Pest Management Options:

Adoption of closed crop seasons, discouraging monocropping and advocating crop rotation with non-host crops reduce the food supply and shelter to *H. armigera*. Selecting Bt hybrids suited to the region and soil provide excellent control of *H. armigera* in addition to other bollworms. Preplanting clean up measures during off-season to keep the fields, their bunds and borders free of weed hosts are a must to break the link for the pest between cotton and alternate host crops. Pheromone traps of *H. armigera* can be set up @ two per ha that attract male moths to indicate the initiation and the degree of population development. The pheromone lures in the form of septa are to be changed once in 45-60 days with the trap height adjusted to one metre above the ground level in the early season, and one metre above crop canopy in the late season. The mechanical removal and destruction of the larvae during outbreak years is more successful than the insecticidal management wherein the control failure occurs. Practices that attract more attack by bollworms through increased vegetative growth such as closer spacing, excessive use of systemic insecticides during early season for sucking pest management and excessive nitrogen application should be avoided. The September is the month wherein *H. armigera* singly or in combination with *Earias* spp. cause excessive shedding of squares. Bollworm management at this stage should be based on the available and damage level to fruiting parts on the plants besides weather. The use of insecticides to be economical should commence only when majority of plants have at least few flowers and set bolls on them and the fruiting damage exceeds 10% in relation to total fruiting structures. Mechanical collection and destruction is advised when all the sizes of larvae occur simultaneously. Hymenopterous and tachinid parasitoids (e.g. *Eriborus argenteopilosus, Campoletis chlorideae, Microchelonus* spp. *Palexorista laxa, Carcelio illota* and *Goniopthalmus halli*) are common on *H. armigera* that regulate the population during moderate levels of incidence. In Central India watch should be kept on medium to large sized bolls during September -October months from damage due to *H. armigera.* Protection of first flush of squares using insecticides is highly difficult coinciding with the occurrence of *H. armigera* due to the overlapping and the consecutive generations. Therefore, use of insecticides to manage *H. armigera* till 90% of fruiting structures on the plant are squares should be avoided. As the name indicates, bollworms should be suppressed only when there are bolls on the plant and boll damage is happening. Decision to spray should be taken not based on the level of damage but based on the retention of bolls on the crop, and in conjunction with the presence of damaging larvae on the crop. When it is observed that the larvae of *H. armigera* are feeding on the bolls of two out of ten plants, during September and first fortnight of October insecticidal application is to be done. The insecticides that are recommended with their dosages for *H. armigera* management are given in table below. *H. armigera* management should be attempted with insecticides selected from IGRs, Spinosyn, conventional (OPs, and Carbamates) and other newer groups (Oxidiazine & Avermectin) in rotation considering the cost of the insecticide and anticipated level of yield saving from their application. There should be minimum of 10 - 15 days interval between two sprays even at times of outbreaks to be cost effective.

Recommended insecticides for *H. armigera* management

Group and name of the chemical	Formulation	Quantity of chemical (ml or g/ha)
Carbamates		
Methomyl	25 EC	2000
Thiodicarb	75 WP	2000
Organophosphorus compounds (OP)		
Acephate	75 WP	780
Chlorpyriphos	20 EC	1250
Profenophos	50 EC	1500
Quinolphos	25 EC	2000
Triazophos	40 EC	1500
Insect growth regulators (IGR)		
Novuluron	10 EC	1000
Lufenuron	5 EC	1200
Diafenthiuron	50 WP	700
Buprofezin	25 EC	400
Pyriproxyfen	10 EC	500
Oxidiazine		
Indoxacarb	15 EC	500
Spinosyn		
Spinosad	48 EC	100
Avermectin		
Emamectin Benzoate	5 EC	200

The amount of spray fluid varies more with the canopy size than with the crop age. It is recommended that power sprayers be used against bollworm management through insecticides. Normally 200-300 litres/ha of water should be used for a crop that had attained eight to sixteen nodes.

Authors
Dr. S. Vennila
Dr. V. K. Biradar
Division of Crop Protection
Central Institute for Cotton Research
Nagpur
Mr. M. Sabesh
Central Institute for Cotton Research (R. S.)
Coimbatore
&
Dr. O. M. Bambawale
National Centre for Integrated Pest Management
New Delhi

Published by
Dr. B. M. Khadi
Director
Central Institute for Cotton Research
Post Bag No. 2, Shankar Nagar P. O.
Nagpur 440 010
Maharashtra

Acknowledgement
Mrs. M. Chakrabarty
Scientist I/c, TMC-MM I Cell
Central Institute for Cotton Research
Nagpur

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English Version

Know your Cotton Insect Pest
AMERICAN BOLLWORM

Common Name	:	American bollworm
Local Name	:	Hiravi bond ali
Scientific Name	:	*Helicoverpa armigera* Hub.
Family	:	Noctuidae
Order	:	Lepidoptera
Pest Category	:	Borer

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Description of Insect Stages:

Egg: Eggs are spherical with a flattened base laid on the tender foliage and calyx of squares and stem of the cotton plants. Surface is sculptured with longitudinal ribs. Colour is white to creamy white after oviposition. As the embryo develops reddish brown band is seen centrally which gradually darkens and together with rest of egg becomes brown before hatching.

Eggs on tender leaf

Larva: Newly hatched larvae are translucent yellowish white with brown to black head capsules. The thoracic and anal shields, spiracles, thoracic legs, setae and their

Colour forms of larval *H. armigera*

tubercle bases are also brown to black, giving the larvae a spotted appearance. Second instar is essentially similar but with darkened ground colour and lightened sclerotized head capsule, thoracic and anal shields and thoracic legs. The third instar has a predominantly brown ground colour. The characteristic patterning becomes more prominent and colouring generally darker in later instars. Considerable variations occur with shades ranging from green, fawn yellow to brown and their combinations. Host diet also plays a role to some extent in determining the colour of the larvae. There are usually six larval instars.

Pupa: Pupa is smooth surfaced, brown, rounded both anteriorly and posteriorly with two tapering parallel spines at posterior tip. Females are on an average heavier than males. Pupae are formed at a depth of 2.5 - 12.5 cm in the soil.

Adult: Adults are stout bodied moths, greenish yellow to buff to brown with darker brown or blackish markings. Males are light brown with greenish cast. Females are darker than males. Moths have a circadian rhythm starting at dusk, continues through midnight after which it virtually ceases. Moths disperse over long distances to suitable crops from source hosts.

Helicoverpa moth

Nature of Damage:

The larvae feed on the leaves initially and then bore on to the square/bolls and seeds with their head thrust into the boll, leaving the rest of the body outside. Larvae show

Larva feeding on square

Larva feeding on flower bud

Larva feeding on flower

Larva feeding on tender boll

Larva feeding on mature boll

preference for feeding on squares and flowers when present, however, feed on young bolls also. A single larva can damage 30-40 fruiting forms during its developmental period. The entry holes are large and circular at the base of the boll. Feeding on bolls can be extensive or only brief. These larvae spread Boll rot microbes, and the damaged bolls rot resulting in yield loss.

Symptoms:

Presence of frass held in place by delicate webbing is seen on squares fed by early instars. Damaged squares flare off and have feeding or damage holes on them. Excessive shedding of squares of variable sizes noticed. Clear-cut

Flared up square with clear cut feeding hole

Shed fruiting structures due to *H. armigera* feeding

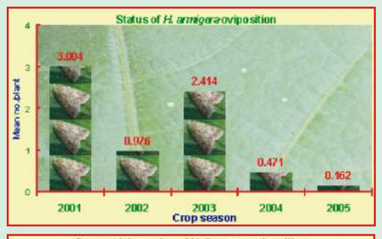
round feeding holes on squares and bolls with or without larvae are seen.

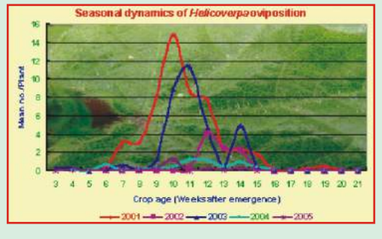
Life History:

Egg period is for 3 to 5 days. Larval and pupal periods last for 17-35 and 17-20 days, respectively. The life cycle is completed in 25-60 days. On an average female moth lays 700 eggs during its longevity of 8-12 days. The pest is polyphagous, voracious in feeding and has wide host range, various colour forms and continues to occur year round. They are multivoltine and have overlapping generations. The moths are highly mobile able to fly up to 200 km and thus have wider regional distribution.

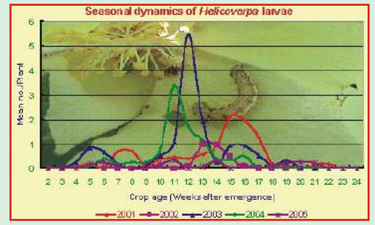
Seasonal Dynamics:

First and second generations are found on several crops and weed hosts. Second generation usually infests cotton in low numbers. Populations increase dramatically during

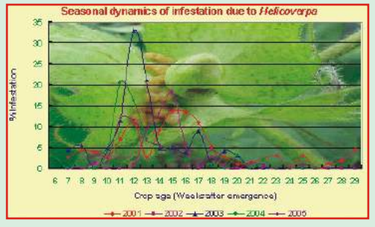




third and fourth generations with major outbreaks coinciding with peak squaring of first and second flush. Generations overlap due to the mixture of immigrant and local populations, and differential developmental rates. Seasonal phenology is host mediated. Seasonal abundance is largely governed by interaction between initial population size and timing, and host suitability and the environmental variables. There has been declined mean infestation due to *H. armigera* during 2005, over the last five years in Central India. Period of onset of *H. armigera* varies with seasons. Lesser oviposition and higher larval survival and *vice-versa* occur. The damage to cotton fruiting structures is directly proportional coinciding with the crop growth with squares outnumbering flowers or bolls. The damage levels can reach as high as 30-40 % and period of damage can extend into November-December months occasionally, however at low levels. Late season populations are high only during outbreak years. The peak damage among different



years is not the same due to the differing fruiting cycle modulated by weather variables and response of crop to earlier attack by sucking pests or bollworms.



Prediction Criteria:

Prediction of onset of *H. armigera*: Calender year based degree-day accumulations of 2450-2500 (DD) predicts onset of *H. armigera* oviposition on cotton.

Predicting the outbreak of *H. armigera* based on weather cum pest developmental variables: Relative humidity levels > 70% throughout the day during August-September months, and dry spells followed by un seasonal rainfall distributed on many rainy days (with excess and / or more rainfall during the season), and rainfall amount more than 50 mm during October first week leads to outbreak of *H. armigera*. Steady increase in moth catches in pheromone traps (>2/trap/night) from mid September, oviposition to the extent of more than two per plant on or before first week of September, and larval incidence more than two per plant for two subsequent or any two weeks between end of September and mid October results in *H. armigera* damage severity. Degree of severity of *H. armigera* on kharif and rabi seasons are directly proportional.