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Analysis of physicochemical attributes of potato lines infected with *Rhizoctonia solanai*

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Abstract

Potato is known to be the richest source of carbohydrates and it is the staple food of many countries. The objective of the present study was to evaluate three potato lines viz. VR-96, VR-94725 and V-3 against *Rhizoctonia solani*. Results for proximate composition showed that the moisture content of potato lines VR-96, VR-94725 and V-3 were 78.41, 70.80 and 73.51%, respectively under controlled conditions whereas moisture content increased up to 86.08, 85.10 and 85.22% when infected with *R. solani*. Protein content exhibited a significant decrease ranging from 4.39-4.64% in control and 2.31-2.64% in inoculated samples. Similar pattern of results were obtained for fat content with an overall decrease of 3.42 to 2.31% when inoculated. Results for fiber content suggested a non-significant variation among the lines. The average ash content reduced from 2.93 to 1.51% and the nitrogen free extract (NFE) was reduced from 11.31 to 5.69% in all the tree lines with inoculation. So it is recommended that VR-96 showed less affects and may be called as tolerant line against *R. solani*.

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Introduction

Potato (*Solanium tuberosum*) is a starch rich tuberous crop of family Solanaceae. According to Solis (2007), potato is known to be indigenous to Chiloe Archipelago, USA and was cultivated about 10,000 years ago (Solis, 2007). Five thousand varieties of potatoes have been introduced so far in all over the world. Three thousands of them were originated from Andes alone, mostly in Peru, Bolivia, Ecuador, Chilly and Columbia. China is the leading potato producing country with 70 million metric tons, followed by Russia, India and United States contributing (Cummings *et al*, 1996).

In Pakistan the total area under potato cultivation was 154317 hectares with total production of 2538971 tons in the year 2007-08. In Khyber Pakhtunkhwa province of Pakistan, the total area was 8860 hectares with a production of 117202 tons for the same year. Punjab stood first with a total production of 2387465 tons with cultivated area of 142018 hectares in 2007-08 (ASP, 2008). The amount of resistant starch in cooked potato is about 7 %, which increases to 13% on cooling. This contains toxic compounds such as glycol-lalkaloides, the most prevalent of which is solaline and chaconine. These compounds are present mostly in sprouts, leaves and stem which protect plants from predators. Glyco-alkaloides causes headache, and sometimes leads to coma and even death in severe cases. In humans the poisoning occurs very rarely (Englyst *et al.*, 1992). The difference in texture of potato is due to occurrence of starch containing phosphate. The amount of P in potato varieties is ranging from 308 to 1244 mg/Kg (Noda *et al.*, 2006). The genetically analyzed samples of potato-cultivated verities for ascorbic acid inhabitant to the Andes of South America contained the ascorbic contents from 217.70-689.47 µg per gram (Andre *et al.*, 2007). The higher concentration of phosphate as compared to other starches has been found in potato starch. The presence of phosphate groups in amyl pectin results in resistance to digestion by amylase, so potato starch is digested slowly, reducing a physiological effect similar to that of resistance starch and indigestible oligosaccharide (Kanazawa *et al.*, 2008).

Protein is present in a thin layer just under the skin which shows a yellowish film when boiled potato is pealed carefully and it suffers from many diseases like Common Scab, Early Blight, Die Back, Black Leg, Late Blight, Pink Rot, Black Scurf and Fusarium Dry Rots.

Rhizoctonia disease is considered as a major cause of crop losses. This disease can affect both the above and below-ground portions of plant. This pathogen affects tubers in many ways. Morse (1927) reported that the main symptoms observed are the black sclerotia on the surface, known to be the Black Scurf. Keeping in view the present situation of food insecurity and importance of potato, this study was planned to investigate and compare the proximate composition of *Rhizoctonia solani* infected three newly developed potato lines.

Material and methods

Plant Materials

Potato lines namely VR-96, VR-94725 and V-3 were collected from Agricultural Institute Tarnab (ARI, Tarnab), Peshawar, Pakistan. *Rhizoctonia solani* mycelia were isolated from the naturally infected potato tubers and these samples were synthetically inoculated by *Rhizoctonia solani*.

Methodology

Experiment was carried out following completely randomized design (CRD). Plant material was separated into two groups i.e. control and infected with *R. solanai* and incubated for 40 days at ambient room temperature. At maturity samples were analyzed and compared for moisture, ash, crude protein and crude fiber content in accordance with the standard procedures of AOAC (2000). Nitrogen free Extract was calculated by using the formula (NFE = 100- % (Moisture + Ash + Crude Protein and Crude Fiber).

Results and discussion

A comparative study was carried out to check the nutritional stability of newly developed potato lines (VR-96, VR-94725 and V-3) against *Rhizoctonia solani*and results are presented here

Proximate Composition

The data regarding the proximate composition i.e. % (moisture, crude protein, crude fats, crude fiber, and ash and NFE contents) of inoculated and un-inoculated (control) samples of selected potato lines are presented in Table 1.

Moisture Content

It was observed that the moisture content was significantly (P≤0.05) affected by both the factors i.e. inoculation and lines difference. In control (uninoculated) samples maximum moisture content (78.41 %) was shown by VR-96 whereas minimum (70.80 %) by VR-94725. Similarly, in case of inoculation, the maximum moisture content (86.08 %) was recorded in VR-96 and minimum moisture content (85.10 %) was noted in VR-94725. However, the results were not significant within the inoculated lines. The overall means showed that the inoculated lines had more moisture content (85.47 %) as compared to control (74.25%) moisture. The results of our findings are closely an agreement with Shehu and Aliero (2010) who reported increase in moisture content from 88 to 94 % in purple Blotch infection on onion leaves. The higher content of moisture in the infected tubers could be attributed to maceration of carbohydrates and pectin components of the cell wall by the purple blotch fungus as a possible mechanism of invasion and subsequent infection of tuber tissue (Shehu and Aliero, 2010).

Protein Content

The average protein content did not significantly (P≤0.05) vary among the selected lines (Table 1). However, inoculation significantly affected the protein content. In control samples the average protein contents ranged from 4.39 % in V-3 to 4.65 % in VR-96. In inoculated samples protein content varied from 2.31 % to 2.64 % and the averages being 2.31, 2.52 and 2.64 % for V-3, VR-96 and VR-94725, respectively. The overall means showed that inoculation significantly (P≤0.05) decreased the protein contents from 4.56 to 2.49 % in all the three lines.

Our findings are supported by that of Amadioha (1998) who reported that protein content decreased from 6.4 to 4 % in *Rhizopus oryzae* infected potato cultivars during 10 days. These findings are also supported by those of Phatak 1997 who observed that microbial infection adversely affected the protein content of vegetable.

Fats Content

The average fats content did not significantly (P≤0.05) affected among the selected lines. However, the effect of inoculation was significant on fats content. In control samples the average fats contents ranged from 3.32 % in V-3 to 3.51 % in VR-96. In inoculated samples fats content varied from 2.22 % to 2.36 % and the averages being 2.77, 2.86 and 2.93 % for V-3, VR-94725 and VR96 respectively. The overall means explained that inoculation significantly (P≤0.05) decreased the fats contents from 3.40 % to 2.31 % in all the three lines. The results of the present study are fairly inline to those of (Shehu and Aliero, 2010) who reported that fats content decreased in purple blotch infected onion leaves from 3.9 to 1.3 %. Previous studies have shown that the decrease in fat content of diseased seed is due to microbial enzymatic catalysis and metabolism of fat (Mba and Akueshi, 2001).

Crude Fiber (%)

Data regarding crude fiber content given in the Table1 showed that in control varieties maximum amount of crude fiber (3.60%) was noted in V-3, while minimum (3.54 %) was observed in VR-96. In inoculated varieties V-3 has maximum fiber content (2.83%) and VR-96 has minimum (2.39%) crude fiber. Analysis of variance showed that control varieties were significant (P≤0.05) on fiber content while the inoculated varieties and their interaction were not significant. Our findings are fully supported by those of (Shehu and Aliero, 2010) who examined the decreased in fiber content in onion leaves infected by *Alternaria porri* from 3.5 to 2.4 %.Vegetables are good sources of fiber, which lowers the body cholesterol level, consequently decrease the risk of cardiovascular diseases (Rumeza *et al*, 2006).

Fibers provide bulk to the food, protect the body from colon cancer and increase glucose tolerance and insulin sensitivity, lower the cholesterol level and triglyceride concentration and also reduce the fat storage (Raban *et al*, 1994; Hylla *et al,* 1998).

Ash (%)

Maximum ash content (3.26%) was found in VR-96 while minimum (2.56%) was observed in V-3, in control treatments. While in inoculated samples maximum ash content (1.86%) was recorded in VR-96 and minimum ash content (1.27 %) was in VR94725. Mean data exhibited that inoculation significantly (P≤0.05) affected the ash content. However the interactions were not significant for ash content. Shehu and Aliero (2010) reported that ash content decreased from 5.2 to 3.0 % in *Alternaria porri* infected onion leaves.

Nitrogen Free Extract (%)

Data regarding NFE content (on fresh weight basis) showed that in control samples, VR-94725 had the maximum NFE content (14.64 %) while minimum value (6.63 %) was recorded in VR-96.

Similar patterns of results were shown by inoculated lines where maximum NFE content (6.25 %) was noted in VR-94725 and minimum (4.79 %) in VR-96. The overall means showed that inoculation significantly decreased the NFE contents. The results are similar to those of (Shehu and Aliero, 2010), who deliberated decrease in NFE from 4.6 to 2.2% in fungus infected onion. After moisture the second major chemical constituent found in potato was carbohydrate. Potato was having high amount of carbohydrates (19.0%) as compared to other vegetables, therefore its energy value is highest (Rumeza *et al*, 2006). The increase in the total carbohydrate in the infected potato tubers compared to healthy potato samples observed in this study may be due to accumulation of reducing sugars in infected tubers during pathogenesis or to lipolytic activities of the fungus or metabolism of the oil in the tuber tissue. It is also due to conversion of part of the fat into carbohydrate. The increase in carbohydrate content was found to be associated with a comparable decrease in the total oil content.

Table 1. Proximate composition of potato line as affected by *Rhizoctonia solani.*

Proximate	Treatment	Potato Lines			Mean
		VR96	VR 94725	V3	
Moisture	Control	78.41	70.80	73.51	74.25a
	Inoculated	86.08	85.10	85.22	85.47b
	Mean	82.24 a	77.97 b	79.36b	
Crude protein	Control	4.65	4.64	4.39	4.56a
	Inoculated	2.52	2.64	2.31	2.49b
	Mean	3.58 a	3.64 a	3.53 a	
Crude fats	Control	3.51	3.38	3.32	3.40a
	Inoculated	2.36	2.34	2.22	2.31b
	Mean	2.93a	2.86a	2.77a	
Crude fiber	Control	3.54	3.55	3.60	3.56a
	Inoculated	2.39	2.40	2.83	2.40b
	Mean	2.97a	2.97 a	3.00 a	
Ash	Control	3.26	2.96	2.56	2.93a
	Inoculated	1.86	1.27	1.40	1.51b
	Mean	2.56 a	2.11b	1.98 b	
NFE	Control	6.64	14.63	12.68	11.31a
	Inoculated	4.77	6.26	6.04	5.69b
	Mean	5.7c	10.5a	9.36b	

Means followed by same letters are not significantly different at P≤0.05

LSD value for lines regarding % moisture content = 1.545

LSD value for lines regarding % protein content = 0.4856

LSD value for lines regarding % fat content = 0.3157

LSD value for lines regarding % fiber content = 0.6402

LSD value for lines regarding % ash content = 0.3646

LSD value for lines regarding % NFE content = 0.05626.

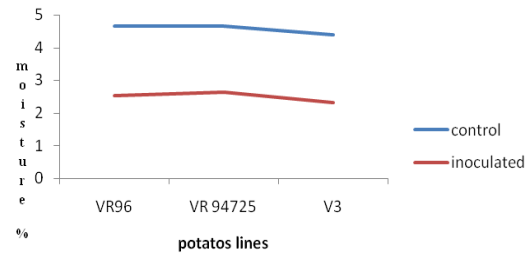

Fig. 1. Moisture content % of control and inoculated potato lines.

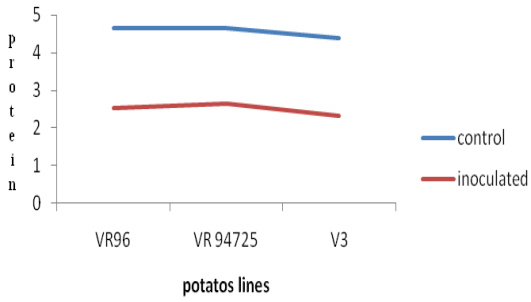

Fig. 2. Protein content % of control and inoculated potato lines.

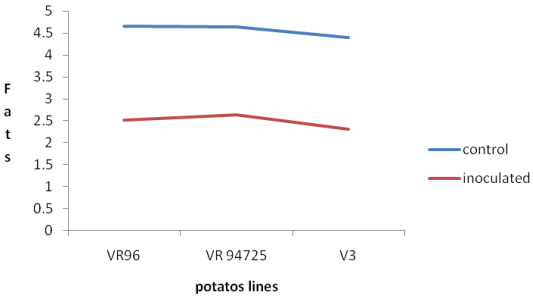

Fig. 3. Crude fats content % of control and inoculated potato lines.

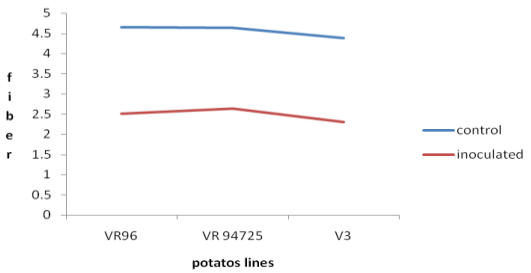

Fig. 4. Fiber content % of control and inoculated potato lines.

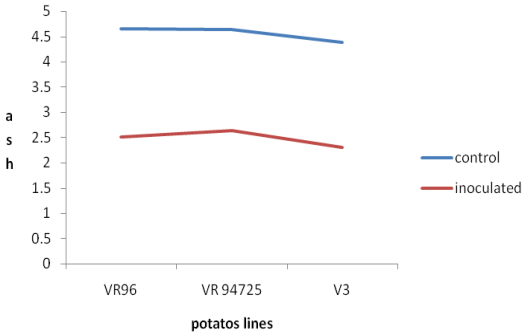

Fig. 5. Ash content % of control and inoculated potato lines.

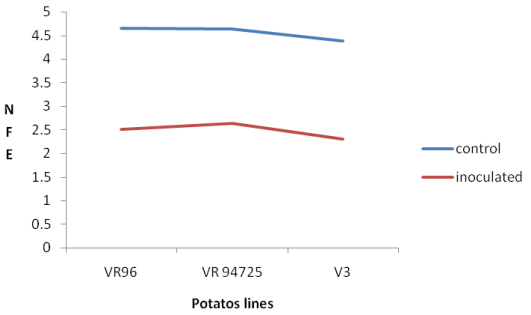

Fig. 6. NFE content % of control and inoculated potato lines.

Table 2. Mean square and CV for different parameters.

SOV	MC	Ptn	Fats	Fiber	Ash	N
Factor A	566.161**	19.243**	5.379**	6.207**	9.074**	142.411**
Factor B	28.516**	0.139^{NS}	0.040^{NS}	0.001^{NS}	0.553*	37.096**
AB	16.629**	0.006^{NS}	0.005^{NS}	0.002^{NS}	0.106^{NS}	17.003**
Error	1.508	0.149	0.063	0.075	0.084	0.002
CV	1.54	10.93	8.76	9.22	13.03	0.52

Conclusion

It was concluded from the present study that the protein, fats, fiber, NFE and ash contents of potato lines (VR-96, VR-94725 and V-3) were significantly decreased with *R. solani* infection but the line VR-96 showed tolerance. Conversely, a significant increase in moisture content was observed during infection. It is concluded that inoculation significantly affected the nutritional quality of potato lines.

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