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Viable mass production method for cotton pink bollworm, *Pectinophora gossypiella* (Saunders)

B. Dhara Jothi [a,*], V. Chinna Babu Naik [b], S. Kranthi [b], K.R. Kranthi [b], R. Valarmathi [a]

[a] *Central Institute for Cotton Research, Regional Station, Coimbatore, Tamilnadu, India*
[b] *Central Institute for Cotton Research, Nagpur 440010, India*

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KEYWORDS

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Abstract Cotton seed based artificial diet has been standardized for continuous rearing of pink bollworm *Pectinophora gossypiella* (Saunders) at the Central Institute for Cotton Research, Regional Station, Coimbatore. The ingredients of the diet are easily available and are cost effective. Basic ingredients of the diet are cotton seed flour (processed) and chick pea flour, Carbohydrate, Protein, Fat sources, multi vitamin, antimicrobial agents and agar as thickening agent are used as other ingredients. Micro centrifuge tubes with lid were used as rearing containers. Individual neonate larvae were released on each piece of the diet inside the micro centrifuge tube and the lids were closed. This prevented larval escape, retaining them inside the tubes and also prevented diet dehydration. The recovery of insect reared on diet was recorded as 95.56%. Egg hatchability and adult emergence were 100% while pupal malformation was nil. Eggs, larval and pupal periods were recorded as 4.8 ± 0.632, 25.10 ± 0.994 and 7.9 ± 0.88 days, respectively. Larval and pupal weights were recorded as 21.40 mg ± 3.63, 18.00 mg ± 2.73, respectively.

Introduction

Cotton is attacked by many species of lepidopterous insects in different stages of crop growth and the pink bollworm, *Pectinophora gossypiella* (Saunders) is the most damaging pest and it is a widespread pest in almost all cotton growing countries of the world (Curl and White, 1952). Moths of this pest are very active fliers, whereas larvae mostly remain inside the fruiting bodies (squares, flowers and bolls) and cause severe damage. They web the cotton flower petals, imparting a characteristic 'rosette' appearance. Feeding within the boll results in malformation, rotting, premature or partial boll opening, reduction in fibre length and overall reduction in quality of the cotton due to staining of the lint.

After China, India is the largest producer and consumer of cotton, the country accounting for a little over 21% of the global cotton production in 2008–09. India is the largest producer covering an area of 103.29 lakh ha with a production of 295.00 lakh bales and 486 kg/ha productivity during 2014–15 (www.cicr.org.in).

* Corresponding author.
E-mail addresses: dhara56@yahoo.co.in, bdhara.jothi@gmail.com (B. Dhara Jothi).

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Among the bollworms, the pink bollworm assumed a major pest status in the recent past (Ghosh, 2001). World over, pink bollworm *P. gossypiella* has become economically the most destructive pest of cotton and has known to cause 2.8–61.9% loss in seed cotton yield, 2.1–47.10% loss in oil content and 10.70–59.20% loss in normal opening of bolls (Patil, 2003). Bt cotton (Bollgard®) offered a high level of resistance against the cotton bollworm complex i e., *Helicoverpa armigera* (Hubner), *Earias vittella* (Fabricius) and *P. gossypiella* both in laboratory as well as field conditions (Ghosh, 2002; Kranthi et al., 2002; Kranthi and Kranthi, 2004). In 2009, the Genetic Engineering Appraisal Committee (GEAC) approved 248 new Bt cotton hybrids for commercial cultivation in the 2009 season, in addition to the 274 Bt cotton hybrids approved for sale in 2008, for a total of 522 hybrids (Choudhary and Gaur, 2010). Currently more than 1000 Bt hybrids are available for cultivation (GEAC, 2012).

But in the present scenario of Bt cotton cultivation, resistance monitoring for Bt toxin in bollworms is essential. As a resistant management measure, the susceptibility of geographic populations of *H. armigera* and *E. vitella* was studied for 2 years before the commercial approval of Bt cotton in India. However, such studies were found to be difficult to conduct primarily because of the difficulties in mass rearing facility of *P. gossypiella* in the laboratory. In India some of the efficient parasites such as *Bracon greeni* Ashmead and *Rogas aligharensis* Quadri could not be mass multiplied and used in the release programmes for want of a simple artificial diet for the rearing of the pink bollworm. The lima-bean diet developed by Patana (1977) and the wheat germ diet developed by Adkinsson et al. (1960) and Raulston (1971) for *P. gossypiella* could not be used under Indian conditions due to non-availability of some of their ingredients. This necessitated an artificial diet prepared from locally available ingredients with easily adoptable methodology by researches, by which importation of expensive diet premixes can be avoided. The aim of the present study was to develop a mass rearing diet for *P. gossypiella* using locally available ingredients.

Materials and methods

Starter culture

Larvae of the pink bollworm were collected from the infested cotton bolls from the fields of the Central Institute for Cotton Research, Regional Station, Coimbatore and reared in the laboratory. The larvae were fed with locules of green bolls and

Table 1 Ingredients and cost economics of the diet.

Fraction A*		Quantity of the ingredients	Cost (INR)
1	Cotton seed flour	50 g	6.00
2	Chickpea flour	35 g	2.10
3	Sucrose	15 g	17.70
4	Distilled water	200 ml	3.00
*Fraction B***			
1	Agar-agar	19 g	79.04
2	Distilled water	200 ml	3.00
*Fraction C****			
1	Dried yeast powder	8.0 g	17.84
2	Ascorbic acid	1.2 g	5.60
3	Methyl 4-hydroxy benzoate	1.6 g	2.70
4	Multivitamin	1.0 ml	2.49
5	Streptomycin sulphate	0.2 g	2.18
6	Bavistin	2.0 g	1.54
7	Casein	10 g	14.02
8	Cystiene	0.1 g	2.65
9	Wessons salt	2.5 g	159.59
10	Cholesterol	0.5 g	12.37
11	Sorbic acid	0.5 g	0.76
		Total cost	332.58

* Sucrose (99% purity, HimediaLaboratories™).

** Agar agar (Ultra pure, Sd Fine Chemicals).

*** Ascorbic acid (99% purity, Sd Fine Chemicals); Methyl 4-hydroxyl benzoate (99% purity, Loba Chemicals); Multi vitamin with minerals (MULTIGATES®, Each ml contains Vitamin C, 4 mg; Zinc sulphate, 13.3 mg; Lysine hydrochloride, 24 mg; Nicotinamide, 2.4 mg; Flax seed oil, 3 mg; D-panthenol, 1 mg; Vitamin B1, 0.8 mg; Vitamin B2, 0.1 mg; Vitamin B6, 0.5 mg; Vitamin A, 500 IU; Vitamin, D 3, 100 IU; Tocopheryl acetate 2.5 IU; Choline bitartrate, 25 mcg; Biotin, 10 mcg; Vitamin B 12, 1 mcg; Folic acid, 100 mcg; Ferric ammonium citrate, 5 mcg; Manganese sulphate, 500 mg; Copper sulphate, 10 mcg; Potassium chloride, 1 mcg; Chromiun chloride, 1 mcg; Sodium chloride, 10 mcg; Sodium selenate, 5 mcg; Nickel sulphate 1 mcg; Stannous chloride, 1 mcg; Sodium terta borate, 1 mcg; Carbohydrates, 595 mg; Energy, 1.9 cal; Fat, 1.5 mg); Strepomycine sulphate (HimediaLaboratories™); Bavistin (Bavistin® DF-fungicide); Casein (95% purity, HimediaLaboratories™); Cystiene (98% purity, HimediaLaboratories™); Wessons salt (Calcium carbonate, 2.63 g; Ferric phosphate, 0.183 g; Magnesium sulphate, 1.125 g; Potassium chloride, 1.50 g; Potassium Phosphate monobasic, 3.875 g; Sodium chloride, 1.312 g; Tricalcium phosphate, 1.860 g; Copper sulphate, 4.48 mg; Manganese sulphate, 2.50 mg; Potassium aluminium sulphate, 1.13 mg; Potassium iodide, 0.63 mg; Sodium fluride, 7.13 mg); Cholesterol (98% purity, Loba Chemicals); Sorbic acid (98.5% purity, Sd Fine Chemicals).