

Incidence and distribution in sorghum of the spotted stem borer *Chilo partellus* and associated natural enemies in farmers' fields in Andhra Pradesh and Maharashtra states

(Keywords: *Chilo partellus*, sorghum, parasitoids, intercropping, Maharashtra, Andhra Pradesh)

A. H. DUALE* and K. F. NWANZE

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India

Abstract A series of surveys was carried out in farmers' fields in two major sorghum-growing states of India (Maharashtra and Andhra Pradesh) during the 1994 and 1995 cropping seasons to determine distribution, abundance, and economic importance of the spotted stem borer *Chilo partellus* Swinhoe and associated parasitoids in sorghum. Stem borer incidence and distribution varied significantly between the two states. In Maharashtra, the highest incidence was recorded in Amravati district (40%), followed by Yavatmal (39%). In Andhra Pradesh, the highest incidence and damage were recorded from Medak (31%), followed by Mahbubnagar (30.3%). The natural enemies recorded in the survey included three larval parasitoids, viz. *Cotesia ruficrus* (Haliday) and *C. flavipes* Cameron, and *Sturmiopsis inferens* Townsend and one pupal parasitoid *Xanthopimpla stemmator* Thunberg. While species composition did not vary between the two states, species predominance varied considerably, such that *Cotesia* spp. were predominant in Maharashtra, and *S. inferens* in Andhra Pradesh.

soccata Rondani, and midge for which loss estimates have been obtained at research stations. Very little information exists for stem borers. A rapid on-line search in the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) Library of SATCRIS, AGRIS, and AGRICOLA databases between 1975 and 1995, revealed there to be over 180 published articles on *Chilo partellus* in India. Only five of these report on the seasonal occurrence of this pest. Although *C. partellus* is considered to be among the most damaging pests of sorghum crop throughout the world (Jepson, 1954; Harris, 1962; Seshu Reddy, 1988) and grain losses due to *C. partellus* ranging between 2 and 88% in sorghum have been recorded (Seshu Reddy, 1988), these studies were conducted in research stations and no information was provided on borer incidence and damage in farmers' fields.

1. Introduction

Sorghum (*Sorghum bicolor* (L.) Moench) is one of the major cereal crops in India, occupying an area of 16 million hectares with a total production of 11 million tons (Gahukar and Jotwani, 1980). Because of the broad genetic diversity in the local landrace cultivars, sorghum grows under a wide range of agro-ecological conditions, and more than 95% of the total sorghum is produced by subsistence farmers (Doggett, 1982; Mann *et al.*, 1983). Among the important states with sizeable hectareage are Maharashtra and Andhra Pradesh. Production in Maharashtra has increased from 3.5 million metric tonnes in 1975 to 4.6 million metric tonnes in 1994 (23.9% increase), this has been the result of the introduction of high yielding hybrid cultivars, and also partially accounts for the reduced area cultivated to sorghum in that state (from 6.2 million ha to 5.4 million ha) over the same period.

Because of changes in cultivation practices and in maturity patterns of the improved cultivars, susceptibility of sorghum to insect pests has increased. For example, all currently grown hybrids and improved varieties of sorghum are highly susceptible to sorghum midge, *Stenodiplosis* (= *Contarinia*) *sorghicola* Coquillett (Diptera: Cecidomyiidae) (Sharma, 1993). The estimated loss of sorghum to insect pests throughout India has been reported by Gahukar and Jotwani (1980) as 15–20%. This figure applies mostly to the sorghum shoot fly *Atherigona*

Adequate knowledge of the incidence, distribution and economic importance, and farmers' perception of an insect is pivotal both in determining its pest status and in the development of a research agenda targeted towards viable management options. Information on pest incidence and distribution needs to be substantiated for clear and directed research planning. Compilation of such information requires accumulation of quantitative data through diagnostic on-farm assessment of pest incidence, associated natural enemies, crop damage and losses, with direct farmer participatory inputs. Periodic review of such an information base is then necessary to ensure a proper focus on research on the target species. ICRISAT has initiated an extensive data collection on pest and associated natural enemies incidence and distribution in its mandate regions in Africa and Asia through compilation of existing information, additional farm surveys, farmer interviews, diagnostic on-farm studies of crop damage and farmers' perception of pests and pest damage. This paper reports the results from such activity conducted in India for sorghum stem borer in the two major sorghum-growing states of Maharashtra and Andhra Pradesh.

Farm surveys were conducted during 1994 and 1995 rainy and post-rainy seasons by a multidisciplinary team of ICRISAT scientists in collaboration with scientists from the Indian national research stations and non-governmental organizations (NGOs).

*To whom correspondence should be addressed.

farmers' perception about insect pests and their damage/control measures were recorded. Data collected on the incidence of *C. partellus* and its associated natural enemies at the field site level were pooled to obtain district averages, and the latter further pooled to obtain state averages. Field site data were also used to classify damage severity. The information was used to develop pest distribution maps for Andhra Pradesh and Maharashtra.

Data on the incidence and distribution of the pest and its natural enemies were subjected to ANOVA using general linear models (SAS Institute, 1985). Significant differences in means between states were separated using the Least Significant Difference Test (LSD) at a probability level of 5% ($P=0.05$).

3. Results and discussion

3.1. Cropping pattern

The cropping pattern in Andhra Pradesh and Maharashtra varied from monoculture to various intercropping or mixed cropping systems. In addition to sorghum, maize, rice, pigeonpea, cowpea, mungbeans, sugarcane, groundnut, and millet were grown.

Of the 352 farmers' fields surveyed, sorghum was grown as a monoculture in 196 farms (55.7%), and, in the rest, was intercropped/mixed with either pigeonpea, cowpea, mungbeans, or millet. At individual state level, 56 farms (45.2%) of the 124 fields surveyed in Andhra Pradesh had sorghum as the sole crop. By contrast, 140 farms (61.4%) of the 228 farmers' fields surveyed in Maharashtra had sorghum grown as the sole crop.

In general, a high proportion (>95%) of the fields in Maharashtra was cropped with a commercial hybrid, CSH 9. Planting was usually in rows with optimum plant densities (150 000 plants ha⁻¹). By contrast, in Andhra Pradesh, the local genotype (Pachcha) was predominant (>90%). When planted in high densities (130 000 plants ha⁻¹), the crop appeared tall, and thin-stemmed with small compact heads. However, at low densities (80 000 plants ha⁻¹) and in fertile soils, the crop appeared tall with loose heads.

Farmers interviewed in Andhra Pradesh villages preferred local genotypes which gave better fodder yields than hybrids. Farmers also indicated that they were unable to afford the purchase of seeds, fertilizer, pesticides and farm operations associated with hybrids.

3.2. Pest observations

3.2.1. Influence of cropping pattern on stem borer incidence. The relative abundance of the stem borer varied with season, sowing date, crop management and crop variety. In Maharashtra, stem borer incidence varied between 26.4% in Akola and 40% in Amravati with a state level mean of 32.4%. Stem borer infestation in Andhra Pradesh varied from 28.2% in Rangareddy to 31% in Medak with a state level mean of 29.8% (table 2). Stem borer incidence and distribution did not vary significantly between the two states.

Stem borers were present in all of the sorghum fields in Andhra Pradesh and 97.9% in Maharashtra, but only 23.4% of the 19543 stems examined in Andhra Pradesh and 27.5% of the 25713 stems examined in Maharashtra exhibited stem tunnelling and stem breakage. Grain filling of heads was hardly affected.

Stem borer incidence was low (6.7%) where sorghum was intercropped with legumes but increased to 24.8% (a 3.7-fold increase) in sole-crop sorghum fields in Rangareddy. In Maharashtra, infestation increased by 2.6-fold in Akola and by 3-fold in Buldana in sole crop sorghum compared with mixed/intercropped sorghum (table 2). Stem borer infestation did not vary significantly between the districts in the two states of Maharashtra and Andhra Pradesh except where sorghum was grown as the sole crop (table 2). However, the stem borer infestation varied significantly within the districts in Maharashtra (figure 2).

Sorghum sole crop had significantly higher stem borer infestation compared with mixed or intercropped systems and the highest stem borer infestation was recorded from Yavatmal with an average infestation level of 25.7% in sorghum sole crop, followed by Amravati with 25.4% stem borer infestation (table 2).

Table 2. Incidence and distribution of the stem borer *Chilo partellus* Swinhoe in Andhra Pradesh and Maharashtra

District	No. of farms surveyed	% farms infested	Mean percentage borer incidence		
			District mean	Monocrop sorghum	Inter/mix crop sorghum
ANDHRA PRADESH					
Medak	38	100.0	31.0±3.5 a	19.7±3.5 a	11.3±2.4 a
Rangareddy	38	100.0	28.2±5.5 a	24.8±6.1 a	6.7±6.1 a
Mahbubnagar	46	100.0	30.3±9.3 a	21.6±6.2 a	8.7±3.2 a
State mean	124	100.0	29.9±3.3 a	22.1±3.1 a	8.9±1.4 a
MARASHTRA					
Akola	40	95.0	36.4±7.8 b	18.9±6.0 b	7.4±1.8 ab
Amravati	32	100.0	40.0±10.1 a	25.4±5.4 a	14.6±4.8 a
Buldana	42	100.0	28.2±10.4 b	21.1±5.4 ab	6.9±5.8 b
Nagpur	30	100.0	30.9±4.5 ab	17.9±2.7 b	13.0±2.9 ab
Wardha	30	100.0	29.8±10.4 ab	22.1±5.6 ab	7.6±6.1 ab
Yavatmal	54	92.59	39.1±11.7 a	25.7±7.8 a	13.4±4.7 ab
State mean	228	97.93	32.4±3.5 a	21.8±2.1 ab	10.5±1.8 a

Means in the same column followed by different letters are significantly different at 5% level.

3.2.2. *Incidence of larval and pupal parasitoids on Chilo partellus.* The natural enemies of sorghum stem borer found during the survey included three larval parasitoids *Cotesia ruficrus* (Haliday) and *C. flavipes* (Cameron) (Hymenoptera: Braconidae), and *Sturmiopsis inferens* (Townsend) (Diptera: Tachinidae) and one pupal parasitoid *Xanthopimpla stemmator* (Thunbery) (Hymenoptera: Ichneumonidae). The survey results show that braconids and tachnids achieved a higher level of

parasitism than ichneumonids, and that *C. ruficrus* reported previously on *Mythimna separata* (Gahukar and Jotwani, 1980), had become a prominent member of the parasitoid complex on *Chilo partellus*.

Only one species of pupal parasitoid, *X. stemmator*, was recorded from Maharashtra and Andhra Pradesh. *C. partellus* pupal parasitism was significantly lower in Andhra Pradesh than in Maharashtra and the highest pupal parasitism in Andhra Pradesh (26.2% in Medak) was lower than the lowest (30.2% in Nagpur) in Maharashtra (tables 3 and 4).

Although species composition did not vary between the two states, species predominance varied considerably, such that in Andhra Pradesh, a higher percentage of larval parasitoids was reared from *C. partellus* than pupal parasitoids. In Maharashtra, the percentage of pupal parasitoids reared was higher than for larval parasitoids (tables 3 and 4).

4. Conclusion

The survey indicates that the spotted stem borer problems in traditional low-input systems do not appear to be severe. However, it should be noted that insect pest situations are dynamic processes and changes in climate and farming practices and the introduction of improved varieties have been known to result in pest outbreaks or changes in pest status (Nwanze, 1988).

The distribution and relative abundance of *C. partellus* in Andhra Pradesh and Maharashtra is thought to be influenced by two main factors: (1) the minimum temperature, which in most areas is a reflection of the altitude, and (2) the occurrence and severity of the dry season. The possibility that temperature might be a limiting factor influencing the distribution of *C. partellus* in India was first suggested by Butani (1955). Similarly, Wellington and Trimble (1984) reported that the number of parasitized hosts, the parasitoid immature development and sex ratio were influenced by

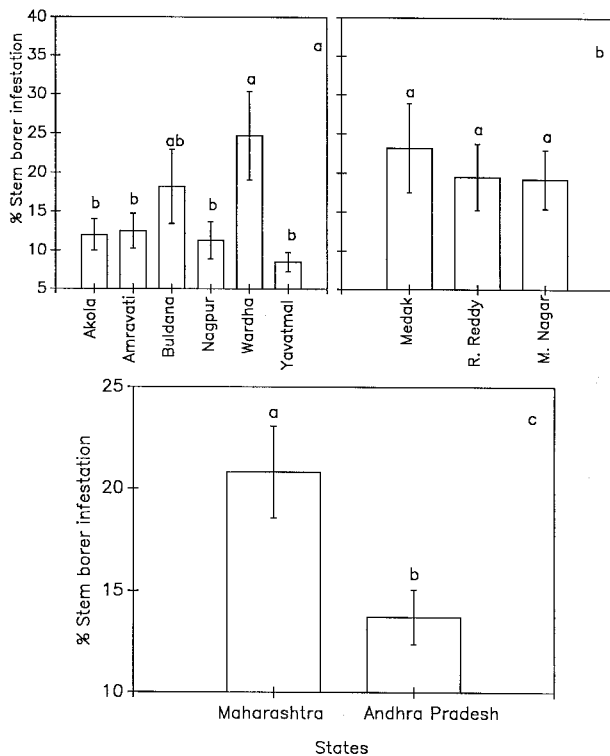


Figure 2. Stem borer infestation of sorghum in Andhra Pradesh and Maharashtra.

Table 3. Incidence of larval and pupal parasitoids of *Chilo partellus* (Swinhoe.) on sorghum under natural infestation in farmers' fields in Andhra Pradesh

District	Total number collected			Frequency of parasitoid species			% Pupal parasitism
	Larvae	Pupae	Percentage larval	1	2	3	<i>X. stammater</i>
Medak	607	210	81.4	11.4	34.3	54.3	26.2
Rangareddy	494	176	59.7	11.5	25.0	63.5	9.76
Mahbubnagar	743	261	50.3	12.1	27.3	60.6	17.2

1. *Cotesia flavipes*; 2. *Cotesia ruficrus*; 3. *Sturmiopsis inferens*.

Table 4. Incidence of larval and pupal parasitoids of *Chilo Partellus* (Swinhoe.) on sorghum under natural infestation in farmers' fields in Andhra Pradesh

District	Total number collected			Frequency of parasitoid species			% pupal parasitism
	Larvae	Pupae	Percentage larval	1	2	3	<i>X. Stammater</i>
Akola	129	36	55.0	45.1	14.1	40.8	55.6
Amravati	250	54	44.8	57.1	19.1	23.8	38.9
Buldana	203	61	72.4	55.0	25.0	20.0	36.1
Nagpur	138	86	27.5	36.8	15.8	47.4	30.2
Wardha	120	88	25.8	38.7	12.9	48.4	31.8
Yavatmal	289	155	63.0	50.0	14.3	35.7	31.6

1. *Cotesia flavipes*; 2. *Cotesia ruficrus*; 3. *Sturmiopsis inferens*.

climatic factors associated with latitude and/or altitude. It would appear that species predominance could partially be associated with latitude. *C. ruficrus* occurred below latitude 20° 32' corresponding with areas in Andhra Pradesh and *C. flavipes* occurred above latitude 18° 03' corresponding with areas in Maharashtra (table 1). Most parasitoids recorded in this study are indigenous to Asia and their association with *C. partellus* is long-standing. They are probably more habitat-specific than host-specific. *Cotesia flavipes*, *C. ruficrus* and *S. inferens* have been recorded from *Chilo* sp., *Sesamia* sp., *Eldana sccharina*, and *Diatrea* sp. (Descamps, 1956; Schmutterer, 1969; Appert, 1971; Breniere, 1977; Breniere et al., 1985; Smith et al., 1992). However, *X. stemmator*, in addition to *Chilo*, *Sesamia* and *Eldana* sp., has been recorded from *Cryptophlebia rhynchias* (Anon. (CIBC), 1977; Nikam and Basarker, 1981; Kfir, 1991; 1992).

Our survey data clearly show that natural enemies are closely associated with sorghum stem borers in farmers' fields at all levels of infestation. However, the levels of infestation were higher in farmers' fields than have been recorded on the ICRISAT research farm (Nwanze et al., 1995). The variation in levels of parasitism has been attributed partly to differences in varietal cultivation, latitude, and climate between the two states. This merits further investigation since it provides a potential area of interaction between host plant resistance and biological control IPM strategies. By implication, because the level of borer resistance in improved genotypes is still very low (Nwanze, 1997), breeding sorghum genotypes which will enhance natural enemy activity could be a new strategic approach in borer management.

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