Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.8681

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **7 (2):** 636-641 (2019)

Research Article

International Journal of Pure & Applied Bioscience

Bio-Chemical Studies of Castor Genotypes against Green Leafhopper, *Empoasca Flavescens* Fabricius.

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Received: 9.03.2019 | Revised: 12.04.2019 | Accepted: 22.04.2019

ABSTRACT

Bio-chemical parameters influencing the castor plant resistance to the green leafhopper (GLH), Empoasca flavescens (Fabr.) (Homoptera: Jassidae) has been studied during 2016-17. Analysis was conducted to compare the varietal differences of castor in relation to resistance or susceptibility to attack by GLH. Bio-chemical characters include proteins, phenols, total free amino acids, total carbohydrates in the leaves of castor. Among, bio-chemical constituents, phenol content had significant negative correlation with leafhopper population and hopper burn scores. Total carbohydrates content had significant positive correlation with leafhopper population. Total free amino acids content had significant negative correlation with hopper burn scores. Proteins had no significant association with both leafhopper population and hopper burn scores.

Key words: *Bio-physical, Bio-chemical, Green leafhopper Empoasca flavescens.*

INTRODUCTION

Castor (*Ricinus communis* L., 2n = 2x = 20, Euphorbiaceae) is an industrially important non-edible oilseed crop widely cultivated in the arid and semiarid regions of the world (Govaerts *et al*. 2000). Castor oil, which has a long history of use for medicinal purposes (Gaginella *et al*. 1998), has been considered a promising raw material for the production of renewable energy in tropical countries. Besides, castor bean has been traditionally cultivated for the production of lubricants and paints (Ogunniyi 2006; Scholz & Silva 2008; Berman *et al*. 2011).

Castor seed contains more than 45% oil, which is rich (80–90%) in an unusual hydroxyl fatty acid, ricinoleic acid (Jeong & Park 2009). A high viscosity of castor oil is the main reason which restricts the use of pure castor bean diesel in the engines (Pinzi *et al*. 2009). However, blended biodiesel with petrol can be exploited in regions with severe winter. It has many advantages associated like low freezing point and lubricant power, which makes it perfect for utilization for renewable energy resources (Ogunniyi 2006; Demirbas 2007; Pinzi *et al*. 2009; Berman *et al*. 2011; Singh 2011).

Cite this article: Mounica, B., Venkateswarlu, N. C., Krishna, T.M. and Sudhakar, P., Bio-Chemical Studies of Castor Genotypes against Green Leafhopper, *Empoasca flavescens* Fabricius., *Int. J. Pure App. Biosci.* **7(2):** 636-641 (2019). doi: http://dx.doi.org/10.18782/2320-7051.8681

Unique chemical and physical properties of the oil make it a raw material for numerous and varied industrial applications, such as manufacture of polymers, coatings, lubricants for aircrafts, cosmetics, hydraulic fluids, plastics, artificial leather, manufacture of fibre optics, bulletproof glass and bone prostheses and as antifreeze for fuels and lubricants utilized in aircraft and space rockets and for the production of biodiesel farming (Ogunniyi 2006; Jeong & Park 2009), and medicines (Allan *et al*. 2008).

MATERIALS AND METHODS

Field experiment was conducted on screening of different castor genotypes for resistance against leafhoppers. The trial was laid out at Dryland farm of Sri Venkateswara Agricultural College, Tirupati, Andhra Pradesh during kharif, 2016.

Bio-chemical constituents

Biochemical constituents *viz*., proteins, phenols, total free aminoacids and total carbohydrates were estimated from leaves of 28 genotypes by using standard procedures in Institute of Frontier Technology, RARS, Tirupati. The leaf samples were collected from each entry when the leafhopper damage was at peak. Leaves were collected from two replications separately for bio-chemical analysis.

Estimation of protein

Estimation of protein content in leaves of castor genotypes was done as per the method developed by Lowry *et al*. (1951).

Estimation of phenols

The phenol content in leaves of castor genotypes was estimated as per the method presented by Malick and Singh (1980).

Estimation of total free amino acids

The total free amino acid content in the leaves of castor genotypes were estimated as per the method developed by Moore and Stein (1948).

Estimation of total carbohydrates

Estimation of total carbohydrates in the leaves of castor genotypes was done as per the method developed by Hedge and Hofreiter (1962).

RESULTS AND DISCUSSION

Bio-chemical constituents of different castor genotypes

Various bio-chemical components *viz.*, proteins, phenols, total carbohydrates and total free amino acids were estimated from leaves of different genotypes and presented here under (Tab. 1).

Total Free Amino Acids

Highest total free amino acid content (0.53) was recorded in the leaves of DCS-78 and significantly different from others (Table 1) followed by GCH-7 (0.47). The lowest total free amino acid content was recorded on PCH-111 (0.30) and significantly different from others followed by VP-1 (0.32).

Total Carbohydrates

Highest content of total carbohydrates was recorded in the leaves of DCH-177 (65.50) and significantly different from others followed by SKI-84 (47.75), SKI-341 (47.08), while the lowest total carbohydrate content (29.67) was recorded in JP-96 and significantly different from others.

Table 1: Bio-chemical constituents of different castor genotypes in *kharif*, 2016

Treatment	TFA (mg/g)	TSS (mg/g)	Protein (mg/g)	Phenols (mg/g)
Jwala	0.35^{bcdef}	46.08^{ij}	2.37^{a}	1.94^{hijkl}
DCH-177	0.38^{efghi}	65.50^{k}	2.46^{a}	1.21^{abc}
DCH-519	0.35^{bcde}	30.08^{abcd}	2.52^{a}	2.16^{lmn}
DCS-107	0.33^{abc}	35.92^{cdefgh}	2.39^{a}	1.57^{def}
DCS-78	0.53^{n}	29.83^{abc}	2.47^{a}	1.39^{cd}
Jyothi	0.42^{jkl}	22.50^{a}	2.37^{a}	1.42^{cde}
DPC-9	0.36^{cdefg}	37.33^{cdefgh}	2.58^{a}	0.99^{a}

GCH-4	0.39^{fghi}	33.00^{bcdefg}	2.41^{a}	2.36^{n}
GCH-7	0.47^{m}	30.42^{abcde}	2.47^{a}	2.13^{klmn}
JC-12	0.42^{jkl}	39.92^{fghij}	2.46^{a}	1.42^{cde}
JP-96	0.35^{bcde}	29.67^{abc}	2.36^{a}	2.23^{mn}
M-574	0.34^{abcd}	40.92^{ghij}	2.44^{a}	1.83^{ghij}
PCH-111	0.30^{a}	25.33^{ab}	2.48^{a}	1.87^{ghijk}
PCH-254	0.40^{ghijk}	29.67^{abc}	2.35^{a}	1.79
PCH-282	0.43^{kl}	36.50^{cdefgh}	2.47^{a}	1.98^{hijklm}
Haritha	0.36^{cdef}	38.33^{defghi}	2.42^{a}	1.41^{cde}
Kiran	0.42^{ijkl}	36.17^{cdefgh}	2.48^{a}	1.87^{ghijk}
Pragathi	0.38^{efgh}	33.00^{bcdefg}	2.50^{a}	1.36^{bcd}
Kranthi	0.40^{ghijk}	31.92^{bcdef}	2.40^{a}	1.92^{ghijkl}
SKI-215	0.44^{klm}	38.67^{efghi}	2.38^{a}	1.66^{efg}
SKI-333	0.37^{defg}	38.67^{efghi}	2.40^{a}	1.41^{cde}
SKI-335	0.38^{efghi}	44.08^{hij}	2.41^{a}	1.74^{fghi}
SKI-336	0.42^{hijk}	31.50^{bcd}	2.50^{a}	1.85^{ghij}
SKI-341	0.34^{bcde}	47.08^{j}	2.38^{a}	1.12^{ab}
SKI-84	0.42^{ijkl}	47.75^{j}	2.51^{a}	1.96^{hijkl}
TMV-5	0.45^{lm}	42.17^{hij}	2.43^{a}	2.04^{ijklm}
VP-1	0.32^{ab}	32.33^{bcdef}	2.41^{a}	1.86^{ghijk}
YRCH-1	0.36^{cdefg}	30.08^{abcd}	2.42^{a}	2.09^{jklm}

The values followed by same letter do not differ significantly as per DMRT

TFA- Total Free Amino acids

TSS- Total Soluble Sugars

Table 2: Correlation studies of bio-chemical constituents of different genotypes with hopper population

S. No.	Variable	Correlation coefficient	Regression equation	R^2 value
a.	Protein content (x) Vs hopper population (y)	0.196 NS	y = -37.355+26.512x	0.038
b.	Phenol content(x) Vs hopper population (y)	-0.721**	y=54.384-15.631x	0.520
c.	Total carbohydrates (x) Vs hopper population (y)	0.381*	y =14.821+0.340x	0.145
d.	Total free amino acids (x) Vs hopper population (y)	-0.133 NS	y = 35.206-20.420x	0.018

* Significant at 0.05 level;

** Significant at 0.01 level

Table 3: Correlation studies of bio-chemical constituents of different castor genotypes with hopper burn scores

S. No.	Variable	Correlation coefficient	Regression equation	R^2 value
a.	Protein content (x) Vs hopper burn (y)	0.217 NS	y = -6.065+2.799x	0.047
b.	Phenol content(x) Vs hopper burn (y)	-0.619**	y = 2.976-1.279x	0.383
c.	Total carbohydrates (x) Vs hopper burn (y)	0.285 NS	y = -0.129+0.024x	0.081
e.	Total free amino acids (x) Vs hopper burn (y)	-0.435*	y = 3.227-6.349x	0.189

* Significant at 0.05 level;

** Significant at 0.01 level

Protein content

Protein content from leaves of different genotypes was similar and did not show any significant difference.

Phenol content

Highest amount of phenol content was recorded in the leaves of GCH-4 (2.36), JP-96 (2.23) and was on par with DCH-519 (2.16), GCH-7 (2.13). Lowest phenol content was recorded in DPC-9 (0.99) and significantly different from others followed by SKI-341 (1.12). Phenol content in the remaining genotypes were in the range of 1.36 (Pragathi) to 2.09 (YRCH-1).

Correlation of different bio-chemical constituents from leaves of different castor genotypes with leafhopper population and hopper burn scores

Results from correlation studies of bio-chemical parameters of castor leaves with leafhopper population and hopper burn scores were summarised and presented here under (Table 2 and 3).

Total free amino acids

From correlation data, it was observed that total free amino acids had a negative non-significant association with leafhopper population and a negative significant correlation with hopper burn scores.

Total carbohydrates

Total carbohydrates had a significant positive correlation with leafhopper population and a non-significant positive correlation with hopper burn scores.

Some of the workers have reported positive correlation between total carbohydrates and sucking pest population. It was well documented that principal carbon and nitrogen sources utilised by most aphids are sugars and amino acids (Dadd, 1985). Masood (2014) reported the association of low sucrose content and high phenol content conferring resistance in cotton to aphids *Myzus persicae*, *Macrosiphum euphorbiae* and *Aulocarthum solani.*

Proteins

The protein content in the leaves of different castor genotypes and both the leafhopper population, hopper burn scores did not show any significant correlation.

Murugesan *et al*. (2010) after screening twenty six cotton genotypes against leafhopper, *Amrasca devastans* for antixenotic and antibiotic mechanism of resistance, reported that protein content had no significant association with resistance.

Phenols

The phenol content in the leaves of different castor genotypes showed a negative significant correlation with both leafhopper population and hopper burn scores.

Phenols are plant secondary metabolites that were evolved to deter the herbivores feeding on them. Negative effects of phenols on insect's performance, which was observed in the present investigations (Table 2), have been reported earlier by several workers. Balakrishnan (2006) reported that total phenol, gossypol and tannin contents in different plant parts (leaves, squares, bolls) of different cotton varieties/ hybrids had shown significant negative relationship with the incidence of leafhoppers, aphids, whiteflies and thrips. Rohini *et al.* (2011) reported that maximum phenol content was found in leafhopper resistant variety of cotton. The minimum phenol content was reported in variety which is susceptible to leafhoppers. Negative effect of phenols on other sucking insects such as aphids was reported by Macfoy and Dabrowski (2009) reported correlations of total phenols and total flavonoids with resistance to *Aphis craccivora* in Cowpea.

Multiple linear regression did not show any significant association between bio-chemical constituents and leafhopper population, hopper burn scores (Tab 4 and 5).

Table 4: Multiple linear regression between bio-chemical constituents and leafhopper population on different castor genotypes during *kharif,* 2016

Variable	Regression coefficient	Standard error	t-value
X_1 – Total Free Amino Acids	-20.293 NS -20.293NS	21.253	-0.955
X_2 – Total Carbohydrates	0.135 NS	0.130	1.042
X_3 – Proteins	15.99 NS	18.891	0.847
X_4 – Phenols	-14.153 NS	3.171	-4.463

R^2 Value = 0.569, F Value = 7.598, NS = Non significant

The multiple linear regression model fitted was, $Y=15.774-20.293X_1+0.135X_2+15.99X_3-14.153X_4$ with R^2 value of 0.569.

Table 5: Multiple linear regression between bio-chemical constituentsand hopper burn on different castor genotypes during *kharif,* 2016

Variable	Regression coefficient	Standard error	t-value
X_1 – Total Free Amino Acids	-6.612 NS	1.932	-3.423
X_2 – Total Carbohydrates	0.005 NS	0.012	0.441
X_3 – Proteins	2.605 NS	1.717	1.517
X_4 – Phenols	-1.167 NS	0.288	-4.048

R^2 Value = 0.608, F Value = 8.917, NS = Non significant

The multiple linear regression model fitted was, $Y= -1.186 - 6.612 X_1 + 0.005 X_2 +2.605 X_3 - 1.167X_4$.

SUMMARY AND CONCLUSIONS

The susceptible genotypes *viz.*, DCH-177 recorded higher amounts of total carbohydrates (65.50 mg/ g) followed by SKI-84 (47.75 mg/g) and lower amounts of phenols in DPC-9(0.99 mg/ g) followed by SKI-341 (1.12 mg/ g).

Studies correlating various biochemical components with leafhopper population and hopper burn scores showed that phenols had a significant negative correlation. There was a significant positive correlation between leafhopper population and total carbohydrates but non-significant positive correlation existed between total carbohydrates and hopper burn scores. Non-significant positive correlation existed between leafhopper population, hopper burn scores and protein content of leaves. There was a non-significant negative correlation between leafhopper population and total free amino acids but significant negative correlation existed between total free amino acids and hopper burn scores.

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