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Morpho-physiological and biochemical analysis of host plants of foliage feeding scarab beetles

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Abstract
The Morpho-physiological and biochemical studies revealed that out of 8 host plants, *Hibiscus mutabilis* recorded maximum leaf breadth (14.24 cm), leaf area (221.27 cm^2), number of veins (26.66 nos.) and number of veinlets (376.66 nos.). The lowest leaf length (5.63 cm), number of veins (10.66 nos.) and number of veinlets (151.66 nos.) was registered in *Zyjiphus jujube*. It was also observed that host plants with alternate type of phyllotaxy were heavily infested by the beetles. The biochemical analysis showed that the carbohydrate content was maximum in *Hibiscus mutabilis* (21.76%) followed by *Rosa chinensis* (19.19%) and *Corchorus* sp. (16.61 %), whereas the minimum was recorded in *Psidium guajava* (11.57%). The protein and nitrogen content was found to be maximum in *Corchorus* sp. (26.59 and 4.255%, respectively) and lowest in *Psidium guajava* (12.65 and 2.025%, respectively). The oil content was found to be highest in *Zyjiphus jujube* (8.07%) and lowest in *Terminalia chebula* (3.6%).

Keywords: Scarab beetles, hosts, Morpho-physiological parameters, biochemical analysis

1. Introduction
'White grub' or 'root grub' is belong to the family Scarabaeidae consisting of coprophagous as well as phytophagous beetles. The grubs which feed on the living roots belong to the subfamily Melolonthinae and partly to Rutelinae and Dynastinae. They feed on the roots of many plants, killing many seedlings and sometimes order plants, reducing draught tolerance and thereby affecting final yields [1].
In India, white grub have become a serious constraint for production of almost all crops grown particularly during *kharif* season [2]. They are distributed from high altitude of Himalayas to low altitude of coastal Kerala, from arid and semi-arid tracts of Rajasthan to high rainfall, humid regions of North-East hill region and West coastal peninsula [3]. The white grub has been recognized as the pest of national importance. During the recent years, white grubs has emerged as an important insect pest of potato, jute, sugarcane, pulses and vegetables in Assam.
Every insect species have a distinctive relationship with the food they prefer. Food plays an important role in the growth, development and survival of an insect species. Quality and quantity of certain substances present in the food have been reported to influence the development, reproduction, resistance to disease and pigmentation of insects [4]. In case of scarab beetle different food material influence shortening and lengthening of the duration of developmental stage and increase and decrease the reproductive capacity. The studies on effect of food materials on the growth and development of insects also provide information on host preferences of the insects. The interaction between insect and its food plant involves feeding, digestion and efficiency of conversion of ingested and digested food to body biomass [5].
Thus, the present study aimed at studying the host plant preference of the foliage feeding scarab beetles in relation to morpho-physiological and Biochemical characters so that the information generated may be used to formulate an effective and successful IPM package.

2. Materıals and Methods
The study was conducted in the Department of Entomology and Department of Biochemistry and Agricultural Chemistry, Assam Agricultural University, Jorhat during 2011-2012. The different morphological characters *viz.,* leaf length, leaf breadth, total leaf area, number of veins and veinlets were studied by using standard procedure. The leaf length and breadth of healthy leaves of eight host plants were determined with the help of a standard centimeter ruler. The leaf areas were measured with the help of a laser hand held leaf area meter (CI-203).

The number of veins and veinlets were counted with the help of a compound Microscope under 10 x magnifications. The leaf phyllotaxy was also determined by standard procedure.

The protein, carbohydrate, oil, nitrogen and chlorophyll content of the leaves of eight different host plants *viz.,* *Sotadolpadma* (*Hibiscus mutabilis*), Agar (*Aquilaria malaccensis*), Ber (*Zyjiphus jujube*), Guava (*Psidium guajava*), *Silikha* (*Terminalia chebula*), Jute (*Corchorus* sp.), Rose (*Rosa chinensis*) and *Soalu* (*Litchea polyantha*) were estimated. Crude protein and nitrogen estimation by micro-Kjeldahl method [6]. The total carbohydrate were determined by following Anthrone method [7]. The oil contents were studied by Soxhlet method [8]. Leaf chlorophyll content was estimated by non-maceration method adsorption at 663 and 645 nm was read in a spectrophotometer. The amount of chlorophyll content was calculated using absorption coefficients. Twenty numbers of leaves were taken from each of the host plant for estimating both the morpho-physiological as well as biochemical parameters. Range as well as the average of the twenty leaves were calculated out and SED was also determined.

3. Result and Discussion

Perusal of data presented in (Table 1) indicated that the maximum mean leaf length was recorded in *Silikha* (19.50 cm), which was significantly superior over rest of the leaf samples except *Soalu* and *Satadol padma viz.,* 18.16 cm and 18.00 cm, respectively. The mean leaf length of Jute leaves (13.66 cm) was found to be *at par* with Guava (12.33cm), but significantly differed with *Agar* (10.00 cm), Rose (6.43 cm) and Ber (5.63 cm). The mean leaf length of Rose (6.43 cm) was *at par* with Ber (5.63 cm). Likewise, the maximum leaf breadth was observed in *Satadol padma* (14.24 cm) which was significantly superior over rest of the leaf samples. The leaf breadth of *Soalu* (7.08 cm) was found to be *at par* with *Silikha* (5.98 cm) but significantly differed from Guava (4.35 cm). The other host plants *viz*., Jute, Ber, Agar registered 4.26, 3.66 and 3.40 cm, respectively. However, minimum leaf breadth was recorded in Rose (3.23 cm).

The maximum leaf area per leaves was observed in *Satadl padma* (221.27 cm^2) which was significantly superior over rest of the leaf samples (Table 1).The leaf area per leaf of *Soalu* (138.86 cm^2) was *at par* with *Silikha* (112.67 cm^2) but significantly differed from Guava (67.48 cm^2). But the leaf area of Guava (67.48 cm^2) was *at par* with Jute (59.07 cm^2), Agar (32.96 cm^2), Ber (25.00 cm^2). The minimum mean leaf area was recorded in Rose (23.25 cm^2).

The leaves of *Sotadolpadma*registered26.66 numbers of mean veins per leaf, which was significantly superior over Rose (16.00 numbers) and Ber (10.66 numbers) but *at par* with Jute (25.33 numbers), *Soalu* (25.00 numbers), Agar (21.33 numbers), *Silikha* (20.00 numbers) and Guava (20.00 numbers) (Table 1)

The maximum mean leaf vein lets were registered in *Satadol padma* (376.66 numbers) which was *at par* with Jute and Agar (331.66 and 286.00 numbers) but significantly differed from rest of the leaves samples. The numbers of veinlets observed in Jute (331.66 numbers) was found to be *at par* with Agar (286.00 numbers) and *Soalu* (261.33 numbers). The veinlets of Rose leaves (216.66 numbers) was found to be *at par* with *Silikha* (195.33 numbers), Guava (192.33 numbers) and Ber (151.66 numbers).

Studies on leaf phyllotaxy of eight different host plants showed that *Sotadol padma* (*Hibiscus mutabilis*), *Soalu* (*Litchea polyantha*), Agar (*Aquilaria malaccensis*), Ber (*Zyjiphus jujube*) and Jute (*Corchorus* sp.) exhibited Alternate Phyllotaxy, where as Guava (*Psidium guajava*) and *Silikha* (*Terminalia chebula*) showed Opposite type. The leaves of Rose (*Rosa chinensis*) plant exhibited Odd pinnate type of phyllotaxy.

Biochemical analysis of the leaves of eight different host plants revealed that maximum mean percentage of carbohydrate was recorded in *Satadolpadma* 21.76 per cent which was significantly superior [9] over rest of the leaves tested except Rose 19.19 per cent (Table 2). The leaves of Jute plants registered 16.61 per cent of carbohydrate which was found to be *at par* with Rose 19.19 per cent and *Soalu* 14.70 per cent but were at par with Agar 13.45 per cent, Ber12.40 per cent and *Silikha*12.29 per cent. The percent carbohydrate respectively was registered in Guava 9.30 per cent.

The mean highest percentage of protein was registered in Jute 26.59 per cent which was significantly superior over rest of the leaves tested. The crude protein content of *Soalu*20.99per cent was found to be *at par* with *Satadol padma* 20.57 per cent and Agar 20.47 per cent but significantly differed with *Silikha* 17.32 per cent. The crude protein content of Rose, Ber and Guava were 14.87, 13.82 and 12.65 per cent respectively (Table 2). The highest nitrogen content was registered in case of Jute (4.255%), which was significantly superior over rest of the samples analyzed (Table 2). The leaf nitrogen content of *Soalu* (3.359%) was found to be at par with *Satadol padma* (3.291%) and *Agar* (3.275%) but significantly differed from *Silikha* (2.771%), Rose (2.379%), Ber (2.211%) and Guava (2.025%).

The maximum oil content was observed was recorded in Ber (8.0%) which was significantly superior over rest of the leaves samples (Table 2). The oil content of Rose (6.3%) was found to be *at par* with *Satadol padma* (5.8%) and Guava (5.5%) but were found to be significantly superior over Jute (4.6%), Agar (4.5%), *Soalu* (4.1%) and *Silikha* (3.6%), respectively.

While estimating the leaf chlorophyll content, it was found that the highest amount of chlorophyll content was recorded in Jute leaves (0.134 mg g^{-1}) which was significantly superior over rest of the leaf samples except Rose (0.102 mg g^{-1}) (Table 2). The Guava leaves contained (0.075 mg g^{-1}) amount of chlorophyll which was found to be *at par* with *Satadol padma* (0.073 mg g^{-1}), *Silikha* (0.063 mg g^{-1}) Agar (0.058 mg g^{-1}), *Soalu* (0.053 mg g^{-1}) and Ber (0.027 mg g^{-1}), respectively.

4. Conclusion

Summarized experimental findings indicated that the maximum population of scarab beetles was observed in *Satadol padma* followed by Agar. Studies on morphological and physiological characteristics of the leaves of eight different host plants also revealed that *Satadol padma* exhibited highest amount of leaf carbohydrate content and reasonable amount of protein content. The Agar tree leaf also contained fair amount of protein as compared to other selected host trees. The maximum numbers of vein and veinlets, leaf breadth and leaf area per leaf were observed in *Satadol padma*. The present finding is in conformity with [10], according to whom, Japanese beetles facilitated green June beetles by biting through the skin and provided access to the soft berry pulp and Juice from early and midseason ripening grape cultivars with relatively high sugar content elicited the greatest feeding. The present investigation also established that the leaves of *Satadol padma,* Agar, Jute, *Soalu* and Ber exhibited alternate type of phyllotaxy and this type of leaf arrangement might have facilitated easy movements of beetles for grasping on the

petioles of the leaves at different angles while shifting from one leaf to another during the process of feeding. Based on the above facts, it may be concluded that both morphological and physiological characteristics of host leaves play a significant role in feeding preferences of scarab beetles and also help to development of attractants for scarab beetles. However, the biochemical analysis of volatile secondary plant substances (phenolic compounds) present in the foliage of host trees of scarab beetles may be helpful to draw a logistic conclusion on this aspect.

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