

## Floral Biology and Wildlife Potential of Ornamental *Thunbergia* Species

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### ABSTRACT

Wildlife adds another dimension to our gardens especially in urban areas. Gardeners are well primed to provide food for birds and animals. Flowering plants can be successfully used to attract wildlife. Pollen and nectar are the main rewards offered by flowers in visiting animals in order to buy their services. Ornamental *Thunbergia* species are widely, used in landscaping either as shrubs or climbers. Therefore, this study was conducted with the objectives of observing floral morphology, flowering phenology, floral nectar production and the animal visitation patterns of *T. grandiflora*, *T. grandiflora* 'Alba' and *T. erecta* in view of identification of potential species to promote in wildlife gardening. *T. grandiflora* produced significantly high nectar volume ( $11.6 \pm 0.28 \mu\text{l}$ ), sugar concentration ( $50.05 \pm 0.36\%$ ) and energetic value ( $257.37 \pm 4.56$  cal) compared to other species. Insect visitations viz. Carpenter bee, Stripped squirrel, Small branded shift butterfly, and *Amegilla* species were observed only in *T. grandiflora* and in *T. erecta*. Therefore, those species could be recommended for wildlife gardening. *T. grandiflora* can be used as a climber to cover overhead structures or as a screen while *T. erecta* can be incorporated as a shrub.

**KEYWORDS:** Landscaping, Nectar production, Phenology, *Thunbergia*, Wildlife gardening.

### INTRODUCTION

Wildlife gardening can be broadly defined to encompass any actions conducted in private or domestic gardens to increase their suitability for wildlife, and thus includes the provision of a diversity of resources such as substrates, food, breeding and overwintering sites (Davies, *et al.*, 2008). A wildlife garden is an environment attractive to various forms of wildlife which include birds, amphibians, small mammals and insects. It usually contains variety of natural habitats and diverse supply of food to attract and keep wildlife in the plants that bloom for a long time and yield abundant nectar and pollen or bear fruit throughout the year to ensure the repeated visitation of wildlife (Anon, 2011). The availability of floral resources is a key factor which attracts wildlife. Among floral resources, nectar is the most common floral resource among animal pollinated angiosperms and its provision within flowers plays a central role in mediating pollinator services (Hernandez- Conrique *et al.*, 2007).

Since plants cannot run off to look for a mate and reproduce, many have evolved elaborate mechanisms of pollination often cheating or bribing animal pollinators into doing the work for them. The focal point of these efforts is attracting pollinators by tempting them with the promise of a reward

(usually nectar) and then uses the opportunity to distribute or gather pollen via the pollinator. Nectar robbers are birds, butterflies, bees, ants and other insects, or other flower visitors that remove nectar from flowers through a hole pierced or damaging the corolla. The plant-pollinator relationship is considered a mutualism because the plant benefits from the pollinator's transport of male gametes. Mutualisms are thought to be especially susceptible to cheaters, species that can obtain the reward produced for the mutualism without providing service in return (Westerkamp and claben-Bockhaft, 2007).

*Thunbergia* is a genus of flowering plants belongs to the family Acanthaceae, that includes native species and few exotic ornamentals that are native to tropical regions of Africa, Madagascar and Southern Asia (Anon, 2013). Ornamental *Thunbergia* species are vigorous evergreen woody-stemmed annual or perennial vines and shrubs growing up to 2-8 m tall. *Thunbergia grandiflora* (Blue Sky Flower) is a vigorous evergreen vine with rope-like stems and dark green leaves that are often 4-5 inches long and with a slightly toothed margin. Flowers are wide and pale blue in colour. The tubular flaring corolla posses pale yellow to cream blue stripes in the center. *Thunbergia grandiflora* 'Alba' is also a vigorous vine, with wide white tubular cup like flowers, with pale yellow to cream blue striped centers. *Thunbergia erecta* is a closed

branched shrub with green coloured leaves and narrow tubular cup like flower.

Ornamental *Thunbergia* species are widely used in landscaping either as shrubs or climbers. They produce large attractive flowers that bloom throughout the year and attract wildlife. Therefore, the present study was conducted with the objectives of understanding floral biology in order to elucidate the wildlife potential of three *Thunbergia* species viz. *T. grandiflora*, *T. grandiflora* 'Alba' and *T. erecta* to promote in wildlife gardening.

## MATERIALS AND METHODS

### Plant Material

Populations of *Thunbergia grandiflora*, *T. grandiflora* 'Alba' and *T. erecta* in the Kurunegala area were selected for the study.

### Flowering Morphology and Phenology

Three individuals were selected to represent each species. Ten flower buds from each individual were tagged and observations were made daily to determine the time and duration of flowering. Further, flower morphology, colour of the flower parts (Royal Horticultural Society Colour chart, 2001), organization of the inflorescence and reward availability were recorded.

### Floral Nectar Production

Randomly selected 20 flower buds were covered with polythene bags and tagged on the day before blooming. Nectar was extracted using a micropipette at hourly intervals throughout the lifespan of the flower. Two to three flowers from these tagged buds were removed with care to withdraw nectar present in the flowers per hour. Nectar volume (NV) was calculated by using following formula (Dafni, 1992).

$$NV = \frac{L \times C}{M}$$

Where,

L = length of nectar column (mm)

C = calibrated volume ( $\mu$ l)

M = total length of Micropipette (mm)

Sugar concentration (%/wt/total wt) (SC) was calculated by using a hand held refractometer (Dafni, 1992). At least 20 nectar samples for each species were observed under refractometer to ensure the accuracy of the results.

$$SC = \frac{R \times V \times S}{100}$$

Where,

R = refractometer reading

V = volume in ( $\mu$ l)

S = Sucrose density

The energetic value was calculated as follows;

1 mg sugar (sucrose) = 4 cal = 16.8 joule (Dafni, 1992) Nectar pH was calculated using pH papers at hourly intervals throughout the lifespan of the flower. Mean separation was used to analyze data using Minitab 15.

### Floral Visitation

Floral visitations were observed for 34 days from 6.30 am to 6.00 pm at hourly intervals. The floral visitors were classified as pollinators if they appeared to transfer pollen to stigmas by touching them and if they carry pollen with them. If not they were classified as nectar robbers. The visitation rates of floral visitors were recorded by counting the number of flowers visited within an hour. Time of stigma receptivity and anther dehiscence was recorded in freshly opened flowers by using the method described by Wanigasekara and Karunarathne (2012).

## RESULTS AND DISCUSSION

### Flowering Phenology

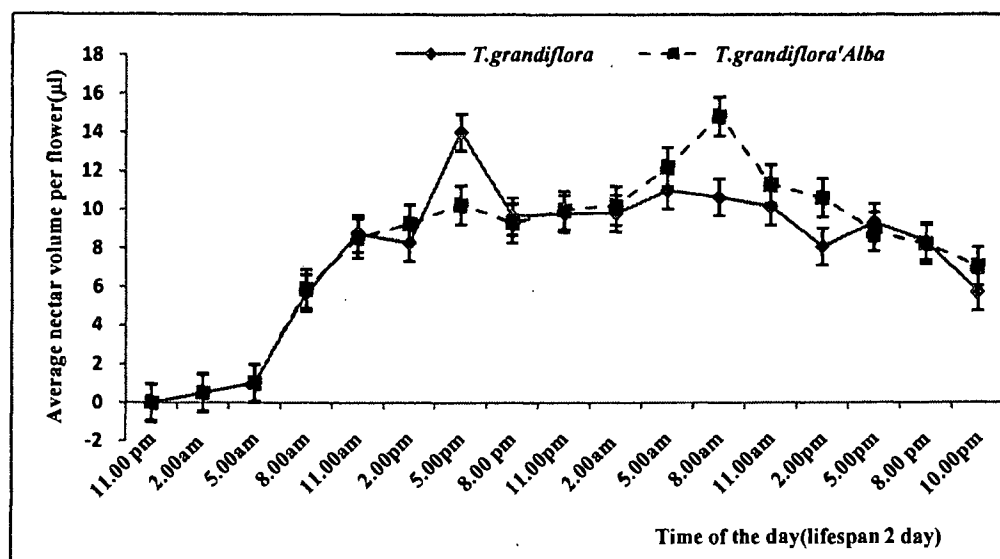
Small buds of *T. grandiflora* and *T. grandiflora* 'Alba' took over 25 days to reach the full bloom stage while *T. erecta* took only 16 days (Table 2). All the flowers start to open during the midnight and reached the fully bloomed stage in the following day morning. The duration of the fully bloomed flowers of *T. grandiflora* and *T. grandiflora* 'Alba' was 35 hrs and *T. erecta* was 10 hrs.

### Floral Morphology

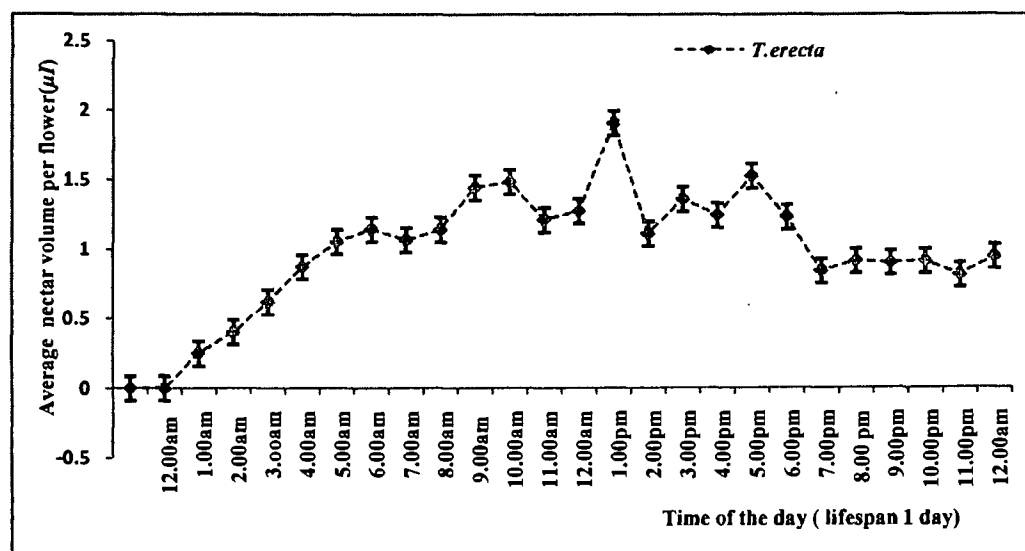
*T. erecta* has a single flower but other two species have an inflorescence and its position is perpendicular and length of the inflorescence was 24 ( $\pm$ 2.28) cm and 39.31 ( $\pm$ 0.27) cm respectively in *T. grandiflora* and *T. grandiflora* 'Alba'. The colour of the petals of *T. grandiflora* *T. grandiflora* 'Alba' and *T. erecta* was Violet blue group 92B, White group 155B and Violet blue group N88A respectively and the colour of throat was Grayed orange 162D in both *T. grandiflora* and *T. grandiflora* 'Alba' while Yellow orange group 14 was in *T. erecta* (RHS colour chart, 2001).

**Table 1. Phenological characters of *Thunbergia* species**

Feature	<i>T. grandiflora</i>		<i>T. grandiflora</i> 'Alba'		<i>T. erecta</i>	
	Time	Duration (hr)	Time	Duration (hr)	Time	Duration (hr)
Small bud to large bud		504 (±0.54)		504(±0.83)		336(±0.89)
Unfolding time	11.30 pm	600 (±0.54)	11.30pm	600(±0.54)	12.00 am	384(0.23)
Fully blooming time	6.30 am	606(±0.54)	3.30am	604(±0.83)	6.00 am	390(±0.49)
Senescence	12.30 pm	636(±0.01)	9.30 am	635(±0.23)	4.00 pm	400(±0.50)
Fallen out	7.30 am	654(±1.34)	5.30 am	655(±1.48)	7.00 am	415(±0.55)



**Figure 1. Nectar production pattern of *T. grandiflora* species**



**Figure 2. Nectar production pattern of *T. erecta***

**Floral Nectar Production**

Nectar is produced in the distal parts of the connective appendages. Peak nectar production time for *T. grandiflora*, *T. grandiflora* 'Alba' and *T. erecta* was at 5.00 pm, 8.00 am and 1.00 pm respectively (Figure 1). The amount of nectar produced at

the Peak nectar production time was significantly higher in *T. grandiflora* (11.6 µl) and *T. grandiflora* 'Alba' (11.45 µl) compared to *T. erecta* (1.9 µl) (Table 3). It is interesting to note that in *T. grandiflora*, the peak was observed in the first day while in *T.*

*grandiflora* 'Alba' it was in the second day. (Figure 1 and 2). Sugar concentrations and energetic values were significantly higher in *T. grandiflora* while it was significantly low in *T. erecta*.

**Table 2. Mean nectar volume, concentration and energetic value of three *Thunbergia* species.**

Species	Peak nectar volume (µl)	Sugar Concentration (%)	Energetic Value (cal)
TG	11.6 <sup>a</sup> (±0.28)	50 <sup>a</sup> (±0.36)	257.3 <sup>a</sup> (±4.5)
TGA	11.45 <sup>b</sup> (±0.06)	34 <sup>b</sup> (±1.13)	158.3 <sup>b</sup> (±7.3)
TE	1.9 <sup>c</sup> (±0.36)	24 <sup>c</sup> (±0.42)	135.8 <sup>c</sup> (±6.6)

Note: Values followed by same letter are not significantly different at 0.05 levels. TG - *T. grandiflora*, TGA - *T. grandiflora* 'Alba', TE - *T. erecta*, (n=15).

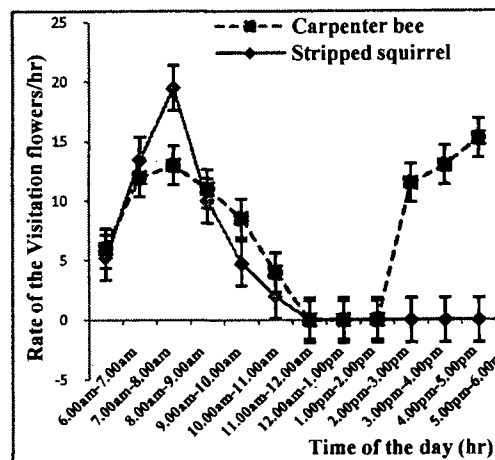
The nectar pH in virgin flowers was slightly acidic in all the three species. Higher viscosity in nectar influence on foraging behavior, flower handling efficiency and the water balance of the pollinator (Dafni, 1992).

**Floral Visitation**

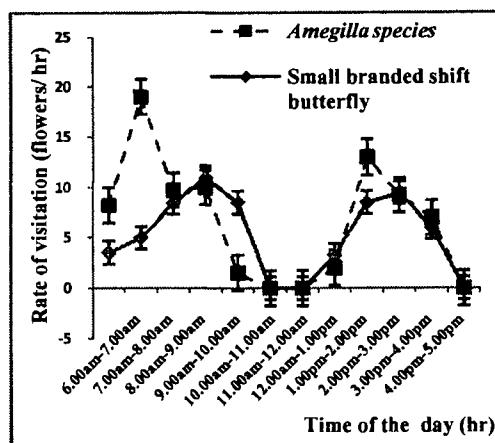
A peak visitation of Stripped squirrels and carpenter bees was observed in *T. grandiflora* flowers between 8.00 am to 9.00 am. However, another peak with high intensity was observed for carpenter bees at 5.00 – 6.00 pm. The later peak overlapped with peak nectar production. Small branded shift butterflies (higher peak from 9.00 am -10.00 am and another peak from 3.00 – 4.00 pm) and *Amegilla* species (higher peak from 7.00 am - 8.00 am and another peak from 2.00 – 3.00 pm) were recorded in *T. erecta*. Both peaks were observed just before and just after the peak nectar production of flowers (Figure 3). It is interesting to note that no visitors were observed in *T. grandiflora* 'Alba' flowers. Stigma of both newly opened *T. grandiflora* and *T. grandiflora* 'Alba' flowers were receptive at 6.30 am. After blooming, anthers dehisced at 6.00 am. Pollen grains are yellowish-white, dry and non sticky. Flowers of *T. erecta* were receptive at 6.00 am.

Floral visitors and their service to the flower were different for all three species. Total damage to the *T. grandiflora* flowers were 70% while in *T. grandiflora* 'Alba' it was 40%. The lowest percentage damage (25%) was observed in *T. erecta* (Figure 5). Nectar of

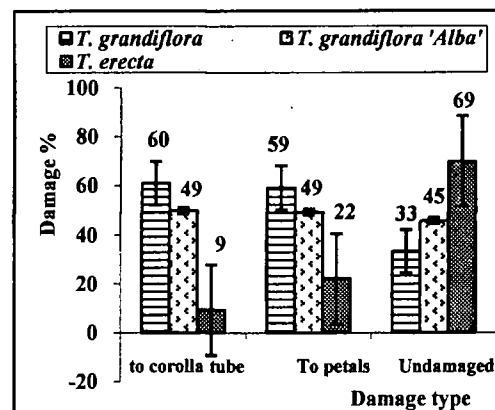
both *T. grandiflora* and *T. grandiflora* 'Alba' were robbed by Stripped squirrels. As a primary nectar robber they removed nectar from flowers through a hole pierced or bite in the alignment channel in corolla tube externally, without contacting the anthers.



**Figure 3. Visitation rate of different animal visitors to *T. grandiflora* flowers**



**Figure 4. Visitation rate of different animal visitors to *T. erecta* flowers**



**Figure 5. Variation of percentages of flower damages by animal visitors**

Carpenter bee (*Xylocopa violacea*) was the most important pollen collector as well as a nectar robber. The movement of the hook of the flower when the bee enters the floral tube is the primary mechanism of pollen gathering. They harvest pollen by vibration while holding onto the anther cuff as well as the backward-forward movement (Leandro, 2002). As a result large amount of pollen is released. Pollen was deposited on the head area and they visit flowers in many inflorescences.

Honey bees (*Apis mellifera*) and Ants were observed collecting nectar through holes made by previous visitors as secondary robber.

The Small branded shift butterfly (*Pelopidas mathias*) was a nectar cheater who visited *T. erecta* flowers during morning and evening of the sunny days. They typically hold their wings together when feeding and partially open while resting, with front wings and hind wings held at different angles. Their visitation rate per hour is 5.80 ( $\pm 1.07$ ) except on heavy rainy days (Figure 4).

*Amegilla* species were observed regularly visiting to *T. erecta* flowers in highest visitation rates and two peaks were observed at 8.00 am and 4.00 pm respectively. They gave a buzzing sound when searching for a flower with a zigzag flying pattern. Visitation rate varied 7.27 ( $\pm 1.09$ ) per hour.

### CONCLUSIONS

The duration of the fully bloomed flowers of *T. grandiflora* and *T. grandiflora* 'Alba' was 35 hrs and *T. erecta* was 10 hrs. Peak nectar production times of *T. grandiflora* and *T. grandiflora* 'Alba' were overlapped. Compared to other species, in *T. grandiflora*, significantly high nectar production, sugar concentration and energetic value was observed. This could be the reason for the visitation of larger animals viz. Stripped squirrels and Carpenter bee to this plant and Carpenter bees act as a pollinator while squirrels are nectar robbers. Visitors were not observed in *T. grandiflora* 'Alba' while, Small branded shift butterfly and *Amegilla* species visited *T. erecta*. Out of the species studied *T. grandiflora* attracted large animals throughout the year hence it can be recommended in wildlife gardening followed by *T. erecta*.

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