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BIOCHEMICAL COMPOSITION OF CUCURBIT LEAVES AND THEIR INFLUENCE ON RED PUMPKIN BEETLE

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ABSTRACT

In order to determine the biochemical composition of cucurbit leaves and their influence on red pumpkin beetle, the study was conducted in the experimental farm, laboratories of entomology and soil science of Bangabandhu Shiekh Mujibur Rahman Agricultural University (BSMRAU), Gazipur during November 2007 to March 2008. Result revealed that the highest quantity of moisture was recorded in young leaf of bottle gourd (86.49%) and mature leaf of khira (87.95%). The lowest moisture content was obtained in young leaf of snake gourd (79.21%) and mature leaf of ribbed gourd (76.43%). The highest nitrogen content was found in young leaf (6.79%) of sweet gourd and in mature leaf (5.57%) of bottle gourd. The lowest percentage of nitrogen was found in young leaf (3.64%) of bitter gourd and in mature leaf (2.52%) of ribbed gourd. The highest quantity of total sugar was found in young leaf of bottle gourd (4.90%) and mature leaf of sweet gourd (4.76%). The lowest quantity of total sugar was found in young (2.03%) and mature leaves (2.09%) of bitter gourd. The highest quantity of reducing sugar was estimated from young leaves of musk melon (4.14%) and from mature leaves (4.01%) of sweet gourd. The lowest quantity of reducing sugar was in young (1.85%) and mature (1.83%) leaves of bitter gourd. Relationship of RPB population per leaf with the percent nitrogen, total and reducing sugar content of mature leaves of cucurbits was found positively correlated.

KEYWORDS: Cucurbit, Red Pumpkin Beetle, Moisture, Nitrogen, Sugar

INTRODUCTION

Cucurbits are among the most widely grown and important crops in the tropical and subtropical countries of the world. Pumpkin beetle is the major pest and causes considerable damage to almost all cucurbitaceous crops (Butani and Jotwani, 1984; Yawalkar, 1985). Among different species of pumpkin beetles, incidence of adult stage of red pumpkin beetle (RPB), *Aulacophora foveicollis* (Lucas) on different cucurbits have been reported by various workers (Nath, 1964; Nath and Thakur, 1965; Bogawat and Pandey, 1967). The pest, however, occurs throughout the year and causes severe damage to the crops, especially at the seedling stage (Alam, 1969; Butani and Jotwani, 1984). The adult beetles feed voraciously on the cucurbit leaf making irregular holes. Plant parts and plant constituents vary with their developmental stages, physiologic conditions and plant genotype. These variations have considerable impact on both the behaviour and developmental success of phytophagous insects (House, 1969). Variation in host plant influences the structure of phytophagous insect communities throughout the year (McNeill and Southwood, 1978; Mattson, 1980). The plants contain various chemicals, which may act as stimulant or repellent for egg laying and feeding. This results in the susceptibility or resistance of a cultivar (Sharma and Brar, 1993). The leaves of plants change chemically with age and the quantity of amino-nitrogen present in the phloem sap of plant changes with the progress of growth and maturation of leaves and shoots (Raupp and Denno, 1983).

Plants provide water and nutrients to phytophagous insects and ensure availability of nitrogen (in the form of amino acids and proteins) that affects the growth rate of immature insects, and its deficiency affects the insect population on plants (Horn 1988). Plant nitrogen also affects the fecundity of insects (van Emden *et al*., 1969). Khan *et al*. (1999) also reported that the terminal and young leaves of ash gourd had the highest nitrogen content and leaf moisture compared to mature and senescent leaves. White (1978) argued that water stress increase the availability of nitrogen in plants, which results in a more nutritious food and enhanced survival of herbivorous insects. Moisture stressed plants appear to suffer from insect attacks, since a given amount of feeding brought about greater injury to plants. Sarker *et al*. (1997) reported that the terminal twigs and leaves appeared as the richest portion in nitrogen content and hair density and decreased with the increase of leaf age of cucumber. Raina and Lee (1983) attributed resistance in bean varieties to Mexican bean beetle, *Epilachna varivestis* Mulsant, to lower amounts of carbohydrates and reducing sugars. Thus present investigation was undertaken to determine the biochemical composition of cucurbit leaves and their influence on red pumpkin beetle.

MATERIALS AND METHODS

The study was conducted at Bangabandhu Shiekh Mujibur Rahman Agricultural University (BSMRAU), Gazipur during November 2007 to March 2008. Ten cucurbit host species of RPB viz., sweet gourd (*Cucurbita moschata* L.), bottle gourd (*Lagenaria siceraria* L.), ash gourd (*Benincasa hispida* L.), bitter gourd (*Momordica charantia* L.), sponge gourd (*Luffa cylindrica* L.), ribbed gourd (*Luffa acutangula* L.), snake gourd (*Trichosanthes anguina* L.), cucumber (*Cucumis sativus* L.), khira (*Cucumis sativus* L.) and musk melon (*Cucurbita melo* L.) were grown in the experimental farm of BSMRAU following recommended procedures described by Rashid (1993). The experiment was laid out in RCBD design with 3 replications. Chemical constituents of selected cucurbit leaves were estimated in the Laboratories of the Department of Entomology and Soil Science of Bangabandhu Shiekh Mujibur Rahman Agricultural University.

Collection of Sample

Plants were selected randomly from each cucurbit host grown in the experimental field. Samples of deep green mature leaves from middle part and light green young leaves from upper region (third leaf from the top of the selected plants were collected at vegetative stage (18 to 35 days after transplanting).

Leaf Moisture

Moisture content of leaf samples collected from each of the test cucurbits were determined following dry method (de Jager and Butot, 1992).

Leaf Sugar and Nitrogen

Sugar contents (reducing and total) of leaf samples were determined following the method described by Somogyi (1952) using Bertrand-A, Bertrand-B, and Bertrand-C solutions. Nitrogen content was estimated by Micro Kjeldahl method (Yamakawa, 1992).

Number of RPB Population

Number of beetles infesting young and mature leaves of various cucurbits was recorded from the experimental field. This operation was done through out the vegetative stage of plant.

All data were analyzed statistically for ANOVA (Steel and Torrie, 1960) using MSTAT-C computer software. For the accuracy of the results, the percent data were subjected to square root [$\sqrt{(x + 0.5)}$] or $\log_{10}$ (x+1) or $\text{ArcSin}^{-1}\sqrt{x}$ transformation whenever needed. Means were separated by Duncan's Multiple Range Test (Steel and Torrie, 1960). Simple correlation of number of beetles with leaf nitrogen content, total and reducing sugar content of leaves were computed.

RESULTS AND DISCUSSIONS

Leaf Moisture Content

Moisture content of young leaves of ten cucurbit ranged 79.21-86.49%. The highest leaf moisture content was found on bottle gourd (86.49%), which was followed by muskmelon (84.67%) and sweet gourd (83.79%). However, differences were not significant. The lowest moisture content of young leaves was found on snake gourd (79.21%), which was statistically similar to cucumber, khira, ash gourd, bitter gourd ribbed gourd and sponge gourd. Mature leaves of ten cucurbits contained 76.43-87.95% moisture. The maximum moisture content was found in mature leaves of khira (87.95%), which was statistically similar to musk melon (87.73%) and bottle gourd (85.61%). The lowest moisture content was observed in mature leaves of ribbed gourd (76.43%), which was also statistically similar to sponge gourd (76.45%), snake gourd (76.59%) and ash gourd (78.26%). Moisture content of mature leaves of other cucurbits varied from 78.26-84.45% (Table 1). The variation in moisture or water content of young and mature leaves might be due to plant species and age of plant parts. The water content of plant tissues varies greatly and plant foliage water may range from less than 50 to over 90 % fresh weight across species (Scriber 1977). Young leaves and shoots contain high percentage of water compared to mature and older plant parts (Scriber and Feeny, 1959).

Leaf Nitrogen Content

In young leaves of ten cucurbits, nitrogen content ranged 3.64-6.79%. The highest nitrogen content was found in sweet gourd (6.79%), which was statistically similar to bottle gourd (6.65%). The third highest nitrogen content was found in young leaves of muskmelon (5.99%), which was followed by khira, cucumber, sponge gourd and snake gourd. The lowest nitrogen content was observed in bitter gourd (3.64%), which was statistically similar to ribbed gourd and ash gourd. In case of mature leaves, nitrogen content ranged 2.52 - 5.57 %. Nitrogen content of sweet gourd and bottle gourd was statistically similar but significantly higher as compared to other cucurbits. The third highest nitrogen content was found in sponge gourd, which was statistically similar to muskmelon, khira and cucumber. The parameter in ash gourd, bitter gourd and snake gourd was statistically similar but significantly higher as compared to only ribbed gourd, which contained the lowest percentage of nitrogen (2.52%) (Table 1)

From the Table 1 it was observed that the percentage of nitrogen content at young leaf stage of different cucurbits were higher than those at mature leaf stage. The variation in nitrogen content might be due to the chemical change along with the quantity of amino-nitrogen in the phloem sap of plant with the progress of growth and maturation of leaves and shoots (Raupp and Denno, 1983). The protein content of insects and mites is 7-14 % N, whereas that of plants or plant parts rarely reaches 7 % N and is generally much lower (Mattson, 1980). He also stated that food quality, particularly protein content, is often limiting for insect development. The feeding of phytophagous insects is often concentrated at the growing point of the plant and on ripening reproductive parts, which generally contain the highest concentrations of nitrogenous compounds (Horn, 1988). Water and nitrogenous compounds (especially protein and amino acids) both being relatively high in young leaves and declining with leaf maturation (Scriber, 1984). Sarker *et al*. (1997) reported that the terminal twigs and leaves appeared as the richest portion in nitrogen content and decreased with the increase of leaf age of cucumber.

Total Sugar Content of Leaves

Total sugar content ranged 2.03-4.90% and 2.09-4.76%, respectively in young and mature leaves of the cucurbits included in the experiment. Significantly the highest total sugar content was found in young leaf of bottle gourd (4.90%), which was followed by muskmelon, sweet gourd and cucumber. These three crops contained statistically similar percentage of total sugar in their young leaves, which was significantly higher as compared to other six crops. Significantly the lowest total sugar content was found in young leaves of bitter gourd (2.03%), which was followed by sponge gourd and ribbed gourd. In case of mature leaf, significantly the highest total sugar content was found in sweet gourd (4.76%). Leaf total sugar content of bottle gourd and cucumber was statistically similar but significantly higher as compared to other cucurbits. The lowest total sugar content was found in mature leaves of bitter gourd (2.09%), which was followed by ribbed gourd, ash gourd, snake gourd, sponge gourd and khira (Table 2).

Reducing Sugar Content of Leaves

In young leaves, reducing sugar content varied from 1.85 to 4.14% among ten cucurbits. Significantly the highest reducing sugar was found in muskmelon (4.14%). The second highest reducing sugar content was found in sweet gourd, which was followed by bottle gourd and cucumber. Young leaves of bitter gourd and sponge gourd contained statistically similar percentage of reducing sugar, which was significantly lower as compared to all other cucurbits. Reducing sugar content in young leaves of snake gourd, ash gourd, khira, cucumber and bottle gourd was 2.33, 2.97, 2.97, 3.53 and 3.57%, respectively. In case of mature leaves, reducing sugar content ranged 2.03-4.01%. Significantly the highest reducing sugar was found in mature leaves of sweet gourd. Reducing sugar content in mature leaves of bottle gourd, cucumber and muskmelon was statistically similar and significantly higher as compared to other six cucurbits. Significantly the lowest reducing sugar content was found in leaves of bitter gourd (1.83%), which was followed by ribbed gourd, snake gourd, ash gourd and sponge gourd (Table 2). Relationship of RPB population per leaf with the percent nitrogen, total and reducing sugar content of mature leaves of cucurbits was found positively correlated (Figure 1).

The variation on population of RPB on cucurbits might be due to variation in the chemical composition of cucurbit leaves. The higher number of RPB in mature leaves might be due to lower moisture content which increase the availability of free amino acids. Moisture stress accelerates the break down and mobilization of leaf protein, thus enriching the amino and amino nitrogen content of phloem sap (Kennedy and Booth, 1959). Young succulent leaves contain higher concentration of qualitative defensive chemicals and lower concentration of quantitative compounds (Scriber, 1984). The expression of resistance of certain crop plants to insect herbivores can be affected with plant maturity. The leaves of plants change chemically with age and the quantity of amino-nitrogen present in the phloem sap of plant changes with the progress of growth and maturation of leaves and shoots (Raupp and Denno, 1983). Monophagous and oligophagous herbivores often show strong preferences for the more nutritious, younger leaf tissues that are high in toxins, whereas polyphagous herbivores demonstrate a strong preferences for the less nutritious, mature leaf tissues (Evans, 1984). It has been reported that leaves on the same plant or even in the same twig may display upto four-fold differences in concentrations of various compounds (Schultz, 1983).

Khan *et al*. (1999) also reported that the terminal and young leaves of ash gourd had the highest nitrogen content and leaf moisture compared to mature and senescent leaves. White (1978) argued that water stress increase the availability of nitrogen in plants, which results in a more nutritious food and enhanced survival of herbivorous insects. Moisture stressed plants appear to suffer from insect attacks, since a given amount of feeding brought about greater injury to plants. Dhillon (1993) reported that purified cucurbitacin B and E act as feeding stimulants for the red pumpkin beetle, but on testing three pairs of isogenic bitter (Bi) and non-bitter (bi) lines of cucumber (*Cucumis sativus*) no relationship was found between the bitter gene and the degree of damage caused by this beetle. In summer squash (*cucurbita pepo*), both resistant and susceptible lines contained cucurbitacin at the susceptible plant growth stage (cotyledon) and there was also no correlation between the quantity of total phenols, free amino acids or reducing sugars in this materials and resistance. Bitter gourd (*Momordica charantia*) which has cucurbitacin in the cotyledons was not preferred by the beetle.

From the above mentioned results it may be concluded that the percentage of moisture and nitrogen content of young leaves of different cucurbits were higher than those of mature leaves. The quantity of total and reducing sugar was the highest at young and mature leaves of musk melon followed by sweet gourd and the lowest quantity was in bitter gourd. Relationship of RPB population per leaf with the percent nitrogen, total and reducing sugar content of mature leaves of cucurbits was found positively correlated.

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APPENDICES

Table 1: Leaf Moisture and Nitrogen Content of Young and Mature Leaves of Different Cucurbit Host Plants at Vegetative Stage

Cucurbit Hosts	Leaf Moisture (%)		Leaf Nitrogen (%)	
	Young Leaf	Mature Leaf	Young Leaf	Mature Leaf
Sweet gourd	83.79abc	79.69cd	6.79a	5.25a
Bottle gourd	86.49a	85.61ab	6.65ab	5.57a
Ash gourd	80.89cd	78.26de	4.20de	3.28cd
Bitter gourd	82.33bcd	80.93c	3.64e	3.39cd
Sponge gourd	80.19d	76.45e	5.04c	4.37b
Ribbed gourd	79.82d	76.43e	3.70e	2.52e
Snake gourd	79.21d	76.59e	4.59cd	2.83de
Cucumber	82.18bcd	84.45b	5.15c	3.87bc

Table 1: Contd.,

Khira	80.38d	87.95a	5.21c	4.24b
Musk melon	84.67ab	87.73a	5.99b	4.25b

Data were Analyzed for ANOVA after ArcSin^{-1} $\sqrt{x}$ and Square Root $\sqrt{(x+0.5)}$ Transformation
Values within the Same Column Having a Common Letter(s) are not Significantly Different (P=0.05) by DMRT

Table 2: Sugar Content of Young and Mature Leaves of Different Cucurbit Host Plants at Vegetative Stage

Cucurbit Hosts	Total Sugar (%)		Reducing Sugar (%)	
	Young Leaf	Mature Leaf	Young Leaf	Mature Leaf
Sweet gourd	4.34b	4.76a	3.82b	4.01a
Bottle gourd	4.90a	4.33b	3.57c	3.62b
Ash gourd	3.35d	2.45f	2.97d	2.35e
Bitter gourd	2.03f	2.09g	1.85f	1.83g
Sponge gourd	2.14f	2.94d	1.97f	2.70d
Ribbed gourd	2.28f	2.35f	2.19e	2.06f
Snake gourd	2.97e	2.64e	2.33e	2.03f
Cucumber	4.27bc	4.33b	3.53c	3.48b
Khira	3.95c	4.04c	2.97d	3.00c
Muskmelon	4.55b	4.04c	4.14a	3.61b

Data were Analyzed for ANOVA after Square Root $\sqrt{(x+0.5)}$ Transformation
Values within the Same Column Having a Common Letter(s) are not Significantly Different (P=0.05) by DMRT

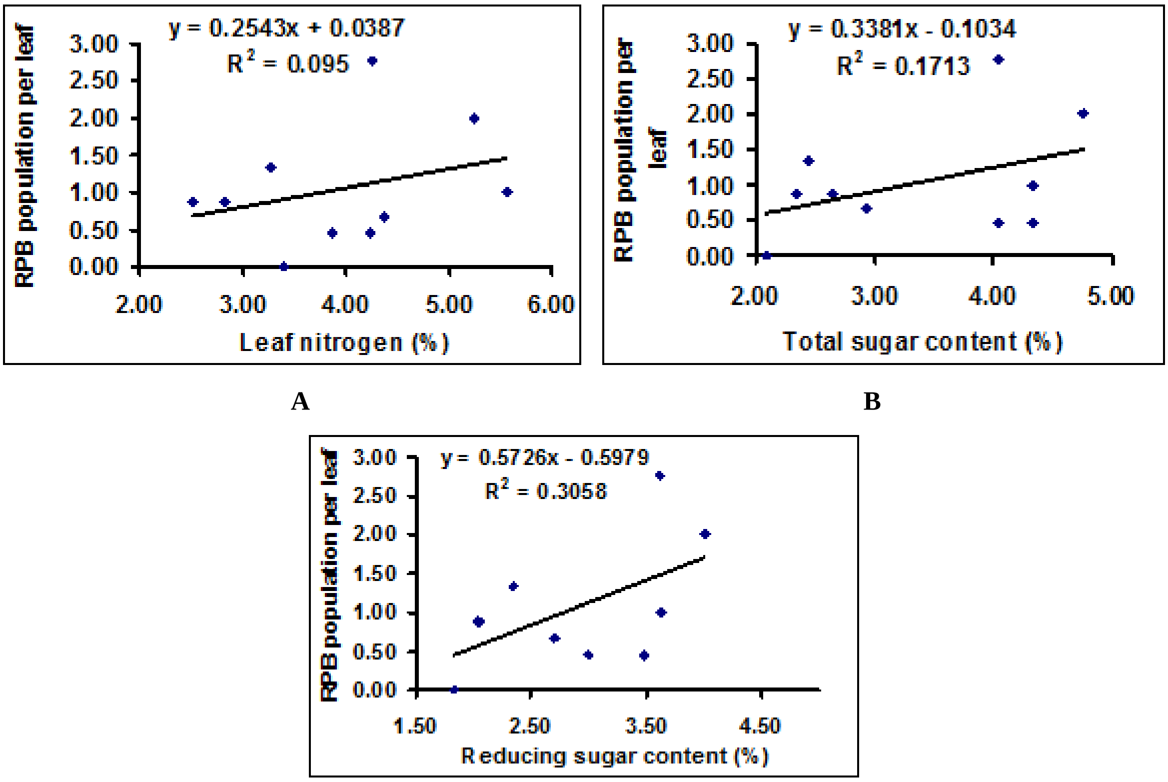

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Figure 1: Relationship of RPB Population with Nitrogen (A) Total (B) and Reducing Sugar (C) Content of the Leaves of Ten Cucurbits