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Influence of bio-chemical constituents of potato varieties on the incidence of insect pests in Andhra Pradesh

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ABSTRACT: Studies were conducted to know the influence of bio-chemical constituents in potato varieties on insect pests in two different locations in the West and East Godavari Districts of Andhra Pradesh. Bio-chemical parameters *viz.,* moisture content (%), sugars (%), protein (mg/100g) and phenol content (mg/100g) were estimated from eight different varieties of potato *viz.,* Kufri Badshah, Kufri Chandramukhi, Kufri Jyoti, Kufri Khyati, Kufri himalini, Kufri surya, Kufri chipsona-3 and Kufri Phukraj grown in two locations (L_1 and L_2). Results revealed highest phenol content in the variety Kufri Badshah (91.10 mg/100g) in L_1, Kufri Himalini variety (86.28 mg/100g) in L_2 and both these varieties were significantly negatively correlated with insect pest's incidence. Subsequently, other bio-chemical parameters *viz.,* moisture content, sugars [reducing and total] and protein content were significantly positively correlated with insect pest's incidence in all the eight varieties in both the locations. Consequently Kufri Badshah in L_1 and Kufri Himalini in L_2 had less pest incidence which might be due to their bio-chemical composition.

Keywords: Potato, varieties, pest incidence, bio-chemical characters, incidence, phenols, moisture, protein, sugars

INTRODUCTION

More than 100 species of insects attack potato plants. Among various insect pests, aphids (*Myzus persicae* Sulzer), thrips (*Thrips palmi* Karny), leaf hopper (*Amarasca biguttula bigutulla* Ishida), whitefly (*Bemisia tabaci* Gennadius) and soil insects like cut worm, (*Agroti sipsilon* Hufnagel*);* potato tuber moth, *(Pthoromea opercullela* Povolny) have significant influence on potato yield (Mishra, 1995 and Bhatnagar, 2013). Jassids, *A. biguttula biguttula* is one of the most important serious sucking pests. Nymphs and adults suck sap from the under surface of the leaves and causing downward curling, yellowing and reddening of leaf lamina which results later in hopper burn and in severe cases leaves dry and drop down (Butani and Jotwani 1984; Misra, 1995). Whitefly, *B. tabaci* is widely distributed throughout the world and has recently emerged as a very serious pest in potato seed production, particularly in the autumn crop in the Indo- Gangetic plains Kumar *et al*. (2003). *Bemisia tabaci* is also a newly emerging vector in India transmitting apical leaf curl disease in potato crop. The direct damage by *B. tabaci* caused to the plant by sucking of the sap from the leaves and indirect damage through the honeydew excretion which attracts sooty mould (*Capnodium* sp.) on the leaves. This mould reduces the photosynthetic capacity of the plant (Reddy and Rao, 1989).

Tobaco caterpillar (*Spodoptera litura*) causes damage by feeding on the leaves and cause holes on the leaves (Anonymous, 2015). Epilachna beetle (*Henosepilachna vigintiotopunctata*), the grubs and adults both are the damaging stages of the insect. They feed on foliage. The grub scraps away the chlorophyll from the leaves at final stage it leaves only veins. (Anonymous, 2015). Pest incidence is known to be influenced by secondary metabolites and biochemical composition of plants which form basis for varietal resistance. In order to reduce insecticide usage, it is desirable to explore possibility of host plant resistance. Hence, the present study was undertaken to know the biochemical basis of resistance/ susceptibility of potato varieties against major insect pests in the coastal region and high altitude zone of Andhra Pradesh.

MATERIALS AND METHODS

The present investigations on the influence of biochemical characteristics of eight varieties of potato (Table 1) on insect pest incidence was carried during the period of 2018 out in two different locations. (L_1 - Venkataramannagudem, West Godavari District; L_2 – Pandirimamidi, East Godavari District) of Andhra Pradesh. The potato varieties were procured from Central Potato Research Station. Jalandar, Punjab. The biochemical characteristics *viz.,* moisture Content (%), sugars (%) [reducing and total], protein content (mg/100g) and phenol content (mg/100g) were estimated by following the respective standard methodology.

Table 1. Biochemical constituents of potato varieties and pest incidence in location -1

Variety	Moisture (%)	Sugars (%)		Protein (mg/100g)	Phenol (mg/100g)	*B. tabaci*	*A. biguttula biguttula*	*S.litura*	*H.vigintioc-topunctata*
		Reducing	Total						
Kufri Surya	67.70	0.39	0.25	20.00	86.20	0.39	0.25	20.00	86.20
Kufri Khyati	93.70	0.62	0.55	40.00	64.10	0.62	0.55	40.00	64.10
Kufri Chipsona-3	72.60	0.43	0.30	28.00	71.40	0.43	0.30	28.00	71.40
Kufri Chandramukhi	69.20	0.41	0.29	24.00	76.20	0.41	0.29	24.00	76.20
Kufri Badshah	62.09	0.37	0.20	17.00	91.10	0.37	0.20	17.00	91.10
Kufri Phukraj	82.30	0.57	0.50	38.00	65.20	0.57	0.50	38.00	65.20
Kufri Jyoti	73.57	0.46	0.35	31.00	69.40	0.46	0.35	31.00	69.40
Kufri Himalini	77.30	0.52	0.41	35.00	67.10	0.52	0.41	35.00	67.10

Table 2. Biochemical constituents of potato varieties and % pest incidence in Location-2

Variety	Moisture (%)	Sugars (%)		Protein (mg/100g)	Phenol (mg/100g)	*B. tabaci*	*A. biguttula biguttula*	*S.litura*	*H.vigintioc-to punctata*
		Reducing	Total						
Kufri Surya	91.90	0.62	0.31	26.00	86.28	16.90	13.00	30.00	30.00
Kufri Khyati	83.40	0.71	0.41	32.50	74.12	26.30	25.00	55.00	55.00
Kufri Chipsona-3	84.90	0.78	0.50	37.50	69.32	31.50	31.00	65.00	60.00
Kufri Chandramukhi	81.10	0.68	0.33	30.00	76.12	21.20	18.00	40.00	43.00
Kufri Badshah	72.30	0.52	0.23	22.00	85.26	14.20	12.20	25.00	20.00
Kufri Phukraj	75.60	0.65	0.25	45.00	72.36	25.50	23.00	45.00	45.00
Kufri Jyoti	70.30	0.73	0.55	42.50	66.36	36.80	36.00	70.00	70.00
Kufri Himalini	66.30	0.50	0.20	17.00	87.36	9.70	8.60	15.00	10.00

Moisture content in plant tissue and tubers (%)

Moisture content in the leaf samples of different potato varieties were determined on per cent basis by using shimabzu MOC 6u-infrared moisture analyzer. Sixty mg of fresh sample was taken and this was kept on the container on the top portion of analyzer and the moisture content was read automatically in the instrument and expressed in per cent, likewise for three replications was worked out and expressed in percent moisture content of the sample/ variety.

Sugar content in plant tissue and tubers (%)

Sugar content of the crop sample from eight potato varieties *i.e.,* reducing sugars and total sugars were estimated by following the method derived by Lane and Eyon method.

a. Reducing sugars in leaf and tubers (%)

Ten grams of sample was taken and ground well and transferred the sample to 250 ml volumetric flask and 2ml of lead acetate solution (45%) was added to the flask to precipitate colloidal matter and kept for 24 hours without disturbing. Later two ml of potassium oxalate (22%) solution was added to sample mixture in volumetric flask to precipitate the lead acetate and volume was made up to 250 ml using distilled water. The contents were then filtered through Whatman No.1 filter paper after testing a little of filtrate for absence of lead by adding a drop of potassium oxalate. Later potato solution was taken in burette and titrated against 10 ml of standard Fehling's solution mixture of A and B (1:1) using methylene blue as an indicator till the end point was indicated by the formation of brick red precipitate. The titration was carried out by keeping the Fehling's solution boiling on the heating mantle. The results were expressed in per cent of reducing sugars.

b. Total sugars in leaf and tubers (%)

Fifty ml quantity of lead free filtrate from the sample used for estimation of reducing sugars was taken in a 100 ml volumetric flask and to it 5 ml of concentrated HCL was added, mixed well and then kept for 24 h. at ambient temperature. Acid was then neutralized with Noah (40%) using a drop by drop of phenolphthalein as indicator till the pink colour persisted. The volume was then made up to 100 ml with distilled water. Total sugars were then estimated by taking this solution in a burette and titrated against standard Fehling's solution mixture of A and B (1:1) using methylene blue as an indicator till brick red colour was recorded as an end point and expressed in percent total sugar.

c. Non reducing sugars in leaf and tubers (%)

Non reducing sugars were estimated by subtracting quantity of the reducing sugars from the total sugars volume.

Protein content in plant tissue and tubers (mg)

For estimating the protein content in potato leaf/ tubers sample of each variety, the following procedure was adopted. Protein content in a sample was measured by extracting 0.5 g of sample in sodium phosphate buffer (pH 6.8) and centrifuged at 5000 rpm for 10 min. An aliquot of 0.2 ml of sample extract was taken in a test tube and the volume was made up to 1.0 ml with distilled water. Solution 'A' was prepared with 2 % sodium carbonate in 0.1N sodium hydroxide; Solution 'B' was prepared with 0.5% copper sulphate in 1% sodium potassium tartrate. Solution C was prepared by mixing 50 ml of solution "A" with 1 ml of solution 'B'. To the sample material 5ml of solution C was added and incubated at room temperature for 10 min. Finally, 0.5 ml of FCR reagent (commercially available Folin Ciocalteu's Reagent diluted with equal volumes of water) was added, mixed well and incubated in dark chamber for further 30 min at room temperature. The absorbance was measured at 660 nm against blank on spectrophotometer. The amount of protein was calculated using a standard graph prepared from bovine serum albumin (200 $\mu g\ ml^{-1}$).

Phenol content in leaves

Total phenol content of leaf was estimated by using Folin-Ciocalteau reagent as per the methodology adopted by Sadasivam (1996). Sample of potato leaves 0.5 to 1.0 g was weighed and it was grounded with a mortor and pestle by adding 80% ethanol 10-times of sample size and later it was centrifuged and homogenated at 10,000 rpm for 20 min and the supernant is saved. The residue was re-extracted for five times with 80% ethanol, in a centrifuge and the supernants were pooled. The supernant was kept open to get the ethanol evaporated. The residue was dissolved in a known volume of distilled water (5 ml). Folin-Ciocalteau 0.5 ml reagent was added to all the aliquots. After 3 minutes, 2 ml of 20 percent Na_2CO_3 solution was added to each test tube, mixed thoroughly and the test tubes were placed in the boiling water exactly for one minute. After cooling it was measured at an absorbance of 650 nm against a reagent in blank sample. A standard curve was prepared by using different concentrations of catechol. The standard curve was found out with concentration of phenols in the test sample expressed as mg phenols/100 g material.

Table 3. Correlation coefficient studies between biochemical components of potato varieties against pest incidence in L_1 (Venkataramannagudem, West Godavari district)

Pest	Moisture (%)	Reducing sugars (%)	Total Sugars (%)	Protein Content (mg/100g)	Phenol content (mg/100g)
B tabaci	0.30	0.89**	0.93**	0.80**	-0.94**
A.bigutula bigutula	0.32	0.91**	0.92**	0.81**	-0.95**
S.litura	0.32	0.91**	0.93**	0.82**	-0.96**
H.vigintioctopunctata	0.32	0.90**	0.93**	0.82**	-0.96**

Table 4. Correlation coefficient studies between biochemical components of potato varieties against pest incidence in L_2 (Pandirimamidi, East Godavari district)

Pest	Moisture (%)	Reducing sugars (%)	Total Sugars (%)	Protein Content (mg/100g)	Phenol content (mg/100g)
B tabaci	0.30	0.89**	0.93**	0.80**	-0.94**
A.bigutula bigutula	0.32	0.91**	0.92**	0.81**	-0.95**
S.litura	0.32	0.91**	0.93**	0.82**	-0.96**
H.vigintioctopunctata	0.32	0.90**	0.93**	0.82**	-0.96**

RESULTS AND DISCUSSION

The data on incidence of various insect pests *viz., B. tabaci, A. biguttula biguttula, S. litura, H. Vigintioctopunctata* were collected from the eight potato varieties and correlated with the bio-chemical parameters *viz.,* moisture (%), sugars (%) [reducing and total], protein content (mg/100g) and phenol content (mg/100g) of the potato crop. The biochemical constituents of potato crop in leaf and tuber samples of eight different varieties were estimated by following standard methods and taking the samples from standing crops in experimental plots of two locations *i.e.,* L_1 & L_2. Correspondingly incidence of different insect pests during crop growth period was recorded at SMW interval in both the locations.

Location 1: Venkataramannagudem, West Godavari district (L_1)

Highest and lowest contents of biochemical constituents *viz.,* moisture content (93.70 & 62.09 %), reducing sugars (0.62 & 0.37 %), total sugars (0.55& 0.20), protein content (40.00& 17.00 mg/100g) were recorded in Kufri khyati and Kufri badshah where as the maximum phenol content (94.10) recorded in Kufri badshah and lowest in Kufri khyati (64.10 mg/100g) varieties of potato, respectively. Moisture content was ranged between 93.70 and 62.09 % among the eight varieties and similarly the protein content was ranged from 40.00 to 17.00 mg/100g while reducing sugars (0.62 to 0.37%), total sugars (0.55-0.20%) and phenol content was ranged from 91.10 to 65.20 mg/100g among eight varieties of potato, respectively (Table 1).

The highest incidence of *B.tabaci* (33.00%) was recorded in the variety Kufri khyati while lowest in the variety Kufri badshah (8.00%). Similarly the incidence of *A. biguttula biguttula* was maximum in the variety Kufri khyati (33.00%) and least in Kufri badshah (6.90%). In case of *S. litura* peak incidence was recorded in Kufri khyati (70.00%) lowest in Kufri badshah (25.00%) alike the incidence of *H. vigintioctopunctata* (65.00%) was recorded as highest in the variety Kufri khyati and lowest in Kufri badshah (15.00 %) (Table 1).

Correlation studies on pest incidence with biochemical constituents revealed that the moisture content (r = 0.30) (r = 0.32) was non significantly positively correlated with *B. tabaci* and *A. biguttula biguttula* incidence in all eight varieties of potato where as total sugars(r=0.93**) (r= 0.92**), reducing sugars (0.89**) (r= 0.91**) and protein content (r= 0.80**) (r= 0.81**) were significantly positively correlated with *B. tabaci* and *A. biguttula biguttula* incidence. Contrarily, phenol content (r= -0.94**) (r= -0.95**) was significantly negatively correlated with *B. tabaci* and *A. biguttula biguttula* population in all the eight varieties (Table 3).

In case of *S. litura* also similar trend was observed, in all the bio-chemical plant characters studied *viz.,* Moisture content (r = 0.32) (r = 0.32) was non significantly positively correlated and reducing sugars (r= 0.91**) (r= 0.90**) total sugars (r= 0.93**), Protein content (r= 0.82**) were significantly positively correlated with *S. litura* and *H. vigintioctopunctata* incidence. Where as Phenol content (r= -0.96**) was significantly negatively correlated with *S. litura* and *H. vigintioctopunctata* incidence in all the eight varieties of potato (Table 3).

Location 2: Pandirimamidi, West Godavari district (L_2)

The range of biochemical constituents in eight potato varieties *i.e.,* moisture content from 91.90 to 66.30% and protein content from 45.00 to 17.00 mg/100g was estimated. While other biochemical constituents *i.e.,* reducing sugars from 0.78 to 0.50%, total sugars from 0.55 to 0.20% and phenol content from 87.36 to 66.36 mg/100g were recorded (Table 2).

Regarding the incidence of pests, the incidence of *B. tabaci* (36.80%) was highest in the variety Kufri jyoti while the lowest in Kufri himalini (9.70%). Similarly the maximum incidence of *A. biguttula biguttula* in the variety Kufri jyoti (36.00%) and least in Kufri himalini (8.60%). In case of the incidence of *S. litura* highest (70.00%) was recorded in the varieties Kufri jyoti and lowest (25.00%) in Kufri himalini. Similarly the incidence of *H. vigintioctopuntata* was recorded maximum (70.00%) and least (10.00%) in the varieties Kufri jyoti and Kufri himalini, respectively (Table 2). Correlation studies between bio-chemical plant characters and pest incidence established that moisture content (r= 0.95**) (r= 0.97**), reducing sugars (r= 0.98**) (0.99**), total sugars (r= 0.99**) and protein content (r= 0.98**) were significantly positively correlated with *B. tabaci* and *A. biguttula biguttula* where as phenol content (r= -0.92**) was significantly negatively correlated with *B. tabaci* and *A. biguttula biguttula* in all the eight varieties (Table 4). In case of *S. litura* also similar trend was observed, in which the bio-chemical plant characters studied *viz.,* moisture content (r= 0.97**), reducing sugars (r= 0.98**) (r= 0.99**), total sugars (r= 0.99**) and protein content (r= 0.98**) (r= 0.96**) were significantly positively correlated with *S. litura*. Phenol content (r= -0.92**) (r= -0.89**) was significantly negatively correlated with *S. litura* and *H. vigintioctopunctata* in all the eight varieties (Table 4).

Considering the present findings, biochemical constituents of the crop express an impact on the occurrence of pests whether sucking or foliage feeders and indicate its role in host plant resistance. A plant secondary metabolite, phenols which act as prime biochemical factor for resistance against insect pests due to their anti-feedant as well as antibiosis property on growth and reproduction. Similarly previous research findings revealed that biochemical constituents, such as total sugars and free amino acids, were positively correlated with pest infestation, whereas, phenols and glycoalkaloids are negatively correlated with insect pest attack. Jyothi *et al.* (2018) revealed that, higher amount of total phenols in leaves and pods showed a significant negative correlation with per cent leaf (r = -0.94**) and pod damage (r = -0.94**) caused by *Anticastra catalaunalis*. While, total sugars (r = 0.89**) and reducing sugars (r = 0.92**) showed a significant positive relationship with percent leaf and pod damage in sesame which was similar to present research findings. Nirmala and Vethamoni, 2016 reported that phenol (r = -0.49**) was significantly negative correlation with fruit infestation and positive correlation with shoot infestation (r = 0.64) in brinjal. These findings are in agreement with the present findings. Prasad *et al.* (*2014*) reported that protein (*r* = 0.48), sugars (*r* = 0.65) and moisture content (*r* = 0.97**) of fruits showed significant positive correlation, while phenols (*r* = -0.89**) showed significantly negative correlation with per cent fruit infestation. Halder *et al.* (2016) reported highest total phenol content in VROB-181 was 75.04 mg/100 g followed by VROT-108 (63.13 mg/100 g) which harboured lower jassid population whereas the highly susceptible genotype SB-6 had lowest phenol content (42.61). Hence correlation was established between total phenol content and jassid incidence was negative and significant (r = - 0.57*) which was similar to findings of this author.

CONCLUSION

Among eight potato varieties tested in two locations, Kufri Badshah in L_1 and Kufri Himalini in L_2 showed resistance against pests attacked due to their bio-chemical

composition. In case of bio-chemical content, the phenol content was significantly negatively correlated and the while remaining parameters *viz.,* moisture content, total sugars, reducing sugars and protein content were significantly positively correlated with insect pest incidence. The present findings proves that there is considerable variation for resistance among eight potato varieties against different insect pests which will be helpful in breeding programes and also further genetic studies by introgression of this resistance sources into susceptible commercial cultivars potato.

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