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STUDIES ON POLLINATOR FAUNA, ABUNDANCE AND FORAGING ACTIVITIES ON SOME OF SELECTED MEDICINAL PLANTS

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ABSTRACT

On adusoge, twelve different species of insect visitors were recorded. Of these, nine species belong to hymenoptera and three to lepidoptera. Peak abundance of pollinators were observed between 1100 h to 1200 h. Hymenopterans and dipterans were found to visit the naagadaali flowers abundantly. Peak foraging activities of all the honeybee species and other pollinators were at 1100 h. The flowers of kaadusevanthi attracted many hymenopterans and lepidopterans. Both *A. dorsata* and *A. cerana* showed their peak activity at 1200 h, whereas *A. florea* showed its peak activity at 1300 h. Hymenopterans, dipterans and lepidopterans were found foraging on the flowers of vishnukanthi. The peak activity of *A.dorsata* was at 1100 h, whereas *A. cerana* and *A. florea* were abundant at 1000 h. Similarly, other insects pollinators were showed their peak activity at 1100 h. Flowers of madhuvantha also visited by many hymenopterans. Peak activity of *A. cerana* and *A. florea* were recorded at 1300 h and 1100 h, respectively. On kaaduharalu, fourteen insects were recorded from orders of hymenoptera, diptera and hemiptera. Peak activity of *A. cerana* was found at 1100 h, whereas, *A. florea* and *T. iridipennis* were at 1200 h. Peak activity of other insect visitors were found at 1100 h.

INTRODUCTION

Pollination is one of the important factors in increasing crop productivity. Crop plants are either self-pollinated or cross pollinated to set fruits or seeds. The hindrance in cross pollinated crops to set fruit or seed can be managed by external agents for completing the pollination process. Wind, water and animals including insects are involved in the pollination of flowering plants. The plants which are mediated by insects for pollination is called entomophilous plants. The yield of agricultural crops can be significantly increased through good management practices including effective pollination. In this context, honeybees play a vital role in increasing crop production through pollination. Pollination by honeybees increases not only the yield, but also helps in increasing hybrid vigor, creates variation and maintains the gene flow in the ecosystem there by conserving the diversity in crop varieties (Melnichenko, 1977).

Perhaps during the last three decades, essential oil industry has grown leaps and the demand for both medicinal and aromatic crops has increased tremendously in global trades. However, the production and productivity of both crops directly depends on the pollination of their flowers and co-incidentally the economic part of several such crops is seeds. Hence, there is a need of pollination for maximum productivity. The world health organization (WHO) has compiled a list of 20,000 medicinal plants used in different parts of the globe. Many of these species have local uses within the country or spread over several countries in the world. Among them, over one hundred botanicals are reported to have consistently large demand and are traded in major drug markets in the world.

Some of other medicinal plants grown in herbal garden, UAS, GKVK, Bangalore such as Adusoge, *Adathoda vasica*Nees (Family: Acanthaceae), Naagadaali, *Ruta graveolens* L. (Family: Rutaceae), Kaadusevanthi, *Taraxacum officinale* Wigg. (Family: Asteraceae), Vishnu kanthi, *Evalvulus alsinoides* L. (Family: Convolvulaceae), Madhuvantha, *Stevia rebudiana* Bertoni. (Family: Asteraceae), Kaaduharalu, *Baliospermum montanum* (Willd). (Family: Euphobiaceae). They are having predominant position as commercially grown medicinal plants and they are greatly used in Ayurvedic drugs, confectionary and culinary purpose.Medicinal crops are not being grown commercially in Karnataka in spite of numerous medicinal uses which may be due to lack of information on various insect pollinators for their perpetuation and multiplication. Hence, the present studies were therefore carried out to study on pollinator fauna and their abundance on some of selected medicinal plants.

MATERIALS AND METHODS

The study pertaining to the insect pollinators of selected medicinal crops and their relative abundance was carryout at the Herbal Garden, Division of Horticulture, Gandhi Krishi Vigyana Kendra, University of Agricultural Sciences, Bangalore. The crops were raised following all the recommended package of practices. Ten plants were randomly selected in each crop to record the different species of insect pollinators visiting the flowers of Adusoge, *Adathoda vasica* Nees., Kaadusevanthi, *Taraxacum officinale* Wigg., Vishnukanthi, *Evalvulus alsinoides* L., Madhuvantha, *Stevia rebudiana* Bertoni., Kaaduharalu, *Baliospermum montanum* (Willd). However, in case of Naagadaali, *Ruta graveolens* L. ten inflorescence were observed. The pollinators visiting on different crops were collected, preserved and identified with the help of Insect taxonomist, Dept. of Entomology. GKVK, Bangalore. The abundance of the insect pollinators visiting flowers of selected medicinal crops were recorded from 0600 to 1800 h at hourly interval for five minutes during their peak flowering period and were expressed as mean number of pollinators visited per plant for five minutes.

The data obtained from field experiments were subjected to $\sqrt{X+1}$ statistical analysis for comparing treatments following the ANOVA technique for randomized complete block design and results were interpreted at five per cent level of significance.

EXPERIMENTAL RESULTS AND DISCUSSION:

The results of present investigations on insect pollinators and their abundance on important medicinal cropswere recorded. Many insect pollinators found to visit medicinal flowers more frequently. The different species of insect visitors on selected medicinal crops are presented in table 1.

Adusoge, *Adathoda vasica* Nees.

Twelve different species of insect visitors were recorded on the flowers of adusoge. Of these, nine species belong to hymenoptera, three to Lepidoptera. The hymenopterans consisted of five species from the family apidae*viz.*, *Apisceran*aFab., *A. florea* Fab.,*Trigonairidipennis* smith., *Amegillaviolacea* (Lep) *and Xylocopa amethystine* Fab., two species from formicidae (*Componatussericeus*Fab. and*Oecophyllasmargdina*Smith.), one species each from scolitidae (*Scolia sp.*) and halictidae (*Nomiasp*). The lepidopterans consisted of three species viz., *Danauschysippus* L. of family nymphalidae, *Papiliodemolius* Lin. and *Pachlioptaaristalochea*Fab.frompapilionidae. Observations on mean abundance of different pollinators visiting adusoge flowers revealed that the maximum intensity of

A.cerana(4.40/plant/5 min), followed by *A. florea* (3.15/plant/min). Apart from honeybee species, other insect pollinators were found to be 2.79/plant/5 min. The foraging activity of *A. cerana*started from 0700 h and terminated at 1800 h, whereas in *A. florea* began its foraging activity from 0800 h and terminated at 1700 h. of the day. Peak foraging activity was observed in *A. cerana*and *A. florea*at 1200 h and 1100 h with mean number of 9.65 and 6.70 /plant/5 min, respectively and second peak at 1100 h and 1200 h with mean number of 8.10 and 6.47 /plant/5 min, respectively. Other insect visitors such as Nomia sp., Scolia sp. ants and lepidopterans recorded their peak activity on adusoge flowers at 1200 h with a mean of 5.05 /plant/5 min.

Naagadaali, *Rutagraveolens* L .

Hymenopterans were found to visit the flowers abundantly. The four species of apidae*viz., A. cerana, A. florea, T. iridipennis and Xylocopa sp.,* two from formicidae (*C. sericeus*and *O. smargdina*), one from halictidae (*Halictus sp.*) of order hymenoptera along with one unidentified species from syrphidae of order diptera were recorded on flowers of naagadaali.The mean abundance of *A. cerana*was found to be maximum (2.97/inflorescence/5 min), followed by *A. florea*(2.14/inflorescence/5 min), *T. iridipennis*(1.13 /inflorescence/5 min) and others (1.83 /inflorescence/5 min). Foraging activity of *A. cerana, A. florea*and *Trigona iridipennis*was observed from 0700 h onwards. But, *A. cerana* and *A. florea*continued their foraging activity upto 1800 h, whereas, *T. iridipennis*continued upto 1600 h. Two peak foraging activity were observed in *A. cerana* at 1100 h and 1200 h with mean number of 4.85 and 4.55 /inflorescence/5 min, respectively. Similarly, *A. florea*and *T. iridipennis* had their peak activity at 1100 h with mean number of 3.52 and 2.40 /inflorescence/5 min, respectively. However, *A. florea* recorded its second peak activity at 1200 h (3.50 /inflorescence/5 min).Naagadaali flowers were visited by *Halictus sp.*, ants and dipterans with their peak activity at 1100 h with 3.57 /inflorescence/5 min.

Kaadusevanthi, *Taraxacumofficinale*Wigg.

The flowers of kaadusevanthi attracted many hymenopterans, which included three species of apidae*viz., A. cerana, A. florea*and *A. dorsata, two* species from formicidae (*C. sericeus*and *O. smargdina*), and one each from vespidae (*Ropalidaimargiinata*), sphecidae (*Philanthus sp.*) and halictidae (*Halictus sp.*) were recorded along with one species from lycanidae (*Gramblo sp.*) of order lepidoptera.The maximum abundance of *A. dorsata* (3.20 /plant/5 min) was recorded on kaadusevanthi compared to *A. cerana*(2.36 /plant/5 min), *A. florea* (1.46 /plant/5

min) and other insect pollinators (1.72 /plant/5 min). Theforaging activity of *A. dorsata*and *A. cerana was observed* from 0700 h to 1800 h. But, in case of *A. florea*it was started from 0700 h and ended by 1600 h. Both *A. dorsata* and *A. cerana* showed their peak activity at 1200 h with 6.92 and 5.25 bees/plant/5 min, respectively. Similarly, *A. florea*showed peak activity at 1300 h with 3.20 /plant/5 min. However, the activity declined gradually towards end of the day in all species of honeybees.The flowers of *Taraxacumofficinale*wigg. were visited by wasps, sphecids and butterflies and their peak abundance was observed at 1100 h with a mean of 4.37 /plant/5 min.

Vishnukanthi, *Evalvulusalsinoides* L.

Four species of apidae*viz., A. cerana, A. florea,A. dorsata* and *Xylocopa sp., t*wo species from vespidae (*R. margiinata* and*Polistes stigma* Fab), two from formicidae (*C. sericeus*and *O smargdina*) and one each from sphecidae (Unidentified) and Eumenidae (*Eumenesconica De. Geer*) of order hymenoptera were found to visit the flowers of vishnukanthi. Similarly, one species of pompillidae (*Pompilus sp.*) of order lepidoptera was also found foraging on the flowers.The observations on mean abundance of different pollinators on *Evalvulusalsinoides*L. flowers revealed the maximum number of *A. dorsata* (5.36 / plant / 5 min), followed by *A. cerana* (3.04 / plant / 5 min), *A. florea*(2.17/plant/5min) and other insect pollinators (2.59 / plant / 5 min).

Foraging activity of *A. dorsata*was found to start from 0700 h and continued upto 1800 h, whereas *A. cerana*and *A. florea*began the foraging activity by 0700 h and continued up to 1700 h. The peak foraging activity of *A. dorsata*was at 1100 h with mean of 11.27 / plant / 5 min. Similarly, *A. cerana*and *A. florea were* abundant at 1000 h with 5.75 and 4.15 bees / plant / 5 min, respectively. Two peak foraging activity of other insect pollinators such as wasps and lepidopterans were observed on the flowers of vishnukanthi at1100 and 1200 h with a mean of 6.10 and 6.05 /plant/ 5 min, respectively.

Madhuvantha, *Stevia rebudiana*Bertoni.

Insect pollinators visiting the flowers of madhuvantha were found to be hymenopterans, which included two species from apidae*viz., A. cerana*and *A. florea,* one species from halictidae (*Halictus sp.*), two species each from vespidae (*R. margiinata* and *P. stigma*), sphecidae (*Philanthus sp.* and one unidentified species) and formicidae (*C. sericeus*and *O. smargdina*).The flowers of *S. rebudiana*were abundantly visited by the pollinators such as *A. cerana*(4.42 /plant/5 min), followed by *A. florea* (3.40 / plant / 5 min). The foraging activity

of *A. cerana*began at 0700 h and continued up to 1800 h, whereas *A. florea*starts its foraging activity at 0700 h and terminated at 1700 h. The peak activity of *A. cerana*was recorded at 1300 and 1400 h with 7.10 and 6.90 /plant/5 min, respectively. Similarly, *A. florea*recorded its peak activity at 1100 h and 1300 h with 7.60 and 6.77/plant/5min, respectively. The other insect pollinators were 2.66 / plant / 5 min during the study period. Peak activity of wasps and halictids were observed on *S.rebudiana*Bertoni.flowers at 1000 and 1300 h with mean of 4.87 and 4.97/plant/5 min, respectively.

Kaaduharalu, *Baliospermummontanum* (Willd).

Among hymenopterans, five species from apidae*viz., A. cerana, A. dorsata, A. florea*, *T. iridipennis*, *A. violacea* and *X. amethystina*, two species from family formicidae (*C. sericeus*and *O. smargdina* Smith.) and one species each from vespidae (*R. margiinata*), scolitidae (*Scolia sp.*), halictidae (*Halictus sp.*) and sphecidae (*Philanthus sp.*) were found to visit the kaaduharalu flowers. One species from family scutellaridae of order hemiptera.Two dipterans unidentified species one each from family syrphidae and tachnidae were also recorded.The flowers of Kaaduharalu were visited by different pollinators, which included *A. cerana* (5.23 /plant/5 min), *A. florea*(5.17 /plant/5 min), *T. iridipennis*(4.23 /plant/5 min) and other insect pollinators (2.67 /plant/5 min). The foraging activity of *A. cerana*began at 0700 h and continued up to 1800 h, whereas *A. florea*starts its foraging activity at 0700 h and terminated at 1700 h. The peak activity of *A. cerana*was recorded at 1300 and 1400 h with 7.10 and 6.90 /plant/5 min, respectively. Similarly, *A. florea*recorded its peak activity at 1100 h and 1300 h with 7.60 and 6.77/plant/5min, respectively. The peak activity of dipterans and other homopterans were observed at 1100 h with 5.32 /plant/5 min on *Baliospermummontanum* (Willd) flowers.

The findings on insect visitors, their abundance and foraging activities on selected medicinal crops in the present study is concluded in agreement with the findings of Youngken (1950 and 1956), Barbier (1958), Kugler (1972), E1-Berry *et al.* (1974), D' Albore (1984), Sih and Baltus (1987), Neelima and Kumar, (1998), Sajjanar (2002), Shilpa (2006). However, variation in number of insect visitors and their abundance in the present study and also earlier studies by several workers on some of the medicinal and aromatic crops may be type of crop, weather conditions of the area and also availability of forage source that vary from place to place.

Table-1: Insect pollinators visiting selected medicinal crops

Order	Family	Species
1. Adusoge, *Adathodavasica*Nees.		
Hymenoptera	Apidae	*A. ceranaindica*Fab.
		*A. florea*Fab.
		Amegillaviolacea(Lep)
		Xylocopa amethystine Fab
	Halactidae	*Nomia sp.*
	Scolitidae	*Scolia sp.*
	Formicidae	*Camponatussericeus*Fab.
		*Oecophyllasmargdina*Smith.
Lepidoptera	Nymphalidae	Danauschysippus L.
	Papilionidae	*Papiliodemolius*Lin.
		*Pachlioptaaristalochea*Fab.
2. Naagadali, *Rutagraveolens* L.		
Hymenoptera	Apidae	*A. ceranaindica*Fab.
		*A. florea*Fab.
		*Trigonairidipennis*Smith.
		Xylocopa sp.
	Formicidae	*Camponatussericeus*Fab.
		*Oecophyllasmargdina*Smith.
	Halactidae	*Halictus sp.*
Diptera	Syrphidae	Unidentified
3. Kaadusevanthi, *Teraxacumofficinale*Wigg.		
Hymenoptera	Apidae	*A. ceranaindica*Fab.
		*A. florea*Fab.
		*A. dorsata*Fab.
	Halactidae	*Halictus sp.*
	Sphecidae	*Philanthus sp.*
	Vespidae	*Ropalidaimargiinata* (Lin.)
	Formicidae	*Camponatussericeus*Fab.
		*Oecophyllasmargdina*Smith.
Lepidoptera	Lycanidae	*Gramblo sp.*
4.Vishnukanthi, *Evalvulusalsinoides* L.		
Hymenoptera	Apidae	*A. ceranaindica*Fab.
		*A. florea*Fab.
		*A. dorsata*Fab.
		Xylocopa sp.
	Formicidae	*Camponatussericeus*Fab.
		*Oecophyllasmargdina*Smith.
	Vespidae	*Ropalidaimargiinata* (Lin.)
		Polistes stigma Fab
	Sphecidae	Unidentified
	Eumenidae	*Eumenesconica De. Geer*
Lepidoptera	Pompilidae	*Pompilus sp.*
5. Madhuvantha, *Stevia rebudiana*Bertoni.		
Hymenoptera	Apidae	*A. ceranaindica*Fab.
		*A. florea*Fab.
	Halactidae	*Halictus sp.*
	Vespidae	*Ropalidaimargiinata* (Lin.)
		Polistes stigma Fab
		Philanthus sp.
	Formicidae	*Camponatussericeus*Fab.
		*Oecophyllasmargdina*Smith.
6. Kaaduharalu, *Baliospermummontanum* (Willd).		
Hymenoptera	Apidae	*A. ceranaindica*Fab.
		*A. florea*Fab.
		Amegillaviolacea(Lep)
		Xylocopa amethystine Fab
	Scolitidae	*Scolia sp.*
	Halactidae	*Halictus sp.*
	Sphecidae	*Philanthus sp.*
	Vespidae	*Ropalidaimargiinata* (Lin.)
	Formicidae	*Camponatussericeus*Fab.
		*Oecophyllasmargdina*Smith.
Diptera	Syrphidae	Unidentified
	Tachnidae	Unidentified
Hemiptera	Sutellaridae	*Chrysocorispurpureus* (westwood)

Table- 2: Abundance of insect pollinators visiting Adusoge, *Adathodavasica*Nees

Time (hr)	Mean No. of Pollinators /plant /5 min		
	Apiscerana	***Apisflorea***	**Others**
0600	0.00 (1.00) [a]	0.00 (1.00) [a]	0.00 (1.00) [a]
0700	1.42 (1.14) [ab]	0.00 (1.00) [a]	1.67 (1.17) [a]
0800	2.47 (1.55) [cd]	1.22 (1.31) [abc]	2.15 (1.49) [b]
0900	4.72 (1.72) [cde]	2.55 (1.51) [cde]	2.42 (1.64) [bc]
1000	5.50 (1.80) [cdef]	5.17 (1.64) [cde]	3.00 (1.80) [c]
1100	8.10 (1.84) [def]	6.70 (1.80) [e]	3.95 (1.81) [c]
1200	9.65 (2.11) [f]	6.47 (1.79) [e]	5.05 (2.15) [d]
1300	8.02 (1.93) [ef]	5.65 (1.71) [de]	7.87 (2.25) [d]
1400	7.30 (1.80) [cdef]	5.40 (1.54) [cde]	4.57 (1.63) [bc]
1500	4.75 (1.78) [cdef]	4.15 (1.47) [bcde]	2.60 (1.64) [bc]
1600	2.37 (1.58) [cd]	2.17 (1.38) [bcd]	1.62 (1.57) [b]
1700	1.80 (1.48) [bc]	1.55 (1.16) [ab]	1.40 (1.42) [b]
1800	1.15 (1.13) [a]	0.00 (1.00) [a]	0.00 (1.00) [a]
Mean	**4.40**	**3.15**	**2.79**
S.Em±	**0.40**	**0.08**	**0.19**
CD @ 5%	**1.16**	**0.25**	**0.55**

Figures in the parenthesis are $\sqrt{X+1}$ transformed values.

Means followed by same letter in a column do not differ significantly by DMRT at 5 per cent level.

Table- 3: Abundance of insect pollinators visiting Naagadaali, *Rutagraveolens* L.

Time (hr)	Mean No. of Pollinators /inflorescence /5 min			
	Apiscerana	***Apisflorea***	***Trigonairidipennis***	**Others**
0600	0.00 (1.00) [a]	0.00 (1.00) [a]	0.00 (1.00) [a]	0.00 (1.00) [a]
0700	2.30 (1.23) [b]	1.27 (1.12) [b]	0.62 (1.00) [a]	0.57 (1.06) [ab]
0800	3.00 (1.69) [cd]	2.12 (1.36) [c]	1.00 (1.52) [c]	2.52 (1.22) [b]
0900	4.45 (1.86) [de]	2.57 (1.53) [d]	1.40 (2.06) [fg]	2.92 (1.87) [d]
1000	3.57 (1.73) [cd]	2.97 (1.67) [ef]	2.37 (1.93) [ef]	3.15 (1.90) [d]
1100	4.85 (1.73) [cd]	3.52 (1.62) [def]	2.40 (2.02) [efg]	3.57 (1.87) [d]
1200	4.55 (1.97) [ef]	3.50 (1.73) [f]	1.70 (2.09) [g]	2.47 (1.77) [d]
1300	4.42 (2.08) [f]	3.27 (1.65) [ef]	1.37 (1.90) [de]	1.70 (1.76) [d]
1400	3.65 (1.85) [de]	3.10 (1.61) [de]	1.45 (1.78) [d]	1.57 (1.53) [c]
1500	3.22 (1.89) [def]	2.37 (1.52) [d]	1.55 (1.98) [efg]	1.40 (1.50) [c]
1600	2.57 (1.54) [c]	1.50 (1.14) [b]	0.92 (1.76) [d]	1.60 (1.52) [c]
1700	1.47 (1.31) [b]	1.22 (1.12) [b]	0.00 (1.31) [b]	1.35 (1.12) [ab]
1800	0.62 (1.00) [a]	0.37 (1.07) [ab]	0.00 (1.00) [a]	1.02 (1.12) [ab]
Mean	**2.97**	**2.14**	**1.13**	**1.83**
S.Em±	**0.17**	**0.12**	**0.12**	**0.09**
CD @ 5%	**0.50**	**0.34**	**0.37**	**0.27**

Figures in the parenthesis are $\sqrt{X+1}$ transformed values.

Means followed by same letter in a column do not differ significantly by DMRT at 5 per cent level.

Table- 4: Abundance of insect pollinators visiting Kaadusevanthi, *Taraxacumofficinale*Wigg.

Time (hr)	Mean No. of Pollinators /plant /5 min			
	Apisdorsata	***Apiscerana***	***Apisflorea***	**others**
0600	0.00 (1.00) [a]	0.00 (1.00) [a]	0.00 (1.00) [a]	0.00 (1.00) [a]
0700	1.10 (1.12) [a]	1.30 (1.09) [a]	0.70 (1.08) [a]	0.00 (1.00) [a]
0800	2.57 (1.53) [b]	2.15 (1.37) [b]	2.02 (1.35) [b]	1.22 (1.51) [bc]
0900	4.02 (1.58) [b]	2.50 (1.70) [c]	1.55 (1.44) [bc]	1.40 (1.52) [bc]
1000	2.60 (1.64) [b]	2.17 (1.80) [cd]	1.60 (1.52) [bc]	1.97 (1.94) [d]
1100	5.75 (2.00) [d]	4.32 (1.93) [de]	3.07 (1.86) [d]	4.37 (2.32) [e]
1200	6.92 (1.93) [cd]	5.25 (2.03) [e]	2.52 (2.20) [e]	3.35 (2.86) [f]
1300	4.25 (1.70) [bc]	3.37 (1.90) [cde]	3.20 (1.92) [d]	2.37 (2.33) [e]
1400	5.00 (1.69) [bc]	3.37 (1.91) [cde]	2.20 (1.85) [d]	2.25 (2.25) [e]
1500	4.02 (1.60) [b]	2.45 (1.98) [de]	1.17 (1.76) [d]	2.17 (2.19) [e]
1600	2.77 (1.24) [a]	1.52 ()1.69 [c]	1.00 (1.59) [c]	2.05 (1.62) [c]
1700	1.37 (1.16) [a]	1.17(1.77) [cd]	0.00 (1.31) [b]	1.20 (1.62) [c]
1800	1.25 (1.13) [a]	1.20 (1.46) [b]	0.00 (1.00) [a]	0.00 (1.31) [b]
Mean	**3.20**	**2.36**	**1.46**	**1.72**
S.Em±	**0.18**	**0.16**	**0.14**	**0.13**
CD @ 5%	**0.53**	**0.47**	**0.40**	**0.39**

Figures in the parenthesis are $\sqrt{X+1}$ transformed values.

Means followed by same letter in a column do not differ significantly by DMRT at 5 per cent level.

Table- 5: Abundance of insect pollinators visiting Vishnukanthi, *Evalvulusalsinoides*L.

Time (hr)	Mean No. of Pollinators /plant /5 min			
	Apisdorsata	***Apiscerana***	***Apisflorea***	**others**
0600	0.00 (1.00) [a]	0.00 (1.00) [a]	0.00 (1.00) [a]	0.00 (1.00) [a]
0700	3.40 (1.29) [ab]	1.25 (1.12) [a]	2.37 (1.83) [e]	1.70 (1.64) [c]
0800	5.87 (1.71) [cde]	4.67 (1.76) [cd]	2.65 (1.91) [f]	3.27 (2.06) [f]
0900	7.45 (1.82) [cde]	5.50 (1.69) [bcd]	3.35 (2.08) [g]	2.65 (1.91) [e]
1000	8.55 (1.87) [def]	5.75 (1.75) [cd]	4.15 (2.26) [i]	4.60 (2.36) [g]
1100	11.27 (2.56) [h]	5.57 (1.92) [cde]	3.72 (2.17) [h]	6.10 (2.66) [h]
1200	8.62 (2.51) [gh]	4.72 (2.21) [ef]	2.72 (1.92) [f]	6.05 (2.65) [h]
1300	7.77 (2.41) [gh]	2.82 (2.35) [f]	2.65 (1.91) [f]	2.57 (1.89) [e]
1400	6.50 (2.25) [fgh]	3.82 (2.25) [ef]	2.07 (1.75) [d]	2.02 (1.73) [d]
1500	5.15 (2.12) [efg]	2.72 (1.80) [cd]	1.60 (1.61) [c]	1.82 (1.67) [cd]
1600	2.50 (1.97) [def]	1.80 (1.72) [bcd]	1.67 (1.63) [c]	1.60 (1.61) [c]
1700	1.70 (1.66) [bc]	0.97 (1.61) [bc]	1.35 (1.53) [b]	1.37 (1.54) [b]
1800	0.92 (1.44) [bc]	0.00 (1.36) [ab]	0.00 (1.00) [a]	0.00 (1.00) [a]
Mean	**5.36**	**3.04**	**2.17**	**2.59**
S.Em±	**0.19**	**0.15**	**0.07**	**0.08**
CD @ 5%	**0.55**	**0.43**	**0.22**	**0.25**

Figures in the parenthesis are $\sqrt{X+1}$ transformed values.

Means followed by same letter in a column do not differ significantly by DMRT at 5 per cent level.

Table- 6: Abundance of insect pollinators visiting Madhuvantha, *Stevia rebudiana*Bertoni.

Time (hr)	Mean No. of Pollinators /plant /5 min		
	Apiscerana	***Apisflorea***	**Others**
0600	0.00 (1.00) [a]	0.00 (1.00) [a]	0.00 (1.00) [a]
0700	0.65 (1.28) [b]	0.35 (1.15) [b]	0.37 (1.16) [b]
0800	3.82 (2.19) [e]	1.77 (1.66) [c]	2.35 (1.82) [d]
0900	4.60 (2.36) [f]	2.20 (1.78) [d]	3.12 (2.03) [e]
1000	5.62 (2.57) [g]	3.67 (2.16) [e]	4.87 (2.42) [g]
1100	6.80 (2.80) [i]	7.60 (2.93) [h]	3.35 (2.08) [e]
1200	6.15 (2.67) [h]	6.40 (2.72) [g]	4.07 (2.25) [f]
1300	7.10 (2.84) [i]	6.77 (2.78) [g]	4.97 (2.44) [g]
1400	6.90 (2.81) [i]	6.60 (2.75) [g]	4.37 (2.31) [f]
1500	5.87 (2.62) [gh]	5.07 (2.46) [f]	3.45 (2.10) [e]
1600	5.82(2.61) [gh]	2.27 (1.80) [d]	2.40 (1.84) [d]
1700	2.92 (1.98) [d]	1.52 (1.58) [c]	1.35 (1.53) [c]
1800	1.17 (1.47) [c]	0.00 (1.00) [a]	0.00 (1.00) [a]
Mean	**4.42**	**3.40**	**2.66**
S.Em±	**0.14**	**0.10**	**0.12**
CD @ 5%	**0.41**	**0.30**	**0.35**

Figures in the parenthesis are $\sqrt{X+1}$ transformed values.

Means followed by same letter in a column do not differ significantly by DMRT at 5 per cent level

Table- 7: Abundance of insect pollinators visiting Kaaduharalu,*Baliospermummontanum* (Willd)

Time (hr)	Mean No. of Pollinators /plant /5 min			
	Apiscerana	***Apisflorea***	***Trigonairidipennis***	**others**
0600	0.00 (1.00) [a]	0.00 (1.00) [a]	0.00 (1.00) [a]	0.00 (1.00) [a]
0700	1.20 (1.48) [b]	0.90 (1.35) [b]	0.57 (1.24) [b]	0.42 (1.18) [b]
0800	2.40 (1.84) [c]	1.30 (1.51) [c]	1.10 (1.44) [c]	1.30 (1.51) [c]
0900	4.35 (2.31) [d]	1.65 (1.62) [c]	1.32 (1.52) [c]	2.27 (1.80) [c]
1000	6.25 (2.69) [f]	5.50 (2.54) [e]	3.42 (2.10) [d]	4.55 (2.35) [d]
1100	11.70 (3.56) [i]	7.82 (2.97) [g]	7.25 (1.87) [f]	5.32 (2.51) [f]
1200	8.85 (3.14) [h]	10.82 (3.43) [i]	8.30 (3.04) [g]	3.45 (2.10) [g]
1300	8.87 (3.14) [h]	9.90 (3.30) [h]	8.17 (3.02) [g]	3.25 (2.06) [g]
1400	8.75 (3.12) [h]	9.62 (3.25) [h]	7.25 (2.87) [f]	4.90 (2.42) [f]
1500	7.27 (2.87) [g]	8.37 (3.06) [g]	7.82 (2.97) [f]	4.30 (2.30) [f]
1600	4.87 (2.42) [e]	6.87 (2.80) [f]	6.07 (2.65) [e]	3.30 (2.07) [e]
1700	2.40 (1.84) [c]	2.90 (1.97) [d]	3.22 (2.05) [d]	1.17 (1.47) [d]
1800	1.12 (1.45) [b]	1.57 (1.60) [c]	0.55 (1.23) [b]	0.50 (1.21) [b]
Mean	**5.23**	**5.17**	**4.23**	**2.67**
S.Em±	**0.16**	**0.19**	**0.13**	**0.10**
CD @ 5%	**0.47**	**0.54**	**0.37**	**0.28**

Figures in the parenthesis are $\sqrt{X+1}$ transformed values.

Means followed by same letter in a column do not differ significantly by DMRT at 5 per cent level.

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