Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 8 [4] March 2019 : 65-68

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.876
Universal Impact Factor 0.9804
NAAS Rating 4.95

ORIGINAL ARTICLE **OPEN ACCESS**

Numerical Response of *Rhynocoris Marginatus* (Fabricius) (Hemiptera: Reduviidae) to Two Pests of Redgram (*Cajanus Cajan* (L.)Millsp.)

Jesu Rajan. S and Sreelatha. E
Centre for biocontrol laboratory, National Institute of Plant Health Management (NIPHM), Hyderabad-500 030, Telangana
Email: sjrajan83@gmail.com

ABSTRACT
Numerical responses of Rhynocoris marginatus (Fabricius) to two pests of redgram pests, viz., Plume moth Exelastis atomosa (Walsingham) and Pod borer Helicoverpa armigera (Hubner) were studied in redgram terminals. R. marginatus reared at 10, 20, 30 and 40 prey densities showed 54.27, 64.34, 68.47 and 74.29 per cent survival respectively on larvae of E. atomosa and 57.28, 59.18, 69.89 and 76.74 on larvae of H. armigera. There was a positive relationship between the per cent survival of R. marginatus and the prey density.
Key words: *Numerical response, Rhynocoris marginatus, Exelastis atomosa, Helicoverpa armigera, Redgram, Cajanus cajan*

Received 12.12.2018 Revised 29.12.2018 Accepted 25.01.2019

INTRODUCTION

Redgram (*Cajanus cajan* (L.) Millsp.) is one of the most important legume crops of the tropics and subtropics of Asia and Africa. India is the world's largest producer and consumer of pulses including redgram [24]. In insect pest management, a lack of knowledge of native predator impact and population estimation has hampered the integration of natural mortality factors into economic injury level assessment [25]. Impact of entomophagous predators on insect pest suppression is currently being studied in several localities of redgram growing area [11, 23]. However, the role of such non-specific predators has not been assessed. *R. marginatus* is an excellent polyphagous predator suppressing the population of redgram pod borer in South India [4, 5].

The numerical response is defined as the change in the predator's reproductive output at varying prey densities [28]. Numerical responses which are due to changing rates of reproduction are likely to be more de-stabilizing to predator-prey interactions than those based on aggregation or changes in survival [6]. The time-lag of the decline of predator numbers also tends to lead to cyclic dynamics [22]. Although, as a rule, numerical responses are more pronounced in specialist than in generalist predators [7]. Generalists tend to stabilize predator-prey interactions [15]. In the face of the advantages associated with using *R. marginatus* as a biocontrol agent, there is a lack of information regarding its reproductive numerical response in relation with prey density and its influence on the fecundity of females. Hence, an attempt was made to analyze the numerical response of *R. marginatus* at different densities of two redgram lepidopteran larvae viz., *E. atomosa* and *H. armigera.*

MATERIAL AND METHODS

The adults of *R. marginatus* collected from red gram field, NIPHM, Hyderabad South India. They were reared in the laboratory in plastic containers (30 x 10 cm) on rice meal moth *C. cephalonica* under laboratory condition (temp. 32±2º C, 75±5 rh and 12±1 hrs photo period). The newly emerged third nymphal instars of *R. marginatus* from the laboratory stock culture were randomly chosen for the experimental studies. The stadial period and percentage survival of III, IV and V nymphal instars and adult *R. marginatus* at varied prey densities viz., 10, 20, 30, 40 prey per 10 predators were calculated. The experiment was conducted in (30 x 10 cm) containers with folded chart papers that provided more space and facilitated free moving of predators as well as oviposition. The age at which the adult female commenced oviposition, fecundity, hatchability and adult longevity were also studied. Analysis of Variance (ANOVA) was used to determine the difference between the prey density categories and the survival, stadial period, preoviposition period, fecundity, hatchability and adult longevity, separately. Tukey Test was used to separate treatment means.

RESULTS AND DISSCUSSION

The average percentage of survival of *R. marginatus* on *E. atomosa* and *H. armigera* were significantly differed at P≥0.05 level. *R. marginatus* reared at 10, 20, 30 and 40 prey densities showed 54.27, 64.34, 68.47 and 74.29 per cent survival respectively on larvae of *E. atom* and 57.28, 59.18, 69.89 and 76.74 on larvae of *H. armigera*. There was a positive relationship between the per cent survival of *R. marginatus* and the prey density. Survival of *R. marginatus* increased as the prey density increased, thus, exhibiting a positive numerical response. A positive numerical response is viewed as an important trait of an effective biological control agent [17]. However, there was additional mortality from the low prey density category due to cannibalism and other factors [12, 10]. Drummand *et al*., [10] stated that prey availability had great impact on the shape of the survival curve throughout the predator life time. Similarly, survivorship of reduviids viz., *R. kumarii* and *R. fuscipes* and *R. longifrons* drastically declined in low prey condition [2, 20]. Cannibalism is common in insect predators subjected to survive at lower prey densities [13]. Furthermore, the numerical response of natural enemies acted mainly through survival, depending prey density rather than fecundity as reported by Izraylevich *et al*., [19]. Rypstra [26] enclosure experiments showed that food abundance influenced densities of several web-spider species; interestingly, some solitary species exhibited some degree of coloniality when prey abundance was high [26]. In addition to that the adult longevity, age-specific fecundity and the cumulative number of nymphs produced / female of *Macrolophus caliginosus* (Wagner) increased as the prey density increased [14].

The stadial periods of IV and V nymphal instars of *R. marginatus* reared on different prey species significantly differed and much influenced by prey density. The IV and V nymphal stadia of *R. marginatus* were 14.67 and 17.45, 13.56 and 16.14, 12.32 and 14.95 and 11.15 and 12.37 days at 10, 20, 30 and 40 prey densities respectively on *E. atomosa* and 11.27 and 16.28, 10.18 and 15.27, 09.26 and 13.47 and 09.13 and 12.16 days at 10, 20, 30 and 40 prey densities respectively on *H. armigera.* Those who study arthropod predators have recognized the food limitation as an important factor affecting population growth and/or size and, as a consequence, guild structure [18]. But the ability to complete development on such low amount of food may contribute to the efficacy of *R. marginatus* as a biocontrol agent. It increases the chance that the predator population persists at prey scarcity. Generally predators that attack prey more frequently, develop faster than predators that attack prey less frequently.

The adult longevity was also statistically differed. The predators reared at low prey density lived longer than those reared at higher prey density. The adult longevities of *R. marginatus* were 94.85, 91.18, 89.18 and 87.36 days at 10, 20, 30 and 40 prey densities respectively on larvae of *E. atomosa* and 90.27, 87.37, 85.83 and 83.56 days at 10, 20, 30 and 40 prey densities respectively on larvae of *H. armigera. R. marginatus* at lower prey density lived for longer time than at high prey density. But, lower prey inputs did not increase the longevity in a mirid *Cyrtopeltis tenuis* Reuter [29]. But, DeClercq and Degheele [8] stated that longevity of poorly fed female pentatomid *Podisus sagitta* (F.) was greater than that of well-fed ones and the longevity of males however, was not found affected at low prey densities. Moreover, Crawley [7] stated that prey density was stabilizing the predator population through reduction of adult longevity and tended to override the significance of numerical response.

The preoviposition periods of *R. marginatus* were 11.37, 10.85, 10.13 and 9.18 days at 10, 20, 30 and 40 prey densities respectively on larvae of *E. atomosa* and 11.83, 11.45, 10.86 and 09.87 days at 10, 20, 30 and 40 prey densities respectively on larvae of *H. armigera*. It is clear that low prey density prolonged the preoviposition period of *R. marginatus*. The reason for the longer preoviposition period in the lower prey density is that they included a period for sexual maturation.

The predators reared at different densities of different species of prey also showed the significant differences in the fecundity. The fecundity of *R. marginatus* were 84.08, 87.28 88.98 and 89.27 at 10, 20, 30 and 40 prey densities respectively on larvae of *E. atomosa* and 83.78, 85.45, 88.73 and 90.65 at 10, 20, 30 and 40 prey densities respectively on larvae of *H. armigera*. The number of eggs laid per female *R. marginatus* increased significantly as the prey density increased as reported for *Menochilus sexmaculatus* (F.) [1]. Yigit and Uygun [31] studied numerical response of ladybird beetle *Stethorus puctillum* Weise and indicated that a linear relationship found between the prey density and number of eggs laid. Fecundity was considered as a function of the amount of prey eaten [9]. Variable egg production as a function of prey input was reported for mirids [29]. Crawley [6] stated that predators that attacked more prey laid more eggs than predators that attacked less prey. A rise in the effective reproductive rate with increasing prey density is otherwise called as numerical response [16].

R. marginatus reared at different densities of different species of prey also showed the significant differences in the hatchability. The hatchability of *R. marginatus* were 91.14, 93.89, 94.76 and 95.12 at 10, 20, 30 and 40 prey densities respectively on larvae of *E. atomosa* and 88.34, 89.26, 91.53 and 91.91 at 10, 20, 30 and 40 prey densities respectively on larvae of *H. armigera*. A shortage of prey also resulted in significant rate of reduction in the proportion of eggs hatched (P<0.05). This indicates that, the percentage of the viability of eggs decreased when the prey density increased. Under limited prey conditions, predators oviposited infertile eggs [21]. The number of eggs oviposited by a spider *Linyphia triangularis* (Clerk) was fixed regardless of prey consumption, whereas egg weight was lower at low prey consumption levels. Variations in the weights of eggs were mainly due to difference in the quantity of yolk in egg. Since the egg yolk provides the sole source of energy for the embryo and for a period following the emergence of the spiderlings from the eggs sac, the quantity of egg yolk greatly influences the number of spiderlings of the next generation [30].

The percentage of abnormal oocytes was consistently greater in females on less prey than females having more prey. These abnormal oocytes could represent oosorption because alternation in shape, size, colour and transparency are typical characteristics of resorbed eggs [3]. Hence, this increasing property of numerical response on egg hatchability constitutes a promising field for further investigations.

ACKNOWLEDGEMENT

S. Jesu Rajan is grateful to Department of Science and Technology (DST), Government of India (YSS/2014/000661 dated 16th November, 2015). Authors are grateful to authorities of National Institute of Plant Health Management (NIPHM), Rajendranagar, Hyderabad for institutional facilities.

Table 1. Average percentage of survival, fourth and fifth nymphal stadial periods, adult longevity, preoviposition period, fecundity and hatchability of *R. marginatus* on different prey densities of *E. atomosa* and *H. armigera* (n= 6; $\bar{X}$ ±SD).

Prey species	Prey density	Survival (%)	Stadial period (days)		Adult longevity (days)	Preoviposition period (days)	Fecundity (no. of eggs/ female)	Hatchability (%)
			IV	V				
E. atomosa	10	54.27a	14.67±1.38a	17.45±1.34a	94.85±2.17a	11.37±1.35a	84.08±3.12a	91.14a
	20	64.34c	13.56±1.42c	16.14±1.45c	91.18±4.27c	10.85±1.39b	87.28±3.17b	93.89c
	30	68.47e	12.32±1.23e	14.95±1.38d	89.18±3.27e	10.13±1.38c	88.98±2.18c	94.76d
	40	74.29g	11.15±1.65g	12.37±1.25f	87.36±3.18g	9.18±1.29d	89.27±1.28d	95.12f
H. armigera	10	57.28b	11.27±2.23b	16.28±1.54b	90.27±2.25b	11.83±1.25a	83.78±3.38a	88.34b
	20	59.18d	10.18±1.52d	15.27±1.27c	87.37±2.18d	11.45±1.47b	85.45±3.27b	89.26c
	30	69.89f	09.26±1.12f	13.47±1.28e	85.83±2.83f	10.86±1.74c	88.73±2.56c	91.53e
	40	76.74h	09.13±1.12g	12.16±1.61f	83.56±2.59h	09.87±1.27d	90.65±2.67d	91.91g

The values followed by the same alphabet in the corresponding prey densities of prey species are statistically not significant different at P<0.05 levels

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CITATION OF THIS ARTICLE

Jesu Rajan. S and Sreelatha. E. Numerical Response of *Rhynocoris Marginatus* (Fabricius) (Hemiptera: Reduviidae) to Two Pests of Redgram (*Cajanus Cajan* (L.)Millsp.). Bull. Env. Pharmacol. Life Sci., Vol 8 [4] March 2019 : 65-68