduced pod set could be linked to increase abundance of *M. sjostedti*, particularly larvae. This was explained by the time of onset and duration of *M. sjostedti* attack as well as the natural flower shedding of cowpea, which can reach up to 88% [26]. The application of Deltamethin ® during the flowering stage of cowpea plants significantly increased the pod yield. As *M. vitrata* and *M. sjostedti* larvae infest cowpea plants, they mostly feed on floral parts and this help them escaping from insecticides contact. This evidence justify why these pests were always detected in flowers despite the Deltamethin ® spray. However, to keep the pest populations of cowpea to minimum, foliar sprays are invariably important, Deltamethrin being the most potent in the field[27,28].

CONCLUSIONS

Our results suggest that caging and treating cowpea with Deltamethrin ® can efficiently reduce thrips and pod borer infestation in the field. The study also gives clear indication that *M. sjostedti* contribute to a very small proportion of flower abortion, the major part occurring naturally or accounting for other cowpea pests or environmental factors. Therefore the flower abortion problem could considerably be reduced if the main causes of the natural flower abortion such as drought, high humidity are well monitored during the growing cycle of the crop.

ACKNOWLEDGEMENTS

The authors wish to thank the IRAD-Maroua and the University of Buea for providing the research plots and the International Institute of Tropical agriculture (IITA) for the financial support in the form of fellowship.

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