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Study on nectar plants of few butterfly species at agriculture ecosystems of Chamarajanagar District, Karnataka, India

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Abstract
Butterflies are opportunistic foragers feed on various plants. To record nectar plants of few butterfly species, systematic field survey was conducted by employing visual count method (VCM) and an all out search method (AOSM) at agriculture ecosystems of Chamarajanagar District during 2013 and 2014. Total 86 flowering plant species which belong to 27 plant families were visited by four butterfly species namely: *P. polytes*, *G. agamemnon*, *A. merione* and *J. hierta* for nectar collection. Interestingly, weeds have contributed more (49%) nectar to these butterfly species and it was followed by shrubs (14%), herbs (13%), trees (8%) and climbers (2%). Compositae (10 plant species) and Acanthaceae (8 plant species) families were visited more often for nectar collection compared to other families by these butterflies. Number of plant species visited by these butterfly species for nectar collection is recorded in detail. However there was a significant difference ($F=11.048$; $P>0.05$) existed between nectar plants visited by butterfly species. Further, color of the flower matters a lot while collecting nectar. Yellow, white, pink and blue coloured flowers were visited more often and there exited a significant difference ($F= 30.117$; $P> 0.05$) between colored flowers visited by butterfly species. Furthermore, floral calendar was prepared by using 86 flowering plants blooming period. It could help understand the locally available flora with different flower colours as source of food for few butterfly species and emphasized the need of herbaceous flora conservation to restore native butterfly species amidst agriculture ecosystems.

Keywords: Butterfly species, nectar plants, agriculture ecosystem

1. Introduction
Butterflies are opportunistic foragers; visit a wide variety of flowering plants thereby performing one of the key ecological processes called 'pollination' at many ecosystems[1]. Interestingly, they have an intimate association with plants for their survival [2]. The food plant specificity is well known among butterfly species and it is more often related with the available flora [3]. Many butterflies are generalists and few are specialists in their food plant preferences. Tudor *et al*. (2004) have reported the nectar feeding and flower preferences of butterflies. Several butterfly species show complex feeding evolutionary relationship during both adult and larval stages [5, 6]. Various authors have reported the nectar plants of different butterfly species at different parts of the world. However, female butterfly's shows host plant specificity which is related with the nectar source utilization and it is correlated with time and space [7]. Thus, butterfly species and their dependence on locally available flora are well established at various habitats [8]. Further, certain butterfly species exhibit distinct floral preference that depends on floral parameters such as color, corollary depth, clustered flowers or florets [9] and chemical clues [10, 11] of flowers. Butterflies visit yellow, orange, pink, red, white and blue coloured flowers. It is ecologically one of the important activities shown by many butterfly species during pollination [12].

Nectar is a food for many adult butterflies visit plants with specific coloured flowers for collecting nectar. Nectar provides amino acids and carbohydrates to butterflies to obtain necessary energy for egg production and maturation of butterflies [13]. During this process, certain butterfly species prefer specific flowering plants [13, 14]. Further, many butterfly species show mud puddling behavior. During this process, they collect minerals, which are used as nuptial gifts [15]. Weiss (1997) has reported the innate learning behavior and flexibility to adjust foraging efforts in response to floral rewards with space and time in butterflies. Janz *et al*. (2005) have opined that visual cues such as shape and color of flowers play an important role for butterflies in host plants finding. Similar type of observations was made by Beck *et al*. (1999) and emphasized the butterfly preference to nectar with high sugar content (30 to 60%). Pyke and Waser (1981) have reported the plant species with tubular and bowl shaped flowers with 20 to 25% sucrose in their nectar and this has attracted butterflies more for nectar collection [19]. Interestingly, abundance of Satyridae, Papilionidae and Hesperiidae family members are directly correlated with the flower abundance [20, 21]. The flower preference is depended on larval host plants and phytophagous nature of butterflies. It has made them to associate closely with plant diversity [22]. Chamarajanagar District lies at $11^{0}40^{1}$ to $12^{0}48^{1}$ N longitudes and $74^{0}52^{1}$ to $76^{0}07^{1}$ E latitude with an area of 5,101 Km^2 in south Deccan plateau [23] at southern tip of Karnataka State. The altitude varies from 600 to 800 MSL and possesses 48.4% forest area [24] and 33% land is used for agriculture purpose. Its geography is shared by protected area network i.e., with Bandipura National Park, B.R. Wildlife Sanctuary and hosts good number of native and migratory butterfly species. Reports on nectar plants visit during adult stage of butterfly species are fragmentary. Therefore, present study was undertaken at agriculture ecosystems.

2. Materials and Methods

Food plants of few butterfly species was recorded by employing visual count method (VCM) and an all-out search method (AOSM) systematically at agriculture ecosystems of Chamarajanagar District during 2013 and 2014. Food plants were classified into cultivable crops, herbs, shrubs, climbers, weeds and their flowering period was recorded as per Basavarajappa (1998), Raghunandan and Basavarajappa (2014). Further, flowering plants were identified with the help of field guides, published by Kehimkar (2009) and Singh and Walia (2010**).** Collected data was compiled and compared statistically as per Saha (1992). Analysis of variance (ANOVA) was used to know the differences between the samples SPSS Statistical Package for Social Sciences.

3. Results

Floral source for few butterfly species, plant family, common name, scientific name, flowering period are depicted in Table 2. Details of flowering plants which were used as nectar plants and host plants were classified into cultivated crops, climbers, herbs, shrubs, trees and weeds (Table 2). Further, based on colour, flowers were grouped into blue, orange, pink, red, white and yellow with their blooming period and it is depicted in Table 2. Altogether, 86 flowering plant species, which belong to 27 plant families, were visited by four butterfly species for nectar collection (Table 2). Interestingly, weeds contributed more (49%) and it was followed by shrubs, herbs, trees and climbers amidst agriculture ecosystems and their per cent contribution was respectively 14, 14, 13, 8 and 2% (Fig. 1). Per cent contribution of different plant types for nectar source to these butterflies is depicted in Figure 2. Around 17 flowering plant species were visited by four butterfly species for nectar collection. Compositae (10 plant species) and Acanthaceae (8 plant species) families were selected respectively 11.6 and 9.3% by these butterflies (Table 2). The Malvaceae, Cucurbitaceae, Tiliaceae and Caesalpinaceae family members' contribution was 8.1, 7.0, 5.8 and 4.7% respectively. Moreover, Amaranthaceae, Oleaceae and Rutaceae family members have contributed 3.5% each from three flowering plants (Table 2). Further, Apocynaceae, Capparaceae and Solanaceae family members have contributed two plant species each with 2.3%. However, Agavaceae, Aizoaceae, Apiaceae, Boraginaceae, Clemoaceae, Convolvulaceae, Labiatae, Lamiaceae, Linaceae, Magnoliaceae, Papilionaceae, Portulacaceae, Primulaceae and Scrophulariaceae families have also contributed their nectar source to these butterfly species. However, their contribution was very less (1% each) (Table 3). Per cent occurrence of different nectar plant species, their families are depicted in Figure 2.

3.1 Most frequently visited plant families by butterfly species: Visit of *A. merione* and *J. hierta*, *P. polytes* and *G. agamemnon* to different plant families is depicted in Table 5. Altogether *A. merione* visited 63 plant species for nectar collection from 24 plant families (Table 5). *J. hierta*, visited 75 plant species for nectar collection (Table 5). However, Aizoaceae, Linaceaea and Portulacaceae family members were not preferred for nectar collection by *J. hierta*. *P. polytes* visited 51 plant species for nectar collection (Table 5). Similarly, *G. agamemnon* visited 49 plant species for nectar collection at agriculture ecosystem. However, Aizoaceae, Apiaceae, Clemoaceae, Convolvulaceae, Lamiaceae, Papilionaceae and Portulacaceae family members were not visited by *G. Agamemnon* for nectar collection (Table 5). Per cent visit to plants belong to different families for nectar collection by *A. merione* and *J. hierta*, *P. polytes* and *G. agamemnon* at different agriculture ecosystems of Chamarajanagar District is depicted in Figure 2. However, plants visited by *P. polytes, G. agamemnon, A. merione* and *J. hierta* didn't show significant variation (F=0.507; P>0.05) between them. But, there existed a significant variation (F=11.048; P>0.05) between plant types (Table 4).

3.2 Visit to different coloured flowers by butterfly species: Yellow coloured flowers were visited more (47%) compared to others. Visit to white, pink and blue coloured flowers by these butterfly species was 22, 21 and 8% respectively. However, red and orange coloured flowers were visited less by these species (Fig. 3). Similarly, visit to different coloured flowers by *P. polytes, G. agamemnon, A. merione* and *J. hierta* didn't show significant variation (F=0.215; P>0.05) between them. But, there was a significant variation (F= 30.117; P> 0.05) existed between plant types (Table 4).

3.3 Floral calendar: The floral calendar of *A. merione, J. hierta, P. polytes* and *G. agamemnon* is shown in Figure 5. Blooming period of 86 flowering plants at agriculture ecosystems of Chamarajanagar District is depicted in Figure 5. Around 18.6% plants were annuals, bloom throughout the year. Remaining plants were bloomed during specific period i.e., August, October, September and November months of the year (Fig. 5). However, only 2% flowering plants bloom during February, March, April and May months at agriculture ecosystems of Chamarajanagar District (Fig. 5). The nectar source availability for different butterfly species was continuous during all the seasons for the years 2013 and 2014 at agriculture ecosystems of Chamarajanagar District.

4. Discussion

Butterflies visited different types of nectar producing flowering plants for nectar collection. Around, 86 plant species belong to 27 families have supported for four butterfly species namely: *P. polytes, G. agamemnon, J. herita* and *A. meriona* at agriculture ecosystems in Chamarajanagar District. The cultivated crops, climbers, herbs, shrubs, trees and weeds with different coloured flowers viz., blue, orange, pink, red, white and yellow have provided nectar source to these butterflies. Since, butterflies are opportunistic foragers, visited specific flowering plants and performed 'pollination' process to many flowering plants at agriculture ecosystem. Similar type of studies was reported by Sharma and Sharma (2013). Interestingly, butterflies visit to different flowers was interlinked with color, corollary depth, clustered flowers or florets and abundance of nectar. Similar types of observations were made by Kunte (2009), Hern *et al*. (1996), Hooks and Johnson (2001). During the present study, weeds with yellow coloured flowers were visited more by these four butterfly species. Perhaps, yellow coloured flowers might have extended more nectar during their visit. Similarly, Tiple *et al.* (2006) have reported 19 nectar plants which belong to 12 plant families, of which, majority of herbs with tubular flowers with red, yellow, blue and purple coloured flowers were visited more compared to white and pink colored flowers. Thus,

native butterflies were associated with the prevailed local flora [30] and their distribution was directly linked with the local floral diversity [31, 32]. Wynter-Blyth (1957) has recorded butterfly density more during March to April and in October. During the present investigation, floral diversity was more during these months and extended good nectar source to these butterflies. As these months were coincided with the pre-monsoon and post-monsoon seasons in India, monsoon season which immediately follow the post-monsoon stimulated many plant species to produce flowers that could in turn might have supported the native butterfly population [33] by extending nectar source. Many butterfly species are strictly seasonal; preferred specific set of habitats [32]. However, there was no evidence to show peak activity of butterflies in summer [32] at this part of the state. Perhaps, it was probably due to high temperature, scarcity of water source accompanied with poor vegetation cover on the ground at Chamarajanagar District. This might have resulted poor flowering during summer. Certain butterfly species are more common and abundant during all the seasons, irrespective of prevailed local conditions. Such species were treated as more stress tolerant species [32] which could able to survive in holistic conditions. Moreover, Polyphagus natures shown by certain butterfly species help adopt to live at diversified habitats and hence become common [34]. Thus, butterflies and many species of flowering plants are interdependent [32] and thus, butterfly diversity clearly indicated the floral diversity of an ecosystem. Further, butterflies select nectar plants to get energy requirements [35]. They generally prefer clustered flowers compared to solitary flowers to obtain good amount of nectar with in short time followed by little expenditure of energy. It could help reduce the energy investment relatively. Although, most of the butterflies are very specific with their floral choice they never visit the same flowers [2]. Adult butterflies choice of flowers is highly evolved relationship between the proboscis length and floral carollary deapth [31]. Moreover, their foraging habit is depeded on choice but not with chance of flower. The flower plants preference of butterfly species was to maximize net energy gain during foraging [36]. Sharma and Sharma (2013) have studied the flower preference of butterflies at Gir Wildlife Scantury and observed *Lantana camara* flowers were preferred more compared to others. Sajjad *et al.* (2012) have reported the preference of flowers by different butterfly species during different seasons. Nectar is a source of food to many butterfly species; it provides amino acids and carbohydrates to get necessary energy for egg production and maturation [13]. Considering this, floral calendar was constructed to understand the floral availability for few butterfly species at agriculture ecosystems. It is a first attempt to depict floral calendar for butterfly species amidst agriculture ecosystem in this part of the State. Agriculture ecosystems of Chamarajanagar District have provided good source of flora during certain seasons. The weed plants with yellow coloured flowers were more predominant, visited by these butterflies for nectar collection. During the present study, an attempt was made to understand the locally available diversified flora for few butterfly species. This could help conserve such type of floral diversity with desired flower colours for butterfly's survival. Our observations are on par with the observations of previously published reports. Further, present study would emphasize the importance of hedge growing herbaceous flora and their conservation to restore native butterfly species amidst agriculture ecosystems.

Table 1: Nectar plants preferred by few butterfly species at agricultural ecosystems of Chamarajanagar District

Family	S. No.	Scientific name	Common name	Plant Type	Flowering season	Color of the flower	Butterfly species visited the flowers			
							Am	Jh	Pp	Ga
Acanthaceae	1.	*Asystasia gangetica* Lin.	Meddhe soppu	W	July - Dec.	Yellow	+	+	-	-
	2.	*Barleria buxifolia* Lin.	Gubble mullu	W	July - Oct.	-do-	+	+	-	-
	3.	*Barleria cristata* Lin.	Spatika	W	-do-	Blue	+	-	-	-
	4.	*Barleria involucrata* Nees var	Spatikada gida	H	Oct. - Jan.	-do-	+	+	+	+
	5.	*Crossandra infundibuliformis* Lin.	Kanakambara	Cp	TOY	Pink	+	+	+	+
	6.	*Ecbolium ligustrinum* Vahl.	Kappu karni	W	TOY	Blue	+	+	+	+
	7.	*Hygrophila schulli* Schumach	Karike Mullu	H	Oct. - April	-do-	-	+	+	-
	8.	*Rhinacanthus nasutus* Lin.	Doddspatika	W	Nov. - May	White	+	+	+	+
Agavaceae	9.	*Polianthes tuberose* Lin.	Sukandaraja	Cp	TOY	-do-	+	+	+	+
Aizoaceae	10.	*Trianthema portulacastrum* Lin.	Chupati	W	March - Oct.	Pink	+	-	-	-
Amaranthaceae	11.	*Alternanthera sessilis* Lin.	Honagone Soppu	H	TOY	White	+	+	-	-
	12.	*Amaranthus viridis* Lin0.	Dhantu	W	TOY	Pink	-	+	-	+
	13.	*Gomphrena globosa* Lin.	Button Flower	H	TOY	-do-	+	+	+	+
Apiaceae	14.	*Coriandrum sativum* Lin.	Kothumburi	Cp	July – Oct.	White	+	+	-	-
Apocynaceae	15.	*Nerium oleander* Lin.	Ganagale gida	S	TOY	Pink	+	-	+	+
	16.	*Tabernaemontana divaricata* Plum.	Najabattlu gida	S	TOY	White	+	+	+	+
Boraginaceae	17.	*Heliotropium indicum* Steud.	Chelukondi gida	H	Oct. – Jan.	-do-	+	+	-	+
Caesalpinaceae	18.	*Cassia auriculata* Lin.	Avarike	W	Jan. – Dec.	Yellow	+	+	+	+
	19.	*Cassia fistula* Lin.	Kakke Mara	T	June – Dec.	-do-	-	+	-	-
	20.	*Cassia sophera* L. Roxb	Tangadi	W	Jan. – Dec.	-do-	-	+	-	-
	21.	*Cassia tora* Lin.	Sogate	W	TOY	-do-	+	+	-	-
Capparaceae	22.	*Capparis zeylanica* Lin.	Mullukattari gida	S	Oct. – Dec.	White	+	+	+	-
	23.	*Crataeva adansonii* Forst.	Nirvala mara	T	July – Nov.	Pink	-	-	+	+

Clemoaceae	24.	*Cleome viscosa* Lin.	Nayibalada gida	W	Sep. - Nov.	Yellow	+	+	-	-
Compositae	25.	*Ageratum conyzoides* Lin.	Oorala gida	W	Dec.- June	Pink	-	+	-	-
	26.	*Bidens biternata* Lour.	Spainish needle	W	TOY	Yellow	+	+	+	+
	27.	*Bidens pilosa* Lin.	Antpurle gida	W	TOY	-do-	+	+	+	+
	28.	*Bidens pilosa* Lin.	Spanish needle	H	Oct. – Jan.	-do-	+	+	+	+
	29.	*Calendula officinalis* Lin.	Sevanthige	S	July – Nov.	-do-	+	+	+	+
	30.	*Erigeron Canadensis* Lin.	Horseweed	W	TOY	White	+	+	+	+
	31.	*Parthenium hysterophorus* Lin.	Parthenium	W	TOY	-do-	+	+	-	-
	32.	*Senecio graham* Lin.	Sonki gida	S	Aug. – Dec.	Yellow	-	+	-	+
	33.	*Tithonia diversifolia* Hemsl. A. Gray	Beli Suryakanthi	S	Sep. - March	-do-	+	+	+	+
	34.	*Tridax procumbence* Lin.	Sanna gida	W	TOY	-do-	-	+	-	+
Convolvulaceae	35.	*Convolvulus arvensis* Lin.	Bhomi ckakra gida	W	Sep.- March	Pink	-	+	+	-
Cucurbitaceae	36.	*Citrullus colocynthis* Lin.	Mekki Kayi	W	July – Dec.	Yellow	+	+	+	-
	37.	*Coccinia grandis* Lin.	Thonde kai	Cp	July – Feb.	-do-	-	+	+	+
	38.	*Cucumis melo* Spp.	Kadu Thonde	W	July – Nov.	-do-	+	+	+	+
	39.	*Cucumis sativus* Lin.	Soutekayi	Cp	TOY	-do-	+	+	+	+
	40.	*Momordica charantia* Lin.	Hagalakayi	Cp	TOY	White	+	+	+	+
	41.	*Trichosanthes cucumerina* Lin.	Padavala kyi	Cp	Aug. – Oct.	Yellow	+	+	+	+
Euphorbiaceae	42.	*Croton sparsiflorus* Morong.	Nayi soppu	H	TOY	White	-	+	-	-
	43.	*Croton sparsiflorus* Morong.	Alpabindi soppu	W	July – Sep.	Yellow	-	+	+	+
	44.	*Ricinus communis* Lin.	Haralu gida	S	Sep. – Nov.	-do-	+	-	+	-
	45.	*Abrus precatorius* Lin.	Gulganji gida	C	July – Nov.	Pink	+	+	+	+
	46.	*Alysicarpus vaginalis* Lin.	Naamada soppu	H	Oct. – Jan.	-do-	+	+	+	+
	47.	*Arachis hypogaea* Lin.	Nelakadale	Cp	Sep. – Jan.	Yellow	-	+	-	-
	48.	*Cajanus cajan* Lin.	Thogari Gida	Cp	Oct. – Dec.	-do-	+	+	+	+
	49.	*Crotalaria juncea* Lin.	Basavanapadada	S	Aug. – Nov.	-do-	+	+	+	+
	50.	*Crotalaria retusa* Lin.	Basavanapada	W	Sep. – April	-do-	+	+	+	+
	51.	*Cullen corylifolia* Lin.	Bavanchigida	W	July - Sep.	Pink	+	+	+	+
	52.	*Desmodium triflorum* Lin.	Kaadu menthe	H	July – Dec.	Blue	+	+	-	-
	53.	*Lablab purpureus* Lin.	Avare	Cp	Oct. – Jan.	Pink	+	+	+	+
	54.	*Pongamia pinnata* Lin.	Honge	T	March - April	-do-	+	-	+	-
	55.	*Rhynchosia minima* Lin.	Bettada avare	Cp	Aug. – Jan.	Yellow	+	+	+	+
	56.	*Sesbania bispinosa* W. Wight	Dhaincha	S	Sep. – Nov.	-do-	+	+	-	-
	57.	*Vigna radiata* Lin.	Hesaru	Cp	Aug. – Oct.	-do-	-	+	-	-
	58.	*Vigna unguiculata* Lin.	Alasunde	H	July – Nov.	Pink	+	+	-	-
Labiatae	59.	*Leucas aspera* (Wild.) Spreng.	Thumbe gida	W	Aug.– Feb.	White	-	+	-	-
Lamiaceae	60.	*Ocimum tenuiflorum* Lin.	Tulsi gida	H	TOY	-do-	+	+	-	-
Linaceae	61.	*Linum mysorense* Heyne	Kadu Agasebeja	W	Oct.- Dec.	Yellow	-	-	+	+
Magnoliaceae	62.	*Michelia champaca* L. Baill.	Sampigemara	T	Sep. – Dec.	Orange	+	+	+	+
Malvaceae	63.	*Abutilon theophrasti* Medik	Button flower	W	TOY	Yellow	+	+	+	+
	64.	*Hibiscus rosa-sinensis* Lin.	Dasavala	W	TOY	Red	-	-	+	+
	65.	*Malva parviflora* Lin.	Button weed	W	Feb.- March	Pink	+	+	-	-
	66.	*Malvastrum coromandelianum* Lin.	Sannabindige Gida	W	TOY	Yellow	+	+	-	-
	67.	*Sida acuta* Burn. F.	Common wire weed	W	Sep.- Oct.	-do-	+	+	-	-
	68.	*Sida cordifolia* Lin.	Hettuti gida	W	Sep.- Dec.	-do-	-	+	-	-
	69.	*Sida rhombifolia* Lin.	Binneggarugagida	W	Sep. - Nov.	-do-	-	+	-	-
Oleaceae	70.	*Jasminum dichotomum* Burm.	Mallige	C	Sep. – Oct.	White	+	+	+	+
	71.	*Jasminum multiflorum* Burm.	Suji malle	S	July – Nov.	-do-	+	+	+	+
	72.	*Nyctanthes arbor-tristis* Lin.	Parijatha	T	July – Feb.	-do-	+	+	+	+
Papilionaceae	73.	*Desmodium triflorum* Lin. D. C.	Kadu Menthe	W	July - Nov.	Pink	+	+	-	-
Portulacaceae	74.	*Portulaca oleracea* Lin.	Doddagooni soppu	W	Jan. – Dec.	Yellow	+	-	-	-
Primulaceae	75.	*Anagallis arvensis* Lin.	Suryakanthi soppu	W	Dec. - Feb.	Blue	+	+	+	+
Rutaceae	76.	*Citrus aurantifolia* Christm	Nimbe Gida	T	TOY	White	-	-	+	-
	77.	*Murraya koenigii* L. Springel	Karibevu	T	TOY	-do-	-	-	+	+
	78.	*Ruta graveolens* Lin.	Nagadaligida	S	TOY	Yellow	+	+	+	+
Scrophulariaceae	79.	*Bacopa indica* Lin.	Barhmi gida	W	TOY	Blue	+	+	+	+
Solanaceae	80	*Solanum nigrum* Lin.	Ganagle gida	W	June - Sep.	White	+	+	+	+
	81.	*Solanum xanthocarpum* Schrad & Wendl.	Kantikari gida	W	June - Sep.	Pink	+	+	+	+
Tiliaceae	82.	*Corchorus aestuans* Lin.	Chanchu gida	W	Sep. - Nov.	Yellow	+	+	-	-
	83.	*Corchorus capsularis* Lin.	Senabu	W	Aug. - Oct.	-do-	-	+	-	-

	84.	*Corchorus olitorius* Lin.	Wild Jute	W	Sep. - Nov.	-do-	+	+	-	-
	85.	*Corchorus trilocularis* Lin.	Kaaduchunchali gida	W	Aug. - Oct.	-do-	-	+	-	-
	86.	*Lantana camara* Lin.	Roja gida	S	TOY	Pink	+	+	+	+

Note: TOY: Throughout the year, Butterfly species: Am: *Ariadne merione*; Jh: *Junonia hierta*; Pp: *Papilio polytes*; Ga: *Graphium agamemnon*, Plant type: We: Weed, Cp: Cultivated plants, C: Climber; S: Shrub; H: Herb; T: Tree.

Table 2: Nectar source obtained from different plants families by butterfly species at agricultural ecosystems

S. No.	Family	Nectar Plants	% Dependence
1.	Acanthaceae	8	9.3
2.	Agavaceae	1	1.2
3.	Aizoaceae	1	1.2
4.	Amaranthaceae	3	3.5
5.	Apiaceae	1	1.2
6.	Apocynaceae	2	2.3
7.	Boraginaceae	1	1.2
8.	Caesalpinaceae	4	4.7
9.	Capparaceae	2	2.3
10.	Clemoaceae	1	1.2
11.	Compositae	10	11.6
12.	Convolvulaceae	1	1.2
13.	Cucurbitaceae	6	7.0
14.	Euphorbiaceae	17	19.8
15.	Labiatae	1	1.2
16.	Lamiaceae	1	1.2
17.	Linaceae	1	1.2
18.	Magnoliaceae	1	1.2
19.	Malvaceae	7	8.1
20.	Oleaceae	3	3.5
21.	Papilionaceae	1	1.2
22.	Portulacaceae	1	1.2
23.	Primulaceae	1	1.2
24.	Rutaceae	3	3.5
25.	Scrophulariaceae	1	1.2
26.	Solanaceae	2	2.3
27.	Tiliaceae	5	5.8
Total		86	100
Mean ± SD		3.19 ± 3.79	-

Note: Data is based on the Table 1

Table 3: Flowering plants visited for nectar source by butterfly species

S. No.	Flowering plant type	Butterfly species				Total	Mean ± SD	'F' value
		A. merione	*J. hierta*	*P. polytes*	*G. agamemnon*			
1.	Crop	9	12	9	9	39	9.75 ± 1.5	11.048 S
2.	Climber	2	2	2	2	8	2 ± 0	
3.	Herb	9	11	5	5	30	7.5 ± 3	
4.	Shrub	11	12	10	9	42	10.5 ± 1.3	
5.	Tree	3	3	5	4	15	3.75 ± 1.0	
6.	Weed	29	44	16	19	108	27 ± 12.6	
Total		63	84	47	48	242	-	-
Mean ± SD		10.50 ± 9.75	14.00 ± 15.38	7.83 ± 4.96	8.00 ± 6.07	-	-	-
'F' value		0.507 NS				-	-	-

Note: Data is based on the Table 1, NS: Not significant, S: Significant.

Table 4: Flower color preferred by butterfly species at agricultural ecosystems

S. No.	Flower color	Butterfly species				Total	Mean ± SD	'F' value
		A. merione	*J. hierta*	*P. polytes*	*G. agamemnon*			
1.	Blue	7	6	5	5	23	5.75 ± 0.96	30.117 S
2.	Orange	1	1	1	1	4	1 ± 0.0	
3.	Pink	14	13	12	12	51	12.75 ± 0.96	
4.	Red	0	0	1	1	2	0.5 ± 0.58	
5.	White	15	17	12	11	55	13.75 ± 2.75	
6.	Yellow	27	37	20	20	104	26 ± 8.04	
Total		64	74	51	50	239	-	-
Mean ± SD		10.67 ± 10.17	12.33 ± 13.79	8.50 ± 7.50	8.33 ± 7.42	39.83 ± 38.65	-	
'F' value		0.215 NS						

Note: Data is based on the Table 1, NS: Not significant, S: Significant.

Table 5: Preferred nectar plants of source by few butterfly species

S. No.	Plant families	Butterfly species				Total
		A. merione,	*J. hierta*	*P. polytes*	*G. agamemnon*	
1.	Acanthaceae	7	7	5	4	23
2.	Agavaceae	1	1	1	1	4
3.	Aizoaceae	1	0	0	0	1
4.	Amaranthaceae	2	3	1	2	8
5.	Apiaceae	1	1	0	0	2
6.	Apocynaceae	2	1	2	2	7
7.	Boraginaceae	1	1	0	1	3
8.	Caesalpinaceae	2	4	1	1	8
9.	Capparaceae	1	1	2	1	5
10.	Clemoaceae	1	1	0	0	2
11.	Compositae	7	10	6	8	31
12.	Convolvulaceae	0	1	1	0	2
13.	Cucurbitaceae	5	6	6	5	22
14.	Euphorbiaceae	13	15	11	9	48
15.	Labiatae	0	1	0	1	2
16.	Lamiaceae	1	1	0	0	2
17.	Linaceae	0	0	1	1	2
18.	Magnoliaceae	1	1	1	1	4
19.	Malvaceae	4	6	2	2	14
20.	Oleaceae	3	3	3	3	12
21.	Papilionaceae	1	1	0	0	2
22.	Portulacaceae	1	0	0	0	1
23.	Primulaceae	1	1	1	1	4
24.	Rutaceae	1	1	3	2	7
25.	Scrophulariaceae	1	1	1	1	4
26.	Solanaceae	2	2	2	2	8
27.	Tiliaceae	3	5	1	1	10
Total		63	75	51	49	238
Mean ± SD		2.3 ± 2.8	2.8 ± 3.5	1.9 ± 2.5	1.8 ± 2.3	-
'F' value		0.678 NS				

Note: Data is based on the Table 1, NS: Not significant.

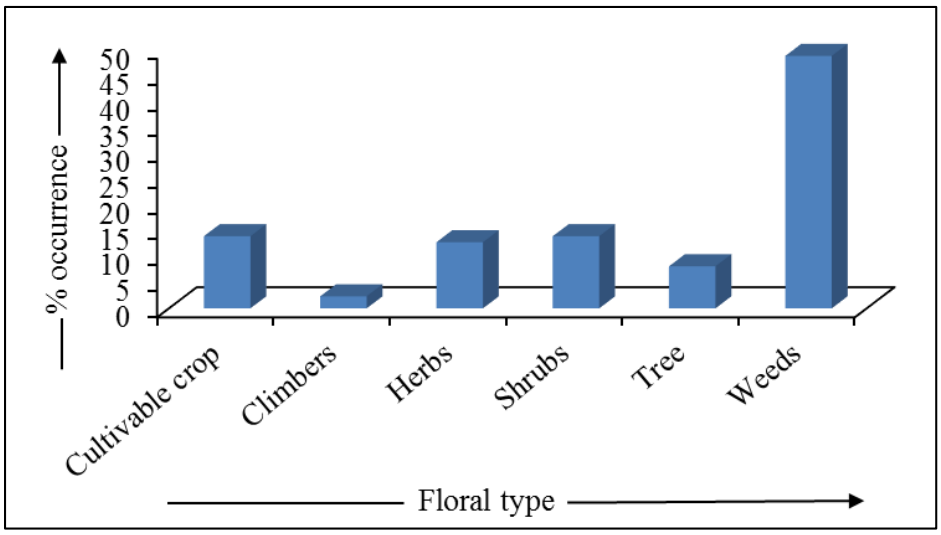

Fig 1: Floral source for few butterfly species at agricultural ecosystems

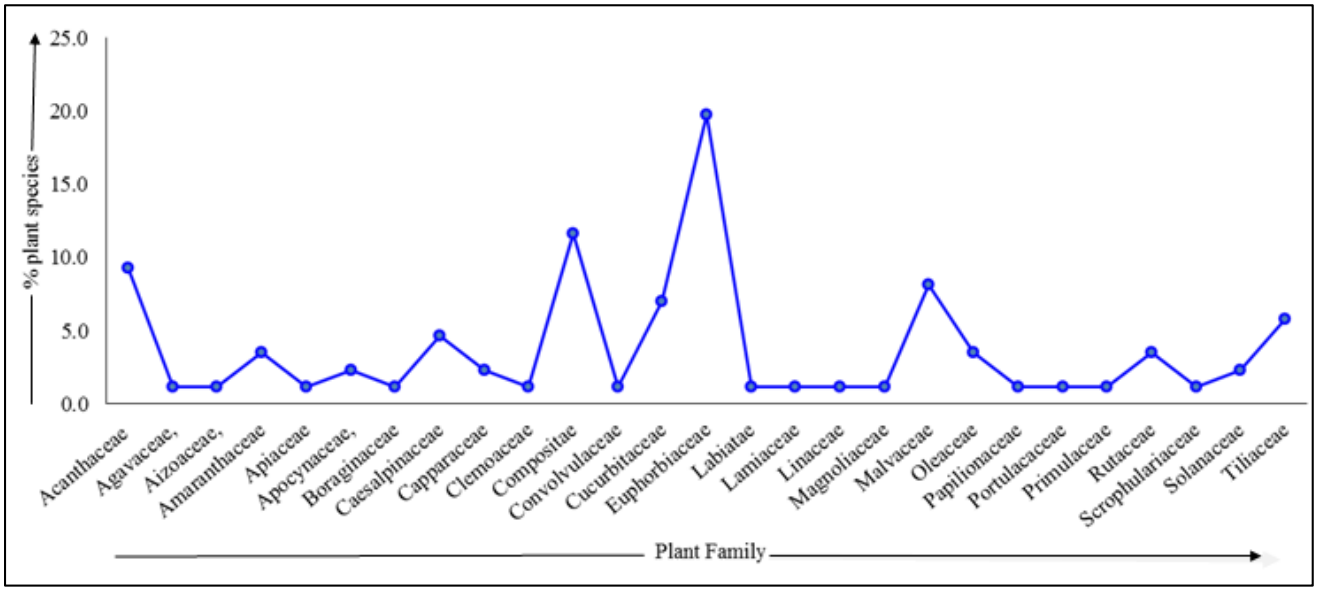

Fig 2: Per cent use of nectar plants of different families

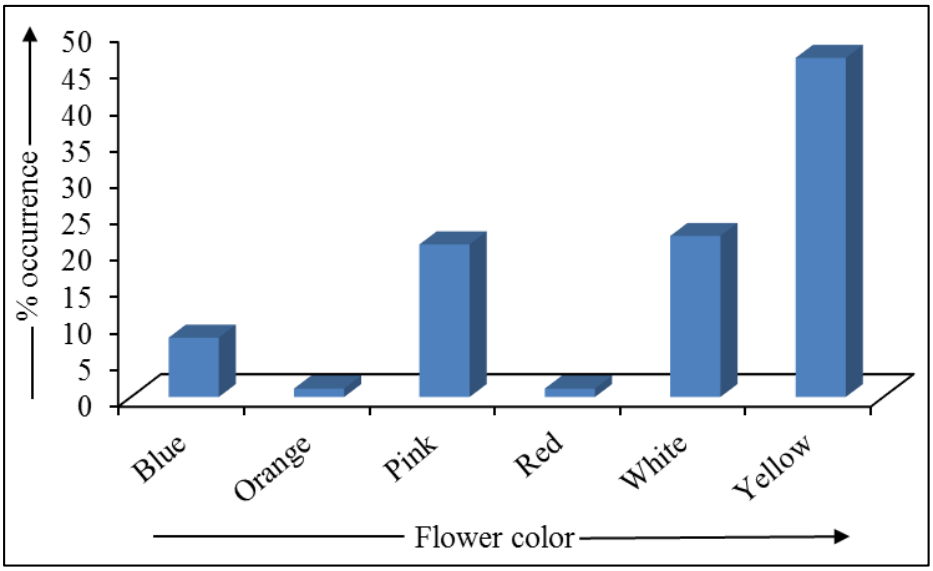

Fig 3: Colored flower occurred for butterfly species at agricultural ecosystems

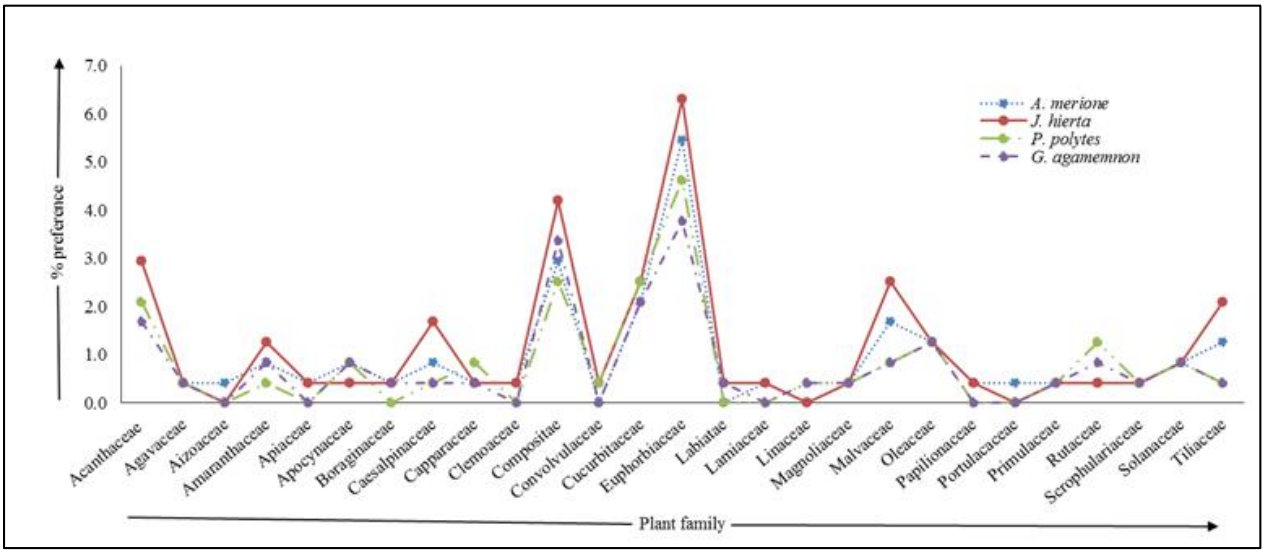

Fig 4: Per cent preference of nectar plants of different families by butterfly species

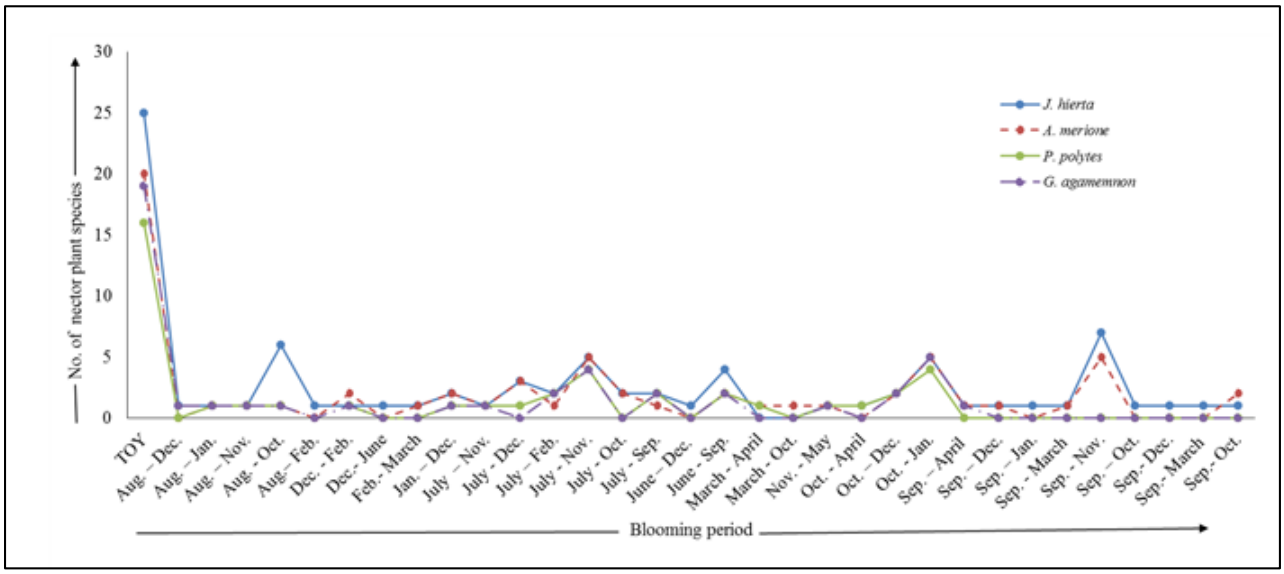

Fig 5: Floral calendar of butterfly species at agriculture ecosystems

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