DOCUMENTATION AND VALIDATION OF INDIGENOUS
PEST MANAGEMENT PRACTICES IN ORGANIC
FARMING SYSTEMS

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DOCUMENTATION AND VALIDATION OF INDIGENOUS PEST MANAGEMENT PRACTICES IN ORGANIC FARMING SYSTEMS

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AFFECTIONATELY DEDICATED TO MY BELOVED PARENTS AND FAMILY MEMBERS
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BANGALORE             (Chandrashekharaiah)
June, 2010
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CHANDRASHEKHARAIH

Abstract

Considering the emphasis on organic farming in recent years, efforts were made to document indigenous pest management practices. Surveys were conducted in eight districts of southern Karnataka and about 100 indigenous plant protection practices were documented. These practices/products were grouped into purely plant-based (28 products), cow urine-based (36 products), kerosene-based (3 products), commercial preparations of unknown composition (9 products) and cultural/mechanical practice and other products (24 products/practices). Six indigenous products commonly used by organic farmers, viz. modified panchagavya, cow urine, dasagavya, chilli + garlic extract, neem fruit + red chilli + custard apple leaf extract and neem seed kernel + Aloe vera + Calotropis + Vitex + Clerodendron leaf extract were assessed for insecticidal and acaricidal properties against diamondback moth (DBM), Plutella xylostella (L.), the cowpea aphid, Aphis craccivora Koch and two spotted spider mite, Tetranychus urticae Koch. The laboratory studies indicated that panchagavya exhibited relatively higher levels of repellent and antifeedant activity against DBM but had negligible insecticidal activity. However it showed moderate level of acaricidal property against two-spotted spider mite. Cow urine was more detrimental to the spider mite compared to the DBM and the aphid. However, it showed moderate level of repellent and antifeedant activity against diamondback moth. Dasagavya exhibited moderate levels of insecticidal and acaricidal properties against DBM and two spotted spider mite, respectively, but it was not detrimental to the aphid. At higher concentration it exhibited good repellent and antifeedant activity against DBM. Chilli + garlic extract exhibited very good acaricidal activity against mite and lower levels of insecticidal activity against DBM and the aphid. This product also showed fairly high repellency and antifeedant activity against DBM. The products containing neem i.e. neem fruit + red chilli + custard apple leaf extract and neem seed kernel + Aloe vera + Calotropis + Vitex + Clerodendron leaf extract exhibited higher levels of biological activity against DBM and the mite compared to aphid and were far superior to other test products.

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Signature of Major Advisor
(Dr. V. T. Sannaveerapannavar)
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I. INTRODUCTION

Crop pests have been a part of environment since ages. Traditional agriculture which includes cultivation of diverse crops and indigenous crop management practices provided little opportunity for the crop pests to build up and spread. However, in the quest of increasing food production to meet demands of the growing population, use of agricultural chemicals has become a norm in crop production process to minimize the losses due to weeds, diseases and pests. Indiscriminate and large-scale application of synthetic pesticides has resulted in several undesirable and serious ill effects such as toxic residues in the food commodities, ecological imbalance, insecticide resistance, toxicity to non-target organisms, resurgence of secondary pests, adverse changes in population of pests and natural enemies. In this context, it is relevant to recall Julian Huxley’s lines, “pest control is of course necessary and desirable, but it is an ecological matter and cannot be handed over entirely to the chemists” in his preface to Rachel Carson’s revolutionary book, Silent Spring.

Greater awareness of drawbacks of synthetic insecticides and other chemicals in recent years has prompted the scientists and farming community to look for alternative approaches of crop production and crop protection practices that are environmentally safe, ecologically sound and socially acceptable. One such rational approach which gained attention of the farming community in recent times is organic farming and employment of traditional pest management practices.

The importance of achieving food production through eco-friendly and sustainable pest management techniques is being realized more and more in the recent past. The organic food production is drawing attention globally and the demand for organic foods is also growing. Since the past
few years, a considerable number of farmers in Karnataka have resorted to organic cultivation of crops, particularly in the southern districts of Dakshina Kannada, Udupi, Shimoga, Chikmagalur, Hassan, Tumkur, Bangalore, etc. Though some farmers are successfully growing organic crops, many of the practices they adopt, particularly in plant protection, have not been neither documented nor validated scientifically. Adoption of cultural practices, conservation and augmentation of natural enemies of pests, use of plant-based and microbial pesticides, and antagonistic organisms in plant protection have been emphasized by the scientific community. In view of hidden advantages, indigenous plant protection technologies that are in practice need to be documented and validated.

In Karnataka, organic farmers use preparations containing cattle urine, dung, extracts of locally available plants etc. for suppressing pests and diseases. The practices vary from farmer to farmer and region to region. The indigenous technologies need to be documented and evaluated for their effectiveness so that the promising practices only can be popularized among the farmers. There is also scope for improving traditional practices for more effective pest management.

In the present study, efforts have been made to document certain indigenous pest management practices prevalent in southern Karnataka against insect and mite pests and to assess their insecticidal/acaricidal properties. Diamondback moth, *Plutella xylostella* (L.) (Lepidoptera: Plutellidae), a cosmopolitan pest of cruciferous vegetables, the cowpea aphid, *Aphis craccivora* Koch (Hemiptera: Aphididae), a sucking pest on pulses and two spotted spider mite, *Tetranychus urticae* Koch (Tetranychidae: Acari), a polyphagous pest of many vegetables and ornamental crops were used as test organisms to ascertain the insecticidal or acaricidal properties of some of the products being used by organic farmers in plant protection.
The objectives of the study are

1. Documentation of indigenous plant protection practices being adopted by farmers in different cropping systems in southern Karnataka.

2. Assessment of insecticidal and acaricidal properties of selected indigenous products / preparations.
Review of Literature
II. REVIEW OF LITRETURE

A brief review of the literature pertaining to indigenous plant protection practices and their validation is included in this chapter. As the literature on the test insects and the mite used in the present studies is limited, the available information on indigenous practices employed in the management of any pest in different cropping system is summarized here under.

Indigenous technical knowledge (ITK) is the knowledge that people in a given community developed over a period of time, and continues to further. It is based on ones experience, tested over centuries, adapted to local culture and environment, dynamic and changing. Indigenous knowledge has two powerful advantages over outside knowledge, it has little or no cost and is readily available (Kothari, 1995). The importance of the indigenous knowledge in a human society is quoted as “where there is no culture, there is no indigenous knowledge, where there is no indigenous knowledge, there is no history, where there is no history, there is no science and technology. The existing nature is the result of our past. Let us protect and conserve our indigenous knowledge” (Anon., 2006a). The organic way of cultivation of crops relies almost entirely on practices that have evolved locally over a period of time.

Organic agriculture is a production system that sustains the health of soil, ecosystem and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs having adverse effects. Organic agriculture combines indigenous technical knowledge, innovation and science to benefit the shared environment and promote fair relationships and ensures a good quality of life for all those involved (Anon., 2008).
2.1 Documentation of indigenous plant protection practices followed by farmers in different cropping systems

In India, Gupta (1990) made a beginning to compile traditional agricultural practices through a quarterly journal, “Honeybee” which is being brought out now in 10 regional languages. It carries information on indigenous practices gathered by extension workers, scientists, innovative grassroots level workers and through interactions with rural as well as tribal people.

Ravishankar et al. (1994) reported that Malayali and rural tribals in Palani hills of Tamil Nadu were following certain practices such as sun drying, storing seeds of *Lablab* sp. and *Cajanus cajan* L. with red earth in airtight containers and mixing vegetables seeds with ash before storing to protect them from storage pests.

A survey carried out by Jayakumar (2002) revealed about 98 indigenous practices adapted by the farmers in Raichur region to manage the pests. Further studies on okra pests revealed that NSKE + cow urine, garlic extract + chilli extract + cow urine, garlic extract + cow urine, neem oil + garlic extract and *Clerodendron* extract + *Vitex* extract were as effective as oxydemeton-methyl against leafhoppers and aphids. Whereas, neem oil + garlic extract + cow urine and NSKE + cow urine treatment was effective against whitefly and mites.

A study conducted in Coimbatore and Erode districts of Tamil Nadu revealed that farmers were using five indigenous technologies involving cattle origin products for various purposes like green leaf extracts with cow urine as a pest control measure, cotton seed treatment with cow dung for removing fuzzy hairs, chilli seed treatment with cow dung slurry to reduce seed born diseases and induce germination,
whitefly control with buttermilk in okra crop and ragi seed hardening using cow urine (Karthikeyan et al., 2005).

Tribal groups of Tamil Nadu practised use of locally prepared products for suppression of rice pests, for which they used fish + neem leaf extract, table salt solution spray at 4 %, goat dung extract at 7 % and fuel wood ash dust at 16 kg/ac. On vegetables, Calotropis leaves + garlic + onion + chilli powder extracts was used. Vitex leaf extract was used against brinjal leaf beetle. Calotropis leaf + garlic + chilli powder extract and Vitex leaf extract was used to suppress tomato fruit borer. Dusting Vitex leaf powder and turmeric powder was practised for the control of pulse beetle (Narayanaswamy, 2006).

Farmers in remote villages of the Mandi, Bilaspur, Shimla, Kinnaur and Lahaul Spiti districts of the Himachal Pradesh used ash against chewing and sucking type of insect pests. Products, like, aged cow urine, Vitex negundo, Ferula asafoetida, Aloe barbadensis, Nicotiana tabacum were found to be effective against the insect pests of cabbage, wheat, peas, grams and other crops (Chaman Lal and Verma, 2006).

The farmers of Golaghat, Jorhat and Sivasagar districts of Assam practised spraying of raw cow dung mixed with water to control thrips on rice, steam decoction of neem seeds and leaves to control Scirpophaga incertulus, smoking in the pumpkin fields to control fruit fly, application of fish water on the base of citrus plant to control citrus trunk borer, placing of long hair of women in the crown portion of coconut tree to protect from rhinoceros beetle etc. (Deka et al., 2006).

The use of botanicals in plant protection has been mentioned in “Vrikshayurveda”, an ancient manuscript from Nalanda University. The messages written very precisely in the granth could protect the crops from wide range of pests and diseases by using plant based extracts to
promote organic farming for the cultivation of medicinal plants. Use of herbs in plant protection like nirgundi, peepli, gazzarghas, neem, tobacco, garlic, Pongamia, mahua, custard apple, tulsi, Adhatoda etc. and their byproducts were used as mentioned in “Vrikshayurveda” (Dodia et al., 2008a).

2.2 Assessment of insecticidal and acaricidal properties of selected indigenous products

2.2.1 Cattle urine based products

Cow urine was observed to have high per cent of antifeedant activity against Spodoptera litura at 10 per cent concentration (More et al., 1989). Iyyappa (1994) reported that application of one per cent lemon juice spray resulted in reduction of aphid population in cotton. Dried tobacco waste extract mixed with neem oil and cow urine was very effective against sucking pests like whitefly and aphids on cotton.

Garlic extract alone and in combination with other plant extracts viz., chilli, ginger, neem, tobacco and cow urine was found effective against sucking pests like aphids, whitefly, thrips and mites for 4 - 13 days. Ginger extract alone and in combination with other plant products and cow urine was effective against aphids, thrips and whitefly (Bemisia tabaci) and turmeric rhizome extract alone and combination with cow urine and soap was effective in controlling aphids, storage pests and Spodoptera litura (Vijayalakshimi et al., 1996 and 1997).

Spraying of cow urine with Ferula asafoetida, green chilli and garlic extracts was effective against aphids (Anon., 1998a). Other indigenous technologies practised by farmers to manage pod borer infestation in red gram were spraying cow urine + cow dung with lime extract, garlic + chilli extract with jaggery 10 per cent and NSKE (Anon., 1999b).
The preparations containing neem, black pepper, garlic and cow urine were commonly used pest management. The water extract of garlic + black pepper + soap was effective against hairy caterpillar infesting fruit crops (Anon., 2000a). Garlic + green chilli extract in equal proportion was effective on aphids infesting many crops (Anon., 2000b).

Angadi (2001) reported that farmers sprayed cow urine and leaf extracts of \textit{Parthenium}, \textit{V. negundo}, \textit{Lantana camara} (5 kg) in Gulbarga to control pod borers in red gram. Later chicks were allowed into the field to feed on the fallen larvae, thus red gram was protected without chemical pesticides. Prasad (2001a) reported the use of herbal preparations from leaves with bitter taste and cow urine to manage sucking pests and fruit borer on okra.

Extracts from \textit{Pongamia} (10\%), \textit{Aloe vera} (5\%), NSKE (10\%) and cow urine (30\%) recorded highest antifeedant activity with 75.57 and 68.63 per cent reduction in larval weight of \textit{S. litura} and \textit{H. armigera} respectively (Barapatre, 2001).

Among the various indigenous products evaluated, the maximum larval mortality of \textit{S. litura} (91.66\%) was caused by \textit{Vitex} (5\%) + \textit{A. vera} (5\%) followed by \textit{Pongamia} (10\%) + \textit{A. vera} (10\%) + NSKE (10\%) + cow urine (30\%), and were statistically on par. NSKE caused highest larval mortality of \textit{H. armigera} (89.92\%) and was as effective as a combined treatment of \textit{Pongamia} (10\%), \textit{A. vera} (5\%), NSKE (10\%) with cow urine (30\%). Cow urine and cow dung were ineffective as they were unable to cause any larval mortality even after 96 h (Barapatre and Lingappa, 2003).

Shukla \textit{et al.} (2003) revealed that fortification of cow urine with leaf extracts of neem, \textit{Ipomea}, \textit{Annona} and \textit{Jatropa} were effective in controlling sucking pests of castor shoot and capsule borer, resulting in
higher bean yield over control. They also reported that uplenckar (1%) and GSA formulation (1%) prepared from more than one foliar extracts along with cow urine provided an effective, economical and eco-friendly alternative to hazardous pesticides to suppress sucking pests and capsule borer on castor.

A revalidation study on the effectiveness of fermented cattle urine and other natural products against barley aphid and cricket in Ethiopia revealed that cow urine (1:6) was toxic to both the insects, increase in yield and the toxicity was at par *viz.* tobacco, neem, chilli, garlic, soap and diesel mixture at booting as well as flowering stages. Further in a laboratory study treatment with 3 days fermented cow urine (1:6) resulted in 79.6% mortality of banana fly, *Drosophila melanogaster* and 3 times more effective than NSKE (5%). On cowpea aphid, *Aphis craccivora* cow urine was found as effective as garlic (*Allium cepa*) and imidacloprid (0.25%) (Tesfaye, 2003).

The kochila (*Strychnos nux-vomica*) mixed with cow dung compost for controlling fruit and shoot borer in brinjal was evaluated by participatory rural appraisal, field survey and experimental methods. Their use reduced the incidence of fruit borer in brinjal, which is also matched with the claim of the discloser. The mixture of tobacco soaked water with soap was effective in controlling fruit and shoot borer but not as effective as kochila mixed cow dung compost (Das *et al.*, 2004e).

Experiments conducted at BAU, Ranchi, OUAT, Bhubaneshwar and CTCRI, Regional Center, Bhubaneshwar, showed that the use of cow urine mixed with tobacco soaked water was effective in controlling major pests in cucurbits, cowpea and lady’s finger. The economic return from this ITK was also higher, but less than chemical control (Das *et al.*, 2004f).
Spraying of Kunapajala (called as Indsafari) prepared by fermenting (aerobically) safari fish (mentioned in Vrikshayurveda) in cow urine on tea bushes at 1% concentration, was effective in controlling tea mosquito bug, *Helopeltis* sp. The foliar spray also controlled loopers on common shade trees in tea gardens (Ayangarya and Sreenivasa, 2005).

In a field trial the efficacy of cow urine against stem borers was compared with a conventional insecticide (chlorpyrifos) and a biopesticide (Dipel). The infestation of girdle beetle, *Obereopsis brevis* was significantly reduced in different concentrations of cow urine (15, 10 and 5 %) treated plots at 7 days after the third spray. Stem fly, *Melanagromyza sozae* infestation was significantly low at higher levels of cow urine (75 and 100 %). There was reduction in stem tunneling per cent at almost all levels of cow urine, chlorpyrifos and Dipel. The plot treated with cow urine and chlorpyrifos recorded significantly higher yield than the control plot. Highest cost benefit ratio (1: 18.9) was obtained for cow urine (5 %). However, highest additional yield value of Rs. 6520 per hectare was obtained with cow urine at 50 per cent (Gupta and Yadav, 2006).

Molluscicidal activity of cow urine alone and with different additives was studied against the snail, *Lymnaea acuminata*. Binary combinations (1:1) of freeze-dried cow urine with *Allium sativum* (Liliaceae) bulb powder, *A. indica* (Meliaceae) oil, *A. squamosa* (Annonaceae) seed powder, *Ferula asafoetida* (Apiaceae) root latex, tea leaves, and *Camellia sinensis* (Theaceae) were more toxic to the snail than the treatment with cow urine alone. Additives to cow urine in often field were more effective than under laboratory conditions (Tripathi *et al.*, 2006).

A local product prepared by mixing mango, neem and tamarind leaves and cow dung slurry in a pot and buried in soil for ten days for
fermentation, and the filtrate was then used after diluting in water at 1:10 ratio against pests on all types of crops (Kumar et al., 2007). Leaf extracts of *Clerodendran inerme*, *Aloe vera* and neem leaves were mixed with a small amount of cow urine. 30 ml of the extract mixed in one litre of water was very effective in managing tomato pests (Ramakrishna, 2007).

Herbal extract prepared from leaves of *Calotropis*, *Jatropa curcus*, neem, guduchhi or amruth, chaste tree, malbar nut, kalmegh, *Cleodendron* and usil, ground and mixed with cow urine was effective against paddy pests. Another extract prepared by mixing crushed ginger, garlic and green chilli with cow urine was used to manage pests such as leaf roller, thrips, mealy bugs, fruit borer, hairy caterpillar and aphids (Prabu, 2008a).

### 2.2.2 Plant based extracts

Spraying neem seed extract (5%) and neem oil (5%) resulted in considerable reduction of whitefly population on cotton (Nimbalkar et al., 1990). The latex of okada (*Calotropis gigantia*) when diluted with 15 parts water sprayed on any crop infested by caterpillar controlled within three days as revealed by Bhanjibhai (1992).

To manage aphids on groundnut, pigeon pea and *Sesamum*, boiled extracts of *Annona squamosa*, *Calotropis*, tobacco leaves and whitish fluid of biogas digester along with 100 g of copper sulphate was effective. Further, these mixtures were also effective against the semilooper attacking castor (Desai, 1994). Pithabhai and Patat (1995) prepared an herbal pesticide mixture using *A. squamosa* (1.5 kg), green chilli (500 g) and ripe neem fruit (1.5 kg) this mixture gave 50 - 90 per cent control of aphids an groundnut and was also effective against insect infesting chilli and brinjal.
Murthy and Sharma (1997) reported some of the traditional pest management practices followed by farmers to manage whitefly in cotton. Neem oil (2%), castor seed oil (1%), Madhuca latifolia (0.5%), tobacco leaf extract (0.5%), fish oil resin soap (0.2%) and nicotine sulphate (0.2%) helped to reduce the pesticide usage.

Farmers of Karuppankulangara, a remote village in the Allepey district of Kerala, spread powdered groundnut cake in the *Amaranthus* fields in the evening. The insects like leafhoppers and grasshoppers on *Amaranthus*, were attracted to the groundnut cake and fed on it. The next day a large number of dead insects were observed near a pond (Anon., 1998b).

The extract prepared by boiling 1 kg of mukkadaka (*Lasiosiphon* sp.) leaf in one litre of water and mixed with 10 litres of water was effective against brown plant hopper in paddy (Dinesh, 1998). Kasyapa (1998) reported from Medak district of Andhra Pradesh that spraying of chilli + garlic extract, jaggery solution and NSKE was a common practice among the local farmers.

Farmers in Palamu district of Bihar used a herbal pesticide prepared from bamboo sprouts (bamboo sprouts were slices into small piece and soaked in twice the volume of water in earthen pot for four to five days) to control BPH and other pests of paddy (Anon, 1999c). Tobacco decoction at one per cent was found as effective as monocrotophos against aphids on cowpea (Ukey *et al.* 1999).

Herbal mixture prepared out of dried leaves of tobacco (500 g), neem (1 kg), *Datura* (800 g) and *Nerium oleander* pods (500 g) immersed in water for 15 days with alternative day stirring was effective against paddy pests. It gave effective control within three days (Anon., 1999a). Extracts prepared by one kg of methi seeds in two litres of water and
sprayed on one hectare of okra crop gave 50 per cent control of *Heliothis* infesting okra within five days (Kantibhai and Dhamnyia, 2000).

Farmers in heavy rainfall regions of Karnataka use the decoction prepared out of mukkadaka (*Lasiosiphon eriocephalus*) leaves to control paddy leaf roller. Similarly farmers in coastal districts grow champaka (*Michelia champaka* L.) tree along the borders of coconut plantation to prevent damage by rhinoceros beetle. They have observed the repellent property of the odour coming from champaka flowers against rhinoceros beetle in coconut (Prakash and Tejashwini, 2000).

The extracts of custard apple leaves, turmeric rhizome, *Clerodendron* leaves *Aloe vera*, *V. negundo*, neem seed kernel were used to manage the eriophyied mites in coconut as reported by Chelamuthu (2000) from Karukkampalayam of Erode district in Tamil Nadu and he was awarded Grassroots Innovation Award, SRISTI Sanman at the National Level by Honey Bee Network, during February 2000.

Patil (2000) conducted an experiment with 20 indigenous plant extracts for the antifeedant property against insect pests. *A. indica* exhibited maximum antifeedant activity followed by *Acorus calamus* and *A. squamosa* against third instar larvae of *Plutella xylostella*.

Studies in Kerala Agricultural University indicated that neem oil + garlic + soap emulsion, neem oil + soap emulsion + wettable sulphur and herbal plant products were effective in managing the eriophyied mite (Kumar and Eswarikumar, 2001). Prasad (2001b) reported use of herbal extracts prepared from seven plants *viz.*, *A. vera*, *C. gigantia*, *V. negundo*, neem seed kernal extracts, *C. innermi* leaves, *A. squamosa* leaves and ginger by Tamil Nadu farmers against coconut mite.
In a field study spraying of garlic and tobacco extracts with washing soap powder was effective in managing the rice pests. As against the yield of 13.55 and 28.35 q/ha from control plots at Dohna and Manda (Uttar Pradesh) village, respectively, and yield harvested from the plots with ITK treatments were 19.90 and 31.66 q/ha (Das et al., 2004a). Spraying of leaf extract of *Prosopis julifera* at 15 days interval for three times during the cropping season was not effective in reducing the populations of *H. armigera* and *Aproaerema modicella* as claimed by the discloser (Das et al., 2004b).

A field study conducted to evaluate the effectiveness of the leaf extracts of Parsa (*Cleistanthus collinus*) and Sali (*Boswellia serrata*) against paddy case worm, both the products reduced the pest population significantly 30 days after the treatment (Das et al., 2004c).

A field study carried out at TNAU, Coimbatore and IIHR, Bangalore to know the effect of *Cynodon dactylon* extract on tomato fruit borer, indicated that the extract was not as effective as endosulfan treatment but reduced the incidence of fruit borer compared with untreated control (Das et al., 2004d). A formulation consisting of extracts of leaves of custard apple, turmeric rhizome, peenari changu, *Aloe vera*, chothukatralai, nochi, neem kernel and *Calotropis* sp. was administered into the crown region at the rate of two liter per palm after the harvest of nuts and repeat it once in two months was effective in controlling eriophyied mite (Anon., 2005a).

Giant weed (*Calotropis procera*) widely distributed in West Bengal, Rajasthan, Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Sri Lanka, East and West Indies was used indigenously in the control of termite, paddy and ginger pests like stem and root borer, mustard saw fly and red hairy caterpillar (Srivastava et al., 2006). Anon., (2006b) reported that indigenous herbal mixtures prepared from ginger (250 g), chilli (250 g),
nochi leaves (1 kg), garlic (500 g), A. vera (1 kg), neem seed (1 kg), C. inerme (1 kg) were effective in controlling nematode on turmeric crop.

Kiruba et al. (2006) studied the traditional methods of pest management in paddy and coconut crops practised by the people of Kanyakumari district, Tamil Nadu. The study revealed that, farmers used lime, fly ash and some plant species, namely A. indica, Aloe barbadensis, Coleus amboinicus and P. pinnata as pest deterrent materials as well as manure. They also used different types of traps against insect pests such as fire trap, meat trap, plant trap and pot trap for controlling pests.

The leaf extract obtained from Clerodendron sp., Aristolochia bracteata, A. indica and Enicostemma littorale were used to control cotton pests. The formulations developed by using these plants were also effective in controlling diseases (Anon., 2007b). A farmer in Shimoga, has been practising organic pest control practice. He used mukkadaka (Lasiosiphon ericephalus) decoction (1 kg leaves in 10 litres water, boiled it, filtered and diluted with water in 1:10 ratio) to manage hoppers and other insect pests in paddy (Anon., 2007c). The neem seed or neem leaf extract at 0.5 per cent and extracts of many herbs which are locally available and are not eaten by goats such as Datura, Negundii, Lantana, Adathoda, Clerodandron, Calotropis etc. were effective in suppressing pest problem (Reddy, 2007).

2.2.3 Panchagavya

Panchagavya is an organic pesticide being used by many organic farmers in various parts of country. It is normally prepared by using, cow milk, curd, ghee, cow urine and dung. In modified formulation besides above basic ingredients, sugarcane juice, tender coconut and ripe banana was added and the entire mixture is fermented for twenty two
days. The fermented solution after filtration has been found very effective in controlling several pests of sunflower and green gram (Anon., 2005b).

Field performance of Panchagavya, cow urine alone and in combination with plant products against *Spodoptera litura* in soybean and groundnut ecosystems was studied by Bharati (2005). The treatment, Panchagavya + NSKE was on par with quinalphos (0.05%) spray recording significantly less number of larvae (3.14 and 5.87/m row) in groundnut and soybean, respectively and recorded highest yields.

Panchagavya spray with *Agnihotra* (fumigation in the field) recorded the least population of cutworms and recorded highest yield of potato (Selvaraj, 2003b). Vadivael (2006) reported that panchagavya caused significant reduction in root knot nematode (*Meloidogyne incognita*) infestation in tomato. Jayashankar et al. (2002) reported that fourth day after spraying of panchagavya, there was an aphid attack on field bean and caused withering of flowers.

Boomiraj and Lourduraj (2006) reported that poultry manure, neem cake, neem and herbal formulation, panchagavya and monocrotophos spray alone or in different combinations, were effective in controlling *Amrasca biguttula biguttula* infesting okra. Application of neem cake in combination with monocrotophos resulted in maximum control of the pest. The Panchagavya along with aqueous extract of different botanicals were evaluated for there larvicidal activity against third instar larvae of *S. litura*. High percentage mortality (80.2%) of third instar larvae was observed, in the treatment panchagavya (3%) with NSKE (5%) at 72 h after treatment, followed by panchagavya (3%) with *V. negundo* (5%) (70.2% mortality) while NSKE alone at 5% caused 60.2 per cent mortality. The treatments, Panchagavya (3%) with *A. vasica* (5%) and *V. negundo* (5%) were found on par with each other by recording 50.4 and 50.2 per cent mortality, respectively. Panchagavya alone at 3.5
and 4.5 per cent concentration recorded only 10.7 per cent mortality at 72 h of treatment while at lower concentrations of 1.5 and 2.5 per cent it could not recorded any mortality even at 72 h after treatment as reported by Bharati et al. (2007).

Panchagavya was found to enhance the biological efficiency of crop plants and the quality of fruits and vegetables. It was found to have the properties of both fertilizer and bio-pesticide and increased the economic yield of crops such as rice, green gram, sunflower, turmeric, moringa, and coleus. Amudhakaraisal spray is used by some farmers in Tamil Nadu (India) as a pest repellent, antifeedant and growth promoter. Vermiwash application was reported to increase the growth and yield of crops such as marigold, chrysanthemum and tomato. Vermiwash is also used as a prophylactic measures for controlling pests and as a pest repellent (Sebastian and Lourduraj, 2007).

2.2.4 Dasagavya

Dasagavya is an organic growth promoter and also acts as insecticide against aphids, thrips, whiteflies, caterpillars and mite pests, which is prepared by mixing five leaf extracts (Lantana, Leucas aspera, Datura metel, Phytolacca octandra, and Artemisia niligirica) along with ingredients of panchagavya (Selvaraj et al., 2007a).

The studies conducted at Horticultural Research Station, Ooty indicated that spraying of dasagavya 3% (5 times) at 15 days interval from one month after planting was effective against foliar diseases like powdery mildew and leaf spots caused by Alternaria, Mycosphaerella and Cercospora. Seed treatment of potato tuber with 40 litres of 3 % dasagavya + 4 kg cow pat pit for 30 minutes enhanced germination (Selvaraj et al., 2003a).
Kabir and Mia (1987) evaluated six indigenous extracts *viz.*, neem, garlic onion, tobacco straw wash and a mixture of soap with kerosene for their repellent activity against mustard aphids, *Lipaphis erysimi* kaltenbach in Bangladesh.

A mixture of crushed garlic bulbs (200 g) soaked in kerosene (200 ml) for 24 hours and mixed with ground chillies (25 g) and 10 ml of soap solution when applied at 20 ml in one litres of water gave good control of sucking pests (Thomos, 1995). Extract prepared from crushed garlic (1 kg) soaked in kerosene (200 ml) for overnight, mixed with the extract of green chilli (2 kg), and diluted in 200 l of water was effective in managing *Helicoverpa* and other caterpillars as reported by Reddy (1998). Lakshmanan (2001) reported that garlic bulb extract alone or in combination with kerosene, neem oil and extract of chilli were effective in managing several sucking pests like aphids, whitefly, *Thrips tabaci* and tetranychid mites infesting many crops.

A herbal insecticide was suggested by Dhayaneshwar patil (Science teacher in Janata high school, Shindkheda, Dhule, Maharastra) consists of *Datura* leaves (50 gm), *Jatropha glandulifera* (50 gm), *Ipomea fistula* (50 gm), tobacco leaves (50 gm), neem seeds (50 gm), neem leaves (50 gm), sorghum tillers (100 gm) and congress grass (100 gm) crushed well to prepare part A. Part B, consists of 3 litres of water, 50 gm of *Embelia ribes* powder, 150 ml kerosene and 5 teaspoonful soap powder heated together for boiling and 200 ml of cow urine is added. Both A and B are mixed and kept for 5 days. After that the mixture is filtered and sprayed to the crops was found effective against many crop pests (Anon., 2007a).
Garlic (1kg) soaked in 100 ml of kerosene overnight, and macerated with green chilli (500 g), pepper (200 g), tobacco leaf extract and neem oil (200 ml) showed repellent activity against insect pests and this was used by farmers in Kodumudi village in Erode district of Tamil Nadu (Prabu, 2009).
Material and Methods
III. MATERIAL AND METHODS

Material used and the methods employed to carry out various investigations in respect of the objectives as outlined in the introduction chapter are described here. The laboratory experiments were carried out in the Department of Agricultural Entomology, University of Agricultural Sciences, GKVK, Bangalore during 2008-09.

3.1 Documentation of indigenous plant protection practices followed by farmers in different cropping systems in Southern Karnataka

Surveys were conducted to document the indigenous plant protection practices followed by the farmers in Southern Karnataka. The lists of farmers in the districts of Dakshina Kannada, Udupi, Shimoga, Chikamagalur, Hassan, Mandya, Tumkur and Bangalore were obtained from the non-government organizations (NGOs) (Appendix I) which are funded by the State Department of Agriculture, GOK, to promote organic farming in the State. A proforma (Appendix II) was developed for documenting various plant protection practices followed by these farmers. It was done by interviewing individual and groups of farmers through regular visits. Indigenous and innovative practices employed by these farmers in the management of crop pests and diseases were documented and grouped as plant based, cow urine based products, etc.

3.2 Assessment of insecticidal and acaricidal properties of selected indigenous products

Based on the information gathered through surveys, the products which were commonly used by farmers in the management of crop pests in different cropping systems were selected for ascertaining their insecticidal / acaricidal activities. The test products included panchagavya, fermented cow urine, dasagavya, chilli + garlic extract, a
preparation containing dry chilli, custard apple and neem fruit extracts and a botanical preparation containing neem seed kernel, *Calotropis*, *Vitex negundo*, *Aloe vera* and *Clerodendron* leaf extracts.

The selected products were investigated for insecticidal and acaricidal properties against diamondback moth (*Plutella xylostella* L. (Lepidoptera: Plutellidae), cowpea aphid, *Aphis craccivora* Koch (Aphididae: Hemiptera) and the two spotted spider mite, *Tetranychus urticae* Koch (Tetranychidae: Acari) under laboratory conditions.

### 3.2.1 Mass rearing of test insects and the mite

#### 3.2.1.1 Diamondback moth, *Plutella xylostella* L.

Culture of *P. xylostella* was maintained in the laboratory by employing the method of Liu and Sun (1984) with suitable modifications. The late instar larvae and pupae were collected from cabbage fields around Bangalore and were reared up to adult stage on mustard seedlings (Plate 1). Three to four days old-mustard seedlings raised in plastic Petri dishes (10 cm diameter) were provided to the moths for oviposition in the cages measuring 35 × 10 × 35 cm. Ten per cent honey solution on cotton wads was fed to the moths to hasten oviposition. After 24 hours, seedlings were then transferred to rearing trays. Fresh seedlings were provided every day for oviposition by the moths.

After egg hatching, early instar larvae survived on leaves by scraping and the later instar larvae could feed on the entire leaves. When the seedlings were completely consumed, the larvae were transferred to fresh seedlings by gently tapping them with the help of a camel hair brush. The paper folds were placed in the rearing trays to facilitate pupation. The pupae were then collected from paper folds carefully and were kept in the cage for adult emergence. When a large number of
Plate 1. *Plutella xylostella* maintained on mustard seedlings raised in plastic Petri dishes

Plate 2: Mustard seedlings raised in nursery bed
larvae were required for studies, the pupae were stored in the refrigerator for a few days and to obtain the moths.

After few (2-4) generations, field collected population of DBM was mixed with the laboratory population to maintain the normal vigour. The rearing trays and culture room were disinfected regularly with four per cent formaldehyde to avoid bacterial infections and also precautions were taken to keep away the predators like ants, lizards etc.

3.2.1.2 Mass culturing of cowpea aphid, *Aphis craccivora* Koch

Cowpea aphid, *A. craccivora* was mass cultured on cowpea seedling raised in plastic pots in a polyhouse. The aphids collected from cowpea plants in GKVK campus were released on cowpea seedlings in the polyhouse and were allowed to multiply. The nymphs and adult aphids survived on seedlings by sucking the sap. When the cowpea seedlings became stunted and got their leaves dried up due to feeding by aphids, the aphids were transferred on to new seedlings. Cowpea seedlings were raised at weekly intervals to sustain the aphid culture and aphids maintained in the polyhouse were used for various studies.

3.2.1.3 Mass rearing of two spotted spider mite, *Tetranychus urticae* Koch culture

French bean leaves infested by the spider mite in the field were brought to the laboratory. Twenty mating pairs of mites were released separately on French bean leaf bits (2.5 × 2.5 cm) kept on moist cotton wads in Petri plates and allowed to lay eggs and colonize for 10-15 days. Later male and female mites were selected from each leaf bit and microscope slides were prepared for taxonomic identification. Leaf bits with two spotted spider mite, *T. urticae* were pooled and used as a starter culture. This mite culture was used to infest potted French bean plants
in a polyhouse. The polyhouse culture of T. urticae was used for various studies.

3.2.2 Preparation of indigenous products

3.2.2.1 Preparation of modified Panchagavya

In Sanskrit, panchagavya means the blend of five products obtained from cow. All these five products are individually called ‘Gavya’ and collectively called as panchagavya. Panchagavya was prepared using five products from cow along with certain other ingredients (as given below) which was incubated for a specific duration in an earthen or wide plastic container (Anon., 2009a).

**Ingredients**

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh cow dung</td>
<td>700 g</td>
</tr>
<tr>
<td>Cow urine</td>
<td>1000 ml</td>
</tr>
<tr>
<td>Cow milk</td>
<td>300 ml</td>
</tr>
<tr>
<td>Cow curd</td>
<td>200 ml</td>
</tr>
<tr>
<td>Cow ghee</td>
<td>100 g</td>
</tr>
<tr>
<td>Tender coconut water</td>
<td>300 ml</td>
</tr>
<tr>
<td>Jaggery</td>
<td>300 g</td>
</tr>
<tr>
<td>Ripe banana</td>
<td>1 fruit</td>
</tr>
<tr>
<td>Water</td>
<td>1000 ml</td>
</tr>
</tbody>
</table>

The panchagavya was prepared initially by mixing 700 g of fresh cow dung with 100 g of ghee in a clean plastic bucket. After two days, one litre each of cow urine and water were added and the mixture was incubated at room temperature for thirteen days. After thirteen days, 300 ml of cow milk, 200 ml of curd, 300 ml tender coconut water, 300 g of jaggery and 1 well-ripened banana fruit were added to the mixture and stirred well. The mixture was allowed to ferment at room temperature for 6 days. After 6 days these mixture was filtered and stored in a plastic
container in a refrigerator. The panchagavya thus prepared was used for studying insecticidal and acaricidal activities.

### 3.2.2.2 Fermented cow urine

Fresh cow urine (1.5 l) was collected and kept it in an air tight two liter plastic bottle for 15 days for fermentation. After 15 days the fermented cow urine was used in different studies to assess the insecticidal and acaricidal activities (Purushothama Rao, 1993).

### 3.2.2.3 Preparation of Dasagavya

Dasagavya was prepared by mixing five leaf extracts along with ingredients of panchagavya (Selvaraj, 2007b).

**Ingredients**

- Fresh cow dung - 700 g
- Cow urine - 1000 ml
- Cow milk - 300 ml
- Cow curd - 200 ml
- Cow ghee - 100 g
- Tender coconut water - 300 ml
- Jaggery - 300 g
- Ripe banana - 1 fruit
- Water - 1000 ml
- *Lantana camara* - 200 g
- *Datura stramonium* - 200 g
- *Calotropis gigantia* - 200 g
- *Ocimum sp.* - 200 g
- *Artemisia absinthium* - 200 g

Initially panchagavya was prepared as described above. Chopped leaves of *Lantana camara, Datura stramonium, Calotropis gigantia,*
*Artemisia absinthium, Ocimum* sp. were taken in a plastic container and soaked in cow urine in the ratio of 1:1 (one kg chopped leaves in one litre of cow urine) for ten days at room temperature. The extract was then filtered and the filtrate was mixed with ten litres of water, further this extract was mixed with panchagavya in the ratio of 5:1 (five litres plant extract and one litre of panchagavya) to obtain dasagavya.

The final product prepared was tested against test insects and the mite for its insecticidal and acaricidal properties.

### 3.2.2.4 Preparation of chilli + garlic extract

Green chillies and garlic bulbs were taken in equal proportion (100 g each) and macerated for few minutes in a waring grinder. The material was then mixed with 200 ml of water and filtered by passing through thin cloth. This extract was used for ascertaining the insecticidal and acaricidal properties against test organisms (Anon., 2009b).

### 3.2.2.5 Preparation of custard apple leaf + dry chilli + matured neem fruits extract

**Ingredients**

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Custard apple leaves</td>
<td>200 g</td>
</tr>
<tr>
<td>Dry chilli</td>
<td>50 g</td>
</tr>
<tr>
<td>Neem fruits</td>
<td>100 g</td>
</tr>
</tbody>
</table>

The neem fruits were crushed using waring grinder and soaked in 200 ml of water and allowed overnight. The contents were filtered through a cloth and the filterate was collected. The water soaked dry chilli (one day) was ground separately and soaked in 50 ml water. Likewise, leaves of custard apple were ground into fine paste and mixed with 50 ml of water in a separate container.
The extracts obtained from these three products were mixed in the ratio of 1:1:1 and the final mixture thus obtained was investigated for its biological activity against test organisms (Anon., 2009b).

### 3.2.2.6 Preparation of neem seeds kernel + Calotropis + Vitex negundo + Aloe vera and Clerodendron leaf extract

Neem seed kernels, leaves of Calotropis gigantia, Vitex negundo, Aloe vera and Clerodendron (100 g each) were ground separately in a waring grinder and then mixed together in a single plastic container. Later, 500 ml of water was added to the mixture and allowed to ferment for seven days at room temperature. After seven days the contents were filtered through cloth and the filtrate was used for assessing the insecticidal and acaricidal properties (Anon., 2009b).

### 3.2.3 Assessment of insecticidal and acaricidal properties of indigenous plant protection products

The biological activity of the selected test products was investigated under laboratory conditions by adapting appropriate methods. As the natural products are known to contain an array of chemicals with different kinds of effects on the pest organisms, the insecticidal / acaricidal properties of the test products was quantified not just based on the mortality of test organisms, but also based on the effects which contribute towards reduction in pest populations, viz., repellent or walk off response, antifeedant activity, effect on growth and development of test insects, etc.

A total of six indigenous products viz. the panchagavya, cow urine, dasagavya, chilli + garlic extract, neem fruit + red chilli + custard apple leaf and neem seed + Aloe vera + Calotropis + Vitex + Clerodendron leaf extract were evaluated for their biological activity against P. xylostella, A. craccivora and T. urticae.
3.2.3.1 The biological activity of indigenous products against *P. xylostella*

The insecticidal property of test products against diamondback moth was studied by assessing the degree of repellency, feeding deterrence and effect on development of the pest.

3.2.3.1.1 Studies on repellent activity against fourth instar larvae of DBM

The repellent activity of various indigenous products was tested at different concentrations against DBM by employing a free choice test. For investigating the repellent activity, mustard seedlings were raised in nursery (Plate 2) and leaves of uniform size (4 × 4 cm) were collected and treated with desired concentration of different test products by following ‘leaf dip’ method. The treated leaves were placed alternatively with untreated leaf discs in a circular pattern at equal distances in a plastic tray. Twenty five fourth instar DBM larvae were released at the centre of the tray. Larvae were allowed to settle on the leaf discs of their choice in 15-20 minutes. The observations were recorded on the number of larvae settled on treated and untreated leaf discs. Each treatment was replicated three times.

Per cent repellency was calculated by using the formula

\[
\text{Per cent Repellency} = \left(\frac{A - B}{A}\right) \times 100
\]

A = Average number of insects present on untreated leaves.
B = Average number of insects present on treated leaves.

Per cent of repellency was then categorized into five classes according to scale given by Rahman *et al.* (2007).
### 3.2.3.1.2 Studies on the antifeedant activity against fourth instar larvae of DBM

The antifeedant activity of test products against fourth instar larvae of DBM was quantified based on the leaf area consumed and reduction in the larval weight gain after feeding for 48 h.

Leaf disc bioassay method (Wada and Muna kata, 1968) as modified by Reena et al. (1983) was employed for studying the antifeedant property against fourth instar DBM larvae. The modification involved the utilization of leaf discs of uniform area (16 sq cm) measured prior to commencement of the treatment. The petioles of leaf discs were swabbed with wet cotton at the cut end to delay the desiccation and after air drying for one hour, the leaf discs were transferred to Petri dishes. Two fourth instar larvae of DBM starved for 6 h were weighed and introduced into each Petri dish. A control was maintained with each treatment. Each treatment was replicated fifteen times.

The observations on the leaf area consumed by each set of larvae and the reduction in weight gain were recorded after feeding for 48 h. The leaf area consumed by larvae was measured by employing graphical method. The per cent antifeedant activity was calculated by using Singh and Pant’s formula (1980).

<table>
<thead>
<tr>
<th>Repellency (%)</th>
<th>Repellency class</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 0.01 - 0.10</td>
<td>0</td>
</tr>
<tr>
<td>0.10 - 20.00</td>
<td>I</td>
</tr>
<tr>
<td>20.10 - 40.00</td>
<td>II</td>
</tr>
<tr>
<td>40.10 - 60.00</td>
<td>III</td>
</tr>
<tr>
<td>60.10 - 80.00</td>
<td>IV</td>
</tr>
<tr>
<td>80.10 - 100.00</td>
<td>V</td>
</tr>
</tbody>
</table>
The antifeedant activity also measured in terms of reduction in the weight gain in larvae that fed on treated leaves as compared to the weight gain in control larvae by using the following formula

\[
\text{Per cent reduction in weight gain} = \frac{\text{Weight gain in control larvae} - \text{Weight gain in treated larvae}}{\text{Weight gain in control larvae}} \times 100
\]

3.2.3.1.3 Studies on the effect of indigenous products on development of *P. xylostella* larvae

The growth disruptive properties of selected plant extracts and other products on DBM was investigated under laboratory conditions. The mustard plants raised in plastic pots were treated with desired concentrations of various extracts using a hand atomiser. The leaves from these treated plants were used for studying the effect on the development of DBM larvae.

Ten newly moulted second and fourth instar larvae were transferred on to treated mustard leaves kept in Petri dishes (10 cm × 1.5 cm) using a camel hair brush. The treatments were replicated thrice and for each treatment, control was maintained with untreated mustard leaves. The petioles of treated leaves were swabbed with wet cotton wads to delay desiccation. The fed leaves were removed and replaced with fresh treated leaves from the respective treatments as and when required.

Observations were recorded for larval mortality, pupation, pupal mortality, adult emergence and any morphogenic effects in the pupal and adults stages.
3.2.3.2 Insecticidal properties of indigenous products against *Aphis craccivora* Koch

Panchagavya (1, 2.5, 5, 10 and 20 %), cow urine (5, 10, 25, 50 and 100 %), dasagavya (2.5, 5, 10, 25 and 50 %), chilli + garlic extract (0.5, 1, 2.5, 5 and 10 %), neem fruit + red chilli + custard apple leaf extract (0.5, 1, 2.5, 5 and 10 %) and neem seed + *Aloe vera* + *Calotropis* + *Vitex* + *Clerodendron* leaf extract (0.5, 1, 2.5, 5 and 10 %) were investigated for their biological activity against cowpea aphid under laboratory conditions.

3.2.3.2.1 Walk-off response

The young cowpea seedlings raised in the plastic cups (3.5 × 5 cm) were used to study the repellent action. ‘Seedling dip’ method was employed to treat the desired concentrations of test products. After air drying for 30 minutes, 20 to 25 adult aphids were released on treated seedlings and observed for their response. The number of aphids that moved out or fell-off from the treated seedlings 1, 2, 3 and 4 hours after treatment was recorded.

3.2.3.2.2 Mortality

To study the effect of test products on mortality of cowpea aphid, a known number (20 to 25) of one-two days old nymphs were taken in Petri plates and directly exposed to desired concentrations of the test products under Potter’s spray tower at a pressure of 15 lbs/inch². The treated nymphs were transferred on to the young seedlings (Plate 3) grown in small plastic cups (3.5 × 5 cm). The mortality of aphids was recorded at 24 h intervals for 4 days and the per cent mortality was computed treatment wise.

The walk-off response and mortality data were corrected using Abbott’s formula (1925). The data in percentages were subjected to arc-
Plate 3. Cowpea seedlings raised in plastic cups were used to study the repellent and insecticidal activity of indigenous products.
sine transformation and analysed following the Analysis of Variance method for Completely Randomized Design (CRD) and the results were interpreted at five per cent level of significance.

3.2.3.3 Evaluation of indigenous products on *Tetranychus urticae* Koch

*Tetranychus urticae* culture was maintained in the glasshouse was used for various studies to determine the biological activity of panchagavya (1, 2.5, 5, 10 and 20%), cow urine (5, 10, 25, 50 and 100%), dasagavya (2.5, 5, 10, 25 and 50%), chilli + garlic extract (0.5, 1, 2.5, 5 and 10%), neem fruit + red chilli + custard apple leaf extract (0.5, 1, 2.5, 5 and 10%) and neem seed + *Aloe vera* + *Calotropis* + *Vitex* + *Clerodendron* leaf extract (0.5, 1, 2.5, 5 and 10%) against eggs and active stages of *T. urticae*.

3.2.3.1 Walk-off response

The repellent action of the test products was studied by recording the walk-off response of mites from treated surface.

Leaf bits measuring about 2.5 × 2.5 cm were prepared from French bean leaves and the test products at different concentrations were treated by following ‘leaf dip’ method. Leaf bits treated with only water served as control and three such replications were maintained for each treatment. Twenty female adult mites were released on each leaf bit kept on moist cotton wad in a Petri plate. The per cent walk-off response was determined by recording the number of adults moving out of the treated leaf bits and got trapped or drowned in the moist cotton wad. Such observations were recorded at 1, 2, 3 and 4 hours after treatment. At each observation, the number of adults that walked-off from the treated leaf bits and got stuck in the wet cotton were carefully placed back on to the same leaf bits using a fine camel hair brush and those mites which
did not recover even after placing them back on the leaf bits were recoded as dead.

### 3.2.3.3.2 Ovicidal activity

To determine the ovicidal activity of test products against eggs of two spotted spider mite, a few active female mites were released on French bean leaf bits measuring 2 × 2 cm placed on moist cotton wad in a Petri plate. The female mites were allowed to lay eggs for 8-10 h. About 30 to 40 eggs laid on each of these leaf bits served as one replication. Three such replications were maintained for each treatment including control (water spray). ‘Leaf dip’ method was followed to expose the eggs to desired concentrations of test products. In all the treatments, eggs were observed for hatching at 24 h interval for 5-6 days or till all the eggs in the control hatched.

### 3.2.3.3.3 Larval mortality

Few active female mites were released on French bean leaf bits measuring 2 × 2 cm placed on moist cotton wad in Petri plates. The female mites were allowed to lay eggs for 8-10 h. Each leaf bits with more than 30 eggs served as one replication. Three such replications were maintained for each treatment including control (water treatment). After 4 days, eggs were observed for their hatching and the unhatched eggs were destroyed. The leaf bits with *T. urticae* larvae were dipped in the desired concentrations of test products and kept for air drying. After air drying, the number of *T. urticae* larvae on each leaf bit was counted and recorded as the initial numbers. The final observations were made on the number of dead larvae after 48 hours and per cent mortality was calculated.
3.2.3.3.4 Adult mortality

A known number of female adult mites (20 to 30) were released on treated (leaf dip method) French bean leaf bits measuring 2 × 2 cm placed on moist cotton wad in Petri plates. Each leaf bit served as one replication and three such replications were maintained for each treatment. The number of individuals (adults) killed was recorded at 24 h interval up to six days and the per cent mortality was computed. Individuals which did not respond to the touch by the fine camel hair brush or moribund were considered as dead.

Walk-off response and mortality data of eggs, larvae and adults were corrected using Abbott’s formula (1925), considering the mortality in untreated control. The data in percentages were subjected to arc-sine transformation and analysed statistically by following the Analysis of Variance method for Completely Randomized Design (CRD) and the results were interpreted at five per cent level of significance.

\[
\text{Corrected mortality} = \frac{\text{Per cent mortality in treatment} - \text{Per cent mortality in control}}{100 - \text{Per cent mortality in control}} \times 100
\]
Experimental Results
IV. EXPERIMENTAL RESULTS

The data from the surveys conducted to document indigenous pest management practices in eight districts of Southern Karnataka and the results of the experiments carried out to ascertain insecticidal / acaricidal properties of selected indigenous products against *Plutella xylostella* L. (Lepidoptera: Plutellidae), *Aphis craccivora* Koch (Aphididae: Hemiptera) and *Tetranychus urticae* Koch (Tetranychidae: Acarina) are presented in this chapter.

4.1 Documentation of indigenous plant protection practices followed by farmers in different cropping systems in Southern Karnataka

Intensive surveys were conducted in eight districts of Southern Karnataka (Tumkur, Mandya, Bangalore, Shimoga, Hassan, Chikamagalur, Udupi and Dakshina Kannada) to document the indigenous pest management practices followed in the organic farming systems. Organic farmers were identified based on the information obtained from KSDA and NGOs followed by the personal interview on the usage of ITks in pest management. The information related to indigenous pest management practices gathered from each district are presented in a tabular form (Table 1).

4.2 Assessment of insecticidal and acaricidal properties of selected indigenous plant protection products

The results of the experiments carried out to assess insecticidal and acaricidal properties of panchagavya (1, 2.5, 5 and 10 %), cow urine (2.5, 5, 10, 25 and 50 %), dasagavya (1, 2.5, 5, 10 and 20 %), chilli + garlic extract (0.5, 1, 2.5, 5 and 10 %), neem fruit + red chilli + custard apple leaf extract (0.5, 1, 2.5, 5 and 10 %) and neem seed + *Aloe vera* + *Calotropis* + *Vitex* + *Clerodendron* leaf extract (0.5, 1, 2.5, 5 and 10 %) against diamondback moth (DBM), cowpea aphid and two spotted spider mite are presented here.
<table>
<thead>
<tr>
<th>Sl. no.</th>
<th>Plant protection practices</th>
<th>Crops</th>
<th>Pests</th>
<th>Name of the farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td><strong>Plant based products</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>A common pesticide for both defoliators and sucking pests is prepared from the leaves of medicinal and/or weed plants. Three kg of leaves is soaked in 3 litres water in a copper vessel. Then vessel is covered with a black cloth and allowed to ferment for 9 days. After 9 days 3 litres each of cow urine and butter milk are added to the above mixture and the contents are stirred thoroughly before filling through a cotton cloth. One litre of the filterate is diluted with 5 litres of water and sprayed on crops.</td>
<td>All crops</td>
<td>Defoliators and sucking pests</td>
<td>Mr. Sadashivaiah, Mharagondanahalli, Tiptur</td>
</tr>
<tr>
<td>2</td>
<td>Rodent menace can be effectively controlled by using <em>Gliricidia</em> seeds. 100 g of these seeds are crushed into fine powder and mixed with one kg of ragi/wheat/jowar flour. Then the mixture is boiled for some time. The boiled material is kept in place where the rodent activity is observed during evening hours at weekly intervals.</td>
<td>All crops</td>
<td>Rodents</td>
<td>do</td>
</tr>
<tr>
<td>3</td>
<td>The leaves of kiratha kaddi (<em>Andrographis puniculatus</em>) are bitter in taste and are used in the preparation of herbal pesticides. About 1 kg of leaves is crushed and mixed with 10 litres of water and allowed to ferment for 24 h. Then the contents are passed through thin cloth and the filterate is sprayed on crops against caterpillars.</td>
<td>All crops</td>
<td>Caterpillars</td>
<td>Mr. Ananda, Thirthahalli</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Crops</td>
<td>Pests</td>
<td>Source</td>
</tr>
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<tr>
<td>4</td>
<td>A simple insecticidal formulation is prepared using bird’s eye chilli and garlic (1 kg each) paste. The chilli and garlic are ground finely and mixed with 2 litre of water. The contents are filtered through cotton cloth and the filterate is sprayed on crops at 10 per cent concentration</td>
<td>Vegetables</td>
<td>All pests</td>
<td>Mr. Abdul Jallil Sab, Pulguni, Mudigere</td>
</tr>
<tr>
<td>5</td>
<td>An extract prepared by soaking finely ground <em>Pongamia</em> pod husk in one litre of water for 12 h. prevents pest attack when sprayed on crops</td>
<td>All crops</td>
<td>All pests</td>
<td>do</td>
</tr>
<tr>
<td>6</td>
<td>An oil emulsion prepared by mixing 1 ml of <em>Pongamia</em> oil and 4 ml of neem oil in one litre of water, gives good control of sucking pests</td>
<td>All crops</td>
<td>Sucking pests</td>
<td>do</td>
</tr>
<tr>
<td>7</td>
<td>A mixture of castor seed cake (1 kg), <em>Agave</em> leaf extract (1 l), adhesive materials (500 ml) and water (10 l) when kept in vessels in the field attracts lepidopteran pests. Placing 5 vessels (each with 200 ml extract) per acre attracts large proportion of moths and the attracted moths fall into the containers. The captured moths are killed and destroyed manually</td>
<td>Vegetables</td>
<td>Lepidopteran pests</td>
<td>do</td>
</tr>
<tr>
<td>8</td>
<td>A decoction is prepared by boiling one kg of <em>Eucalyptus</em> leaves in one litre of water. Spraying of the mixture of this decoction and neem oil (2 ml / l of decoction) gives good control of whitefly</td>
<td>-</td>
<td>Whitefly</td>
<td>Mr. Chankeshava, Mudigere</td>
</tr>
</tbody>
</table>

Cont...
<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Crops</th>
<th>Pests</th>
<th>Responsible Officer</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>A formulation prepared by using coriander seeds controls aphids and mites.</td>
<td>All crops</td>
<td>Aphids and mites</td>
<td>Mr. Chankeshava, Mudigere</td>
</tr>
<tr>
<td></td>
<td>The coriander seeds are boiled for one hour (200 g in one litre of water) and then cooled. The contents are then passed through a cloth. Finally one litre of the extract is diluted in two litres of water and sprayed on crops</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>One litre of toddy is mixed with 10 litres of water. When 100 ml of this mixture is taken in a container and kept in the coffee fields, the berry borer adults got attracted and trapped. About 10 traps are required per acre to control the pests.</td>
<td>Coffee</td>
<td>Berry borer</td>
<td>do</td>
</tr>
<tr>
<td>11</td>
<td>One kg of stem portion of <em>Euphorbia tirucalli</em> (kolukalli) is ground and soaked in 10 l of water for 24 h. After that, the contents are filtered and the filterate is sprayed on crops to suppress different pests</td>
<td>All crops</td>
<td>Aphids, termites and stem borer</td>
<td>do</td>
</tr>
<tr>
<td>12</td>
<td>A paste prepared by grinding leaves of <em>Lantana</em>, neem, <em>pongamia</em> (100 g each) is mixed with 300 ml each of water and butter milk in a plastic container. The mixture is passed through a cotton cloth to collect the filterate. One litre of filterate is diluted in 10 litre of water and sprayed on crops</td>
<td>Vegetables and paddy</td>
<td>All pests</td>
<td>do</td>
</tr>
<tr>
<td>13</td>
<td>The coffee stem borer can be controlled by swabbing the stem portion with a mixture prepared by mixing 10 ml of garlic extract, 2 ml of neem oil and one litre of water</td>
<td>Coffee</td>
<td>Coffee stem borer</td>
<td>Mr. M.J. Dinesh, Devarunda, Mudigere</td>
</tr>
<tr>
<td>No.</td>
<td>Description</td>
<td></td>
<td></td>
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<td>-------------</td>
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<td></td>
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<tr>
<td>14</td>
<td>Finely ground leaves of <em>Vitex</em>, neem, <em>Aloe vera</em> and <em>Pongamia</em> are mixed with one litre each of butter milk and water. The extract of this mixture is sprayed on crops at 10 per cent concentration to control the pests.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>An insecticidal extract prepared by mixing ground leaves of <em>Nerium oleander</em> (kanigilu), <em>Pterocarpus marsupium</em> (honne), <em>Xanthoxylum strumarium</em> (jummana mara), <em>Butea monosperma</em> (mutthuga), young shoots of bamboo and inflorescence of ganganamara with equal quantity of water has good insecticidal properties. Spraying of 10 per cent extract controls insects, snails and slugs.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Spraying of neem oil emulsion (20 ml oil + 2 ml of soap in 1 litre of water) is effective against sucking pests.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Root grub infestation in arecanut gardens is controlled by applying neem cake (1 kg / plant), FYM (10 kg/plant) and vermiwash (1/2 litre/plant) around the base of the plants.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Kasaraka (<em>Strychnos nuxvomica</em>) leaves (5 kg) are boiled in 15 l of water for 3-4 h till the volume of water reduces to about 5 litres. After that, the content are filtered and the filterate is sprayed on crops at 10 per cent concentration to ward-off the pests.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
19. Spreading of green or fallen leaves of kasaraka plant in paddy fields suppresses pests and weeds when the leaves start decaying.

20. Spraying of 10 per cent extract prepared by fermenting one kg each of finely ground leaves of *Adathoda vasica* (adusoge), *Diospyros candolleana* (kare mara), *Calotropis*, custard apple and *Vitex* in 5 litre of water for 7 days give good control of jasmine bud borer.

21. The plants like kasaraka and kirataka kaddi (*Swertia chirayita*), *Acorus calamus* (baje), leaves of *Withnia somnifera* (Ashvagandha), *Datura metel* (ummatthi), *Annona* sp., *Derris elliptica*, *Allium sativum*, *Melia azadarach*, *Chrysanthemum cinerariaefolium*, *Adathoda vasica*, *Nicotiana tabaccum*, *Ocimum basilicum*, *Anacardium occidentale*, *Eucaliptus* sp. *Lycopersicon esculentum*, *Calotropis gigantia*, *Agave americana*, *Gliricidia* sp., *Pongamia pinnata*, *Piper betle*, *Lantana camara*, *Strychnos nuxvomica*, *Lasiosiphon eriocephalus* and *Aegle marmelos* are abundantly available in hilly areas of Dakshina Kannada and the organic farmers commonly use these plants to prepare pesticides for use against several pests. A pesticide product is prepared by mixing leaves of these plants (25-50 kg each) with bio-digester liquid and allowing for one year. After that, the contents are filtered and about 150 ml of filtrate is diluted in one litre of water before spraying on crops.

<table>
<thead>
<tr>
<th>Plant</th>
<th>Crop/Cultivation</th>
<th>Pest Type</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Adathoda vasica</em></td>
<td>Paddy</td>
<td>Sucking pests</td>
<td>Mr. Jaarappa Moalya, Kervashe, Udupi</td>
</tr>
<tr>
<td><em>Diospyros candolleana</em></td>
<td>Jasmine</td>
<td>Bud borers</td>
<td>do</td>
</tr>
<tr>
<td><em>Calotropis</em></td>
<td>Vegetables, areca nut</td>
<td>All pests</td>
<td>Mr. Vinayaka Prabu, Kadirudyavara, Beltangadi taluk</td>
</tr>
<tr>
<td><em>Vitex</em></td>
<td>and cocoa</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
During Bheemana amavasya, farmers in the Dakshina Kannada Erect a bamboo pole at the centre of the paddy field and a wooden vessel is fixed on top of the pole. Leaves of 10 different medicinal plants are kept in vessel and then left for 8-12 days. The odours from these leaves repel the pests.

About 1-2 liter of butter milk is taken in a copper vessel and allowed to ferment for 5-6 days. Thereafter the contents are filtered and 10 per cent filterate is sprayed on the crops against cucumber and paddy pests.

Dashaparani is an indigenous plant extract prepared from the leaves of *Lantana, Vitex negundo, Pongamia, neem, Aegle marmelos* (bilwa patre), *Calotropis*, custard apple, *Acorus calamus* (baje), *Gymnema sylvestre* (madhunahini), *Leucas aspera* (thumbe), or *Parthenium*. Two kg of leaves of each of these plants are soaked in 50 l of water in a plastic drum and mixed thoroughly. Then the mixture is kept covered with a wet gunny bag for 2-3 days. After that, the filterate is collected and 500 ml of filterate is mixed with 15 l of water before spraying on crops. Two sprays are given at 5-6 days interval and spraying done in morning or evening hours.

Coconut mite can be controlled by mulching kasarka leaves (1 kg / plant) around the base of the trees.
One kg each of *Lantana*, *Eupatorium* (croton weed), *Jatropha*, *Agave*, custard apple, neem and *Hibiscus* leaves are soaked in 7 l of water in a plastic container. The container is kept covered with a white cotton cloth for overnight. Then the contents are filtered through a fine cloth. One litre of this filterate is diluted in 10 litres of water and sprayed on crops.

About 50 kg of weed plants that are abundantly available in the field are cut into small pieces and soaked in cement tank in 50 litres of water for 7 days. Then the contents are filtered through a cloth and the filterate is used for spraying on crops.

The extracts of plant parts indicated below are effective against different pests. One kg of each plant parts is mixed with 10 litres of boiling water in a plastic bucket. After 24 h the contents are filtered and 1 litres of the extracted is diluted in 10 litres of water before spraying on crops.

<table>
<thead>
<tr>
<th>A</th>
<th>Annona sp. (leaves, fruit, seeds and root extracts)</th>
<th>All crops</th>
<th>Aphids, DBM, grass hoppers, bugs, pumpkin beetles, aphids on potato</th>
<th>Mr. Purushottam Rao, Krishi Prayoga Parivara, Kuruvalli, Thirthahalli</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>Azadirachta indica (leaves and seeds)</td>
<td>-</td>
<td>All pests</td>
<td>do</td>
</tr>
<tr>
<td>c</td>
<td>Derris elliptica (root) (meenumari)</td>
<td>-</td>
<td>Borers, army worm, DBM, fruit fly, aphids</td>
<td>do</td>
</tr>
<tr>
<td></td>
<td>Plant Name</td>
<td>Crops</td>
<td>Pests</td>
<td>Contact</td>
</tr>
<tr>
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<td>--------------------------------------------</td>
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</tr>
<tr>
<td>d</td>
<td><em>Allium sativum</em> (bulbs and seeds)</td>
<td>All</td>
<td>Aphids, army worm, beetle, wine worm</td>
<td>Mr. Purushottam Rao, Thirthahalli</td>
</tr>
<tr>
<td>e</td>
<td><em>Capsicum frutescens</em> (green fruit)</td>
<td>do</td>
<td>Ants, caterpillars, and weevils</td>
<td>do</td>
</tr>
<tr>
<td>f</td>
<td><em>Melia azaderachta</em> (leaves and seeds)</td>
<td>do</td>
<td>GH and army worm</td>
<td>do</td>
</tr>
<tr>
<td>g</td>
<td><em>Chrysanthemum cinerariaefolium</em> (flowers)</td>
<td>do</td>
<td>Bugs, aphids, beetles, GH, thrips and mites</td>
<td>do</td>
</tr>
<tr>
<td>h</td>
<td><em>Acorus calamus</em> (baje) (root)</td>
<td>do</td>
<td>Weevil, army worm, fruit fly and beetles</td>
<td>do</td>
</tr>
<tr>
<td>i</td>
<td><em>Adathoda vasica</em> (adusoge)</td>
<td>do</td>
<td>Caterpillars and others pests</td>
<td>do</td>
</tr>
<tr>
<td>j</td>
<td><em>Curcuma domestica</em> (root) (turmeric)</td>
<td>do</td>
<td>Caterpillars, beetles, storage and mites pests</td>
<td>do</td>
</tr>
<tr>
<td>k</td>
<td><em>Nicotiana tabaccum</em> (leaves)</td>
<td>do</td>
<td>Aphid, thrips, mites, leaf minor and stem borer</td>
<td>do</td>
</tr>
<tr>
<td>l</td>
<td><em>Ocimum basilicum</em> (leaves and seeds)</td>
<td>do</td>
<td>Aphids, beetles, flies and mites</td>
<td>do</td>
</tr>
<tr>
<td>m</td>
<td><em>Anacardium occidentale</em> (leaves)</td>
<td>do</td>
<td>All pests</td>
<td>do</td>
</tr>
<tr>
<td>n</td>
<td>Eucalyptus sp. (leaves)</td>
<td>All crops</td>
<td>Potato tuber moth and bruchids</td>
<td>Mr. Purushottam Rao</td>
</tr>
<tr>
<td>o</td>
<td>Lycopersicon esculentum (tomato) (leaves)</td>
<td>do</td>
<td>Cabbage pests</td>
<td>do</td>
</tr>
<tr>
<td>p</td>
<td>Agave americana</td>
<td>do</td>
<td>Termites, bugs and stem borers</td>
<td>do</td>
</tr>
<tr>
<td>q</td>
<td>Glyricidia sp. (leaves)</td>
<td>do</td>
<td>General insecticide</td>
<td>do</td>
</tr>
<tr>
<td>r</td>
<td>Pongamia pinnata (seeds and leaves)</td>
<td>do</td>
<td>Caterpillars</td>
<td>do</td>
</tr>
<tr>
<td>s</td>
<td>Piper betle (betleveine)</td>
<td>do</td>
<td>Caterpillars, borers and leaf feeders</td>
<td>do</td>
</tr>
<tr>
<td>t</td>
<td>Lantana camara (leaves)</td>
<td>do</td>
<td>Caterpillars and leaf feeders</td>
<td>do</td>
</tr>
<tr>
<td>u</td>
<td>Strychnos nuxvomica (Kasaraka)</td>
<td>do</td>
<td>All pests</td>
<td>do</td>
</tr>
<tr>
<td>v</td>
<td>Lasiosiphon eriocephalus (mukkdaka)</td>
<td>do</td>
<td>Paddy pests</td>
<td>do</td>
</tr>
<tr>
<td>w</td>
<td>Aegle marmelos (bilvapatre)</td>
<td>do</td>
<td>Mites, thrips and storage pests</td>
<td>do</td>
</tr>
<tr>
<td></td>
<td>Cow urine based products</td>
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</tr>
<tr>
<td>29</td>
<td>Amruth sanjeevini is an indigenous pesticide prepared by mixing 50 kg of cow dung, 2 kg of jaggery, 2 kg of neem or groundnut or <em>Pongamia pinnata</em> (L.) seed cake, 5 litres of butter milk and 250 g of turmeric powder with 200 litres of water in a large cement tank and fermenting for 2-7 days. The fermented material is passed through a thin cloth and the filterate is sprayed on crops to suppress pests.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>30</td>
<td>About 25-30 l of cow urine is collected in a plastic drum and kept for 30-40 days. After that, 1 litre of cow urine is diluted in 10 litres water and applied to soil at the base of plants.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>An organic pesticide for seed treatment is prepared by thoroughly mixing cow dung (5 kg), cow urine (5 litre) and lime (100 g) in 5 litre water. The bag containing seeds being sown is immersed into the mixture for 1 minute and seeds are shade dried for 12 h before sowing. This practice is helps in suppression of seed borne pests and diseases.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>The fermented butter milk (500 ml) is diluted with 10 litre of water and sprayed on the crops.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Jeevamrutha is an indigenous pesticide, which is prepared by mixing 10 kg of cow dung, 10 l of cow urine, 2 kg of jaggery, 1/2 kg of field soil, 2 kg of pulse flour in 200 l of water. In a modified form of jeevamruta, addition of 2 l of *Agave americana* leaf extract, 2 l of neem leaf extract and 2 l of *Pongamia* leaf extract to above ingredients enhances the pest suppressing property.

Application of cow dung (10 kg / plant), neem seed cake (1/2 kg / plant) and jeevamruta (0.5 l / plant) around the base of coconut (2 m away), arecanut (1 m away) and banana (1 m away) plants and covering it up with soil keep away root feeders.

Jeevamrutha is an indigenous pesticide prepared by mixing 10 kg of cow dung, 10 l of cow urine, 2 kg of black jaggery, 1/2 kg of field soil, 2 kg of pulse flour with 200 l of water in a large cement tank and allowed to fermenting for 2 days in rainy and summer seasons and 3 days in winter season. The fermented material is passed through a thin cloth and the filterate is sprayed on crops to suppress pests.

Neem leaves (10 kg) are mixed with cow urine (5 l) and 200 l of water in a plastic drum and the contents are allowed to ferment for 5-10 days. Thereafter the contents are filtered and sprayed on the crops to keep away the pests.
One litre of cow urine is mixed with 10 l of water and sprayed to the crops against ants which are a major problem during harvesting of cacao.

Cow urine is collected in a plastic container and kept for 40-50 days so that the scorching gets reduced to some extent. Later one litre of cow urine is mixed with 50 g of garlic paste, 50 g of lime, 50 g of bengal gram flour, 50 g of neem leaves and 10 l of water in a plastic container and allowed to ferment for 15-25 days. Then the contents are filtered and the filterate is applied on jasmine at 5 per cent concentration to suppress the mite.

One litre of fermented cow urine is mixed with 10 litres of water, 100 g of garlic paste, 100 g of lime, 100 g of bengal gram flour, 50 g of neem leaves and 10 kg cow dung in a plastic bucket and allowed to ferment for 15-25 days. The filterate when applied at 10 per cent concentration is effective against pests of sapota.

Old cow urine (1 l), garlic paste (100 g) and maida (25 g) are taken in a plastic container and allowed to ferment for 8-10 days. Later the contents are filtered and the filterate is sprayed on crops against defoliators and sucking pests at 10 per cent concentration.
<table>
<thead>
<tr>
<th>No.</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>100 g of finely ground garlic, 25 g of maida and 1 l of cow urine mixed in a plastic container and allowed to ferment for 10 days. Later the contents are passed through a thin cloth and filterate is applied to crops at 10 per cent concentration.</td>
</tr>
<tr>
<td>42</td>
<td>Leaves of neem (3 kg) + <em>Pongamia</em> (2 kg) + <em>Vitex</em> (2 kg) + castor (2 kg) and custard apple (2 kg) are crushed and mixed with 10 l of cow urine. Then the contents are boiled for 4-5 times in a day and allowed for 48 h. Then the contents are filtered and filterate is sprayed on crops against caterpillars and thrips at 3 and 1.5%, respectively</td>
</tr>
<tr>
<td>43</td>
<td>Waste tobacco (1 kg) + green chilli (1 kg) + garlic (1/2 kg) are ground finely and mixed with 10 l of cow urine. The mixture is boiled for 4-5 times in a day and allowed for 48 h. After cooling, the contents are filtered and sprayed on crops against borers and thrips at 3 and 1.5% respectively</td>
</tr>
<tr>
<td>44</td>
<td>100 g of garlic paste is soaked in 1 l of cow urine and allowed to ferment for 8-10 days. Then the filterate is sprayed on the crops at 10 % concentration</td>
</tr>
<tr>
<td>45</td>
<td>One litre of cow urine mixed with 10 l of water and sprayed to the crops at flowering stage repels pod borers</td>
</tr>
</tbody>
</table>
One kg of *Agave*, 1 kg of *Lantana* and 1 kg neem leaves are soaked in 5 l of cow urine in a plastic container. Then the container is covered with wet gunny bag and the contents are allowed to ferment for 15 days. After that, the fermented material is passed through a thin cloth and the filtrate is used for spraying crops.

Panchagavya is prepared by mixing fresh cow dung (7 kg) with ghee (1 kg) in a clean plastic bucket, then kept covered with a wet gunny bag for 2 days. This mixture is again mixed with cow urine and water (10 l each), and kept for 15 days. The contents are stirred once in a day and again covered with wet gunny bag. Thereafter 3 l of milk, 2 l of curd, 3 l of tender coconut water, 3 kg of jaggery and 12 well-ripened banana fruits are added to it and kept for another 6 days. Then the contents are filtered using double layered cotton cloth and sprayed on crops at 3 per cent concentration.

A paste prepared out of garlic bulbs, turmeric (rhizome), neem leaves, *Ocimum* sp. leaves and curry leaves (1 kg each) is soaked in 5 l of water for over night. The contents are filtered and the filtrate is mixed with cow urine at 1:1 ratio. This fluid is sprayed on crops to keep away the pests.
Jeevarasa is an organic pesticide prepared from 12-15 different types of weeds and/or medicinal plants (25-30 kg). These plants are cut into small pieces and transferred to a cement tank. Then about 20 litres of cow urine is added to the mixture and kept covered for 6 months. After 6 months the contents are filtered into another container and the filtrate is sprayed on crops at 10 per cent concentration.

A paste prepared out of leaves of Agave (10 kg), Parthenium (10 kg) and Lantana (10 kg) is soaked with 30 l of water in a mud pot. Then this mixture is boiled for 20 minutes and incubated for one day. Then the mixture is filtered and 30 ml of neem oil and 3 l of cow urine are added to the filtrate. The fluid thus prepared is sprayed on red gram and field beans against fruit borers.

Red gram, field beans

The butter milk is allowed to ferment for 6-7 days and then it is filtered and sprayed on the crops. This will not only suppress pests but also eliminates all bad effects of chemicals.

Fresh milk (10 %) can be used to spray the crops which are grown organically to control pests and diseases and also eliminate all bad effects of chemicals.

<table>
<thead>
<tr>
<th>All crops</th>
<th>All pests</th>
<th>Mr. Narayanaswamy, Ibbeedu, Hassan</th>
</tr>
</thead>
<tbody>
<tr>
<td>All crops</td>
<td>-</td>
<td>Mr. Gide Gowda, Bramhadevarahalli, Hassan</td>
</tr>
<tr>
<td>All crops</td>
<td>All pests</td>
<td>Mr. V.P. Hegade, Gowrishankar estate, Harihalli, Hassan</td>
</tr>
</tbody>
</table>

Cont...
The organic farmers in Mudigere taluk are commonly treat the seeds or seedlings with jeevamruta before sowing. The treated seeds are shade dried for 24 h and then used for sowing. This treatment eliminates several seed borne pest and disease problems and promotes germination of seeds.

Ten kg each of ground leaves of neem and *Agave* are soaked in 20 l of water for one hour. Then the contents are filtered and mixed with 10 l of cow urine. This mixture is boiled in a mud pot for some time and allowed to cool. The pot is covered with muslin cloth and buried in the soil for 15 days. The pot is buried in such a way that, the upper portion is exposed to air and the bottom parts is inside the soil. After 15 days the pot is taken out carefully and the contents are filtered. One litre of the extract is diluted in 10 litre of water and sprayed on crops.

A mixture of cow urine (1 l), garlic paste (1 kg) and neem leaves (1 kg) is fermented in a vessel for 7 days. After that the contents are filtered and sprayed on the crops at 10 per cent concentration as a common pesticide against many pests.
<table>
<thead>
<tr>
<th>Page</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>56</td>
<td>A mixture of 2 litres of cow urine, 2 kg each of neem and <em>Parthenium</em> leaves is fermented in an earthen pot for 3 months. Application of the filtrate of this fermented materials at 10 per cent concentration has good insecticidal properties.</td>
</tr>
<tr>
<td>57</td>
<td>“Mosaru maddu” is organic pesticide used by a farmer in Tarikere for several years. Three litres of curd (15 days old one), garlic paste (1 kg), powdered pepper seed (1/2 kg), cow dung (3 kg), cow urine (3 litre) and neem leaf extracts (1 litre) are soaked in 30 litres of water in a copper vessel for 24 h. Then the contents are filtered into a separate plastic container. Half a litre of extract is mixed with 15 l of water and sprayed on the crops to control pests.</td>
</tr>
<tr>
<td>58</td>
<td>Cow milk (1/2 litre), cow urine (2 litre), cow dung (2 kg), lime solution (100 ml) and water (4 litre) are thoroughly mixed in a vessel. This mixture is used to treat seedlings before transplanting to keep away seed borne pests.</td>
</tr>
</tbody>
</table>
A plant extracts prepared by fermenting finely ground leaves of *Vitex* (1 kg) + kasaraka (1 kg) + beyyae soppu (1 kg) + bird’s eye chilli (250 g) and garlic bulbs (250 ml) in 5 litres each of cow urine and water for two days is effective against caterpillars. One litre of extracts is diluted in 16 l of water and sprayed on crops. 

Cow dung (5 kg), cow urine (5 l), kasaraka leaves (5 kg) and water (10 l) are taken in an earthen pot and allowed to ferment for 10-15 days. The filterate of this fermented material is applied at 10 per cent concentration on crops to control pests.

Leaves of mukkdaka (*Lasiosiphon eriocephalus*), neem, curry leaf, adusoge (*Adathoda vasica*), *Agave* and *Jatropha* (6 kg) are mixed with cow urine in a mud pot and kept undisturbed for 15 days. Then the mixture is passed through a cotton cloth to collect the filterate. About one litre of the filterate is mixed with ten litres of water and sprayed on crops against leaf rollers.
62 A mixture of cow dung (1 kg), sliced banana fruits (5 fruits), jaggery (100 g) and bengal gram flour (100 g) is placed in bucket traps specially designed for trapping the rhinocerous beetles. These traps are hung in coconut gardens at 6 feet height to attract the beetles.

63 Half a kg of finely ground tobacco leaves is soaked in one litre of fermented butter milk in a container for 24 h. 750 ml of filterate obtained from this mixture is diluted in 17 l of water before spraying.

64 A common pesticide for all types of insect pest is prepared by fermenting bheedi soppu (*Diospyros melanoxylon*) + kavate soppu (*Zanthoxylum rhetsa* (Roxb.) Dc.) + *Vitex* + kasaraka (*Strychonos nuxvomica*) + adusoge (*Adathoda vasica*) + kiraatha kaddi (*Swertia chirayita*) leaves (1 kg each) in 6 l of cow urine for 45 days. One litre of extract obtained from the fermented material is diluted in 15 l of water before spraying.

<table>
<thead>
<tr>
<th>Coconut</th>
<th>Rhinocerous beetle</th>
<th>Mr. Krishna Kulal, Avrsashale, Udupi</th>
</tr>
</thead>
<tbody>
<tr>
<td>All crops</td>
<td>All pests</td>
<td>do</td>
</tr>
<tr>
<td>Vegetables and paddy</td>
<td>All pests</td>
<td>do</td>
</tr>
</tbody>
</table>
### Other practices

<p>| 65 | Establishment of live fence around the field using neem trees, <em>Aegle marmelos</em> (bilvapatre), <em>Lantana camera</em>, <em>Glyricidia</em> sp. <em>etc.</em> along with the medicinal plants acts as a barrier for the many airborne pests and diseases. Pomegranate and Lemon | All pests | Mr. Sadashivaiah. Mharagondanahalli Tiptur |
| 66 | Multi-storey cropping system helps in managing pests and diseases to some extent. Growing of crops like coconut, arecanut, betelvine, pepper, cocoa, lemon, coffee and jasmine in a multi-storey cropping system reduces pest and diseases incidence. | - | All pests and diseases | do |
| 67 | Water tanks constructed around the vemicompost unit attract rhinocerous beetles. The attracted beetles fall into water tanks when some barriers provided around the vemicompost unit. | Coconut | Rhinocerous beetle | do |
| 68 | The coconut mite can be effectively controlled by nutrient management. Application of neem or <em>Pongamia</em> cake (1 kg / tree) and cow dung (10 kg / tree) in trenches around the tree and covering it up with soil facilitates good aeration for roots and supplies required nutrients to the crop. This will reduce mite infestation. | Coconut | Mite | Mr. Ramesh raj, Adhya, Dudda hobli, Mandya |</p>
<table>
<thead>
<tr>
<th>Page</th>
<th>Text</th>
<th>Sugarcane</th>
<th>Wooly aphids</th>
<th>Mr. Ramesh raj, Adhya, Mandya</th>
</tr>
</thead>
<tbody>
<tr>
<td>69</td>
<td>Spraying of a solution of jaggery dissolved in 10 l of water with 20 g of soap powder on sugar cane in the early stages of infestation suppresses woolly aphid. The nymphs are immobilized and killed.</td>
<td>-</td>
<td>-</td>
<td>do</td>
</tr>
<tr>
<td>70</td>
<td>Multiple cropping systems involving sequential growing of sugarcane, cowpea, green gram, fenugreek, marigold, onion, brinjal and tomato in a single piece of land reduces overall pest incidence.</td>
<td>-</td>
<td>All pests</td>
<td>do</td>
</tr>
<tr>
<td>71</td>
<td>To control aphids on vegetable crops, 1 l of fermented butter milk is mixed with 10 l of water and sprayed on the crops at 2 days interval or the dusting of a mixture consisting of 1 kg of finely ground tobacco leaves and 5 kg of ash suppresses the aphids.</td>
<td>-</td>
<td>Aphids</td>
<td>do</td>
</tr>
<tr>
<td>72</td>
<td>The rice bran (5 kg) and jaggery (2 kg) are mixed with water (300 ml). The mixture is then dried for one day. Small amount of this mixture is placed on top leaves of sunflower, groundnut and banana during evening time. The hidden larvae come out to feed on the mixture. The next day morning, these larvae are collected and killed by putting them in 10% soap solution.</td>
<td>Sunflower, groundnut and banana</td>
<td>Hairy caterpillars</td>
<td>Mr. H.M, Gangadar swamy and Lokesh Kittadahalli, Shikaripura</td>
</tr>
</tbody>
</table>

Cont...
A mixture of crushed naphthalin balls and camphor (10 g each) is taken in a perforated polyethylene cover and hung on the newly opened inflorescence in coconut crown to keep away the mite.

Growing of horse gram as an intercrop in coconut fields helps in reducing the damage caused by mites.

The paddy stem borer can be effectively managed by applying castor cake to paddy fields. Before application, water should be drained out from the plots. The castor cake (2 kg) is mixed with the 2 kg of soil and broadcasted in the plots. After 6-7 h of treatment, water is again allowed into the plots.

A farmer in Hassan district is growing paddy organically for 12 years and he manages the pests by growing local varieties (ex: Rajmudi), spraying jeevamrutha once in a 15 days as a preventive measure and encouraging predatory spiders and other natural enemies.

Agnihotra is an age old practice which is done by using turmeric powder (10 g), rice (10 g) and ghee (10 g). The above products are placed on dried cow dung cake and burnt to produce smoke. It is believed that, the smoke repels insect and pests and it may also improve color and quality of fruits.
<table>
<thead>
<tr>
<th>Page</th>
<th>Text</th>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>78</td>
<td>Traps containing 10 per cent toddy attracts berry borer beetles in coffee gardens</td>
<td>Coffee</td>
<td>berry borer</td>
<td>Mr. Chankeshava, Mudigere</td>
</tr>
<tr>
<td>79</td>
<td>Spraying of <em>Beauveria bassiana</em> (1 l products diluted in 200 l water) gives good control of coffee pests.</td>
<td>Coffee</td>
<td>Stem and berry borer</td>
<td>Mr. Arvind, Boothenakad estate, Mudigere</td>
</tr>
<tr>
<td>80</td>
<td>Yellow plastic sheet (smeared with an adhesive on both the sides) hung in coffee garden trapped berry borer beetles</td>
<td>Coffee</td>
<td>Berry borer</td>
<td>do</td>
</tr>
<tr>
<td>81</td>
<td>A paste prepared from roots of baje (<em>Acorus calamus</em>), leaves of ashvagandha (<em>Withania somnifera</em>) and ummatthi (<em>Datura metel</em>) (100 g each) is mixed with 100 ml of goat milk. Treatment of paddy seeds with this paste protects them from storage pests for a long period.</td>
<td>Paddy</td>
<td>Storage pests</td>
<td>Mr. Anil B. Bangera, Kervashe</td>
</tr>
<tr>
<td>82</td>
<td>Traditionally, the paddy seeds are stored in a separate structure which is locally called as “mudi kattuvadu”. The paddy seeds are tied in a cloth and covered with the material made out of paddy straw to protect them from pests attack</td>
<td>Paddy</td>
<td>Storage pests</td>
<td>do</td>
</tr>
<tr>
<td>83</td>
<td>Storing of seeds in the middle portion of the chimneys in the kitchen protect seeds from pest attack</td>
<td>All seeds</td>
<td>Storage pests</td>
<td>Mr. Jaarappa Moalya</td>
</tr>
</tbody>
</table>
The wastes generated in the field are dumped in a corner of the field and covered with a layer of soil. This is repeated for several times. Later, the entire material is burnt and the ash obtained is locally called as ‘Sudubhoodi’. The sudubhoodi is broadcasted on vegetable crops during morning hours to keep away pest species.

The use of asafoetida in jasmine pest management is common in Udupi district. The asafoetida (10 g) is taken in a perporated polyethylene cover (4-5 small holes) and hung on the plants to keep away pest organisms.

Mixing of 50 kg of paddy seeds with one handful of common salts provides protection from storage pests.

A dust consisting of powdered neem leaves and ash (1 kg) is mixed with 10 kg of pulse seeds and stored in the gunny bags to avoid infestation by pulse beetle.

Paddy seeds are immersed in salt water (5 %) for one hour to separate the chaffy seeds from good ones. This practice also helps in control of some seed borne pests and diseases.
<table>
<thead>
<tr>
<th>D</th>
<th><strong>Kerosene based extracts</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>89</td>
<td>Finely crushed garlic and green chilli (200 g each) are mixed with kerosene (200 ml) and kept for 24 h. Thereafter the filtrate is collected and combined with 10 g soap and 4 l of water before spraying on crops.</td>
</tr>
<tr>
<td>90</td>
<td>100 g of garlic paste is soaked in equal quantity of kerosene for 24 h. The filtrate of this mixture is diluted in 10 litre of water and sprayed to control snails in areca gardens.</td>
</tr>
<tr>
<td>91</td>
<td>A paste of chilli (1 kg) and garlic (1 kg) is mixed with kerosene (1 l) and allowed for 8-10 days. Thereafter the contents are filtered and mixed with 400 litres of water and 100 ml of soap before spraying on crops.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>All crops</th>
<th>Fruit borer</th>
<th>Mr. Purushottam Rao, Thirthahalli</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Arecanut</td>
<td>Snails</td>
<td>Mr. Abdul Jallil, Sab, Pulguni</td>
</tr>
<tr>
<td></td>
<td>Vegetables</td>
<td>All pests</td>
<td>Do</td>
</tr>
</tbody>
</table>

Cont...
<table>
<thead>
<tr>
<th>No</th>
<th>Commercial products</th>
<th>Crops/Use</th>
<th>Pests Control</th>
<th>Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>92</td>
<td>Hasiru – neem blended vermicompost</td>
<td>All crops</td>
<td>Leaf roller, leaf hopper, leaf miner, mites, hairy caterpillars, shoot and fruit borer</td>
<td>Mr. Arvind B. C, Boothankad group of Estates, Mudigere</td>
</tr>
<tr>
<td>93</td>
<td>Hasiru Siri Hasiru Shaktiiri</td>
<td>do</td>
<td>All pests</td>
<td>do</td>
</tr>
<tr>
<td>94</td>
<td>Nisarga liquid</td>
<td>All crops</td>
<td>For all pests</td>
<td>Mr. V. P. Hegade, Gowrishanar estate, Harihalli, Hassan</td>
</tr>
<tr>
<td>95</td>
<td>Prajwal</td>
<td>do</td>
<td>do</td>
<td>do</td>
</tr>
<tr>
<td>96</td>
<td>Vijnana</td>
<td>do</td>
<td>do</td>
<td>do</td>
</tr>
<tr>
<td>97</td>
<td>NCG liquid</td>
<td>Coconut</td>
<td>Coconut mites</td>
<td>do</td>
</tr>
<tr>
<td>98</td>
<td>Ayurvedic rose mix</td>
<td>Rose</td>
<td>All pests</td>
<td>do</td>
</tr>
<tr>
<td>99</td>
<td>Thrishika</td>
<td>Pepper, coffee, tea, banana and drumsticks</td>
<td>White ants</td>
<td>do</td>
</tr>
</tbody>
</table>
4.2.1 The biological activity of indigenous products against *P. xylostella*

The test products were evaluated for their repellent activity, antifeedant activity and effect on growth and development of DBM and the results are presented in Tables 2, 3, 4 and 5.

**4.2.1.1 Repellent activity of indigenous products against fourth instar larvae of *P. xylostella***

All the test products exhibited different intensity of repellency against fourth instar larvae of DBM (Table 2). In all the cases, the extent of repellency increased with increase in concentrations. The neem seed kernel + *Aloe vera* + *Calotropis* + *Vitex* + *Clerodendron* leaf extract at the highest concentration of 10 per cent, showed the highest level of repellent activity (86.62 %) followed by panchagavya (65.74 %), dasagavya (58.95 %), neem fruit + red chilli + custard apple leaf extract (57.24 %) and chilli + garlic extract (45.36 %). At lower concentrations also, neem seed kernel + *Aloe vera* + *Calotropis* + *Vitex* + *Clerodendron* leaf extract (1 %) exhibited relatively higher levels of repellency (38.96 %) compared to other products. Cow urine at very high concentrations (25 and 50 %) caused 53.76 and 70.16 per cent repellency, respectively.

Based on the level of repellent activity exhibited by the test products at 10 % concentration, neem seed kernel + *Aloe vera* + *Calotropis* + *Vitex* + *Clerodendron* leaf extract was grouped into the Repellency Class V (80 - 100 %), panchagavya into Repellency Class IV (60 – 80.0 %), whereas dasagavya, neem fruit + red chilli + custard apple leaf extract, cow urine and chilli + garlic extract were categorised as Repellency Class III (40 - 60.00 %).
Table 2. Repellent activity of indigenous products against fourth instar larvae of *P. xylostella*

<table>
<thead>
<tr>
<th>Indigenous products</th>
<th>Conc. (%)</th>
<th>Repellency (%)</th>
<th>Repellency class*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panchagavya</td>
<td>1.00</td>
<td>16.24</td>
<td>I</td>
</tr>
<tr>
<td></td>
<td>2.50</td>
<td>27.56</td>
<td>II</td>
</tr>
<tr>
<td></td>
<td>5.00</td>
<td>42.15</td>
<td>III</td>
</tr>
<tr>
<td></td>
<td>10.00</td>
<td>65.74</td>
<td>IV</td>
</tr>
<tr>
<td>Cow urine</td>
<td>2.50</td>
<td>18.80</td>
<td>I</td>
</tr>
<tr>
<td></td>
<td>5.00</td>
<td>34.03</td>
<td>II</td>
</tr>
<tr>
<td></td>
<td>10.00</td>
<td>49.77</td>
<td>III</td>
</tr>
<tr>
<td></td>
<td>25.00</td>
<td>53.76</td>
<td>III</td>
</tr>
<tr>
<td></td>
<td>50.00</td>
<td>70.16</td>
<td>IV</td>
</tr>
<tr>
<td>Dasagavya</td>
<td>1.00</td>
<td>07.69</td>
<td>I</td>
</tr>
<tr>
<td></td>
<td>2.50</td>
<td>16.24</td>
<td>I</td>
</tr>
<tr>
<td></td>
<td>5.00</td>
<td>20.82</td>
<td>II</td>
</tr>
<tr>
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<td>10.00</td>
<td>46.06</td>
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</tr>
<tr>
<td></td>
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<td>58.95</td>
<td>III</td>
</tr>
<tr>
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</tr>
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<td>III</td>
</tr>
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<td>20.82</td>
<td>II</td>
</tr>
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<td>III</td>
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</tr>
<tr>
<td></td>
<td>10.00</td>
<td>86.62</td>
<td>V</td>
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</table>

*Per cent repellency class was calculated according Rahman *et al.* (2007)
4.2.1.2 Antifeedant activity of test products against fourth instar larvae of *P. xylostella*

The data on antifeedant activity of different test products against fourth instar larvae of DBM are presented in Table 3.

Among the test products, neem seed kernel + *Aloe vera* + *Calotropis* + *Vitex* + *Clerodendron* leaf extract at 10 and 5 per cent registered high levels of antifeedant activity (64.45 and 53.31 %, respectively) followed by cow urine at 50 per cent (54.32 %) and were on par with panchagavya at 10 and 5 per cent (51.37 and 45.22 %, respectively) and neem seed kernel + *Aloe vera* + *Calotropis* + *Vitex* + *Clerodendron* leaf extract at 2.5 per cent (43.22 %). The next highest was recorded in neem fruit + red chilli + custard apple leaf extract at 10 per cent (40.92 %), cow urine at 25 per cent (39.07 %), dasagavya at 20 per cent (38.37%), neem seed kernel + *Aloe vera* + *Calotropis* + *Vitex* + *Clerodendron* leaf extract at 1 per cent (35.25 %) and panchagavya at 2.5 per cent (35.15 %).

In general, the test products showed varying levels of antifeedant activity against the larvae of DBM, the activity increased with the increase in concentrations. Among all the products, chilli + garlic extract inhibited feeding to the least extent (6.43 to 20.30 %) at 1 to 10 per cent concentration.

The feeding deterrence caused by the test products was quantified in terms of reduction in larval weight gained after 48 hours of feeding. In all the treatments reduced feeding by larvae reflected in reducing in body weight gained.

Among the test products, neem seed kernel + *Aloe vera* + *Calotropis* + *Clerodendron* leaf extract at 10 per cent caused a maximum of 59.46 per cent reduction in larval weight gained over control and was on par
<table>
<thead>
<tr>
<th>Indigenous products</th>
<th>Concentration (%)</th>
<th>Antifeedant activity* (%)</th>
<th>Reduction in weight gained over control ** (%)</th>
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<tr>
<td>Panchagavya</td>
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<td>24.00 (29.33)bcd</td>
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<td>35.15 (36.27)bcdef</td>
<td>33.30 (35.24)bc</td>
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<tr>
<td></td>
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<td>45.22 (42.25)ab</td>
<td>43.22 (41.09)ab</td>
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<td>51.37 (45.75)ab</td>
<td>55.43 (48.04)a</td>
</tr>
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<td>39.07 (38.70)bcdef</td>
<td>30.50 (33.21)bc</td>
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<td>50.00</td>
<td>54.32 (47.47)ab</td>
<td>50.32 (45.15)a</td>
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<td>09.09 (17.46)fgi</td>
</tr>
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<td>15.19 (22.95)ghi</td>
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<td>18.18 (25.18)ghi</td>
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<td>36.36 (37.05)ghi</td>
</tr>
<tr>
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<td>00.00 (0.00)j</td>
</tr>
<tr>
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<td>06.43 (12.31)j</td>
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<tr>
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<td>10.00</td>
<td>20.30 (25.20)ghi</td>
<td>18.18 (25.18)cde</td>
</tr>
<tr>
<td>Neem fruit + red chilli + custard apple leaf extract</td>
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<td>09.43 (17.85)jk</td>
<td>05.50 (13.56)h</td>
</tr>
<tr>
<td></td>
<td>1.00</td>
<td>14.25 (22.09)ghi</td>
<td>11.20 (19.55cdefg</td>
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<td></td>
<td>2.50</td>
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<td>10.00</td>
<td>40.92 (39.76)cdefg</td>
<td>36.52 (37.17ab</td>
</tr>
<tr>
<td>Neem seed kernel + <em>Aloe vera + Calotropis + Clerodendron leaf extract</em></td>
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<td>28.14 (32.08)cdefg</td>
<td>08.83 (17.26fg)</td>
</tr>
<tr>
<td></td>
<td>1.00</td>
<td>35.25 (36.34)cdefg</td>
<td>16.66 (24.04cdefg</td>
</tr>
<tr>
<td></td>
<td>2.50</td>
<td>43.22 (41.25)cdefg</td>
<td>23.50 (29.20cde)</td>
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<tr>
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<td>5.00</td>
<td>58.16 (49.60)a</td>
<td>53.21 (46.85)a</td>
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<td>10.00</td>
<td>64.45 (53.31)a</td>
<td>59.46 (50.42)a</td>
</tr>
<tr>
<td>SEm ±</td>
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<td>2.95</td>
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<td>CD at 5%</td>
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<td>8.50</td>
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</table>

* Based on leaf area consumed

** Mean of 15 replications 2 larvae each after 48 h of feeding (n=30)

Mean values with the same alphabetical superscript within a column are not significantly different at 5 per cent level of significance
with neem seed kernel + *Aloe vera* + *Calotropis* + *Clerodendron* leaf extract at 5 per cent (53.21 %), panchagavya at 10 per cent (55.43 %), cow urine at 50 per cent (50.32 %) and panchagavya at 5 per cent (43.22 %). The next highest of 36.52, 36.36, 33.30, 30.50 and 27.27 per cent reductions in larval weight gained over control were observed in case of neem fruit + red chilli + custard apple leaf extract at 10 per cent, dasagavya at 20 per cent, panchagavya at 2.5 per cent, cow urine at 25 per cent and dasagavya 10 per cent, respectively.

The observed reduction in larval weight gained was in accordance with the level of feeding deterrence caused by the test products. Greater levels of antifeedant activity at higher concentrations of test products resulted were evident with greater reduction in larval weight gained and the vice-versa. Among all the test products, chilli + garlic extract had least effect on larval weight gained, with no reduction in larval weight gained at 0.5 and 1.0 per cent concentrations though a slight feeding deterrence was observed at these concentrations.

### 4.2.1.3 The effect of indigenous products on the development of *P. xylostella*

The effect of test products on development of *P. xylostella* larvae was investigated by recording larvae and pupal mortality, pupation, adult emergence and morphologenic effects in pupal and adult stages. The results of the experiment are presented in the Table 4 and 5.

#### 4.2.1.3.1 Effect on development of second instar larvae

##### 4.2.1.3.1.1 Larval and pupal mortality

The indigenous product, neem seed kernel + *Aloe vera* + *Calotropis* + *Clerodendron* leaf extract was highly detrimental to the second instar larvae causing complete mortality followed by the same products at 0.5
and 1.0 per cent concentration (60.00 and 66.66 % mortality, respectively) and another product, neem fruit + red chilli + custard apple leaf extract at 10 per cent concentration (66.70 % mortality). Most of the surviving larvae that were exposed to neem seed kernel + Aloe vera + Calotropis + Clerodendron leaf extract at 1.0 to 2.5 per cent died at the pupal stage (7.46 to 21.16 % mortality). The next best product in causing larval and pupal mortality (36.03 to 87.46 %) was neem fruit + red chilli + custard apple leaf extract (0.5 to 10 % concentration). Dasagavys was moderately toxic to the test insect causing 10.00 to 29.99 per cent larval + pupal mortality at 1.0 to 20.00 per cent concentrations. Panchagavya and chilli + garlic extract exhibited very low insecticidal property causing 23.32 to 13.32 per cent larva + pupal mortality at 10 per concentration. Cow urine was least toxic to the test insects causing 16.66 per cent larval mortality at 50 per cent concentration (Table 4).

4.2.1.3.1.2 Adult emergence

Complete mortality of second instar larvae was evident when treated with 5 and 10 per cent neem seed kernel + Aloe vera + Calotropis + Clerodendron leaf extract and hence no moth emergence was observed. At lower concentrations (2.5 and 1.0 %) only 9.20 and 12.17 per cent of larvae developed into adults. Likewise, in the case of neem fruit + red chilli + custard apple leaf extract, only 12.33 and 16.96 per cent of treated larvae (at 10.00 and 5.0 % concentrations, respectively) developed into adults whereas at other concentrations (2.5 and 1.0 % concentrations) greater proportion of larvae developed into adults (46.94 and 63.97 %, respectively). Panchagavya (10.00 %) and dasagavya (20.00 %) at higher concentration restricted the adult emergence to 76.66 and 70.00 per cent, respectively. Cow urine (up to 50 % concentration) had the least effect on adult emergence. Of the six indigenous products tested, two products containing neem i.e neem fruit + red chilli + custard apple leaf extract and neem seed
Table 4. Effect of indigenous products on development when second instar larvae of *P. xylostella* were treated

<table>
<thead>
<tr>
<th>Indigenous products</th>
<th>Conc. (%)</th>
<th>Larval mortality* (%)</th>
<th>Pupation (%)</th>
<th>Pupal mortality* (%)</th>
<th>Cumulative mortality* (%)</th>
<th>Adults emergence (%)</th>
<th>Normal adults (%)</th>
<th>Abnormal adults (%)</th>
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<td>6.66(14.48)fg</td>
<td>93.33bc</td>
<td>3.33(10.46)de</td>
<td>10.00(18.44)fg</td>
<td>90.00(71.56)bc</td>
<td>90.00 bc</td>
<td>0.00 c</td>
</tr>
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<td></td>
<td>2.50</td>
<td>6.66(14.48)fg</td>
<td>93.33bc</td>
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<td>90.00(71.56)bc</td>
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<td>90.00 bc</td>
<td>0.00 c</td>
</tr>
<tr>
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<td>83.33bed</td>
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<td>23.32(28.95)def</td>
<td>76.66(61.71)ced</td>
<td>76.66 bc</td>
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</tr>
<tr>
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<td>3.33 (6.14) bc</td>
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<td><strong>Neem seed kernel + Aloe vera + Calotropis + Clerodendron leaf extract</strong></td>
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Mean of three replications containing 10 larvae per replication (n=30)
Figures in parentheses are angular transformed values
*Corrected mortality
Plate 4. Effect of neem fruit + red chilli + custard apple leaf extract on development when second instar larvae of *P. xylostella* were treated

**A:** Dead larva with partially separated head capsule and old cuticle  
**B and C:** Abnormal pupae without cocoon formation  
**D:** Dead pupa with flimsy cocoon  
**E:** Abnormal adult  

**A:** Dead larva with partially separated head capsule and old cuticle  
**B and C:** Abnormal pupae without cocoon formation  
**D:** Dead pupa with flimsy cocoon  
**E:** Abnormal adult  

Plate 4. Effect of neem fruit + red chilli + custard apple leaf extract on development when second instar larvae of *P. xylostella* were treated
A: Dead larva with partially separated head capsule and old cuticle  
B: Dead pupa with flimsy cocoon  
C and D: Abnormal adults that fail to emerge  
E: Abnormal adult

Plate 5. Effect of neem seed kernel + Aloe vera + Calotropis + Clerodendron leaf extract on development when second instar larve of P. xylostella were treated
Kernel + Aloe vera + Calotropis + Clerodendron leaf extract produced morphogenic effects in the adult stage. In case of the neem fruit + red chilli + custard apple leaf extract, out of 46.94 and 16.96 per cent of larvae that developed into adults (at 2.5 and 5 % concentration, respectively), 10.00 and 3.33 per cent were abnormal adults, respectively (Plate 4). The adults were smaller in size with twisted wings. Likewise, increase of neem seed kernel + Aloe vera + Calotropis + Clerodendron leaf extract, at 1.0 per cent concentration, few adults (3.33 %) out of 12.17 per cent of the total adults were abnormal (Plate 5). The remaining test products viz., panchagavya, cow urine, dasagavya and chilli + garlic extract did not exhibit morphogenic effects on adult stage of the test insets.

4.2.1.3.2 Effect on development of fourth instar instra larvae of P. xylostella

The effects of indigenous products on development of fourth instar DBM larvae was studied by recording larval and pupal mortality, extent of pupation, adult emergence and morphogenic effects at adult stage. The findings of this experiment are presented in Table 5.

4.2.1.3.2.1 Larval and pupa mortality

As observed in second instar larvae, two neem based products viz., neem seed kernel + Aloe vera + Calotropis + Clerodendron leaf extract and neem fruit + red chilli + custard apple leaf extract caused higher levels of larval and pupal mortality compared to other products when newly moulted fourth instar larvae were treated with different concentrations. Neem seed kernel + Aloe vera + Calotropis + Clerodendron leaf extract at 5.00 and 10.00 per cent concentrations caused 73.33 and 100 per cent larval mortality. The total larval + pupal mortality was 49.99, 73.32, 96.99 and 100 per cent at 1, 2.5, 5 and 10 per cent concentrations of the
Table 5. Effect of indigenous products on development when fourth instar larvae of *P. xylostella* were treated

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<th>Indigenous Products</th>
<th>Conc. (%)</th>
<th>Larval mortality* (%)</th>
<th>Pupatio n (%)</th>
<th>Pupal mortality* (%)</th>
<th>Cumulative mortality* (%)</th>
<th>Adults emergence (%)</th>
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extract, respectively (Table 5). The other product, neem fruit + red chilli + custard apple leaf extract caused total larval + pupal mortality of 33.32 to 90.00 per cent at 1.0 to 10.00 per cent concentrations. Dasagavaya exhibited moderate insecticidal property causing 20.00 to 29.99 per cent larval + pupal mortality at 5 to 20 per cent concentrations. Panchagavya and cow urine exhibited the least level of insecticidal activity, cow urine caused 16.66 per cent larval + pupal mortality at 50 per cent concentration

4.2.1.3.2.2 Adult emergence

Exposure of fourth instar larvae to two indigenous products affected the adult emergence to a greater extent (Table 5). None of the treated larvae developed into adults when exposed to 10 per cent neem seed kernel + Aloe vera + Calotropis + Clerodendron leaf extract, at 5 per cent concentration, also only 3.33 per cent of larvae reached the adult stage. Another indigenous product, neem fruit + red chilli + custard apple leaf extract at 10 and 5 per cent concentrations, reduced the adult emergence to 10.00 and 43.33 per cent, respectively. Dasagavya at 20 and 10 per cent concentrations restricted the adult emergence to 70.00 and 76.66 per cent, respectively. The remaining products viz., chilli + garlic extract, cow urine and panchagavya had only marginal effect on adult emergence when fourth instar larvae were exposed to different concentrations.

Four test products viz., panchagavya, cow urine, dasagavya and chilli + garlic extract did not have any morphogenic effects on second instar larvae of the test insect. Two products containing neem fruit or seed extract produced the abnormal adults (Table 5). In case of neem seed kernel + Aloe vera + Calotropis + Clerodendron leaf extract, out of the 66.66, 50.33 and 26.66 per cent adults that emerged at 1, 2.5 and 5 per cent concentrations, respectively, 6.66, 3.33 and 3.33 per cent of
adults were abnormal with twisted wing, respectively. Similarly, out of 66.66, 56.66, 43.33 and 10.00 per cent of the moths that emerged from fourth instar larvae treated with neem fruit + red chilli + custard apple leaf extract at 1.0, 2.5, 5.0 and 10.00 per cent concentrations, respectively, 6.66, 13.33, 13.33 and 6.66 per cent of the adults were malformed.

4.2.2 Biological activity of indigenous products against *Aphis craccivora* Koch

The repellent activity (walk off response) and the insecticidal property of the indigenous products against the sucking pest, *A. craccivora* was studied.

4.2.2.1 Walk-off response

When aphids were released on treated young cowpea seedlings, a small proportion of them wandered off the seedlings within first hour. Once the aphids settled down on the treated seedlings, no walk-off response especially 2 and 3 hours after the release (Table 6). All the indigenous products exhibited low levels of repellent action causing 8.33 to 16.66 per cent walk-off response compared to no response in the untreated control. However, the walk-off response of aphids to the treatments did not vary significantly between the test products and the concentrations used.

4.2.2.2 Mortality

All the six indigenous products exhibited very low to moderate levels of insecticidal property against the cowpea aphid. The neem seed kernel + *Aloe vera* + *Calotropis* + *Clerodendron* leaf extract exhibited moderate toxicity to the aphid at all the concentrations (0.50 to 10.00 %) causing 15.00 to 26.67 per cent mortality (Table 7) and different concentration were on par. The other products *viz.*, panchagvya (at 5, 10
Table 6. Walk-off response of *A. craccivora* to indigenous products

<table>
<thead>
<tr>
<th>Indigenous products</th>
<th>Conc. (%)</th>
<th>Walk-off response (%) at one hour after treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.00</td>
<td>11.66 (19.88)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>2.50</td>
<td>15.00 (22.59)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>5.00</td>
<td>16.66 (23.74)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>10.00</td>
<td>15.00 (21.90)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>20.00</td>
<td>15.00 (22.59)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Panchagavya</strong></td>
<td>5.00</td>
<td>11.66 (19.30)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>10.00</td>
<td>15.00 (22.01)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>25.00</td>
<td>10.00 (18.04)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>50.00</td>
<td>13.33 (21.14)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>100.00</td>
<td>13.33 (20.45)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Cow urine</strong></td>
<td>2.50</td>
<td>13.33 (20.45)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>5.00</td>
<td>13.33 (21.14)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>10.00</td>
<td>13.33 (20.75)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>25.00</td>
<td>15.00 (22.20)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>50.00</td>
<td>15.00 (22.59)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Dasagavya</strong></td>
<td>0.50</td>
<td>10.00 (18.04)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>1.00</td>
<td>11.66 (18.61)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>2.50</td>
<td>11.66 (19.88)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>5.00</td>
<td>13.33 (20.75)&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>10.00</td>
<td>13.33 (21.33)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Chilli + garlic extract</strong></td>
<td>0.50</td>
<td>08.33 (16.59)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>1.00</td>
<td>08.33 (16.20)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>2.50</td>
<td>08.33 (16.59)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
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<td>5.00</td>
<td>15.00 (22.59)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>10.00</td>
<td>11.66 (18.61)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Neem fruit + red chilli + custard apple leaves extract</strong></td>
<td>0.50</td>
<td>15.00 (22.59)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>1.00</td>
<td>13.00 (21.44)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>2.50</td>
<td>11.66 (19.88)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>5.00</td>
<td>15.00 (22.59)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>10.00</td>
<td>13.33 (19.68)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Neem seed kernel + Aloe vera + Calotropis + Clerodendron leaf extract</strong></td>
<td>0.50</td>
<td>15.00 (22.59)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>1.00</td>
<td>13.00 (21.44)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>2.50</td>
<td>11.66 (19.88)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>5.00</td>
<td>15.00 (22.59)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>10.00</td>
<td>13.33 (19.68)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Control (water)</strong></td>
<td>00.00</td>
<td>(00.00)&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>SEm ±</strong></td>
<td>3.55</td>
<td></td>
</tr>
<tr>
<td><strong>CD at 5%</strong></td>
<td>10.05</td>
<td></td>
</tr>
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</table>

Mean of three replications containing 20 aphids each

Figures in parentheses are angular transformed values
Table 7. Insecticidal activity of indigenous products against *A. craccivora*

<table>
<thead>
<tr>
<th>Indigenous products</th>
<th>Conc. (%)</th>
<th>Corrected mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Panchagavya</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td>06.66</td>
<td>(14.75)efg</td>
</tr>
<tr>
<td>2.50</td>
<td>08.33</td>
<td>(16.59)defg</td>
</tr>
<tr>
<td>5.00</td>
<td>16.97</td>
<td>(24.04)abcde</td>
</tr>
<tr>
<td>10.00</td>
<td>16.97</td>
<td>(24.04)abcde</td>
</tr>
<tr>
<td>20.00</td>
<td>23.33</td>
<td>(28.85)ab</td>
</tr>
<tr>
<td><strong>Cow urine</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.00</td>
<td>01.66</td>
<td>(4.30)h</td>
</tr>
<tr>
<td>10.00</td>
<td>06.66</td>
<td>(14.75)efg</td>
</tr>
<tr>
<td>25.00</td>
<td>11.67</td>
<td>(19.91)bcdef</td>
</tr>
<tr>
<td>50.00</td>
<td>10.00</td>
<td>(18.44)bcdef</td>
</tr>
<tr>
<td>100.0</td>
<td>15.00</td>
<td>(22.79)abcdef</td>
</tr>
<tr>
<td><strong>Dasagavya</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.50</td>
<td>05.00</td>
<td>(12.92)fh</td>
</tr>
<tr>
<td>5.00</td>
<td>05.00</td>
<td>(12.92)fh</td>
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<td>05.00</td>
<td>(12.92)fh</td>
</tr>
<tr>
<td>25.00</td>
<td>08.33</td>
<td>(16.74)defg</td>
</tr>
<tr>
<td>50.00</td>
<td>11.67</td>
<td>(19.91)bcdef</td>
</tr>
<tr>
<td><strong>Chilli + garlic extract</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.50</td>
<td>01.66</td>
<td>(4.30)h</td>
</tr>
<tr>
<td>1.00</td>
<td>08.33</td>
<td>(16.59)defg</td>
</tr>
<tr>
<td>2.50</td>
<td>08.33</td>
<td>(16.59)defg</td>
</tr>
<tr>
<td>5.00</td>
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<td>(18.44)bcdef</td>
</tr>
<tr>
<td>10.00</td>
<td>11.67</td>
<td>(19.91)bcdef</td>
</tr>
<tr>
<td><strong>Neem fruit + red chilli + custard apple leaves extract</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.50</td>
<td>08.33</td>
<td>(16.59)defg</td>
</tr>
<tr>
<td>1.00</td>
<td>08.33</td>
<td>(16.59)defg</td>
</tr>
<tr>
<td>2.50</td>
<td>08.33</td>
<td>(16.59)defg</td>
</tr>
<tr>
<td>5.00</td>
<td>15.00</td>
<td>(22.79)abcdef</td>
</tr>
<tr>
<td>10.00</td>
<td>18.33</td>
<td>(25.30)abcd</td>
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<tr>
<td><strong>Neem seed kernel + Aloe vera + Calotropis + Clerodendron leaf extract</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.50</td>
<td>15.00</td>
<td>(22.59)abcdef</td>
</tr>
<tr>
<td>1.00</td>
<td>16.67</td>
<td>(23.85)abcde</td>
</tr>
<tr>
<td>2.50</td>
<td>18.33</td>
<td>(25.30)abcd</td>
</tr>
<tr>
<td>5.00</td>
<td>21.67</td>
<td>(27.52)abc</td>
</tr>
<tr>
<td>10.00</td>
<td>26.67</td>
<td>(31.07)a</td>
</tr>
</tbody>
</table>

Mean of three replications containing 20 aphids each

Figures in parentheses are angular transformed values

Mean values with the same alphabetical superscript within a column are not significantly different at 5 per cent level of significance
and 20 % concentrations), neem fruit + red chilli + custard apple leaf extract (at 5 and 10% concentrations) and cow urine (100% concentration) were comparable with the above product only at higher concentrations causing mortality of the aphids. Dasagavya and chilli + garlic extract showed low toxicity to aphid even at the highest concentrations.

4.2.3 Biological activity of indigenous products against *Tetranychus urticae* Koch

The overall biological activity of test products was assessed by studying walk-off response (repellency), ovicidal action, susceptibility of egg, larvae, and adult stages of the spider mite, *T. uricae* under laboratory conditions.

4.2.3.1 Walk-off response

The repellent effect of indigenous test products on the two-spotted mite was investigated by recording the walk-off response of adult mites from treated leaf bits (Table 8). All the products exhibited very low levels of repellency against the mite at 1 to 10 per cent concentrations. One hour after treatment only panchagavya at 20 per cent concentration produced the walk-off response of 23 per cent by the adults. The rest of the indigenous products viz., cow urine, dasagavya, chilli + garlic extract, neem fruit + red chilli + custard apple leaf extract and the neem seed kernel + *Aloe vera* + *Calotropis* + *Clerodendron* leaf extract had very low or no repellent action on mites. At higher concentrations of the test products very low repellent effect was observed after 2 hours.

4.2.3.2 Ovicidal action

The ovicidal activity of the test products was studied by exposing the eggs of the spider mite to different concentrations in the laboratory (Table 9). In general, all the test products exhibited very low levels of
Table 8. Repellent activity of indigenous products against adults of two spotted spider mite, *T. urticae* Koch

<table>
<thead>
<tr>
<th>Indigenous Products</th>
<th>Conc. (%)</th>
<th>Walk-off response (%) at different hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 hours</td>
</tr>
<tr>
<td></td>
<td>1.00</td>
<td>3.33 (10.41)(^{bc})</td>
</tr>
<tr>
<td>Panchagavya</td>
<td>2.50</td>
<td>5.00 (12.92)(^{b})</td>
</tr>
<tr>
<td></td>
<td>5.00</td>
<td>5.00 (12.92)(^{b})</td>
</tr>
<tr>
<td></td>
<td>10.00</td>
<td>6.70 (15.00)(^{b})</td>
</tr>
<tr>
<td></td>
<td>20.00</td>
<td>23.0 (28.66)(^{a})</td>
</tr>
<tr>
<td>Cow urine</td>
<td>5.00</td>
<td>3.33 (10.41)(^{bc})</td>
</tr>
<tr>
<td></td>
<td>10.00</td>
<td>1.67 (7.27)(^{bc})</td>
</tr>
<tr>
<td></td>
<td>25.00</td>
<td>3.33 (10.41)(^{bc})</td>
</tr>
<tr>
<td></td>
<td>50.00</td>
<td>5.00 (12.92)(^{b})</td>
</tr>
<tr>
<td></td>
<td>100.00</td>
<td>3.33 (10.41)(^{bc})</td>
</tr>
<tr>
<td>Dasagavya</td>
<td>2.50</td>
<td>3.33 (10.41)(^{bc})</td>
</tr>
<tr>
<td></td>
<td>5.00</td>
<td>3.33 (10.41)(^{bc})</td>
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<td></td>
<td>10.00</td>
<td>6.70 (15.00)(^{b})</td>
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<td></td>
<td>25.00</td>
<td>8.30 (16.74)(^{b})</td>
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<td>50.00</td>
<td>8.30 (16.74)(^{b})</td>
</tr>
<tr>
<td>Chilli + garlic extract</td>
<td>0.50</td>
<td>0.00 (0.00)(^{bc})</td>
</tr>
<tr>
<td></td>
<td>1.00</td>
<td>1.67 (7.27)(^{bc})</td>
</tr>
<tr>
<td></td>
<td>2.50</td>
<td>1.67 (7.27)(^{bc})</td>
</tr>
<tr>
<td></td>
<td>5.00</td>
<td>3.33 (10.41)(^{bc})</td>
</tr>
<tr>
<td></td>
<td>10.00</td>
<td>3.33 (10.41)(^{bc})</td>
</tr>
<tr>
<td>Neem fruit + red chilli + custard apple leaves extract</td>
<td>0.50</td>
<td>0.00 (0.00)(^{c})</td>
</tr>
<tr>
<td></td>
<td>1.00</td>
<td>3.33 (10.41)(^{bc})</td>
</tr>
<tr>
<td></td>
<td>2.50</td>
<td>3.33 (10.41)(^{bc})</td>
</tr>
<tr>
<td></td>
<td>5.00</td>
<td>3.33 (10.41)(^{bc})</td>
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<tr>
<td></td>
<td>10.00</td>
<td>5.00 (12.92)(^{b})</td>
</tr>
<tr>
<td>Neem seed kernel + <em>Aloe vera</em> + <em>Calotropis</em> + <em>Clerodendron</em> leaf extract</td>
<td>0.50</td>
<td>1.67 (7.27)(^{bc})</td>
</tr>
<tr>
<td></td>
<td>1.00</td>
<td>1.67 (7.27)(^{bc})</td>
</tr>
<tr>
<td></td>
<td>2.50</td>
<td>3.33 (10.41)(^{bc})</td>
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<td></td>
<td>10.00</td>
<td>6.70 (15.00)(^{b})</td>
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<tr>
<td>Control (water)</td>
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<td>0.00 (0.00)(^{c})</td>
</tr>
<tr>
<td>SEM ±</td>
<td></td>
<td>3.43</td>
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<tr>
<td>CD at 5%</td>
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<td>9.68</td>
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Mean of three replications containing 20 mites per replication
Figures in parentheses are angular transformed values
Mean values with the same alphabetical superscript within a column are not significantly different at 5 per cent level of significance
Table 9. Acaricidal property of indigenous products against different life stages of two spotted spider mite, *T. urticae* Koch

<table>
<thead>
<tr>
<th>Indigenous products</th>
<th>Conc. (%)</th>
<th>Corrected mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Egg*</td>
</tr>
<tr>
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<td>1.00</td>
<td>3.90 (11.19)de</td>
</tr>
<tr>
<td></td>
<td>2.50</td>
<td>3.33 (10.39)de</td>
</tr>
<tr>
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<td>5.00</td>
<td>5.03 (12.81)bcede</td>
</tr>
<tr>
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<td>10.00</td>
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</tr>
<tr>
<td></td>
<td>20.00</td>
<td>6.36 (14.55)bcede</td>
</tr>
<tr>
<td>Cow urine</td>
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<td>2.46 (8.72)e</td>
</tr>
<tr>
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<td>10.00</td>
<td>3.33 (10.39)de</td>
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</tr>
<tr>
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<td>50.00</td>
<td>6.70 (14.54)bcede</td>
</tr>
<tr>
<td></td>
<td>100.00</td>
<td>8.66 (17.07)ab</td>
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<td>2.50</td>
<td>3.60 (10.69)de</td>
</tr>
<tr>
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<td>5.00</td>
<td>2.66 (9.35)e</td>
</tr>
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<td>10.00</td>
<td>3.86 (11.24)de</td>
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<td>4.60 (12.33)bcede</td>
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<td></td>
<td>50.00</td>
<td>5.90 (14.03)bcede</td>
</tr>
<tr>
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<td>3.20 (9.85)e</td>
</tr>
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<td>3.66 (10.76)de</td>
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<tr>
<td></td>
<td>2.50</td>
<td>4.80 (12.63)bcede</td>
</tr>
<tr>
<td></td>
<td>5.00</td>
<td>6.00 (14.14)bcede</td>
</tr>
<tr>
<td>Chilli + garlic extract</td>
<td>0.50</td>
<td>2.56 (9.18)e</td>
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<td>1.00</td>
<td>5.16 (13.05)bcede</td>
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<td>5.60 (17.07)abc</td>
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<td></td>
<td>5.00</td>
<td>7.69 (15.89)abc</td>
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<tr>
<td></td>
<td>0.50</td>
<td>3.60 (10.68)de</td>
</tr>
<tr>
<td></td>
<td>1.00</td>
<td>3.73 (10.95)de</td>
</tr>
<tr>
<td></td>
<td>2.50</td>
<td>5.11 (13.03)bcede</td>
</tr>
<tr>
<td></td>
<td>5.00</td>
<td>6.16 (14.05)bcede</td>
</tr>
<tr>
<td>Neem seed kernel + <em>Aloe vera</em> + <em>Calotropis</em> + <em>Clerodendron</em> leaf extract</td>
<td>10.00</td>
<td>10.8 (19.19)a</td>
</tr>
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<td></td>
<td></td>
<td>SEm ±</td>
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<td></td>
<td></td>
<td>CD at 5%</td>
</tr>
</tbody>
</table>

* mean of three of three replication (n= varying number)
** mean of three of three replication (n=60)
Figures in parentheses are angular transformed values
Mean values with the same alphabetical superscript within a column are not significantly different at 5 per cent level of significance
ovicidal activity. A maximum of 10.80 and 10 per cent egg mortality was caused by neem seed kernel + *Aloe vera* + *Calotropis* + *Clerodendron* leaf extract and neem fruit + red chilli + custard apple leaf extract at 10 per cent concentration, respectively. The rest of the test products *viz.*, chilli + garlic extract, cow urine, panchagavya and dasagavya caused less than 9 per cent ovicidal action even at highest concentrations.

All the test products were detrimental to larval stage of the two spotted spider mite compared to the eggs. At 10 per cent concentration chilli + garlic extract, neem seed kernel + *Aloe vera* + *Calotropis* + *Clerodendron* leaf extract, neem fruit + red chilli + custard apple leaf extract caused 93.91, 91.72, 87.23 and 87.09 per cent larval mortality, respectively and were statistically on par. At higher concentrations of 100 and 20 per cent, cow urine and panchagavya caused 91.72 and 91.31 per cent larval mortality, respectively, but were on par with the above products at 10 per cent concentration. Even at lower concentrations (1 to 5 per cent) neem seed kernel + *Aloe vera* + *Calotropis* + *Clerodendron* leaf extract, chilli + garlic extract, panchagavya and neem fruit + red chilli + custard apple leaf extract showed considerable acaricidal activity against larvae causing 23.19 to 86.55 per cent mortality. Cow urine at 5 to 50 per cent concentration caused 30.33 to 64.47 per cent larval mortality.

The indigenous products were found toxic to adult mites, but adults were relatively less susceptible compared to the larvae. Neem seed kernel + *Aloe vera* + *Calotropis* + *Clerodendron* leaf extract at 10 per cent, panchagavya at 20 per cent and cow urine at 100 per cent caused 71.70, 83.30 and 85.60 per cent adult mortality, respectively and were statistically on par. At 5 per cent concentration, neem seed kernel + *Aloe vera* + *Calotropis* + *Clerodendron* leaf extract, neem fruit + red chilli + custard apple leaf extract and chilli + garlic extract caused 62.10, 55.20 and 56.30 per cent adult mortality, respectively and were superior to
other products. Cow urine at very high concentrations (25 to 100 %) caused 39.50 to 85.60 per cent mortality of adult mites. Acaricidal property of the test products increased with the increase in test concentration.
Discussion
V. DISCUSSION

In recent years, organic farming is drawing more attention of farming community mainly due to drawbacks associated with the use of agricultural chemicals and the increasing demand for organic foods. In southern Karnataka, a good number of farmers are practising organic farming and the Karnataka state department of agriculture is also encouraging the farmers to switch over to organic farming. Though the farmers have been largely successful in substituting chemical fertilizers with organic sources of nutrients, but there is a lot of confusion among the farmers about the practices to be adapted to manage pests and diseases of the crops. Most farmers use preparations containing water extracts of locally available plants, cow urine, dung etc. These practices vary from region to region and farmers to farmers. In the present study, efforts were made to document the indigenous plant protection practices followed by organic farmers in southern districts of Karnataka and to investigate on the insecticidal or acaricidal properties of some of the products using two insect species and a spider mite species. Information on indigenous plant protection practices were collected by personally interviewing the farmers and the results of the laboratory investigations to ascertain the insecticidal and acaricidal properties of some products are discussed in this chapter.

5.1 Documentation of indigenous plant protection practices followed by farmers in different cropping systems in Southern Karnataka

Intensive surveys were conducted in eight districts of southern Karnataka viz., Tumkur, Mandya, Bangalore, Shimoga, Hassan, Chikamagalur, Udupi and South Canara to document indigenous pest management practices followed by the farmers. Totally, 100 plant
protection practices were documented and for convenience, these practices were grouped into purely plant-based (28 products), cow urine-based (36 products), cultural or mechanical practice, other products (24 products / practices), kerosene-based (3 products) and commercial preparations of unknown composition (9 products).

The plant based products used by the organic farmers varied from place to place (Table 10 and 11). In general, the products derived from *Pongamia pinnata*, turmeric powder, *Lantana camara*, *Vitex negundo*, neem, *Calotropis*, custard apple, *Acorus calamus* (baje), *Gymnema sylvestre* (madhunashini), *Leucas aspera* (thumbe), *Parthenium* and *Agave americana* were used commonly by organic farmers in Bangalore, Tumkur, Mandya, parts of Hassan and Chikamagalur districts. Apart from these, Kiratha kaddi, *Derris elliptica*, *Melia azadarach*, *Chrysanthemum cinerariaefolium*, *Adathoda vasica*, *Curcuma domestica*, *Nicotiana tabaccum*, *Ocimum basilicum*, *Anacardium occidentale*, *Eucalyptus* sp. *Lycopersicon esculentum*, *Piper betle*, *Strychnos nuxvomica* and *Lasiosiphon eriocephalus* are most popular in the hilly areas of Shimoga and parts of Hassan and Chikamagalur districts. In coastal districts of the Karnataka (Udupi and dakshina kannada) and parts of the Chikkamagalur the products containing *Euphorbia tirucalli* (kolukalli), *Nerium oleander* (kanigilu), *Pterocarpus marsupium* (honne), *Xanthoxylum rhetsa* (jummana mara), *Butea monosperma* (mutthuga), young shoots and inflorescence of bamboo, ganganamara, *Lasiosiphon eriocephalus* (mukkdaka), curry leaf, *Adathoda vasica* (adusoge) and *Jatropha* were commonly use in plant protection. Most of the plants listed have been known to possess insecticidal properties since ancient time and their use in plant protection by the farmers in different parts of the country has been reported. Prabu (2008b) reported that farmers in Kozhikottu Pothai, a small village in Kanyakumari district (Tamil Nadu), use *Pongamia* and neem leaf and seed kernel extract against many pests.
Anon., (2009b) reported use of custard apple leaf extract (against DBM, aphids, BPH, defoliator), *Acorus calamus* leaf extract (against beetles, fruit fly and army worm), *Lantana* leaf extract (against caterpillars and defoliators), *Vitex negundo* leaf extract (against all pests) and *Calotropis* leaf extract (against termites) was popular among the farmers.

Among the cow-urine based products jeevamrutha, panchagavya, jeevasara, mosaru maddu and other products including mixture of cow urine and plant extracts were commonly used by the farmers. Jeevamrutha which is basically used as plant growth promoter is popular in Dakshina Kannada, Mandya, Shimoga, Hassan and Chikkamagalur districts and the modified form of jeevamrutha is popular in Bangalore where plant extracts are added to the jeevamrutha to add the insecticidal properties. The use of jeevamrutha was popularized by Subhash Palekar to provide a congenial environment for microorganisms that would in turn enhance the availability of essential nutrients to plants (Anon., 2000c). The use of modified form of panchagavya and jeevasara were popular in Hassan district to promote the plant growth. Somasundaram and Amanullah (2007) reported that modified panchagavya acted both as a fertilizer and a bio-pesticide and it was one of the sustainable inputs for organic production of crops. Mosaru maddu was used in Chikkamagalur district and Amruth sanjeevini is popular in Tumkur. Mihale (2009) reported that farmers in Tanzania prepare a organic pesticide using animal products like cow urine, cow dung, plant extracts like *Azadirachta indica*, *Tephrosia vogelii*, *Tamarindus indica*, *Aloe* sp., red pepper, *Capsicum* sp., *Nicotiana tabacum* and ash to manage pests of field crops. They also use neem, *Chenopodium opulifolium*, *Ocimum* sp., *Senna siamea*, tobacco and *Eucalyptus* and plant products such as rice husk, ash of rice husk and maize cobs to control storage pests. Most of these products were used in one or the other way in different forms. Ranga Rao *et al.* (2007) observed
Table 10. List of plants / plant products used by the organic farmers in the different districts of South Karnataka

<table>
<thead>
<tr>
<th>Si, no,</th>
<th>Districts</th>
<th>Plants / plant products</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tumkur</td>
<td><em>Gliricidia</em>, neem, groundnut cake, <em>Pongamia pinnata</em> (L.), turmeric powder, <em>Aegle marmelos</em> (bilvapatre) and <em>Lantana camara</em></td>
</tr>
<tr>
<td>3</td>
<td>Bangalore</td>
<td><em>Agave americana</em>, neem leaf extract, <em>Pongamia</em> leaf extract and neem seed cake</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th></th>
<th>Place</th>
<th>Plants and Fruits</th>
</tr>
</thead>
</table>
that product prepared by using cow urine, cow curd, jaggery and bread yeast was effective against many pests of crops.

Organic farmers generally follow different cultural practices to manage the crop pests as a preventive measure. The establishment of live fence around the fields and adoption of multi cropping systems was common in Tumkur region, whereas spraying of jaggery solution for the management sugarcane woolly aphid and multiple cropping systems were popular in Mandya district. For the management of coconut mite, farmers in Tumkur region applied neem or *Pongamia* cake in trenches around the trees, crushed naphthalene balls and camphor were used as repellents against coconut mite in Shimoga district. Farmers in Hassan district believe that the mite can be controlled by growing horse gram as an intercrop in coconut gardens. For the management of coffee berry borer, organic farmers in Chikamagalur commonly used traps containing 10 per cent toddy or yellow plastic sheet smeared with an adhesive on both the sides or spraying products containing *Beauveria bassiana*.

Storage pests have been effectively managed more traditionally by treating the seeds with a paste prepared from roots of baje + leaves of ashvagandha and ummatthi leaves + goat milk. Other practices included storing seeds in a separate structure which is locally called as “mudi kattuvadu”, placing the seeds in the middle portion of the chimnies in the kitchen, mixing of paddy seeds with salt and neem leaves, and mixing of ash with pulse seeds and storing in the gunny bag (Table 1).

The present survey also revealed that some of the farmers prepared organic products on a commercial scale for the management of crop pests. The commercial products included, Hasiru, Hasiru Siri, Hasiru Shakti, Nisarga liquid, Prajwal, Vijnana, NCG liquid, Ayurvedic rose mix and Thrishika. Out of nine products NCG liquid was recommended for the suppression of coconut mite, Thrishika against termites, Hasiru for
the management of leaf roller, leaf hoppers, leaf miners, mites, hairy caterpillars, shoot and fruit borers and the remaining products as general insecticide for use on different crops.

5.2 Assessment of insecticidal / acaricidal properties of selected indigenous product.

Panchagavya, dasagavya, chilli + garlic extract, neem fruit + red chilli + custard apple leaf extract and neem seed kernel + Aloe vera + Calotropis + Vitex + Clerodendron leaf extract were tested against diamondback moth, cowpea aphid and the two spotted spider mite for their insecticidal or acaricidal properties.

In general, the killing effect, antifeedant and repellent activity and effect on growth and development exhibited by the indigenous products against test insects and the mite could be attributed to presence of secondary metabolites in the plants possessing defensive action against insects and also as chemical cues.

The biological effects of panchagavya on test insects and the mite were studied under laboratory conditions. Many of the organic farmers use panchagavya at 3 per cent concentration. In the present investigations, panchagavya at 2.5 per cent concentration caused 27.56 per cent repellency (Figure 1), 35.15 per cent feeding deterrence and 33.30 per cent reduction in weight gained by DBM larvae (Figure 2). But negligible larval and pupal mortality were recorded when second and fourth instar larvae were treated with these products (Figure 3). In the case of cowpea aphid very low levels of walk-off response and insecticidal activity were recorded (Figure 4). Though panchagavya (at 2.5 % concentration) had very low ovicidal action (3.33 %) against two spotted spider mite, it caused moderate level of larval and adult mortality (29.58 and 38.10 %, respectively). At higher concentrations of 5 and 10 per
Figure 1. Repellent activity of indigenous products against fourth instar larvae of *P. xylostella*

T1 – Pachagavya,         T2 - Cow urine,         T3 – Dasagavya,
T4 - Chilli + garlic extracts,   T5 - Neem fruit + red chilli + custard apple leaves extract and,
T6 - Neem seed kernel + *Aloe vera* + *Calotropis* + *Clerodendron* leaf extract
Figure 2. Antifeedant activity of indigenous products against fourth instar larvae of *P. xylostella*

T1 – Pachagavya,  
T2 - Cow urine,  
T3 – Dasagavya,  
T4 - Chilli + garlic extracts,  
T5 - Neem fruit + red chilli + custard apple leaves extract and  
T6 - Neem seed kernel + *Aloe vera* + *Calotropis* + *Clerodendron* leaf extract
Fig. 3, Effect of indigenous products on development of second and fourth instar larvae of *P. xylostella*

T1 – Pachagavya,  
T2 - Cow urine,  
T3 – Dasagavya,  
T4 - Chilli + garlic extracts,  
T5 - Neem fruit + red chilli + custard apple leaves extract and  
T6 - Neem seed kernel + *Aloe vera* + *Calotropis* + *Clerodendron* leaf extract
Figure. 4, Insecticidal activity of indigenous products against *A. craccivora*

T1 – Pachagavya,   T2 – Cow urine,   T3 – Dasagavya,  
T4 - Chilli + garlic extracts,   T5 - Neem fruit + red chilli + custard apple leaves extract and  
T6 - Neem seed kernel + *Aloe vera* + *Calotropis* + *Clerodendron* leaf extract
cent, panchagavya exhibited relatively higher levels of repellent, antifeedant and insecticidal properties, however, it is never used at these concentrations in the field by farmers. About 7.5 litre of panchagavya is required per acre when it is used at 3 per cent concentration and the cost of which will be Rs. 300. In other studies done elsewhere, panchagavya in combination with NSKE exhibited 30.14 per cent antifeedant activity against *Spodoptera litura* followed by a combination product of *Adathoda vesica* and panchagavya (Bharati, 2005). As observed in the present investigations, the ineffectiveness of panchagavya against aphids was also observed by Jayashankar et al. (2002) who reported aphid infestation on crops within four days after spraying. While, panchagavya is basically used by organic farmers as a plant growth promoter and is known to contain almost all major and micro nutrients, fatty acids, alcohols, alkanes, growth hormones (IAA and GA) and fermentative micro organisms like yeast and *Lactobacillus*. There is hardly any information on its insecticidal or acaricidal properties. Yeast and *Lactobacillus* also produces various metabolites such as organic acids, hydrogen peroxide and antibiotics which are believed to be responsible for observed effects of panchagavya (Somasundaram and Amunullah, 2007).

The cow urine is used by farmers at 10 per cent concentration and even at this concentration, it showed very low insecticidal activity resulting in low levels of larval and pupal mortality of DBM. However, at this concentration, it showed moderate level of antifeedant activity (28.34 %), with corresponding reduction in larval weight gained (24.00 %). The repellent (49.77 %) activity was also relatively high. Antifeedant and repellent activities increased with increase in concentrations. The phytotoxic effect was observed when mustard leaves were treated with cow urine without any dilution. Against cowpea aphid, it resulted in very low level of walk-off response and showed negligible insecticidal activity.
even at higher concentrations (Figure 4). The exposure of two spotted spider mite to cow urine (10 %) resulted in maximum mortality i.e. 43.50 and 30.83 per cent of adult and larval stages, respectively. The ovicidal and repellent activities were very low or negligible at all the concentrations (Figure 5). Similar observations were made by Das et al. (2004g) who tested the efficacy of cow urine and cow dung against cabbage pests. There was reduction in the incidence of diamondback moth, but the decrease in pest incidence was not consistent. In other studies cow urine, with aqueous extracts of botanicals the combination of cow urine at 10 per cent with NSKE, *C. gigantia*, *V. negundo*, *A. mexicana* and *A. visica* extract showed increase in mortality of third instar larvae of *S. litura* than when they were used separately. Cow urine with *C. gigantia* caused 70 per cent mortality, whereas sole application of *C. gigantia* inflicted only around 12 per cent mortality (Bharati. 2005). Similar results were obtained by Baraptre and Lingappa (2003) when cow urine along with NSKE, *Pongamia*, *Vitex* and *Aloe* were used against *S. litura* and *H. armigera*. This was attributed due to release of more number of secondary metabolites from botanicals when combined with cow urine and also increased microbial activity in fermented extracts compared to the aqueous extracts of botanicals alone. A field study conducted at Himachal Pradesh showed that, cow urine spray was effective in controlling aphid on cabbage, but, a similar study conducted at IIHR, Bangalore, revealed that the cow urine treatment was not effective in reducing the aphid population on cabbage (Das et al., 2004g). Also the present study indicated insignificant insecticidal activity of cow urine against cowpea aphid. The possible reason for biological activity of cow urine is attribute to the presence of constituents like minerals (Ca, Mg, SO3, silica, NaCl, sulphates of Ca and Mg N, P and K), uric acid, allantoin, allantoic acid, amino acids (glycine, arginine, methionine, etc.), creatinine, carbonic acid, carbonates, bicarbonates, hippuric acid,
Figure 5, Repellent activity of indigenous products against adults of two spotted spider mite, *T. urticae* Koch

T1 – Pachagavya,  
T2 – Cow urine,  
T3 – Dasagavya,  
T4 - Chilli + garlic extracts, T5 - Neem fruit + red chilli + custard apple leaves extract,  
T6 - Neem seed kernel + *Aloe vera* + *Calotropis* + *Clerodendron* leaves extracts and  
T7 – Control
precipitins, DHEA, natural cortisone, urine peptides, vitamins (A, B, C, D and E), malic acid, citric acid, succinic acid and some hormones and enzymes that might have additive or synergistic effects (Das et al., 2004g). The cow urine was also believed to serve as a repellent to many pests and also as an attractant to beneficial insects, like wasps. (Ranga Rao et al., 2007).

The dasagavya exhibited moderate level of insecticidal activity against DBM, but it was not toxic to the aphid. On mites, it caused a maximum of 71.68 and 35.60 per cent mortality of larval and adults stages, respectively, at 50 per cent concentration. It exhibited good repellent and antifeedant activity against DBM (58.95 and 38.37 per cent respectively) at 20 per cent concentration, but against the cowpea aphid and the spider mite, the repellent activity was low. There is no literature on biological activity of dasagavya against insects or mites for comparison. It is believed that the lantana leaves one of the constituents of dasagavaya contain beta-coryaphyllone (23.3 %), alpha-hamalene (11.5 %), germacrone-D (10.97 %), davanone (7.3 %) and gamma-caraemene (6.3 %), which might be responsible for insecticidal, antifeedant, repellent and growth inhibitory activity on certain insects (Rena et al., 2004).

Chilli + garlic extract (10 %) treatment against mites caused 93.91 and 65.60 per cent of larval and adult mortality, respectively compared to lower insecticidal activity against DBM (13.32 % mortality both in second and fourth instar larvae) and the aphid (11.67 % mortality). The repellent activity was observed to be low against aphid and the mite, but it was fairly high against DBM larvae (45.36 %). Its antifeedant (20.30 %) activity against DBM was low compared to other products. Rastogi and Mehrotra (1993 and 1995) reported that chilli fruits contain capsaicin, and the roots, cortex and seeds contain saponin-capsicidin.
which might be responsible for ovipositional deterrence, insecticidal and repellent activities. The effectiveness of garlic as pesticide is attributed to the volatile oil which contains diallyl sulphide, diallyl disulphide, diallyl trisulphide, allylmethyl disulphide, allylmethyl trisulphid and sulfoxides. Ovicidal, repellent, insecticidal and nematicidal effects of garlic extract have been documented Dodia et al. (2008c).

An indigenous product, neem fruit + red chilly + custard apple leaf extract exhibited a wide range of biological activity against DBM and the mite. It caused 21.19 to 87.46 and 23.33 to 90.00 per cent mortality of second and fourth instar larvae of DBM, respectively, at 0.5 to 10.00 per cent concentrations. It also exhibited fairly good levels of repellent (20.52 to 57.24 %) and antifeedant activities (9.43 to 40.92 %) against fourth instar DBM larvae. The morphogenic effects of the products were evident in the adult stage when last instar DBM larvae were exposed to the product. The product had fairly good level of acaricidal activity against larval and adult stages (87.09 % and 65.20 % mortality, respectively) of the mite, but ovicidal action was negligible (Figure 6). The insecticidal activity against the aphid, the walk-off response / repellent activity against both aphid and the mite were low. The insecticidal, antifeedant and repellent activities of neem against caterpillar pests has been documented (Kumar and Parmar, 1998). Likewise, the presence of long chain fatty acid derivatives i.e acetogenins has been attributed to the biological activity of custard apple against many insects (McLaughlin et al., 1997). However, the biological activity of these products in combination with chilli is superior to the effects of individual compounds which needs to be investigated further.

Another indigenous product neem seed kernel + Aloe vera + Calotropis + Vitex + Clerodendron leaf extract at 10 per cent concentration was highly detrimental to DBM causing cent per cent
Figure 6. Acaricidal property of indigenous products against different life stages of two spotted spider mite, *T. urticae* koch

T1 – Pachagavya,  
T2 - Cow urine,  
T3 – Dasagavya,  
T4 - Chilli + garlic extracts,  
T5 - Neem fruit + red chilli + custard apple leaf extract and  
T6 - Neem seed kernel + *Aloe vera* + *Calotropis* + *Clerodendron* leaf extract
mortality of both second and fourth instar larvae (Figure 3), the surviving larvae at lower concentrations showed delayed development, suffered mortality at pupal stage and majority of the emerged adults were abnormal. The product also exhibited high level of repellent (86.62 %) and antifeedant (64.45) activities. It was moderately toxic to the aphid (26.67 % mortality) but had fairly good acaricidal activity causing 87.23 and 71.70 per cent larval and adult mortality at 10 per cent concentration, respectively. The product had very low or no repellent action against mite and the aphid. The observed effect of the product against the test organisms is attributed to the chemical compounds present in the individual plants, in case of neem, the major compounds would be triterpenes (limonoids) which an ability to block growth in a wide range of pest species. The triterpenoids present in the neem seed include protomeliacins, azadirones, gedunin, vilasinins, salanins, nimbins and azadirachtins (Kumar and Parmar, 1998). Aloe vera contains constituents like, isobarbaloin, β-barbaloin, aloesin, agycone aloesone, aloes-emodin, aloin A, aloin B, and resins (Dodia et al., 2008b), the Calatropis latex has a faint smell, subacid taste and gives acid reaction. It is known to contain triterpene calotropenyl acetate and other compounds like calotokin, uscharin, calactin, β-amyrin, α-amyrin, tetraxasterol and β-systosterol (Rastogi and Mehrotra, 1993 and 1995). V. negundo, the flavonoides-α-pinene, limonene, linalool and camphy have been identified from these essential oils, vitexin in bark and the alkaloid vitricin, a flavonoid, pendicularisin and negundoside from leaves (Rastogi and Mehrotra, 1993 and 1995). The insecticidal property in Clerodendron is attributed to the presence of trans-decalin (Dhaliwal and Arora, 2001). Rastogi and Mehrotra (1993 and 1995) reported that a diterpene, uncinatone, isolated from leaves and stem of Clerodendron inhibited feeding of adult rice weevil. The efficacies of Calatropis leaf extract against leaf folder in rice was confirmed by Baskaran and
Narayanaswamy (1995) and they attributed its effect to the presence of an antifeedant.

From the overall findings of the present investigations, it is inferred that

- Totally, 100 plant protection products / practice are employed by the organic farmers of southern Karnataka in different cropping system

- Laboratory assessment of test products revealed that panchagavya, cow urine, dasagavya and chilli + garlic extract have low insecticidal activity compared to neem seed kernel + Aloe vera + Calotropis + Clerodendron leaf extract and neem fruit + red chilli + custard apple leaf extract. However, these products possess very good levels of repellent and antifeedant properties against DBM. All the test products have very low repellent and insecticidal activity against cowpea aphid. The test products also have moderate to high levels of acaricidal property against the two spotted spider mite with very low repellent and ovicidal action.
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Common name</th>
<th>Scientific name</th>
<th>Pests</th>
<th>Insecticidal Property</th>
<th>Insecticidal Compounds</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Karanja or Pongmia</td>
<td><em>Pongamia pinnata</em> Vent. (Fabaceae)</td>
<td>Rice weevil, pulse beetle, white grub, tobacco caterpillar, gram pod borer and potato tuber moth</td>
<td>Repellent, ovicidal, insecticidal and antifeedant activity</td>
<td>Karanjin-a furaflavone, pongamol, pongone and pongapin</td>
<td>(Rastogi and Mehrotra, 1993 and 1995)</td>
</tr>
<tr>
<td>2</td>
<td>Neem or margosa tree</td>
<td><em>Azadirachta indica</em> A. (Meliaceae)</td>
<td>Almond moth, locust, been beetle, DBM, sugarcane root borers, semi-looper, tobacco caterpillar, aphid and gram pod borer</td>
<td>Ovicidal, repellent, antifeedant, insecticidal and IGR activity</td>
<td>Azardirachtin, limonoids, meliantriol, salannin, nimbin and nimbiden</td>
<td>(Kumar and Parmar, 1998)</td>
</tr>
<tr>
<td>3</td>
<td>Gliricidia</td>
<td><em>Glyricidia sepium</em> Kunth. Leguminosae</td>
<td>European corn borer</td>
<td>Insecticidal and repellent activity</td>
<td>Gliricidol, sepinol, and isomuronulatol</td>
<td>(Rastogi and Mehrotra, 1993 and 1995)</td>
</tr>
<tr>
<td>4</td>
<td>Bilvapatre</td>
<td><em>Aegle marmelos</em> Linn. (Rutaceae)</td>
<td>Storage pests of rice, green leafhopper</td>
<td>Insecticidal</td>
<td>-</td>
<td>(Prakash <em>et al.</em>, 1982)</td>
</tr>
<tr>
<td>5</td>
<td>Chilli</td>
<td><em>Capsicum annuum</em> Linn. (Solanaceae)</td>
<td>Storage pests</td>
<td>Insecticidal and repellent activity</td>
<td>Capsaicin and saponin-capsicidin</td>
<td>(Rastogi and Mehrotra, 1993 and 1995)</td>
</tr>
</tbody>
</table>

Cont..
<p>| 6 | Crown plant | <em>Calotropis gigantean</em> Ait. (Asclepiadaceae) | Rice weevil, jute hairy caterpillar, locust, aphids, sugarcane top shoot borer, brinjal spotted leaf beetle | Repellent, insecticidal, antifeedant, Acrical and fungicidal activity | Calotropenyl and Calotoxin (Oudhia and Tripathi, 1997) |
| 7 | Custard apple | <em>Anona squamosa</em> linn. (Annonaceae) | Rice weevil, mango hopper, cotton staine, green leaf hopper, hairy caterpillar | Repellent, insecticidal and antifeedant activity | Annonin or squamocin and asimicin (Raman et al., 2004) |
| 8 | Sweet flag | <em>Acorus calamus</em> Linn. (Araceae) | Rice weevil, pulse beetle, rice moth lesser gain borer, khapra beetle, rice moth, termite, | Repellent, ovicidal insecticidal, antifeedant and IGR activity | Methyleugenol, calamenol, β-asarone (cis) and α-asarone (Sharma, 2004) |
| 9 | Madhunahi ni | <em>Gymnema sylvestre</em> (Retz.) Schult. (Asclepidaceae) | Spodaptera litura and other storage pests | Antifeedant | Gymnemic acid (Granich et al., 1974) |
| 11 | Carrot grass | <em>Parthenium hysterophorus</em> Linn. (Asteraceae) | Pericalia recini, Spodaptera litura, cabbage leaf webber, migratory grasshopper pulse beetle | Insecticidal, ovicidal and antifeedant activity | Parthenin (Datta and Sexena, 2001) |
| 12 | Kiratha kaddi or king of bitters | <em>Andrographis paniculatus</em> (Burm f.) wall. ex ness (Acanthaceae) | Grasshopper, whorl maggots, paddy pest <em>Spodaptera litura</em> and Angoumois grain moth and rice weevil, | Nematicidal, insecticidal and antifeedant property | - (Gupta et al., 1990) |</p>
<table>
<thead>
<tr>
<th>No.</th>
<th>Plant Name</th>
<th>Scientific Name</th>
<th>Pest Types</th>
<th>Natural Products</th>
<th>References</th>
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</thead>
<tbody>
<tr>
<td>13</td>
<td>Derris or duba-root</td>
<td><em>Derris elliptica</em> (wall.) Benth (Fabaceae)</td>
<td>DBM, mustard web worm, mustard web moth, white mustard rosette worm, webworm or DBM, mustard web worm</td>
<td>Insecticidal property</td>
<td>Rotenone (Srimannarayan and Rao, 1985)</td>
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<td>15</td>
<td>Giant green pepper</td>
<td><em>Capsicum frutescens</em> Linn. (Solanaceae)</td>
<td>Rice weevil</td>
<td>Insecticidal and repellent</td>
<td>- (Debkirtaniya et al., 1980)</td>
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<tr>
<td>16</td>
<td>Pride of India / dharek</td>
<td><em>Melia azaderach</em> Linn. (Myrtaceae)</td>
<td><em>Spodaptera litura</em> and <em>Hliothis zea</em></td>
<td>Repellent, insecticidal, antifeedant, ovicidal and acaricidal activity</td>
<td>Terpinoids, limonoids, flavonoids, acids, anthraquinone and steroids (Kumar et al., 2003)</td>
</tr>
<tr>
<td>17</td>
<td>Pyrethrum plant or Marigold</td>
<td><em>Chrysanthemum cinerarfolium</em> L. (Compositae)</td>
<td>Pulse beetle, cabbage worm and aphids</td>
<td>Repellent, insecticidal antifeedant and acaricidal activity</td>
<td>Pyrethrin-I, Pyrethrin-II, cinerin-I, cinerine-II and jasmolin I &amp; II (Stoll, 2000)</td>
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<td>18</td>
<td>Turmeric</td>
<td><em>Curcuma longa</em> (Zingiberaceae)</td>
<td>Flour beetle</td>
<td>Repellent activity</td>
<td>Curcumin and curcumol (Rastogi and Mehrotra, 1993 and 1995)</td>
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<tr>
<td>20</td>
<td>Sweet basil</td>
<td><em>Ocimum basilicum</em> L. (Lamiaceae)</td>
<td>Milkweed bug</td>
<td>Juvenile hormone analogue mimic</td>
<td>Juvocimene-I, juvocimene-II and ocimin (Kathuria and Kaushik, 2005)</td>
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<td>21</td>
<td>Betel pepper</td>
<td><em>Piper betle</em> Linn. <em>(Piperaceae)</em></td>
<td>Bean leaf beetle, melon worm and cotton stainer</td>
<td>Insecticidal property</td>
<td>(Jacobson, 1975)</td>
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<td>22</td>
<td>Tomato</td>
<td><em>Lycopersicon esculentum</em> Mill. <em>(Solanaceae)</em></td>
<td>Cabbage butterfly, flies and bees, Colorado potato beetle and leaf hopper</td>
<td>Repellent activity</td>
<td>2-tridecanone</td>
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<td>23</td>
<td>Century plant</td>
<td><em>Agave americana</em> Linn. <em>(Amaryllidaceae)</em></td>
<td>Rice weevil</td>
<td>Repellent activity</td>
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<td>24</td>
<td>Kasaraka</td>
<td><em>Strychnos nux-vomica</em> Linn. <em>(Longaniaceae)</em></td>
<td>Defoliator coccinellid</td>
<td>Insecticidal</td>
<td>Strychnine and brucine</td>
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<td>25</td>
<td>Mukkdaka</td>
<td><em>Lasiosiphon eriocephalus</em></td>
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<td>26</td>
<td>Castor</td>
<td><em>Ricinus communis</em> Linn. <em>(Euphorbiaceae)</em></td>
<td>Pulse beetle, rice weevil, leafhopper, whitefly and spotted leaf beetle</td>
<td>Insecticidal, repellent and antifeedant</td>
<td>Ricin and ricinne</td>
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<tr>
<td>27</td>
<td>Eucalyptus</td>
<td><em>Eucalyptus globulus</em> Labill <em>(Myrtaceae)</em></td>
<td>Woolly apple aphids, cotton stainer, rice moth, lesser grain borer and pulse beetle</td>
<td>Insecticidal juvenile-mimetic and repellent</td>
<td>Camphene, limonene, linalool, α&amp;β pinenes</td>
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<td>28</td>
<td>Coriander seed</td>
<td><em>Coriandrum sativum</em> Linn. <em>(Apiaceae)</em></td>
<td>Colorado potato beetle and leafhopper</td>
<td>Insecticidal and ovicidal activity</td>
<td>-</td>
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<tr>
<td>29</td>
<td>Kolukalli or milk bush</td>
<td><em>Euphorbia maculate</em> Linn. <em>(Euphorbiaceae)</em></td>
<td>Citrus aphid</td>
<td>Insecticidal and repellent</td>
<td>-</td>
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<tr>
<td>30</td>
<td>Indian aloes</td>
<td><em>Aloe vera</em> Mill. <em>(Liliaceae)</em></td>
<td>Mustard sawfly, lace wing and teak skeletonizer</td>
<td>Larvicidal</td>
<td>Aloin and aloesin</td>
</tr>
<tr>
<td>31</td>
<td>Kanigilu</td>
<td><em>Nerium oleander</em> Mill. <em>(Apocynaceae)</em></td>
<td>Red flour beetle and rice weevil</td>
<td>Insecticidal</td>
<td>Oleanderol and oleanderin</td>
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<tr>
<td>No.</td>
<td>Sample Name</td>
<td>Scientific Name</td>
<td>Taxonomy</td>
<td>Activity Type</td>
<td>Active Substance</td>
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<tr>
<td>32</td>
<td>Curry leaf</td>
<td><em>Murraya koenigii</em> Linn. (Rutaceae)</td>
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<tr>
<td>34</td>
<td>Indian Kino Tree</td>
<td><em>Ptrocarpus marsupium</em> Linn. (Fabaceae)</td>
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<td>-</td>
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<tr>
<td>35</td>
<td>Mutthuga (Flame of forest)</td>
<td><em>Butea monosperma</em> Lamk. (Papilionaceae)</td>
<td><em>Spodaptera litura</em></td>
<td>-</td>
<td>Juvenile hormone analogue activity</td>
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<tr>
<td>36</td>
<td>Bamboo</td>
<td><em>Shibataea kumasasa</em> makino (Poacea)</td>
<td>Vinegar fly</td>
<td>Insecticidal</td>
<td></td>
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<td>37</td>
<td>Gangganamara</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>39</td>
<td>Barbados nut</td>
<td><em>Jatropha curcas</em> Linn. (Euphorbiaceae)</td>
<td>Leaf cutting larvae and Potato tuber moth</td>
<td>Insecticidal and ovicidal activity</td>
<td>-</td>
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<tr>
<td>40</td>
<td>Eupatorium</td>
<td><em>Chromolaena odorata</em> (L.) King &amp; Robinson</td>
<td><em>Dysdercus cingulatus</em></td>
<td>Inhibit the growth and development</td>
<td>4-desoxy-8-epi-vangustin, isoalantolactone and diplophylloide</td>
</tr>
<tr>
<td>41</td>
<td>Rose of china or shoe flower</td>
<td><em>Hibiscus rosa-sinensis</em> Linn. (Malvaceae)</td>
<td>Rice weevil</td>
<td>-</td>
<td>-</td>
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<tr>
<td>No.</td>
<td>Plant Name</td>
<td>Scientific Name</td>
<td>Common Names</td>
<td>Uses</td>
<td>Active Principles</td>
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<td>----------------------------------</td>
<td>-----------------------------------</td>
<td>-------------------------------------</td>
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<tr>
<td>42</td>
<td>Bheedi soppu</td>
<td><em>Diospyros virgniana</em> Linn. (Ebenaceae)</td>
<td>Termite</td>
<td>Insecticidal</td>
<td>7-methyl juglone</td>
</tr>
<tr>
<td>43</td>
<td>Ashvagandha</td>
<td><em>Withania somnifere</em> Linn. (Solanaceae)</td>
<td><em>Sodoptera litura</em></td>
<td>Antifeedant</td>
<td>Nicalin-A, and 8-withanolids</td>
</tr>
<tr>
<td>44</td>
<td>Ummatthi or black datura</td>
<td><em>Datura metel</em> Linn. (Solanaceae)</td>
<td><em>Sodoptera litura</em>, pulse beetle</td>
<td>Larvicidal, repellent and antifeedant</td>
<td>Hyoscyamine, atropine and scopolamine</td>
</tr>
<tr>
<td>45</td>
<td>Kavate soppu</td>
<td><em>Zanthoxylum alatum</em> Roxb. (Rutaceae)</td>
<td>Migratory locust</td>
<td>Antifeedant</td>
<td>-</td>
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<td>46</td>
<td>Lantana</td>
<td><em>Lantana camera</em> Linn. (Asteraceae)</td>
<td>Corn weevil, aphids, potato tuber moth, leaf beetle, semilooper, bihar hairy caterpillar silkmoth</td>
<td>Repellent, insecticidal and antifeedant activity</td>
<td>Lantic acid and lantanolic acid</td>
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</table>
Summary
VI SUMMARY

India is recognised world wide as a country where indigenous technical knowledges have been evolved and carried over to many generations. In recent years, the organic farmers have begun to use indigenous products as a substitute for the synthetic chemicals to improve the quantity and quality of products as the demand for organic food in the world market is increasing. In the present study, efforts were made to document the indigenous plant protection practices followed by organic farmers in eight districts in southern Karnataka and to assess insecticidal / acaricidal properties of selected indigenous products against two tests insects and a spider mite under laboratory conditions. The plant protection practices documented and the finding of laboratory investigations are summarised hereunder.

Intensive surveys were conducted in eight districts of southern Karnataka viz., Tumkur, Mandya, Bangalore, Shimoga, Hassan, Chikamagalur, Udupi and Dakshina Kannada to document indigenous pest management practices followed by the farmers. About 100 plant protection practices were documented and were grouped into purely plant-based, cow urine-based, kerosene-based products, commercial preparations, cultural and mechanical methods etc.

Eucalyptus globulus, Lycopersicon esculentum, Piper betle, Strychnos nuxvomica and Lasiosiphon eriocephalus were popular in the hilly areas of Shimoga and parts of the Hassan and Chikamagalur districts. In the coastal areas of Karnataka (Udupi and Dakshina Kannada) and parts of Chikamagalur the plant preparations containing parts of Euphorbia tirucalli (kolukalli), Nerium oleander (kanigilu), Pterocarpus marsupium (honne), Xanthoxylum rhetsa (jummana mara), Butea monosperma (mutthuga), young shoots and inflorescence of bamboo, gangganamara, Lasiosiphon eriocephalus (mukkdaka), curry leaf, Adathoda vasica (adusoge) and Jatropha were commonly employed in plant protection.

Among the cow-urine based products, jeevamrutha, panchagavya, jeevasara, mosaru maddu, amruth sanjeevini and others including mixture of cow urine and plant extracts were commonly used in the plant protection by organic farmers. The cultural practices generally adopted in the management of crop pests in organic farming systems were establishment of live fence around the cultivated fields and adoption of multi-storey cropping systems. Other types of practices included spraying of jaggery solution for the management sugarcane woolly aphid, application of neem or Pongamia cake in the trenches around the trees for the management of coconut mite, use of crushed naphthalene balls and camphor as repellents against the coconut mite, traps containing 10 per cent toddy against coffee berry borer.

The present survey also revealed that some of the farmers prepared organic products on a commercial scale for use by other farmers in the management of crop pests. The commercial products were Hasiru, Hasiru Siri, Hasiru Shakti, Nisarga liquid, Prajwal, Vijnana, NCG liquid, Ayurvedic rose mix and Thrishika.

The laboratory studies revealed that the modified panchagavya at higher concentrations of 5 and 10 per cent exhibited relatively higher
levels of repellent and antifeedant properties. At the concentration normally used by the farmers at 2.5 per cent panchagavya caused 27.56 per cent repellency, 35.15 per cent feeding deterrence and 33.30 per cent reduction in weight gain in diamondback moth larvae but caused negligible larval and pupal mortalities when second and fourth instar larvae were treated. Against cowpea aphid, it produced very low levels of walk-off response and exhibited low insecticidal activity. Panchagavya (at 2.5 %) showed acaricidal property causing moderate levels of larval and adult mortality (29.58 and 38.10 %, respectively) of the two spotted spider mite.

The cow urine is used by farmers at about 10 per cent concentration and at this concentration it exhibited lower insecticidal activity against diamondback moth. However, at the same concentration, it showed moderate level of antifeedant activity (28.34 %) and reduced the larval weight gain by 24.00 per cent. The repellent activity was considerably high (49.77 %) at 10 per cent concentration. It produces very low level of walk-off response and showed low insecticidal activity against the cowpea aphid. The exposure of two spotted spider mite to cow urine (at 10 %) resulted in relatively higher levels mortality i.e. 43.50 and 30.83 per cent of adult and larval stages, respectively. But the ovicidal activity was negligible at all the test concentrations.

The dasagavya exhibited moderate level of insecticidal activity against DBM larvae, but it was not detrimental to the aphid. At higher concentration (20 %) it exhibited good repellent and antifeedant activity against DBM larvae (58.95 and 38.37 per cent respectively). in case of two spotted spider mite, it caused maximum of 71.68 and 35.60 per cent mortality of larval and adult stages, respectively, at 50 per cent concentration. The product had very negligible repellent action against both the aphid and mite.
Chilli + garlic extract (at 10 %) exhibited very good acaricidal activity causing 93.91 and 65.60 per cent larval and adult mortality of *T. Urticae* respectively, compared to lower insecticidal activity against DBM (13.32 % mortality of both in second and fourth instar larvae) and the aphid (11.67 % mortality). The product showed fairly high repellency (45.36 %) and antifeedant (20.30 %) activity against DBM larvae. The repellent action against the cowpea aphid and spider mite was low.

The indigenous preparation, neem fruit + red chilli + custard apple leaf extract exhibited a wide range of biological activity against DBM and the mite. It caused maximum of 87.46 and 90.00 per cent mortality of second and fourth instar larvae of DBM, respectively, at 10 per cent concentration. It also exhibited fairly a good repellent (57.24 %) and antifeedant (40.92 %) activity against fourth instar DBM larvae. The morphogenic effects were also observed in the adult stage when last instar DBM larvae were exposed to the product. The product had fairly good level of acaricidal activity against larval and adult stages (13.92 to 87.09 % and 26.70 to 65.20 % mortality, respectively at 0.5 to 10.00 % concentrations) of the mite, but the ovicidal action was negligible. Its killing effect on the aphid, the repellent activity against both the aphid and the mite were very poor.

The neem seed kernel + *Aloe vera* + *Calotropis* + *Vitex* + *Clerodendron* leaf extract at 10 per cent concentration was highly detrimental to DBM larvae causing complete mortality of second and fourth instar larvae. The surviving larvae from treatment at lower concentrations recorded delayed development, mortality at the pupal stage and majority of the adults that emerged were abnormal. The product also exhibited high level of repellent (86.62 %) and antifeedant (64.45 %) activity at 10 per cent concentration. It was moderately toxic to the aphid (26.67 % mortality) but showed fairly good acaricidal activity
causing 87.23 and 71.70 per cent larval and adult mortalities at 10 per cent concentration, respectively. The product had very poor repellent action against aphid and the mite.

Future line of study

- The scientific validation of all the promising indigenous products under field conditions to ascertain their efficacy against major crop pests.

- Assessment of biological activity of the indigenous compounds and their combinations against pest species to understand their nature of joint action.
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VII. REFERENCES


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ANONYMOUS, 2009a, Organic Farming: Panchakavya, [http://agritech.tnau.ac.in/org_farm/orgfarm_panchakavya.htm](http://agritech.tnau.ac.in/org_farm/orgfarm_panchakavya.htm)


*LIU, M. Y. AND SUN, C. N., 1984, Rearing diamondback moth (Lepidoptera: Yponomeutidae) on rape seedlings by a modification of the Koshinar and Yamuda method. J. Econ. Entomol.*, **77**: 1608-1609.


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* Original not seen.
Appendices
## APPENDIX I

**List of non-government organizations (NGOs)**

<table>
<thead>
<tr>
<th>Sl. no.</th>
<th>District</th>
<th>Taluk</th>
<th>Name &amp; Address of NGO’s</th>
<th>Phone No &amp; Mob. No</th>
<th>E-mail ID</th>
<th>Village / Site</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Bangalore rural district</td>
<td>Nelmannala</td>
<td>CENTER FOR RURAL DEVELOPMENT &amp; APPLIED RESEARCH, #1268 Vishwesharaiah Layout, 1st Cross, Kodigehalli. Tindlu Main Road, Vidyaranpura Post Banglore-5600097</td>
<td>9740226128</td>
<td><a href="mailto:ranebennur@yahoo.co.in">ranebennur@yahoo.co.in</a></td>
<td>Sulikunte/Kempapura Agrahara</td>
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<tr>
<td>2</td>
<td>Chickmagalur</td>
<td>Chickmagalur</td>
<td>JANASPANDANA DEVELOPMENT SOCIETY, Shivani, Tarikere Tq, Chickmagalur. MIG-11, # 195, 4th Main Road, 3rd Stage, Housing Board, Chikkamangalor-577102</td>
<td>08261-681011, 08262-220075 and 9242869722</td>
<td><a href="mailto:janaspandana-soc@rediffmail.com">janaspandana-soc@rediffmail.com</a></td>
<td>Lakkammanaha Lili Lakya Hobli, Chickmagalur Tq</td>
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<td>3</td>
<td>Chickmagalur</td>
<td>Mudugere</td>
<td>BHOMI SUSTAINABLE DEVELOPMENT SOCIETY, Ratnagiri Nilaya, Opp. to 11 Aralikatte, Kempanahalli, Chickmagalur-577101.</td>
<td>9448805001</td>
<td><a href="mailto:bhoomi.k@gmail.com">bhoomi.k@gmail.com</a></td>
<td>Palguni Grama Panchayat, Sabenahalli</td>
</tr>
<tr>
<td>4</td>
<td>South Canara</td>
<td>Belthangady</td>
<td>SRI KSHETHRS DHRMSTHALA GRAMABHIVRUDDI YOJANE®, Dharmasthala, Belthangady Tq D.K. Dist</td>
<td>08256-277215 and 9448252745</td>
<td><a href="mailto:skdrp@skdrpindia.org">skdrp@skdrpindia.org</a></td>
<td>Kadirudyavara, Belthangady Tq Kasaba Hobli</td>
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<td>Mandya</td>
<td>Mandya-Dist Level</td>
<td>SRI KAMADHENU NISARGIKA SAVYAVA KRISHI AND GRAMMENABHIRUDDI SAMSTHE (R)</td>
<td>Ramgowda Building, 3rd Floor, V.V. Road, Mandya Tq/ Dist Pin 571405</td>
<td>08232-222411, 9845268377, 9986687958, 9986323317 and 9901244221</td>
<td><a href="mailto:kamadhenusrga@yahoo.co.in">kamadhenusrga@yahoo.co.in</a></td>
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<td>Shimoga</td>
<td>Sagar -Dist Level</td>
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<td><a href="mailto:Aruna-kpp@yahoo.com">Aruna-kpp@yahoo.com</a> <a href="mailto:krishiparivar@sancharnet.in">krishiparivar@sancharnet.in</a></td>
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<td>Udupi</td>
<td>Karkalla Dist –Level</td>
<td>SRI KHETRA DHARMASTHALA RURAL DEVELOPMENT PROJECT (REGD) Dharmasthala Belthangadi Tq</td>
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<td>08256-277215, 9845473515, 9845393760 and 9448548679</td>
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APPENDIX II

Proforma for the documentation of indigenous plant protection practices

Information about the farmer:
1. Name of the farmer: ........
2. Name of the village: ........
3. Hobli: ..........................
4. Taluk: ..........................
5. District: ........................

6. Plant protection practices: Natural products (botanicals, minerals and plant products) for pest control by farmers.
   Natural products:
   Material used:
   Preparation Method:
   Application Methods:
   Dosage:
   Crops:
   Target pests:

7. Important cultural practices adapted by the organic farmers

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<th>Target pests</th>
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8. Information on plant products (Botanicals):

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<thead>
<tr>
<th>Si. No.</th>
<th>Name of the plants</th>
<th>Scientific name</th>
<th>Family</th>
<th>Plant parts used</th>
</tr>
</thead>
<tbody>
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