J. Biol. Control, 15(2): 119-125, 2001

Impact of augmentative release of *Rhynocoris kumarii* Ambrose & Livingstone (Heteroptera: Reduviidae) on *Dysdercus cingulatus* (Fabricius)(Hemiptera: Pyrrhocoridae) population and damage on cotton

M. ANTO CLAVER and DUNSTON P. AMBROSE
Entomology Research Unit, St. Xavier's College
Palayankottai 627 002, Tamil Nadu, India
E-mail: sxcent@md4.vsnl.net.in

ABSTRACT: An attempt was made to augment *Rhynocoris kumarii* Ambrose and Livingstone in a cotton field to suppress *Dysdercus cingulatus* (Fabricius). The first release of adult stage of *R. kumarii* did not affect the number of adult *D. cingulatus* in the released and control field plots. The second release of *R. kumarii* in egg stage also did not significantly affect the number of first instar *D. cingulatus*. The third release of *R. kumarii* in III instar did not affect the number of II and III nymphal instars of *D. cingulatus*. However, after the fourth release of V instar stage of *R. kumarii* there was significantly fewer IV, V and adult *D. cingulatus* in predator released plots compared to non-released (control) plots. Plant damage by *D. cingulatus* was less severe in predator released plots than in non-released control plots. There was no difference in the number of predatory arthropods, such as *Menocholis* sp., *Orius* sp., *Geocoris* sp., *Cantheconidia* sp., *Rhynocoris fusciepes*, *Mantis* sp. and spiders found in released and non-released field plots. The percentage of good quality cotton and yield of seed-cotton was greater in released plots than in non-released control plots.

KEY WORDS: Augmentative release, biocontrol potential, *Dysdercus cingulatus*, *Rhynocoris kumarii*

Augmentative release of insectary-reared predators is an integral part of insect pest management programmes in agricultural systems when non-augmentative levels of predation are too low or when predation by a few species is unable to successfully control the crop pests. Augmentative release system consists of field tests to determine the optimal number of predators to be released as well as optimal release time to coincide with the earliest seasonal availability of host stages. It is obvious that sufficient quantities of the host species should be available and exist in the correct stages for attack by the predatory species released and that the host voltinism should correspond to the seasonal biology and the action of the natural enemies in crop (Waage, 1992; van Driesche, 1993). *Rhynocoris* species are the predominant reduviids found in the agricultural environment in India and they have several characteristics that make them particularly useful in augmentative release programmes (Claver, 1998; Ambrose, 2000). Field releases to augment reduviid predators against insect pests have been carried out on an experimental scale on several crops (Antony *et al.*, 1979; Powell, 1989; Rosenheim and Wilhoit, 1993; Grundy and Maelzer, 2000). Hence, an attempt was made to augment *R. kumarii* Ambrose & Livingstone in open cotton field against *Dysdercus cingulatus* to determine the exact life stages of *D. cingulatus* (Fabricius) to be suppressed by *R. kumarii* and to study the biocontrol potential of *R. kumarii* in terms of damage and yield loss reduction. The study provides complementary data on reduviid predators, which may prove useful in planning its utilization in classical biocontrol programme.

MATERIALS AND METHODS

Field site

Two cotton plots (var. LRA 5) each measuring 0.2ha were selected at a distance of 100m from one another at Dhalapathisamudram village (77.63E' and 8.45N'), Tirunelveli district, Tamil Nadu, India. Recommended commercial practices including the application of insecticides at the early stage of the crop cycle against leafhopper, *Amrasca devastans* (Distant) and aphid, *Aphis gossypii* Glover were followed on these selected plots. The farmers were convinced not to use insecticidal sprays where the bioagents had to be released. These two field stands of cotton were infested with naturally similar level of *D. cingulatus*. One field was treated as test and another as control. Cotton plants established around the outer perimeter of each field were not accounted to eliminate edge effect. Remaining area of each field was sub-divided into 20 subplots for replication. Each subplot consisted of 10row, 3m long with a 0.7m spacing between rows and 0.25m between plants.

Augmentative release of predatory reduviid

The reduviid, *R. kumarii* was collected from Marunthuvazhmalai scrub jungle and successfully reared in the laboratory since 1995 on *Corcyra cephalonica* (Stainton) larva and subsequently released in the selected test cotton field against *D. cingulatus* in 1996. Selective releases of *R. kumarii* were made from September 7 to October 9 in the test field plots. Equal number of reduviids per plot were released at every release. One hundred adults, 20 batches of eggs (56.72 eggs/ batch; ready to hatch, the next day), 200 third nymphal instars and one hundred fifth instars were released in subsequent occasions (7th Sept., 18th Sept., 27th Sept. and 9th Oct. 1996, respectively). All reduviids were transported in bags from Entomology and Research Unit, Palayankottai and released in the test field within one hour, before 9 AM.

Observations

Observations were made on five tagged plants selected at random from each subplot. *D. cingulatus* populations were counted in predator released and control plots at weekly interval till the final picking.

The number of predatory arthropods, such as coccinellids, praying mantids, spiders and predatory hemipterans on the plant foliage were recored for twelve days by visually examining five randomly chosen plants from each subplot. A visual estimate of percentage cotton boll damage in five tagged plants per sub-plot was also made for six days in 1996. Cotton was picked from these five plants at 3 day interval and the yield of *kapas* was weighed.

Statistical analysis

The effect of the *R. kumarii* release was evaluated by using a repeated measures student's "t" test to compare the *D. cingulatus* densities, predator densities, boll damage and *kapas* yield in the test field with those of control field. Percentage defoliation was subjected to angular transformation.

RESULTS AND DISCUSSION

Prey density

First release of adults of *R. kumarii* did not affect the number of adult *D. cingulatus* popuation in the test (X = 4.9) and in the control (X = 5.2) field plots during the sampling dates (9th Sep. and 14th Sep. 1996; Table 1.). Second release of *R. kumarii* in egg stage also did not significantly affect the first instar *D. cingulatus* population on 19th, 24th and 29th Sept. 1996. Again third release of the predator (III nymphal instar) did not reduce the number of II and III nymphal instar of *D. cingulatus* population in the test field plots. But only after the fourth release of *R. kumarii* in V instar there was significantly ($P < 0.05$) fewer fourth and fifth instar *D. cingulatus* population in the predator released plots. By the last sampling date (3rd, Nov.), there was a two fold greater number of *D. cingulatus* in the control (non-released) plots compared to test plots. Grundy and Maelzer (2000) reported that field released *Pristhesancus plagipennis* (Walker) nymphs could locate and capture insect prey within the crop canopy. Further they reported that the number of *Helicoverpa* sp. larvae in cotton was reduced with the release of three or more *P. plagipennis* nymphs per meter row. According to Simmons and Minkenberg (1994), the augmentative release of biocontrol agents in the field plots suppressed higher pest numbers as compared to naturally occurring natural enemies. The cotton crop surrounding the experimental plots may have also acted as a source of pest insects that continually immigrated into the plots. Thus, they partially replaced predated insects causing a reduction in the effectiveness of *R. kumarii* (Gundy and Maelzer, 2000). Aldrich and Cantelo (1999) suggested that while augmenting mass-produced predatory spined solider bugs, the pheromone dispensers were placed peripherally to promote dispersal of young predators and immigration of new wild spined soldier bug adults.

Table 1. Mean number of *D. cingulatus* per 5 cotton plants in the *R. kumarii* released (T) and control (C) plots

Sampling dates	*Dysdercus cingulatus* population											
	I instar		II instar		III instar		IV instar		V instar		Adult	
	C	T	C	T	C	T	C	T	C	T	C	T
9 Sept.'96	-	-	-	-	-	-	-	-	-	-	5.85	4.70
14 Sept.'96	-	-	-	-	-	-	-	-	-	0.05	4.50	5.10
19 Sept.'96	90.15	88.40	2.85	0.90**	-	-	-	-	-	-	1.85	2.55**
24 Sept.'96	73.70	72.65	10.70	6.60*	-	-	-	-	-	-	0.91	1.40*
29 Sept.'96	25.85	24.67	30.40	30.15	3.70	1.85**	-	-	-	-	0.50	0.35*
4 Oct.'96	20.10	16.20	23.75	28.55	6.25	5.10	0.80	0.55	-	-	0.05	0.15**
9 Oct.'96	2.10	2.30	13.15	14.00	11.50	9.85	3.50	2.15	0.90	-	-	-
14 Oct.'96	1.20	0.50	6.50	6.90	11.03	8.90	5.92	3.10	1.10	0.80	-	-
19 Oct.'96	-	-	0.70	0.90	8.72	5.70	9.30	6.40	2.45	1.05	-	-
24 Oct.'96	-	-	-	-	1.90	0.95**	6.10	4.70	5.90	3.70	0.61	0.65
29 Oct.'96	-	-	-	-	-	-	2.22	1.95	2.85	2.05	3.85	2.7
3 Nov.'96	-	-	-	-	-	-	0.34	0.80**	2.05	1.65*	4.70	2.15**

Significant *P = 0.1; **P = 0.05

Plant damage

Feeding damage by *D. cingulatus* was significantly ($P < 0.01$) less severe in released plots than in control plots (Table 2). Multiple release of reduviid predator gave better flower and boll protection and this was not constant across dates. Similar results were also recorded in tomato and small potato plots for two pentatomid predators released (*Podisus maculiventris* Say and *Perillus bioculatus* F.) (Hough Goldstein and Keil, 1991; Biever and Chauvin, 1992a,b; Hough-Goldstein and Whalen, 1993;

Cloutier and Bauduin, 1995; Hough-Goldstein *et al.*, 1996). Grundy and Maelzer (2000) reported that the release of three or more *P. plagipennis* nymphs per meter row improved cotton boll retention.

Predator density

There were some differences in the number of other predatory arthropods such as *Menochilus* sp., *Orius* sp., *Geocoris* sp., *Cantheconidia* sp., *Rhynocoris fuscipes*, *Mantis* sp. and spiders found in the released and non-released plots (Table 3; Fig. 1). Rosenheim and Wilhoit (1993) reported that the generalist reduviid *Zelus renardii* Kolenati prey upon lace wing *Chrysoperla carnea* (Stephens), a biological control agent against *Aphis gossypii* in cotton fields in the San Joaquin Valley. But Tipping *et al.* (1999) reported that release of *P. maculiventris* increased other predators about 10 days after the first release. Hence it is imperative to understand the interaction between predators, keeping in mind that some generalist predators may attack other specialist predators, with potentially negative effects on pest control. Augmentative release of *R. kumarii* did not help to increase predator density. Although *R. kumarii* is a generalist predator, it might have differential habitat or prey preference that caused decrease in density as observed by James (1994) and Danne *et al.* (1996). Proper assessment of the role of reduviid predators in regulation of insect pests in diverse crop systems and the management of environment and habitat to increase predator population need attention. Moreover, Tipping *et al.* (1999) reported that the release treatment had greater influence on the local increases of the number of *P. maculiventris* in tomato.

Table 2. *D. cingulatus* defoliation damage reduction due to *R. kumarii* release in cotton fields in 1996 ($n = 100$; $\overline{X} \pm SD$)

Sampling dates	Mean defoliation (%)	
	Predator released plot	Control plot
19 September	12.5 (13.9)	17.1* (19.0)
29 September	17.0 (18.90)	18.3 (20.33)
9 October	55.0 (61.11)	50.5 (56.11)
19 October	44.0 (48.95)	57.0 (63.33)
29 October	28.0 (31.11)	44.6* (49.55)
8 November	30.8 (38.7)	40.3* (44.8)

Figures in parentheses are arcsine values; significance at $P < 0.1$

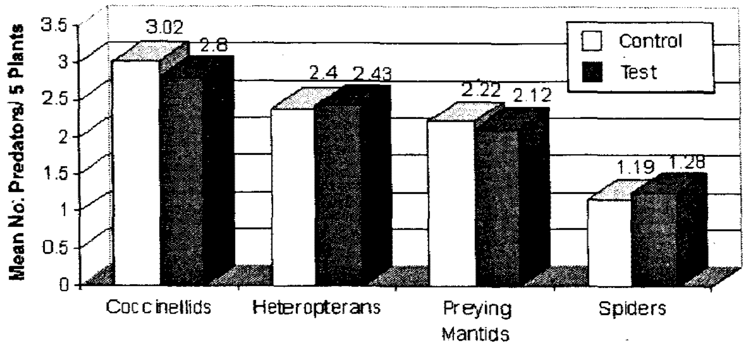

Fig 1. Mean Number of predators on cotton foliage

Table 3. Mean number of other foliage arthropod predators

Sampling dates	Predator population/5 plants ($\bar{X} \pm SD$)	
	Test plot	Control plot
9 September, 1996	5.65 ± 2.61	5.75 ± 2.47
14 September, 1996	7.45 ± 3.75	7.65 ± 4.86
19 September, 1996	9.55 ± 3.98	10.7 ± 4.24
24 September, 1996	10.58 ± 4.39	10.95 ± 3.59
29 September, 1996	11.25 ± 4.41	11.55 ± 3.63
4 October, 1996	11.85 ± 5.30	10.3 ± 4.45
9 October, 1996	9.6 ± 4.73	9.35 ± 3.95
14 October, 1996	10.45 ± 3.45	9.40 ± 4.21
19 October, 1996	7.75 ± 3.88	7.95 ± 3.70
24 October, 1996	6.95 ± 2.78	6.45 ± 5.18
29 October, 1996	4.35 ± 2.52	5.45 ± 3.41*
3 November, 1996	2.95 ± 2.11	3.80 ± 1.72*

Significant at $P < 0.1$

Yield

The yield of seed cotton was not significantly greater ($P > 0.05$) in predator released plots ($\bar{X}$ = 141.1 gm) than in predator control plots ($\bar{X}$ = 138.75 gm/5 plants). The percentage of good quality cotton was greater in released plots (63.1%) than in control plots (61.0%). The lower number of harvestable bolls in the control might have been due to the earlier flower damage, which did not allow the plant to produce compensatory growth for earlier stage bolls. Seed cotton yield loss decreased to 1.69per cent over the control plots by *R. kumarii* release; similar to the increased seed-cotton yield reported by King *et al.* (1989) and Simmons and Minkenberg (1994). More number of pests observed in the control plots might have led to a reduction in yield.

Augmentative release of *R. kumarii* successfully reduced *D. cingulatus* population and plant damage in these trials. Still our knowledge is meagre and we need more investigation on their colonization and synchronization with plant phenology.

ACKNOWLEDGEMENTS

We are grateful to our Principal Rev. Dr. A. Lourdusamy, S. J. for facilities. Financial assistance received from Department of Science and Technology, New Delhi (Ref. No: HR/OY/Z-13/98) is gratefully acknowledged.

REFERENCES

Aldrich, J. R. and Cantelo, W. W. 1999. Suppression of Colorado potato beetle infestation by pheromone-mediated augmentation of the predator spined soldier bug, *Podisus maculiventris* (Say) (Heteroptera: Pentatomidae). *Agricultural and Forest Entomomogy,* **1**: 209-217.

Ambrose, D. P. 2000. Assassin Bugs (Reduviidae excluding Triatominae), pp. 695-712. In: C. W. Schaefer and A. R. Panizzi (Eds.), *Heteroptera of Economic Importance.* CRC Press, Boca Raton, Florida, USA.

Antony, J., Danial, M., Kurian, C. and Pillai, G. B. 1979. Attempts on introduction and colonization of the exotic reduviid predator *Platymeris laevicollis* Distant for the biological suppression of the coconut rhinocerous beetle, *Oryctes rhinocerous, Placrosym,* **11**: 445-454.

Biever, K. D. and Chauvin, R. L. 1992a. Suppression of the Colorado potato beetle (Coleoptera: Chrysomelidae) with augmentative releases of predacious stink bugs (Hemiptera: Pentatomidae). *Journal of Economic Entomology,* **85**: 720-726.

Biever, K. D. and Chauvin, R. L. 1992b. Timing of infestation by the Colorado potato beetle (Coleoptera: Chrysomelidae) on the suppressive effect of field released stinkbugs (Hemiptera: Pentatomidae) in Washington. *Environmental Entomology,* **21**: 1212-1219.

Claver, M. A. 1998. Biological control potential evaluation of the predator, *Rhynocoris kumarii* Ambrose and Livingstone (Hemiptera: Reduviidae) against three selected cotton insect pests. Ph. D. thesis. M. S. University, Tirunelveli, T. N., India.

Cloutier, A. and Bauduin, F. 1995. Biological control of the Colorado potato beetle (Coleoptera: Chrysomelidae) in Quebec by augmentative release of the two-spotted stinkbug *Perillus bioculatus* (Hemiptera: Pentatomidae). *The Canadian Entomologist,* **127**: 195-212.

Daane, K. M., Yokota, G. Y., Zheng, Y. and Hagen, K. S. 1996. Inundative release of common green lacewings (Neuroptera: Chrysopidae) to suppress *Erythroneura variabilis* and *E. elegantula* (Homoptera: Cicadellidae) in vineyards. *Environmental Entomology,* **25**: 1225-1234.

Grundy, P. and Maelzer, D. 2000. Assessment of *Pristhesancus plagipennis* (Walker) (Hemiptera: Reduviidae) as an augmented biological control in cotton and soybean crops. *Australian Journal of Entomology,* **39**: 305-309.

Hough-Goldstein, J. and Keil, C. B. 1991. Prospects for integrated control of the Colorado potato beetle (Coleoptera: Chrysomelidae) using *Perillus bioculatus* (Hemiptera: Pentatomidae) and various pesticides. *Journal of Economic Entomology,* **84**: 1645-1651.

Hough-Goldstein, J. and Whalen, J. 1993. Inundative release of predatory stink bugs for control of Colorado potato beetle. *Biological Control,* **3**: 343-347.

Hough-Goldstein, J., Janis, J. A. and Ellers, C. D. 1996. Release methods for *Perillus bioculatus* (F.), a predator of the Colorado potato beetles. *Biological Control,* **6**: 114-122.

James, D. G. 1995. Prey consumption by *Pristhesancus plagipennis* Walker (Hemiptera: Reduviidae) during development. *Australian Entomologist,* **21**: 43-48.

King, E. G., Powell, J. E. and Steiner, W. M. M. 1989. Control of *Heliothis* spp. (Lepidoptera: Noctuidae) in the western Hemisphere by propagation and release of predators and parasites strains. pp. 415-425. In: King E. G. and Jackson R. D. (Eds.). *Biological Control of Heliothis Increasing the effectiveness of natural enemies.* Amerind Pubishers, New Delhi, India.

Powell, J. E. 1989. Importation and Establishment of predators and parasitoids of *Heliothis* into the USA, pp. 387-395. In: King, E. G. and Jackson, R. D.(Eds.). *Biological control of Heliothis Increasing the effectiveness of Natural Enemies.* Amerind Publishers, New Delhi, India.

Rosenheim, J. A. and Wilhoit, L. R. 1993. Predators that eat other predators disrupt cotton aphid control. *California Agriculture*, **47**: 7-9.

Simmons, G. S. and Minkenberg, O. P. J. M. 1994. Field cage evaluation of augmentative biological control of *Bemisia argentifolii* (Homoptera: Aleyrodidae) in southern California cotton with the parasitoid *Eretmocerus* nr. *californicus* (Hymenoptera: Aphelinidae). *Environmental Entomology*, **23**: 1552-1557.

Tipping, W. P., Holko, C. A., Abdul-Baki, A. A. and Aldrich, J. A. 1999. Evaluating *Edovum puttleri* Grissell and *Podisus maculiventris* (Say) for augmentative biological control of Colorado potato beetle in tomatoes. *Biological Control*, **16**: 35-42.

Van Driesche, R. G. 1993. Methods for the field colonization of new biocontrol agents. pp. 67-86. In: van Driesche R. G. and Bellows T. S., Jr. (Eds.). *Steps in Classical arthropod biological control.* Thomas Say Publ., Entomological Society of America, Lanham, Maryland, USA.

Waage, J. K. 1992. Biological control in the year 2000, pp. 239-340. In: Kadir, A. A. S. A. and Barlow H. S. (Eds.). *Pest Management and the Environment in 2000.* CAB International, UK.