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Effect of late blight of potato incited by *Phytophthorainfestans* (Mont.) de Baryon nitrogen contents of potato leaves

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Minerals are the crucial part of plant nutrition and their presence in excess or deficiencies may cause certain maladies in the plants either through disturbing metabolism or plant physiology abnormally by favoring the plant pathogens or discouraging the plant growth. Nitrogen availability was the most important limiting factor for yield. Nitrogen content of 50 potato genotypes including 8 cultivars and 42 lines were tested from three samples taken at different times, first from healthy plants after 50 days of crop planting before disease appearance, second from healthy and diseased plant separately 30 days after the first appearance of the late blight symptoms on the plants. Results of present study revealed that there was an overall increase in the quantity of nitrogen in all tested lines after disease appearance. This increase was ranged from 1.0 to 10.7 percent over the healthy plants of that same age group. Maximum increase of 10.7 percent in FD 3-10 in nitrogen content after disease appearance was observed, while minimum 1.0 percent increase in nitrogen content was observed in line N 22. Increase in nitrogen content was also observed in the healthy plants of all potato lines/cultivars which were not infected by the disease but this increase might be due to aging factor and was quit insignificant and unnoticeable. All though the nitrogen content was slightly increased in the plants which were not diseased than that of healthy plants which were tested at the time when disease was not appeared. It is apparent from the above figures that the increase in nitrogen content was more pronounced due to the effect of disease and there was no or very slight effect of aging was observed. Pathogen attack has significantly increased percent nitrogen in the potato lines/cultivars under observation.

Key Words: Potato, late blight, resistance, nitrogen, mineral content, disease severity

INTRODUCTION

Potato (*Solanumtuberosum* L.) is the most important crop with immense yield potential and having excellent nutritional value. It is one of the most widely grown food crops in the world and produces approximately twice as many calories per hectare as rice and wheat (Poehlman and Slepper, 1995).The average tuber yield of potatoes in the Pakistan is only 22.17 t/ha which is very low as compared to the developed countries of the world e.g. Netherlands 46.7, USA 46.27, UK 41.43 and Australia 36.18 t/ha (Swaminathan, 2000). Several factors can be

responsible for low potato production in Pakistan including diseases and insect pests. Among diseases late blight is the most important one affecting potatoes (Dowley and O'Sullivan. 1994; Agrios, 2005).*Phytophthorainfestans* (Mont.) de Bary, the causal organisms of the late blight disease of potato and tomato is the most important worldwide factor, limiting the production of potatoes worldwide.

Late blight of potato not only causes the yield losses but also affect the accumulation of different minerals in the foliage of the plants. The pathogen *Phytophthorainfestans* (Mont.) de Bary is very aggressive and hinders the uptake of minerals from soil but also increase the accumulation of these minerals in the foliage. Macro- and microelements have long been recognized as being associated with size, quality, and yield of crops, and also with changes in levels of the incidence of disease (Rush *et al*., 1997).Minerals are the crucial part of plant nutrition and their presence in excess or deficiencies may cause certain maladies in the plants either through disturbing metabolism or plant physiology abnormally by favoring the plant pathogens or discouraging the plant growth (Sahi*et al.,* 2010, Subhani*et al*., 2015). Nitrogen availability was the most important limiting factor for yield variation up to 73% in organic potato crop while only 25% of this variation could be attributed to the influence of late blight (Moller *et al*., 2007). Powdery mildew disease on *Dalberigasissoo* seriously effects uptake potential of following mineral nutrients nitrogen, phosphorus, magnesium, sulphur, zinc, ferrous, manganese and molybdenum (Thite, 2013). This study was carried out to assess the effect of late blight on the uptake and accumulation of nitrogen in foliage of potato lines/cultivars.

MATERIALS AND METHODS

Total 50 potato genotypes including 8 cultivars and 42 lines were grown under field conditions in during 2009-10 and 2010-11 seasons Department of Plant Pathology, University of Agriculture, Faisalabad, Punjab, Pakistan. The trial was conducted with plot of four rows of six meter length with 20 cm plant to plant and 60 cm row to row distance, in RCBD with four replications in winter season of 2009-10 and was repeated in 2010-11. Field was fertilized @ 250: 125: 125 NPK Kg h^{-1}. First sampling was done 50 days after plantation of crop when there was no symptoms of disease, while second sampling was done around 30 days after the first appearance of the symptoms of late blight. In the second sampling healthy and diseased plants of each line/cultivars were collected and tagged separately... Collected samples were washed in 0.2 percent detergent solution to remove dirt from the leaf surfaces followed by washing in 0.8 percent HCl to remove metallic contaminants and deionized water to wash out remains of detergent and HCl solutions. These samples were air-dried for 2-3 days in the shade on the paper towels and then placed in paper bags. These air-dried samples were dried in an oven at 70 °C for 72 hours to get constant weight, and were ground with Buhler sample grinder and then processed for the determination of nitrogen content in leaf samples of potato lines, following protocol described earlier (Bhargava and Raghupathi, 1995). Nitrogen content was recorded as percentage of leaf dry weight.

RESULTS AND DISCUSSION

The data regarding the change in the Nitrogen contents in the leaves of 50 potato lines/cultivars is given in Table 1. Results of present study revealed that there was an overall increase in the quantity of nitrogen in all tested lines after disease appearance. This increase was ranged from 1.0 to 10.7 percent over the healthy plants of that same age group. Maximum increase of 10.7 percent in FD 3-10 in nitrogen content after disease appearance was observed, while minimum 1.0 percent increase in nitrogen content was observed in line N 22. Increase in nitrogen content was also observed in the healthy plants of all potato lines/cultivars which were not infected by the disease but this increase might be due to aging factor and was quit insignificant and unnoticeable. This increase in nitrogen content of diseased plant in all lines/cultivars was statistically significant. All though the nitrogen content was slightly increased in the plants which were not diseased than that of healthy plants which were tested at the time when disease was not appeared. It is apparent from the above figures that the increase in nitrogen content was more pronounced due to the effect of disease and there was no or very slight effect of aging was observed. Pathogen attack has significantly increased percent nitrogen in the potato lines/cultivars under observation.

Nitrogen is the most important plant nutrient, needed by all plants, derived from decaying organic matter, but also likely of the plant nutrient to become deficient, due to leaching. Excess of nitrogen in soil favour some diseases while its deficiency also cause also favour some other symptoms in plants. The diseased potato cultivars contained more nitrogen in diseased plants as compared to the healthy ones of the same age plants. As the nitrogen is mobile within the plant (Devlin and Witham, 1983), the younger leaves definitely contain more nitrogen than the older ones. Perhaps, that is the reason that the topmost leaves are more susceptible to the disease.

Although the mineral content was assayed for the whole shoot, yet it seems that if only topmost foliage would have been assayed, this would have given a clearer concept of the picture. Nitrogen if in excess,

Table: 1. Nitrogen (percent dry weight) contents of Potato lines/cultivars

Lines/ Cultivars	Before disease appearance		After disease appearance				Per cent increase over healthy plants
	Healthy Plants		Healthy Plants		Diseased Plants		
9619	2.66	ijklmn	2.67	jklmnop	2.87	ghijk	8.6
CARDINAL	2.56	no	2.56	opq	2.66	n	3.6
FD 1-10	2.71	ghijkl	2.72	hijklmn	2.83	hijklm	3.8
FD 1-3	3.10	bc	3.11	bc	3.25	b	4.4
FD 3-10	1.96	s	1.98	u	2.22	p	10.7
FD 32-2	2.76	fghi	2.75	hijkl	2.83	hijklm	2.8
FD 35-25	2.63	jklmn	2.63	klmnopq	2.74	klmn	3.9
FD 35-36	2.21	q	2.24	rs	2.35	o	4.8
FD 37-13	2.64	ijklmn	2.64	klmnopq	2.72	klmn	3.1
FD 3-9	2.75	fghij	2.77	ghijkl	2.94	fghi	3.7
FD 48-54	2.68	hijklm	2.69	ijklmno	2.86	ghijk	6.9
FD 49-28	2.75	fghij	2.74	hijkl	2.95	fghi	5.8
FD 49-62	3.15	b	3.17	ab	3.37	a	5.9
FD 51-5	2.82	defg	2.85	efghi	3.05	def	5.8
FD 51-6	2.92	d	2.93	def	3.06	def	4.1
FD 52-2	2.50	o	2.54	opq	2.68	mn	5.2
FD 53-6	3.05	c	3.03	cd	3.20	bc	5.3
FD 56-1	2.89	de	2.91	defg	3.07	cdef	9.0
FD 53-7	2.12	r	2.16	st	2.38	o	5.2
FD 61-3	2.71	ghijkl	2.73	hijklmn	2.92	fghij	6.6
FD 63-2	2.80	efgh	2.82	efghij	2.93	fghij	3.8
FD 63-4	3.16	b	3.17	ab	3.35	a	7.0
FD 64-2	2.22	q	2.27	rs	2.41	o	5.8
FD 65-4	2.61	klmno	2.60	lmnopq	2.80	ijklmn	7.0
FD 65-6	2.36	p	2.34	r	2.47	o	5.1
FD 69-1	2.86	def	2.91	defg	3.07	cdef	5.2
FD 70-1	2.10	r	2.08	tu	2.22	p	6.3
FD 71-1	3.27	a	3.27	a	3.39	a	3.4
FD 76-59	2.91	de	2.92	def	3.04	def	3.7
FD 8-1	2.61	klmno	2.63	lmnopq	2.70	lmn	2.7
FD 8-3	2.66	ijklmn	2.64	klmnopq	2.80	ijklmn	5.6
FSD RED	2.86	def	2.84	efghi	3.01	defg	5.5
FSD White	2.51	o	2.52	pq	2.75	klmn	8.4
KARODA	2.88	de	2.93	def	2.96	fghi	1.1
MARATO	2.72	ghijk	2.74	hijklm	2.81	ijklmn	2.6
N- 18	2.82	defg	2.79	fghijk	2.99	efgh	6.6
N- 22	2.86	def	2.87	efgh	3.11	cde	1.0
N- 30	3.02	c	3.12	bc	3.15	bcd	5.2
N- 37	2.57	mno	2.57	nopq	2.77	jklmn	7.3
N- 8	2.56	no	2.58	mnopq	2.69	mn	4.0
N-13	2.94	d	2.95	de	3.15	bcd	6.1
N-34	2.60	lmno	2.61	lmnopq	2.86	ghijk	6.4
N-39	2.10	r	2.09	tu	2.15	p	2.9
RODIO	2.68	hijklm	2.73	hijklm	2.94	fghi	7.0
SH- 692	2.75	fghi	2.74	hijkl	2.88	ghijk	4.7
SH 788	2.76	fghi	2.77	ghijkl	2.88	ghijk	7.8
SH-5	2.02	s	2.02	u	2.17	p	7.1
SH-704	2.55	no	2.56	opq	2.69	mn	4.8
SHANAN	2.77	fghi	2.76	hijkl	2.85	ghijkl	3.3
SIPLY RED	2.50	o	2.50	q	2.68	mn	6.8
CV	1.645%		2.140%		2.017%		

favours the development and growth of a lot of plant pathogens as it is an integral part of their nutrition, thus reducing the resistance against the pathogens. This situation seems to be true in this case as well. A higher amount of nitrogen in the late blight infected plants may be attributed to the spread of the pathogen in a nitrogen richer foliage and accumulation of fungal mycelia, the latter being richer in nitrogen. As such during the course of estimation of nitrogen from the plant tissue, these could not be repeated being impracticable, there was a general increase in the nitrogen content of both the diseased and healthy plants. This increase was much higher in the diseased plants as compared with the healthy ones of same age and growing in the same field conditions. Reddy and Khare (1984) reported that nitrogen content, although higher in lentil varieties susceptible to rust than in the resistant ones, yet decreased in both the groups. Randhawa (1994) and Sahi*et al*., (2010) reported increase in nitrogen content in chickpea cultivars resistant to *Ascochyta* blight while there was a decrease in the susceptible cultivars. These results are in conformity with Olanya*et al*., 2001; Juarez *et al*., 2000. Moller *et al*., (2007) who also reported the non-significant nitrogen increase in foliage in late blight infected leaves.

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