from the numbers calculated (Y') on the basis of Holling's 'disc' equation.

The highest attack ratio (Y/X) was observed at prey density (X) of one prey per predator which decreased as the prey density was increased (Table 1). The predator spent some time for searching its prey. The searching time (Ts) (days) was calculated by the following formula:

$$Ts = Tt - by$$

The time taken by the predator to feed the captured prey was observed as handling time or feeding time (b). Ts decreased with increased prey density. Hassell et al. (1977) stated that the attack rate decreased with increasing prey density in predators having type II functional response. Theoretically, each milligram of prey food required a constant amount of time 'B' for consumption. As observed for searching time, the handling time also decreased with increased prey density. This indicates that the predator subdued the prey more quickly and consumed them faster at higher prey density than at lower prey density. The handling time was minimum when the predator was provided with *A. modicella*. This might be due to the small size of this prey. Presence of hairs in *A. albistriga* may have caused stress during feeding and thus handling time was high. More time was taken by the predator to paralyze the single prey and to consume increased amount of food from the prey.

The maximum predation at the highest prey density is represented by the 'k' value. The k/Tt value was highest for *A. modicella* (18.37) followed by *H. armigera* (16.93), *S. litura* (16.12), and *A. albistriga* (4.06). Higher k/Tt in *A. modicella* was presumably due to small size of the prey, active searching and quicker paralyzing, and shorter intervals between successive attacks of the predator. However, the utilization of the predator for the control of *A. modicella* can only be determined through actual field trials. Lower predation in *A. albistriga* might be due to the presence of hairy body surface. The positive functional response observed in *R. marginatus* suggests its biocontrol potential. These studies and the previous observations (Sahayaraj 1999) where *R. marginatus* reduced 92.73% *H. armigera* and 94.91% *S. litura* confirms that it can be used in an integrated pest management (IPM) program.

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Natural Fungal Pathogencity on Groundnut Defoliator *Spodoptera litura*

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Groundnut crop monitoring team of scientists constituted for Zone V Breeder Seed Plot visited ICRISAT, Patancheru, India on 23 September 1999. During the field visit mycoses (11%) among the larval population of *Spodoptera litura* was observed. The entomopathogenic fungus was identified as *Nomuraea rileyi* (Farlow) Samson (Moniliales: Moniliaceae). The dispersion and spread of this pathogenic fungus in rabi (postrainy season)-sown crop will naturally contain the *S. litura* larval population. Hence it is the right time to exploit the pathogen under field conditions to strengthen the existing effective ecofriendly pest management strategies. Apart from this pathogen, use of botanicals, parasitoids, and predators to contain the defoliation by less than 10% damage in 60-day-old crop had no effect on the pod yield. Preliminary confined studies of the fungal pathogenicity against *S. litura* conducted at the Regional Research Station, Vridhachalam, Tamil Nadu, India revealed that the third instar larval mummification was due to the infection on the fifth day after spraying with *N. rileyi* at a concentration of 1×10^8 spores mL^{-1}. Assessment on the dynamics of conidial dispersal and density within the groundnut crop ecosystem at field level is in progress.

In future, studies at the field level on the utilization of naturally occurring fungal pathogens such as *Beauvaria bassiana* (white muscardine fungus) and *N. rileyi* (green muscardine fungus) to contain the groundnut defoliators without any reduction in pod yield will be an accessible ecofriendly pest management strategy for sustainable groundnut cultivation.

Impact of Some Plant Products on the Behavior of *Tribolium castaneum* in Groundnut Seed

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Groundnut (*Arachis hypogaea*) is stored both as pods and seeds. Both forms are susceptible during storage to attack by insects, which cause approximately 6–10% damage in stored seed (Srivastava 1970). The red flour beetle, *Tribolium castaneum* Herbst is one of the most important pests of stored groundnut seeds (Wightman and Ranga Rao 1993). As groundnut is used for human food, the use of insecticides against this stored product pest may represent a health hazard. Use of plant-derived pesticides to manage stored product pests is a traditional method that is environmentally safe and economically viable alternative method. *Azadirachta indica* (neem) has been found to affect more than 200 insect pests (Warthen 1989, National Research Council 1992) including several stored product pests (Jacobson 1988). In the present study, the leaf extracts of *A. indica, Vitex negundo, Calotropis gigantea,* and bulb extract of *Allium cepa* (onion) were evaluated for their repellent and insecticidal properties on the adults of *T. castaneum* in groundnut seeds.

The leaf extracts of *A. indica, V. negundo,* and *C. gigantea* and bulb extract of *A. cepa* were prepared according to Sahayaraj (1998). Ten grams each of the leaves and bulbs were macerated individually in pestle and mortar and extracted with 10 mL of water. The extract was passed through muslin cloth and the final volume made up to 100 mL to get 10% extracts. It was treated as a stock solution. From the stock solution 5 different concentrations, 0.5, 1.0, 2.0, 4.0, and 6.0% were made with required quantity of water. Groundnut seeds (5 g) were dipped in different concentrations separately for 15 min and air dried for 10 min.

In control, the groundnut seeds were dipped in water only. A glass olfactometer was used to find the repellent properties of the plant extracts against *T. castaneum*. An olfactometer consists of a middle glass chamber (60 mm diameter) from which 6 equally spaced tubes (20 cm length and 2.5 cm diameter) project outwards. The middle chamber has an opening of 2.5 cm diameter. The distal end of each arm is attached with a glass beaker (7 cm diameter and 9 cm height). The repellent property of the plants was tested by choice test. Ten-day-old *T. castaneum* adults were collected from the culture medium maintained in the laboratory and used for this study. Groundnut treated with different concentrations of the plant extracts were placed separately in the beaker attached in each arm. Then they were closed with muslin cloth. Sixty *T. castaneum* adults were introduced into the olfactometer through the opening present in the middle chamber and closed with muslin cloth and allowed for 3 h. After 3 h, the number of beetles present in each concentration was recorded. From the observed value the repellence was observed and defined in terms of excess proportion index (EPI) according to Sakuma and Fukami (1985). Each experiment was replicated six times with different insects and also groundnut seeds treated with plant extracts. The EPI is defined as follows:

$$EPI = NS - NC / NS + NC$$

where NS = number of animals in the sample side and NC = number of animals in the control side. In another experiment, ten adults were placed in a plastic container (250 ml capacity) and provided with 1 g of groundnut seed treated with different concentrations of each plant extract separately. Control categories were provided with water treated groundnut seeds. Mortality was recorded in all the categories for every 24 h up to 7 days. Six replications were maintained in each category.

EPI values ranged from +1 to −1. These terms simply express polarity of the directional choice. Positive and negative values indicated positive and negative approaches respectively. The results of the experiment are summarized