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Comparative studies on biophysical and biochemical basis of resistance in Brinjal and chilli against aphid (*Aphis gossypii*)

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Abstract
Investigations on studies of aphid on brinjal and chilli and host plant resistance studies were carried out during 2020 in vallampadugai village, Tamil Nādu, India. Significant difference was observed between the brinjal and chilli local variety in length, thickness, breath was positive correlated and trichome density and trichome length and types were negatively correlated. Biochemical component of resistant plants is sugar, nitrogen was positively correlated, and phenol, potash and silica were negatively correlated with aphid feeding preference.

Keywords: Resistance, biophysical, biochemical, *Aphis gossypii*

Introduction
Brinjal (*Solanum melongena* L.) is an important vegetable. In India it is cultivated in 73,300 hectares with an annual production of 12,510 million tonnes and productivity of 26.68 metric tonnes. However, China stands first with 35.97 metric tonnes. Chilli (Capsicum annum L.) is a popular vegetable and condiment crop grown throughout the world. India is the world leader in chilli production followed by China. In India it is cultivated throughout the country in about 31,600 hectares with an annual production of 3,634 million tonnes and productivity of 16.43 metric tonnes.

Materials and Methods
Estimation of leaf length, width and thickness: The length and width of the Solanaceous plant (Brinjal, tomato and chilli) was measured and expressed in centimetre (cm), (Amin *et al.*, 2014) [3].

Trichome length and density: Density of trichomes present in the adaxial and abaxial surface of leaf was estimated. One mm long transverse section of leaf was cut from leaves of 50 days old plants and the sectioned sample of brinjal was placed transversely on a clean glass slide and the trichomes length and density per mm were counted with the help of stage and ocular meter using a microscope. Similar procedure was followed to estimate the trichome length and density of tomato and chilli plant leaves (Amin *et al.*, 2011) [2].

Biochemical factors of resistance on Brinjal and chilli crops: The biochemical constituents *i.e.*, total sugars, nitrogen, total phenols, potash, silica were estimated in 50 days old leaf samples of brinjal and chilli plant. Collected samples were preserved by using freeze dryer and powdered leaf samples were analysed.

Estimation of sugar: Total sugars present in leaves of brinjal, tomato and chilli plant were estimated by calorimetric assay described by Sadasivam and Manikam (1992) [6]. 200 mg of leaf sample of respective test plant was taken in a conical flask and 5 ml of 2.5 N HCL was added and hydrolysed by boiling the sample on mantle heater for 3 hours. The sample as cooled to room temperature and the volume was, made up to 100 ml by adding distilled water and supernatant was collected and aliquots of 0.5 ml and 1.0 ml were used for estimation. Aliquots of 0.5 and 1.0 ml were pipette out into different test tubes, after making up the volume to 10 ml in each tube with distilled water. 1.0 ml of 5 per cent volume to 10 ml in each tube with distilled water. 1.0 ml of 5 per cent phenol was added followed by 5.0 ml 96 percent sulphuric acid, after incubating the samples for ten minutes to room temperature. The absorbance was read at 490 nm.

The amount of total sugars reagent present in samples was calculated from the standard glucose calibration curve established with different concentration (20-100 mg) of glucose. The data were represented as per cent.

Estimation of total phenol: The total phenols present in leaves of brinjal, tomato and chilli were estimated as per the method developed by Sadasivam and Manickam (1992) [6]. From each sample 0.5 g materials were weighed and were added with ten times volume of 80% ethanol and the homogenate was centrifuged at 10,000 rpm for 20 minutes. The supernatant was collected, and residues were extracted with five times the volume of 80% ethanol, then centrifuged and the supernatants were pooled and evaporated to dryness. The residue then dissolved in 5ml distilled water and different aliquots ranging from 0.26 to 2.0 ml were pipette out into the test tubes and the volume in each tube was made up to 3 ml by adding distilled water. To this extract, 0.5 ml of folin- ciocalteau reagent was added and after 3 minutes 2 ml 0f 20% sodium carbonate solution was added to each tube. The material was mixed thoroughly, and tubes were placed in boiling water exactly for one minute. The tubes were then cooled, and the absorbance was measured at 650 nm against a reagent blank in spectrophotometer. The standard curve was prepared by plotting the catechol concentrations on X-axis and absorbance values on Y- axis. From the standard curve, concentration of total phenols in terms of mg phenols/100 gm of test plant's leaf material was estimated and converted to per cent (%).

Estimation of Silica: Estimating silica content as per the method developed by A.O.A.C. (1960) [1], 0.5g of dried leaf sample of brinjal, Tomato and chilli plants were individually weighed and transferred to 50 ml Erlenmeyer flask which was thoroughly cleaned with hot alkali followed by acid and distilled water. Ten ml of triple acid mixture was added, and the contents were digested over a hot plate. The digestion was continued till the brown fumes ceased and the volume of the acid was reduced to about 2ml which took about 30 min. overheating and drying were avoided. The resultant solutions from the digestion were then carefully transferred with repeated washing into tall stainless-steel beakers containing 1-1.5g anhydrous sodium carbonate in suspension such that there was sufficient alkali in excess after boiled for 3-5 min to ensure complete dissolution of silica. The resultant solution after cooling as made up to 250 ml and stored in polyethylene bottles. Two ml of aliquots were treated with 2ml of 1:1 HCl and agitated for a while to remove the CO2 evolved. This was followed by addition of 2ml of 10 per cent Ammonium molybdate and the content in the flask were allowed to stand for 5 min. the interference of iron was then removed b the addition of 0.5ml of 5 per cent solution of hydroxylamine HCl and of phosphorous by the addition of 1 ml of 10 per cent oxalic acid. The resultant silica molybdate complex after dilution to volume as reduced by the addition of 2 ml of 0.5 per cent ascorbic acid and the volume made up to 50 ml. The blue color developed was kept on standard for 15-20 min and read at 650nm in a Bauchand Lomb spectronic calorimeter. Reagent blank as also employed for minimizing the error. The unknowns were calculated from standard prepared with sodium meta silicate.

Estimation of nitrogen: The leaf samples of brinjal, tomato and chilli were analysed for nitrogen content by micro kjedahl method as suggested by A.O.A.C. (1960) [1].

Estimation of potassium: The potassium content of the brinjal, tomato and chilli leaf samples were estimated by flame photometer using the tri acid mixture as suggested by Jackson (1973) [5].

Result and Discussion

Biophysical factors of resistance on brinjal and chilli:

Various biophysical factors of resistance operative in the test Solanaceae crops were investigated. Among the biophysical factors, trichome density on the foliage was found to influence the insect activity. Trichomes detected in the leaves, flower stalk and petioles of the selected crops. Regarding the distribution and density of the trichomes on their foliage, a wider variation was observed among the test crops. Trichome density was more predominant in adaxial surface of brinjal (33.5 no/mm^2) and tomato (37.6 no/mm^2) and followed by abaxial surface of brinjal (18.45 no/mm^2) followed by chilli (0.56 cm). Trichomes density on flower stalk on brinjal (12.87 no/mm^2) and chilli (5.11 no/mm^2) Leaf length and width on brinjal was highest (20.57 & 9.49 cm). Brinjal leaf thickness (242. 23 µm) was more when compared chilli (170.70 µm). Among the biophysical factors, trichome density on foliage influence aphid population more on brinjal whereas, chilli have less trichome density and thickness of leaf.

Biochemical factors of resistance in brinjal and chilli:

The sugar and nitrogen content of the foliage favour the sucking pests on the selected Solanaceae crops. The sugar content was higher in brinjal (10.74%) and nitrogen content in brinjal (7.32%). The phenol content of the foliage was maximum in chilli (7.08) followed by in brinjal (5.64). Similarly, potassium and silica content were more on chilli potassium (4.83) and silica (6.40) which exhibits the resistance against sucking pests. Aphid feeding on brinjal positively correlated with the biophysical factors. Trichome length (0.826), trichomes adaxial density (0.910) trichomes abaxial density (0.967), in addition, trichome on flower stalk, trichome density in petiole, leaf length, leaf width, leaf thickness was positively correlated (0.970), (0.989), (0.911), (0.936) respectively. Whereas estimation of biochemical components in the leaf samples concerned, sugar (0.902) and nitrogen (0.855) were positively correlated in brinjal but phenol (-0.988), potash (-0.900) and silica (-0.970) were negatively correlated with preference of aphids feeding. Aphid feeding on the leaves of chilli was positively correlated with the biophysical factors *i.e.*, trichome length (0.515), trichomes adaxial density (0.437) trichomes abaxial density (0.283), whereas trichome in flower stalk, trichome density in petiole, leaf length, leaf width, leaf thickness was also positively correlated (0.937), (0.570) (0.640), (0.563), (0.326) respectively. Whereas correlation of biochemical component in chilli sugar (0.402) and nitrogen (0.380) was positive correlated but phenol (-0.290), potash (-0.854) and silica (-0.377) were negatively correlate.

Table 1: Correlation between biophysical and biochemical constituents with feeding of aphid on brinjal

	Feeding Choice	No Choice	Trichome Length	Trichome Density – Adaxial	Trichome Density- Abaxial	Trichome Density in Flower Stalk	Trichome Density in Petiole	Leaf Length	Leaf Width	Leaf Thickness	Sugar	Nitrogen	Phenol	Potassium	Silica
Feeding choice	1														
No choice	0.266	1													
Trichome length	0.826	-0.32	1												
Trichome density –adaxial	0.910**	-0.15	0.985	1											
Trichome density- abaxial	0.967**	0.015	0.941	0.985	1										
Trichome density in flower stalk	0.950**	-0.04	0.960	0.993	0.998	1									
Trichome density in petiole	0.970**	0.489	0.667	0.783	0.879	0.848	1								
Leaf length	0.989**	0.124	0.898	0.960	0.993	0.985	0.925	1							
Leaf width	0.911**	0.638	0.522	0.659	0.779	0.739	0.983	0.843	1						
Leaf thickness	0.936**	0.088	-0.971	-0.997	-0.994	-0.999	-0.825	-0.977	-0.710	1					
Sugar	0.902**	-0.17	0.988	0.999	0.981	0.991	0.772	0.955	0.646	-0.996	1				
Nitrogen	0.855	-0.27	0.998	0.993	0.958	0.974	0.706	0.921	0.568	-0.982	0.995	1			
Phenol	-0.998**	-0.318	-0.794	-0.886	-0.952	-0.932	-0.982	-0.980	-0.933	0.916	-0.877	-0.82	1		
Potash	-0.900**	0.179	-0.989	-0.999	-0.98103	-0.99102	-0.76994	-0.953	-0.643	0.995	-0.99	-0.995	0.875	1	
Silica	-0.970**	-0.02	-0.937	-0.982	-0.999	-0.997	-0.885	-0.995	-0.787	0.99326	-0.979	-0.954	0.9558	0.978	1

Table2: Correlation between biophysical and biochemical constituents with feeding of aphid on chilli

	Feeding Choice	No Choice	Trichome Length	Trichome Density – Adaxial	Trichome Density- Abaxial	Trichome Density in Flower Stalk	Trichome Density in Petiole	Leaf Length	Leaf Width	Leaf Thickness	Sugar	Nitrogen	Phenol	Potassium	Silica
Feeding choice	1														
No choice	0.607	1													
Trichome length	0.515	-0.368	1												
Trichome density –adaxial	0.437	-0.44	0.996	1											
Trichome density- abaxial	0.283	0.585	-0.968	-0.986	1										
Trichome density in flower stalk	0.935**	0.287	0.784	0.726	-0.604	1									
Trichome density in petiole	0.57	0.300	-0.997	-0.987	0.947	-0.826	1								
Leaf length	0.64	-0.219	0.987	0.970	-0.917	0.8711	-0.996	1							
Leaf width	0.563	0.313	-0.998	-0.989	0.952	-0.819	0.999	-0.995	1						
Leaf thickness	0.326	-0.554	0.977	0.992	-0.999	0.637	-0.960	0.933	-0.964	1					
Sugar	0.402	-0.483	0.991	0.999	-0.992	0.699	-0.980	0.9602	-0.982	0.996	1				
Nitrogen	0.380	0.50	-0.988	-0.998	0.994	-0.682	0.975	-0.953	0.978	-0.998	-0.999	1			
Phenol	-0.290	0.936**	-0.670	-0.733	0.835	-0.066	0.61	-0.547	0.627	-0.810	-0.759	0.774	1		
Potash	-0.854	0.114	0.881	0.836	-0.734	0.984	-0.91	0.944	-0.907	0.763	0.814	-0.80	-0.24	1	
Silica	-0.377	0.965**	-0.59	-0.667	0.780	0.026	0.540	-0.467	0.551	-0.753	-0.695	0.712	0.99	-0.149	1

**Significant at 0.01 probability level

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