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Study on Agrobiodiversity And Biodiversity of Planthoppers And Its Bio Control In Rice Fields of Kolli Hills-Tamilnadu, India

KEYWORDS: Plant hoppers, pesticides, Kolli hills

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ABSTRACT *Evolution of science and technology brought variety of changes that increased the birth rate and decreased the death rate lead to rapid increase in population and increased demand in agriculture produce and product. Such increase leads to green revolution with the help of modern breeding technique. However, this triggered variety of issues like pest attack, narrow food basked, increased use of fertilizer and pesticide etc. Among the pest attack plant hoppers forms one of the dominant pests that create devastating effect especially in rice fields. In the present investigation in Kolli hills showed that decreasing agro biodiversity with increasing transformation of landscape along with cultivation pattern. Plant hoppers are found to be increasing trend with increasing transformation especially in rice fields. Plant hopper identification showed 22 species in 16 genera in Kolli Hills in the present study. Estimation plant hoppers at different altitudes of Kolli Hills showed Nilaparvata lugensas dominant in all altitudes with highest number in 250 amsl followed by Sogatella furcifera with highest number in 500 amsl. It was also identified that with increase in altitude planthoppers also in paddy fields also decreased. Among numerous traditional methods available in the study area 17 methods were found to be within top ten preferred in the area. However, Adhathoda vasica leaf along with cow dung slurry preferred by most of the people followed by Vitex negundo leaf extract with butter milk as effective pesticide against planthoppers.*

Introduction

Development of agriculture travelled a long distance from shifting agriculture to intensive mono cropping with genetically modified crops. A different stage of agricultural development still exists in different agro ecological zones depending upon their socio economic development. Socio economic development of different societies of the world varies with their access to science and technology along with their feasibility in their local environmental conditions. It has been seen that development in agriculture moved away from harvesting the benefits of ecological functions of agro ecological conditions. This lead to change in agriculture practices like use of modified seeds, cropping pattern, readymade nutrient inputs which in turn also increased variety of pest attack due to loss of ecological linkages in the agricultural systems which balanced their prey predator relationships with minimal loss and maintained their resilience capacity. However, there are traditional communities in the remote margins of the world where such changes are meager and continue to practice their traditional agricultural management. Kolli Hills is one such hilly tract region in the southern Indian subcontinent fall in the Eastern Ghats of Tamilnadu state where the present research is conducted to identify effective traditional management practices in managing the Plant hoppers in agricultural fields.

Green revolution in Asian sub subcontinent played a vital role in the outbreak of these plant hoppers through various means. During this period introduction of short duration dwarf varieties increased the need of fertilizers especially the nitrogenous fertilizers since natural organic inputs are not able to synchronize with the release and demand of the crop nutrients but synchronized with the life cycle of plant hopers for their food lead to their prosperity (Preap et al., 2001). Further increased use of insecticides in the agricultural fields also killed the natural enemies of plant hoppers that lead to their population outbreaks (Kenmore et al., 1984; Shepard et al., 1995; Heinrichs and Mochida, 1984).

However, in the recent past traditional communities living in the margin of modern agricultural systems evolved variety of natural mechanism to control the plant hoppers in their agricultural fields which not only supports their economy but also ensured safe agricultural products. The agricultural community of Kolli Hills, continue this kind of traditional management strategies to control these pests. The present research was carried out, to evaluate, and to compile these practices that will lead to a scientific documentation. Kolli Hills is a tall hill range located in central Tamil Nadu in the Namakkal district. The mountains are about 1370 amsl in height and cover an area of approximately 280 km². These hills are in the Southern part of the Eastern Ghats, which is a mountain range that runs mostly parallel to the east coast of peninsular India. The Kolli Hills mountains are covered with evergreen forests, agriculture include coffee, tea, jackfruit, pineapple, black pepper and other spices apart from the staple food Rice and other minor millets of the tribal people who inhabit these mountains.

Volume : 6 | Issue : 4 | April 2016 | ISSN - 2249-555X | IF : 3.919 | IC Value : 74.50

Plant hoppers are large group of insects exceeding 12,000 species that feed on green plants referred as phytophagous insects belong to the order Hemiptera, suborders Homoptera, Auchenorrhyncha, Flugoroida, infraorderFulgoromorpha and super family Fulgoroidea distributed throughout the world (Watson and Dallwitz, 2003). The Order Hemiptera comprises of 77 families (Martin and Webb, 2010), in which plant hoppers belong to the family Delphacidae and dominate with more than 2000 species. Most of the species of plant hoppers are plant feeders among which 55 species are considered as pests, for more than 25 plant species and also acts as insect vectors for virus in rice, sugarcane, coconut palms, maize and several other cereals (Wilson and O'Brien, 1987). Plant hoppers feed on plant sap and damage the plant tissue by ovipositing that lead to wilting of plant commonly known as hopper burn. Apart from feeding on the plant sap hoppers also transmit virus during their feeding behavior which causes disease such as grassy stunt and ragged stunt in rice plant (Reissig et al., 1986) and extensive damage to the crop (Dyck and Thomas, 1979). However, in Asia two plant hoppers were found to be causing extensive damage to the agriculture are brown plant hopper (BPH), Nilaparvata lugens and White backed plant hopper (WBPH), Sogatella frucifera. Among these two hoppers White backed plant hoppers occur in large numbers and kill the plants by hopper burn (Reissig et al., 1986). In the light of the above the present paper analysis the agro biodiversity in Kolli Hills and its role in plant hopper diversity and identifies effective traditional bio control measure.

MATERIALS AND METHODS

Study area Kolli Hills is located in the Eastern Ghats region of Tamilnadu southern part Indian subcontinent. The investigation was conducted in the Kolli Hills region in Namakkal district spread over 418.5 km within the range of 11 101130 N latitude and 75 30 E longitude with average altitude of around 1000m amsl. Kolli Hills is occupied with 44% forest and 56% agricultural fields of the total geographical area (Vaidhanathan et al., 2013). Local indigenous people are known as malayali tribes (Thurston and Rangachari, 1909; Jayasree, 2002) who live synchrony with nature for their survival.

The present research was based on field work which was carried out during 2012 with a reconnaissance survey, followed by brainstorming session in each location known as nadu locally. Fourteen nadu's spread over Kolli Hills in each nadu twenty farmers in the group of 40 to 60 years were surveyed with structured questionnaire on their different aspects of agricultural practices and pest management. Among the twenty farmers' fields plant hoppers were estimated with hand net through sweeping. Plant hoppers collected were aspirated with chloroform and labeled. Before mounting plant hoppers are dried in hot air oven at 70ºC for 24 hours and slides of genitalia are prepared as per Knight (1965) and adopted terminology as per O'Brein and Wilson (1985). Plant species were collected and identified through Karnatic flora (Gample 1935; Mathew, 1983).

RESULTS

Kolli Hills is a part of Eastern Ghats hills which showed undulating surface area, settlements are only on top not gradual from the bottom this on map shows that all the 14 panchayats surrounded with thick non approachable forest other than laid road and foot paths. This demography facilitated in keeping malayali tribal people from keeping them away from modern development and preserved their traditional practices in all walks of life which include their agriculture practices. However, developments in the recent past with increased transport facility gradually and presently divided the region distinctly into three regions towards modernization as transformed, under transformed and traditional regions at different stages of changing agricultural practices (Figure 2).

Transformed

Five panchayats nearby road like Gundur Nadu, Valapur Nadu, Selur Nadu, Valavanthi Nadu Thirupuli Nadu transform their agriculture crops towards cash crops with Silviculture in maichalkadu (Grazing land), mono cropping with crops like tapioca and coffee in kollakadu (Backyard), pure tapioca monocropping in mettankadu (upland) and pure paddy monocropping in vayal (Valley or Wetland).

Under transformation

Four panchayats in the intermediate in the transport facility like Chittu Nadu, Edapuli Nadu, Alathur Nadu and Ariyur Nadu gradually transforming their agricultural practices with Silver oak and pepper and reduced their grazing land area in their maichalkadu (Grazing land), mixed cropping with millets, Bannana, Fruit trees, Coffee, etc., in kollakadu (Backyard), Mixed cropping with tapioca, pulses, millets, etc., in mettankadu (upland) and mixed cropping with paddy in vayal (Valle or Wetland).

Traditional

Five panchayats in the remote regions like GundaniNadu, DevanurNadu, ThinnanurNadu, Perakkarai Nadu and Bail Nadu where they still continue to practice traditional agriculture with mixed farming with grass land, home garden, and animal husbandry in their maichalkadu (Grazing land) andkollakadu (Backyard), Mixed farming with upland paddy, millets, pulses, banana, etc., etc., in mettankadu (upland) and mixed farming with colocasia, paddy, cardamom in vayal (Valley or Wetland).

Transformation of agricultural systems in Kolli Hills present investigation showed 46.76 % area transformed, 38.23% area under transformation and only 15.01% area traditional (Table 1). Diversity of agriculture was high in backyard followed by upland, grazing land and valley and decreased from traditional farmers to farmers under transformation and farmers with transformed agriculture. However in the present scenario the farmers of Kolli Hills nine landraces of little millet, nine landraces of Italian millet, one landrace of common millet, three landraces of Kodo millet and five landraces finger millet (Table 2). Distribution of millets in different regions of Kolli Hills showed that millets are grown even now throughout one or other time but their concentration is high amongst farmers in the remote regions (Plate 1).

Plant hoppers in agricultural fields counted number per 10 sweeps ranged between 3.67 to 24.67, highest was recorded in transformed agricultural systems which ranged from 9 to 24.67 individuals, followed by agricultural systems under transformation with 5.67 to 17.33 individuals. Less number plant hoppers were recorded in traditional agricultural systems ranging from 3.67 to 15.33 individuals (Figure 2 to 4). However in all the regions plant hoppers are significantly high in numbers in paddy fields with p value 0.001.

The present study was able to identify 22 plant hopper species in 16 genera Cemus levicula, Euidella horvathi, Harmalia anacharsis, Latistriat estacea, Nilaparvata lugens, Opiconsivabalteata, Peregrinus maidis, Perkinsiella saccharicida, Perkinsiell asinensis, Purohita cervina, Sardiarostrata, Sogatellafurcifera, Sogatella vibix, Sogetella kolophon, Stenocranus distinct, Tagosodes pusanus, Terthronal bovittatum, Toya attenuate, Toya bridwelli, Toya propinqua, Tropido cephalaflaviceps and Tropido cephalaserendiba

Volume : 6 | Issue : 4 | April 2016 | ISSN - 2249-555X | IF : 3.919 | IC Value : 74.50

(Table 3). Among the density of different plant hoppers Nilaparvata lugens was significantly high in all paddy fields in all the altitude ranges with p value o.oo1 followed by Sogatella vibix also p value 0.001 (Figure 5).

Number of pesticides to control plant hoppers were recorded during our investigation in Kolli Hills in which 17 traditional pesticides were found to be common throughout the hills (Table 4). Among the common pesticides used in Kolli Hills Adhathoda vasica leaf along with cow dung slurry preferred by most of the people followed by Vitex negundo leaf extract with butter milk, Lantana camera leaf with Ocimum gratissimum leaf extract and Agave attenuate leaf extract with kerosene.

DISCUSSION

Tribal community lives in harmony with the local ecological conditions and have strong link between man and his environment. In India such tribal population comprise of 53.8 million people in more than 5000 villages dominated or surrounded by forest constituting around 15% of the total geographical area (Albert and Kuldip 2006). Kolli Hills is also one such region inhabiting tribal settlements surrounding the forest, where 14 panchayats or nadus completely surrounded by forest. Agriculture forms the basic livelihood option for these communities from where they draw almost 99% of their energy needs. Though domestication of plants and animals in agriculture took place even before 10,000 B.C.E. they have been undergoing significant developments for their variety of needs and benefits (Bar-Yosef and Meadows, 1995). Millets were found to be earliest cereals cultivated during earlier agricultural development around 10, 000 BC through archeological evidences (Houyuan Lu et al., 2009) whereas Barley, wheat, hemp, rice jujube, muskmelon and mango cultivated by Indus Valley Civilization during 9000 BC (Dev, 2006), rice and hemp cultivated in Kashmir and Harappa regions during second millennium BC (Pillay, 1972). Ploughing of soil and systematic sowing of seeds through broadcasting method, application of cow dung as fertilizer and irrigation along with drainage facility was adopted by Indus Valley Civilization during 4500 B.C. (Rodda and Ubertini, 2004) and prominent during Vedic period (Ray et al., 1985). Immediately after the evolution of agriculture crops, their practices developed for agriculture (Rogan, 1999), mixed farming is the first ever agriculture practice which supported even the Indus Valley Civilization (Dev, 2006; Thulasamma, 2006), in which resources from agricultural systems like home gardens, shifting cultivation, valley land cultivation mixed with livestock for dung manure fertilization, ploughing, crop processing, transport etc. (Myrdal and Morell, 2011; Grigg, 1974). Such mixed farming systems are existing still in Kolli Hills traditional farming communities.

Development of science and technology during 18th century changed the above traditional agriculture practices as a result of increased transport facility, electrification, mechanization, commercialization, crop improvement, global climate change and change in living standards. Hilly track such as Kolli Hills access to above changes are delayed due to their difficult terrain, hence agricultural practices at different stages are available even now in these regions. Present investigation classified these agricultural practices as transformed, under transformation and traditional and clearly shown that reducing agro-biodiversity with increasing transformation from traditional (Figure 6).

Evolution of knowledge on biological science gradually increased life expectancy and increased population induced radical change in developing new crop varieties, farmers practice, their perception on crop and increased food production (Else van de Fliert, 1997). Such modern agriculture lead to environmental pollution due to fertilizer and pesticide input (Conway and Pretty, 1991) and health hazard due to pesticide residue in food crops (Rola and Pingali, 1993) where wealth of indigenous knowledge based agriculture practices are vanished (Van de Fliert, 1993). However regions like Kolli Hills such still retain many of indigenous traditional agricultural practices and facing increasing demand for fertilizer and pest management techniques. Plant hoppers are one of the important pest that not only effect the crop by feeding on them but also transmitting viral and bacterial diseases. Therefore present investigation estimated plant hoppers in different agricultural systems in the classified regions transformed, under transformation and traditional.

Green revolution in Asian sub subcontinent played a vital role in the outbreak of these plant hoppers through various means. During this period introduction of short duration dwarf varieties increased the need of fertilizers especially the nitrogenous fertilizers since natural organic inputs are not able to synchronize with the release and demand of the crop nutrients but synchronized with the life cycle of plant hopers for their food lead to their prosperity (Preap et al., 2002). Further increased use of insecticides in the agricultural fields also killed the natural enemies of plant hoppers that lead to their population outbreaks (Kenmore et al., 1984; Shepard et al., 1995; Heinrichs and Mochida, 1984). Estimation of plant hoppers in Kolli Hills at different regions also showed high plant hoppers population in the transformed region followed by under transition and less population in regions with traditional agriculture. Among the different agricultural systems plant hoppers decreased with decrease in agro biodiversity in agricultural systems (Figure 6). However, plant hopper population was highly pronounced in rice fields in all the regions this is not only due to paddy crop but also that they are not traditional landraces they are short duration, dwarf variety improved varieties. However, the investigation showed that number of natural pesticides traditionally evolved still exists and use mostly the local biodiversity and natural material and preference is given for pesticides prepared from local biodiversity.

Number of insects attack paddy in which insect pests plant hoppers gall midges and stem borers are economically important pests. It has been reported that six different plant hoppers create devastating loss in paddy fields through hopper burn, transmitting viral disease, stunt growth, etc., The six plant hoppers are (BPH)-browth plant hopper (Nilaparvatha lugensstal), SBPH-small brown plant hoppers (Laodelphax striatellus Fallen), GLH-green leafhopper (Nephotettix virescens Distant), GRH-green rice leafhopper (Nephotettix cincticepsUhler), WBPH-White backed plant hopper (Sogatella furicifera Horvath), and ZLH-zigzag leafhopper (Reciliadorsalis Motschusky) (Brar et al., 2009). Nilaparvata lugens was found to be dominant in all altitudes of Kolli Hills highest number was seen in 250 amsl followed by Sogatella furcifera highest number was seen in 500 amsl. As the height of the paddy fields increases number of plant hoppers decreases in general it may be due to increase in biodiversity of natural forest.

Figure and tables

Figure 1. Cross sectional representation of land use and land cover change in Kolli Hills

Volume : 6 | Issue : 4 | April 2016 | ISSN - 2249-555X | IF : 3.919 | IC Value : 74.50

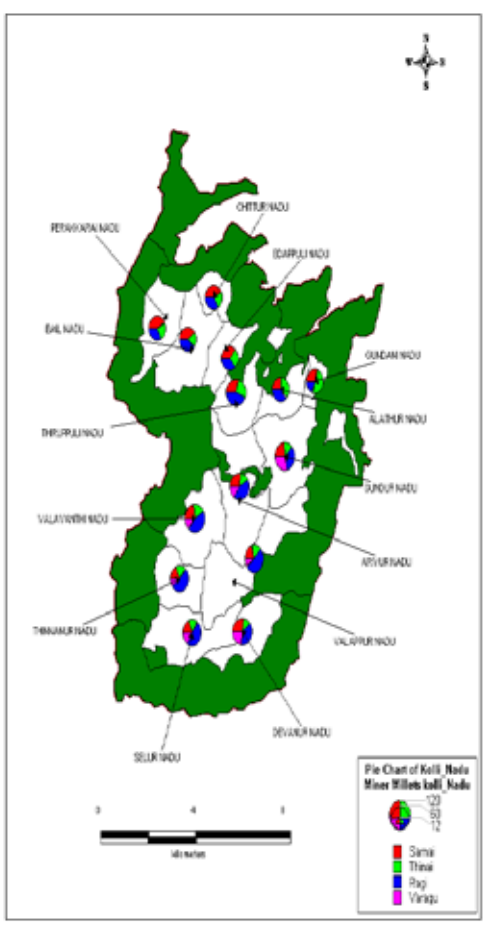
Table 1.
Status of transformation of agricultural systems in Kolli Hills

S. No.	Status of Agriculture	% of farmers	Grazing land	Backyard	Upland	Valley
1	Transformed	46.76	Silver Oak, Pepper, Eucalyptus, Pine, etc.	Tapioca, Coffee, Guava, Cashew, Clove, Lemon, Pomegranate, etc.	Tapioca, Banana, etc.	Paddy
2	Under transformation	38.23	Silver Oak, Pepper	Ragi, Coffee, Guava, Jackfruit, Vegetables Pomegranate, Rose apple, Water Millon, Chilly, Coriander, Curry leaf, etc.	Little Millet, Italian Millet, Tapioca Banana Pulses, Lentils,	Paddy, Turmeric,
3	Traditional	15.01	Grass	Banana, Guava, Jackfruit, Pulses, Silver Oak, Pepper, Vegetables, Clove, Lemon, Pomegranate, Rose apple, Water Millon, Chilly, Coriander, Curry leaf, Bitter Guard, Brinjal, Moringa, Musk Millan, Snake guard, Anola, custard, apple, Grapes, etc.	Little Millet, Italian Millet, Finger Millet, Kodo Millet, Paddy Pulses, Lentils, Blackgram, Castor, Sesame, Green Gram, Ground nut, Horse gram, Sunflower, Onion, Sweet potato, Rasa valligizhangu, Potato,	Paddy, Turmeric, Cardamom Colocasia

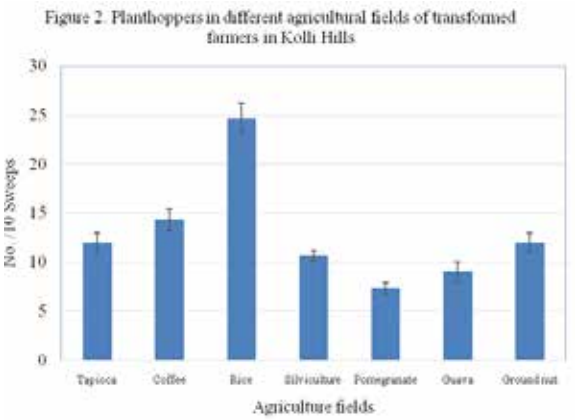
Table 2. Millets conserved by traditional malayali tribal communities of Kolli Hills

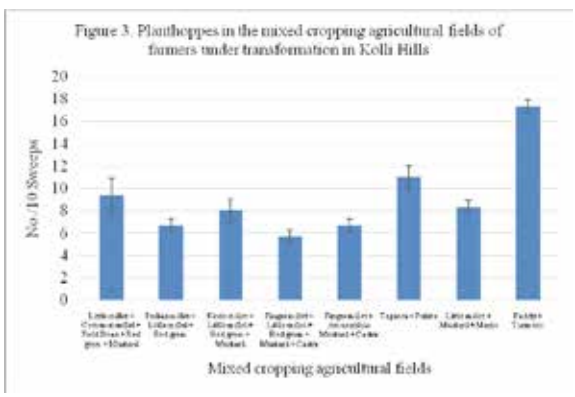
Common name	Photos	Local existing landraces
Common name: Little millet Scientific name: Panicumsumatrence Vernacular name: Samai		Sadansamai, Thirikulasamai, Karumsamai, Karumperumsamai, Kettavettisamai, Malliasamai, Perumsamai, Chinnamalliasamai, Vellaperumsamai, Pillusamai
Common name: talian Millet Scientific name:Setariaitalica Vernacular name: Thinai		Senthinai, Palanthinai, Karunthinai, Perunthinai, Koranthinai, Vellathinai, Vellaperunthinai, Chinnaperunthinai Moochanthinai
Common name: Common Millet Scientific name: Panicummiliaceum Vernacular name: Panivaragu		Panivaragu
Common name: Kodomillet Scientific name: Paspalumscrobiculatum Vernacular name: Varagu		Peruvaragu, Thirivaragu, Karunkalivaragu, Senkalivaragu.
Common name: inger millet Scientific name: Eleusinecoracana Vernacular name: Kezhvaragu		Sattaikezhvarugu, arakezhvaragu Kuruvakezhvaragu Sundangikezhvaragu Perungkezhvaragu

Plate 1 Distribution of millet cultivation in Kolli Hills



Volume : 6 | Issue : 4 | April 2016 | ISSN - 2249-555X | IF : 3.919 | IC Value : 74.50





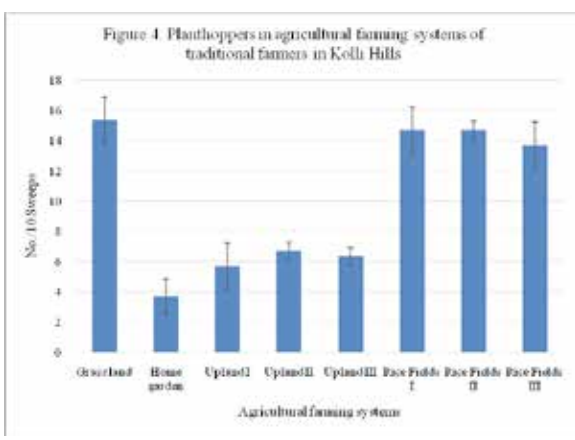


Table 3. Characteristics of identified planthopper species in Kolli Hills

S. No.	Name of the Planthopper	Distinct characters
1	Cemuslevicula	Vertex very short and broad between the eyes, pronotum reddish-black with crinae cream colour. Tebmina with characteristic black dots along veing, fuscous streaks apically with a distinct pterostigma. Frons with conspicuous raised pits on either side of the median carina.
2	Euidellahorvathi	Vertex produced in front of eyes. Legs are long and slender. Tegmina with pterostigma
3	Harmaliaanacharsis	Body is light brown in colour, Vertex is short. Tegmina is pale brown without pterostigma
4	Latistriatestacea	Vertex pronotum and scutellum are green colour. Tegmina with pterostigma
5	Nilaparvatalugens	Yellowish or dark brown in colour with blue eyes. Tegmina with pterostigma
6	Opiconsivabalteata	Head is smaller than pronotum, mesonotum and scutellum are black colour. Pterostigma present
7	Peregrinusmaidis	Vertex are small and broad. Vertex, pronotum and mesonotum are orange colour. Pterostigma present
8	Perkinsiellalasaccharicida	Vertex, pronotum and scetellum are yellowish, wings are vrownish, veings granulate and pterostigma present.
9	Perkinsiellalasinensis	Vertex, pronotum, and scutellum are yellowish colour, wings are brownish colour. Pterostigma present
10	PurohitaCervina	Head narrow than pronotum, Pterostigma present but not differentiated
11	Sardiarostrata	Vertex, thorax, tegmina are dark brown colour. Tegmina dark brown with pterostigma.
12	Sogatellafurcifera	Body is black in dorsal view, creamy white in ventral view. Tegmina with a pterostigma
13	Sogatellavibix	Vertex yellowish white. Face with frons, clypeus pale yellowish brown in colour. Genae dark brown in colourTegmina without a pterostigma
14	Sogetellakolophon	Vertex and pronotum is light yellowish colour. Face with frons, clypeus and genae entirely pale yellowish brown in colour. Tegmina without a pterostigma
15	Stenocranus distinct	Head narrow than pronotum, Vertex elongated. Tegminastramineous and veins are dark without pterostigma
16	Tagosodespusanus	Body is black in dorsal view, creamy white in ventral view. Tegmina with pattern of dark markings Tegmina with a pterostigma
17	Terthronalbovittatum	Dark brown with cream colour, Frons, clypeus and genae dark brown colour. Tegmina without pterostigma
18	Toyaattenuata	Plae yellow brown with dark brown colour. Head narrower than pronotum, vertex are wide, frons longer at midline, clypeus are wider.
19	Toyabridwelli	Aedeagus is broader basally and slightly curved with sub apical teeth like projections.
20	Toyapropinqua	Plae yellowish brown with brown frons, abdomen dark brown. Vertex are long, frons are long in mid half znd clypeus are wider at base. Tegmina without pterostigma
21	Tropidocephalaflavicep	Vertex, pronotum and mesonotum are prominent. Tegmina longer than abdomen and pterostigma are present.
22	Tropidocephalaserendiba	Chocolate brown in colour. Vertex, pronotum and scutellum are cream coloured. Tegmina are present with pterostigma

Volume : 6 | Issue : 4 | April 2016 | ISSN - 2249-555X | IF : 3.919 | IC Value : 74.50

Figure 5. Number of Individual of different species of planthoppers represented at different altitude of Kolli Hills

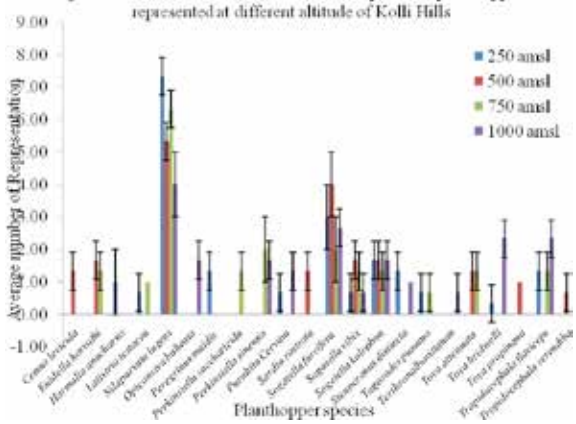
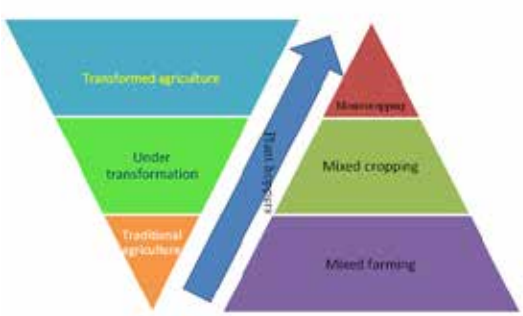


Table 4. Common pesticides used in Kolli Hills and their percentage preference

S. No.	Pesticides used to control planthoppers	% Preference
1	Red earth	1
2	Wood ash	1
3	Goat urine	2
4	Cow dung ash	2
5	Kitchen ash	1
6	Cow dung	5
7	Ragi husk	1
8	Kerosene	6
9	Rice bran + ash	2
10	Ragi husk + Kerosene	6
11	Rice bran + Kerosene	7
12	Vitexnegundo leaf extract + butter milk	13
13	Nerium oleander extract + Ipomoea purpurea	8
14	Adhathodavasica leaf + cow dung slurry	15
15	Lantana camera leaf + Ocimumgratissimum leaf extract	11
16	Agave attenuata leaf extract + Kerosene	10
17	Jatrophacurcus leaf extract + Cow urine	9

Figure 6. Trend of Planthoppers in agriculture fields in Kolli Hills



Conclusion

Present agriculture transformation in Kolli Hills are towards decreasing agro biodiversity. Such decrease in biodiversity leads to increasing planthoppers. Among the different crops rice fields showed high planthopper population especially Nilaparvata lugens at 25 amsl and Sogatella furcifera at 500 amsl. Adhathoda vasica leaf along with cow dung slurry and Vitex negundo leaf extract with butter milkis preferred by the local tribal population as effective pesticide against planthoppers

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