Assessment of beneficial role of an insectivorous bird, jungle babbler (*Turdoides striatus*) predation, on *Helicoverpa armigera* infesting pigeon pea (*Cajanus cajan*) crop

Evaluación del rol benéfico de *Turdoides striatus* como predator de *Helicoverpa armigera* en el cultivo de guandul (*Cajanus cajan*)

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Recibido: 03.04.09 Aceptado: 06-04-10

Abstract

Jungle babbler (*Turdoides striatus*), a widely spread sub-tropical insectivorous passerine is considered beneficial to agro-ecosystem, as they devour voraciously on insect matter especially *Helicoverpa armigera,* the gram pod borer, a notorious pest infesting and causing heavy loses to crops like pigeon pea (*Cajanus cajan*) which is a vital crop of semi-arid tropical and subtropical farming system, providing high quality vegetable protein. *Helicoverpa* is known to feed on flowers, pods, and seeds and is the most important biotic constraint affecting pigeon pea yields. Jungle babblers have a peculiar foraging style which helps expose the *Helicoverpa* larvae as well as pupae through various phenological stages of pigeon pea. For comparative assessment of their beneficial role and as a possible bio control agent, in Baroda city (State of Gaujarat), India, was studied, two crops of pigeon pea (insecticide treated and untreated (control) were selected. In both treated and control crops, the number of jungle babblers were maximum in pigeon pea fields during october and november in both small pod stage and large pod stage which had heavy infestation of *Helicoverpa.* Least number of birds was seen during the flowering stage in September. Later in treatment crop three applications of Dunnate and Monocrotophos insecticide spray was done after which the pest population decreased which is reflected in number of birds in the field, while the bird number in control crops grew since insecticide spray was not done and number of larvae increased with the stage of the crop. Along with the main crop pigeon pea, comparative study was also done to see the food preference by these birds in crops like sorghum, maize, cow pea and ploughed and unploughed fields. Maximum number of birds was seen in unploughed field and least in sorghum suggesting that *Helicoverpa* is preferred food over sorghum grains thus pigeon pea and sorghum can be used as mixed crops to protect the crop from heavy losses. This work investigates the interactions among pigeon pea, its key pest, and their natural enemies. These relationships have implications on the pest status of individual species and on possible control strategies.

Key words: Jungle babbler, *Helicoverpa*, pigeon pea, small pod stage, large pod stage.

Resumen

Turdoides striatus es un pájaro insectívoro muy común en áreas subtropicales altamente predador de *Helicoverpa armigera*, un insecto perforador del fruto de varios cultivos, entre ellos *Cajanus cajan* (guandul). Para evaluar el rol de *T. striatus* en el control del insecto, en Baroda (estado de Gaujarat), India, se hicieron observaciones en campos sobre sus hábitos y frecuencia de aparición. Fueron muestreos

al azar en 60 plantas con una frecuencia cada 1 – 2 minutos, durante 2 h en la mañana y un tiempo igual en la tarde. Se encontró una relación positiva entre el ataque de las larvas del perforador y la población de *T. striatus*. Se observó que el insecto prefiere las semillas de guandul sobre las de sorgo, un cultivo asociado incluido en los tratamientos.

Palabras clave: *Turdoides striatus, Helicoserpa,* guandul, control insecto.

Introduction

Birds of agricultural system are one of the most threatened species of birds mainly due to their sharp population decline in the recent decades. Habitat intensification resulting for more production, agricultural practices has been proposed as a major cause for this decline. Intensification of agricultural practice, such as crop specialization, pesticide use and elimination of natural and semi-natural habitats have been proposed causes underlying the reported decrease in the faunal quality of agricultural habitat. In a country like India, the increasing pressure on natural habitat due to urbanization and industrialization, farmers have adapted to large-scale monoculture practices, which forces animals to adapt to the change in habitat or to leave it. Intensive agriculture has led to the decrease in biodiversity in many areas of the world. Many animals, especially birds, have adapted to these altered conditions (Ranjit Daniels, 1994) and they have started depending directly or indirectly on agricultural fields. On one hand, they damage the crop at various stages, beginning from sowing to the storage state; while on other hand they benefit the crop by feeding voraciously on the pest species and in turn controlling the pest population (Gokhale, 1992). There is an increased evidence that insectivorous birds increase the fitness of the plants on which they forage, e.g. by significantly reducing the number of insects on the plants (Solomon et al., 1976; Holmes et al., 1979; Gradwohl and Greenberg 1982; Campbell et al., 1983; Lyon et al., 1983; Joern 1986; Atlegrim 1986; Fowler et al., 1991; Moore and Yong 1991; Bock et al., 1992).

Jungle babbler (*Turdoides striatus,* Order: Passeriformes, Family: Timalidae) is an insectivore and wide spread passerine of the Indian subcontinent. It's a co-operative breeder and always seen in huge flocks especially during the non-breeding season. Even though they are insectivores only few studies have been carried out to assess their impact on the insect pest species in the agricultural fields as a part of biological control an alternate for insecticides. Jungle babbler is considered as beneficial to crops (Gupta and Midha, 1994; Gokhale, 1992) especially the ones infested with *Helicoverpa armigera* Hubner (Lepidoptera: Noctuidae) (Gokhale, 1992). This polyphagous moth *H. armigera* (Hubner) is one of the world's most important agricultural pests (Zalucki et al., 1986; Fitt, 1989). *Helicoverpa armigera*, the old world bollworm, is a major pest threat because the larva can feed on a wide range of economically important crops including cotton, corn, tomato, legumes and tobacco (King, 1994; Shanower and Romeis, 1999). In addition to feeding on high value crops the old world bollworm is an extremely dangerous pest because: (1) it is extremely fecund, (2) it can sustain itself on over 180 different plant species, (3) it can undergo diapause during adverse conditions and (4) it can migrate over long distances (Manjunath et al., 1989, Shanower and Romeis, 1999). To make matters worse, the bollworm has evolved a high degree of resistance to organophosphate and pyrethroid insecticides (Armes et al., 1996). *Helicoverpa amigera* larva are extremely damaging because they prefer to feed and develop on the reproductive structures of crops which are rich in nitrogen (Fitt, 1989). These structures are often the part of the crop that is harvested (King, 1994). Depending on the crop, bollworm induced damage can range from 50 to 90% of the yield (Reed and Pawar, 1982, Sehgal and Ujagir, 1990). The ability of population of *H. armigera* to persist in agricultural fields and seemingly to adapt to changes in agricultural practices taking place in its environment, is one of the major factors contributing to the pest status of this moth (Fitt, 1989). Direct damage to flowering

and fruiting structure by larvae and extensive insecticide spraying results in low yields and high control costs (McGahan et al., 1991). Increased resistance to insecticides in *H. armigera* (Forrester et al., 1993; McCaffery 1998) has led to renewed interest in developing alternatives to insecticidal control.

Jungle babbler is known to devour on insects like Orthopterans and Lepidopterans (Gaston, 1978; Gupta and Midha, 1994; Dhindsa et al., 1994). These authors have also reported seasonal variation in percentage consumed with more insect matter during monsoon when the insect population is high. Therefore on one hand, Jungle babbler is considered as useful species of bird as it feeds on the global pest, the pod borer, *H. armigera* (Gokhale, 1992). Their most conspicuous diurnal activity is the feeding activity wherein they spend maximum time in foraging on ground. This foraging behavior of Jungle babblers is probably very effective in locating the underground pupae of *H. armigera or* the root infesting white grubs. The agricultural crop selected in the present study is pigeon pea. Pigeon pea (*Cajanus Cajan*) a kharif crop grown in large scale from october to march in and around Baroda District was further investigated at various stages of cropping. The pods of this crop are known to be infested by *H. armigera* during various stages of its growth (Patankar et al., 2001). One of the main objectives of this project was to investigate the effects of avian species, jungle babbler (*Turdoides striatus)* in Pigeon pea (*Cajanus cajan*) fields. Secondly to quantify the number of jungle babblers visiting different fields (host/plant preference) along with the observation for the main crop pigeon pea. Third objective was visual inspection of the plants for evaluating the damage caused by the *H.* larvae and lastly to see whether any damage is caused to the pods by the birds.

Materials and methods

Study area. The fields were at the Pulse Research Centre present in the middle of the Baroda city (State of Gaujarat), India. Being a Pulse research centre, the main crops grown here during kharif season is pigeon pea whereas sorghum, maize and cowpea are also grown as alternate crops. The specific time intervals in the sowing gave at least two stages of the crop at a time in different parts of the field. Pigeon pea is generally sown in September. At the beginning of the study in October 1997, the crop was at the flowering stage in one field and at small pod stage in the other.

Sampling method and statistical analysis. (1) Insect sampling: insect population density/damage to plant was determined by visual inspection of 60 plants/plot chosen randomly in a stratified sampling plan. At least five plants were sampled/row, excluding the first and the last to prevent edge effects. Inspection lasting 1 - 2 minute/plant was made from the plant bottom to the top, the plant being disturbed as little as possible. For pod borer (*H. armigera*), a hole in the pod of *Cajanus cajan* or larva was recorded as a unit of infestation (Brunet 1996). The nature of this measurement means that infestation scores were cumulative within a season. In november-january (1997-1998), a destructive sampling was made to detect the presence of the larvae inside the pod. (2) Bird observation: Bird was observed in different plots using field binoculars (Zeiss 10 x 50). Because of high density of pigeon pea plant, it was not possible to observe bird activity inside the fields. To estimate the frequency and the duration of bird visit, all bird arrivals/departures were recorded according to Fletcher and Greig Smith (1998). Observation period was divided into intervals of 3 minutes, to estimate the average time spent by the bird in the field. The number of visits were adjusted for the surface area under observation.

Period of observation varied between 120 minutes at sunrise and sunset daily from october to march (1997-99). The observer waited 15 minutes before the observation period to minimise the disruption effect of the observer's arrival. The data was collected according to the pigeon pea phenology i.e. (flowering stage, small pod stage, large pod stage, mature stage). The feeding activity of jungle babbler in the pigeon pea field visiting both the treated and the control fields was noted and number of birds feeding /hr was calculated.

Results

The number of jungle babblers feeding in insecticide treated and insecticide untreated (control) pigeon pea crop during different crop stages are given in Tables 1 and 2. The number of birds in the early flowering stage, i.e. October in treated crop, was about 16 while in control (untreated) it was 25 . During October to December, when the crop progresses from flowering stage to small pod stage, the number of jungle babblers in treated crop were 24, 78 and 14, respectively. In case of control (untreated) crop, the number of birds were significantly higher during November and December (106 and 45, respectively).

As the larvae undergoes different instars stages and increases dramatically in size, the large pods during november to march are significantly affected in control crop. The numeral of birds being 76, 49, 48, 53 and 35 , respectively, while in treated crops at the end of november and the beginning of december, pigeon peas were heavily infested with *H. armigera,* and the crop was sprayed with three applications of insecticide Monocrotophos and Dunnate at the interval of 10 days each. Due to insecticide treatment there is drastic decrease in the population of larvae which is reflected in the reduced number of birds in these plants during that month. The number of jungle babblers in the treated crop at the large pod stage were 56, 16, 8, 39 and 28 in november to march. The drastic decrease in bird number is seen during december and january at 16 and 8 birds/hr.

The birds were also seen foraging on ground especially by upturning the soil. After the last instar stage, the larva pupates underground. Birds were observed to pick on these pupae along with the larvae in the pods. During the last stage of crop maturation, the number of birds decreased non-significantly in both treated and control crops. The mature stage was available in january to march and the number of jungle babblers visiting during these months in the mature crop in treated crop was 19, 14 and 25 birds/ hr, respectively, while in the control crop it was about 39, 25 and 37 birds/hr, respectively.

As a part of the study, the average number of *Helicoverpa* infestation/plant was also done by visual inspection as well as destructive sampling method in both treated and control crops during different phenological stages (Table 3). During the flowering stage, the number of larvae seen on the plant devouring the leaves as well as flowers in both treated and control crops showed moderately

Table 1. Number of jungle babblers (*Turdoides striatus*) (birds/hr) feeding in insecticide treated pigeon pea (*Cajanus cajan*) crop during different stages.

Months	Crop phenology			
	Flowering stage	Small pod stage	Large pod stage	Mature stage
October	16	24	–	–
November	–	78	56	–
December	–	14	16	–
January	–	–	8	19
February	–	–	39	14
March	–	–	28	25

Table 2. Number of jungle babblers (*Turdoides striatus*) (birds/hr) feeding in untreated (control) pigeon pea (*Cajanus cajan*) crop during different stages.

Months	Crop phenology			
	Flowering stage	Small pod stage	Large pod stage	Mature stage
October	25	36	–	–
November	–	106	76	–
December	–	45	49	–
January	–	–	48	39
February	–	–	53	25
March	–	–	35	37

Table 3. Average number of *Helicoverpa armigera* infestation/plant.

Months	Crop phenology							
	Flowering stage		Small pod stage		Large pod stage		Mature stage	
	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated
October	22	31	40	51	–	–	–	–
November	–	–	54	69	85	97	–	–
December	–	–	39	62	66	99	–	–
January	–	–	–	–	45	90	65	71
February	–	–	–	–	51	86	56	68
March	–	–	–	–	44	73	59	62

significant number which was about 22 and 31 larvae/plant, respectively.

The number of larvae in small pod stage during october in treated and control crops was 40 and 51, respectively, but the number significantly grew in november, while after the treatment of insecticide in december, the number of larvae drastically reduced while the number was nearly maintained in the control plants. Before treatment in november, the number of larvae in both treated and control was moderately significant at 85 and 97 respectively while after treatment the number drastically decreased in following months, i.e. december (66), january (45), february (51) and march (44). In control plants, the proportion of the larvae remained nearly constant at december (99), january (90), february (86) and march (73).

In mature stage (treated crop), the larvae number were comparatively low and constant in january to march at 65, 56 and 59 respectively, while in control/untreated the number was slightly higher in these months at 71, 68 and 62, respectively.

The study area was a research (model) farm supported by State Agricultural Ministry and ICAR (Indian Council of Agricultural Research). Number of different crops were sown and cultivated and studied with respect to IPM (Integrated Pest Management). The other crops which were grown along with pigeon pea were maize, sorghum and cow pea which are also known to be heavily infested with the *Helicoverpa* larvae. Along with these crops some plots were ploughed while some were unploughed. The comparative feeding activity and the number of jungle babblers in these fields were also done. The number of jungle babblers visiting in maize, cow pea, sorghum, ploughed and unploughed field was 87, 73, 46, 48 and 140 (Table 4) respectively, while the total time spent by the birds was 4.31, 1.68, 3.76, 4.08 and 8.48 hours, respectively.

Table 4. Comparative feeding activity and number of jungle babblers (*Turdoides striatus*) in various field crops.

	Maize	Cow-pea	Sorghum	Unploughed field	Ploughed field
No. of birds	87	73	46	48	140
Total time in feeding (hr)	4.31	1.68	3.76	4.08	8.48

One of the objectives of this study was to evaluate whether the birds were damaging the pods at any stage to feed on the pod rather than on the larvae. Jungle babblers were never seen damaging or devouring on the pods. This fact is also supported by the data regarding the amount of protein content observed in intestine and liver during these months.

Discussion

Pigeon pea is one of the heavily infested crops and highly vulnerable from the predation by *H. armigera,* the pod borer, especially at the time of pod formation stage. All the instars of *H. armigera* have been observed feeding on the pods of pigeon pea, *Cajanus Cajan* (Steveson et al., 2002). Bird predation starts as medium and large larvae become available and they continue to do so till the harvest station.

In the present study, two crops of pigeon pea were selected (treated and untreated/control) to measure the role of jungle babblers in agro-ecosystem as a possible bio-control agent and which could replace the use of harmful insecticides which not only destroy

the target species but also damages the innocent and rather useful fauna of the farmland along with upsetting the soil chemistry. The treated plants were twice sprayed with insecticides in he october after the sowing in september. As seen in Table 1 in treated crop maximum number of jungle babblers was observed in november in small pod stage and in large pod stage. The number of jungle babblers in these two stages is a reflection of high infestation of *H. armigera* as this is the pod formation time when the plants easily get infested with the pod borer. Infestation is comparatively less in flowering stage due to insecticide spray and fully mature stage due to non-availability of pods but is still the larvae are known to damage the leaves leaving only the veinlets and this is reflected by the comparatively less number of jungle babblers in these stages.

The plucking practices of fresh pigeon pea pods as well as other human activities within the crop fields also lead to the fall of ests that jungle babblers can become an integral part of the IPM (Integrated Pest management) as a bio control agent. As seen in Table 3, the number of larvae at all the different phenological stages were high in the control plants while the number was comparatively less in the treated plant which is reflected in the number of birds also.

In the present study along with the major crop, pigeon pea certain other crops were also observed for jungle babbler activity in these fields. The various crops being maize, cow pea, sorghum, ploughed and unploughed land. Least number of birds being in sorghum and unploughed land, while maximum number of birds were seen in ploughed fields which may be because of this activity the pupal stage is exposed for easy access for the birds. The data also suggests that more work is required to better understand the use of farm fields by birds, especially in relation to the phenology of the crop. A more sympathetic management of agro-ecosystem has been advocated to aid in the conservation of declining farmland species (Mineau and McLaughlin, 1996). It would clearly be easier to convince farmers to adopt such management practices if they were economically advantageous.

Conclusion

- Insects are the core of babblers' diet and are considered as beneficial to agro-ecosystem as they devour on the pod borer (Gokhale, 1992) and thus are useful to the crops heavily infested by the pod borer and reports suggest that jungle babblers are beneficial to these crops. At the present study site, two test fields of pigeon pea treated and untreated were assessed for possible role of jungle babbler as bio-control agent. These birds had great influence on reducing the number of *Helicoverpa* larvae in both treated and control crops in early stages and in later stages the number of birds increased with the increase in the larvae in the control crops. Also as a part of the study other fields were also observed.
- Sorghum was grown next to pigeon pea but jungle babblers were seen only couple of times visiting the sorghum field. This suggests that birds preferred insects available in the pigeon pea fields to the grains of sorghum. This food preference suggests that if proteinaceous food is available, carbohydrate diet is not preferred. The diet of the adult birds constitute maximum of protein rich food (Gaston, 1978; Gupta and Midha, 1994). Therefore pigeon pea and sorghum can be grown as mixed crops to protect the other from the heavy losses.
- Also as a part of conclusion it could be suggested that the birds are the potent predators on the larvae of insects and the chance of gram pod borer larvae being predated by the avian gets hastened by erecting the bird perches randomly in the field. A wooden log or a branch bifurcated at the top provided with an earthen container filled with water mixed with puffed rice attracts the birds in the fields.

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