INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
ISSN Print: 1560–8530; ISSN Online: 1814–9596
18–0944/2019/21–1–120–124
DOI: 10.17957/IJAB/15.0871
http://www.fspublishers.org

Full Length Article

Variations in Yield and Nutritional Profile of Onion Germplasm under the Influence of Purple Blotch Disease

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Abstract

Purple blotch of onion caused by *Alternaria porri* (Ellis) Cifferi. induces paramount losses in different parts of the world. In the present study, potential of 25 onion genotypes was evaluated against purple blotch and their yield response during two years (2014–15) under field conditions. Selected onion genotypes were also evaluated for the mineral and proximate parameters. Five varieties (Phulkara, Sunset, Ceylon, TI-172, XP-Red) showed resistant response while Desi Red, Early Red, Robina, Dark Red and Mirpurkhas exhibited moderately resistant response. VRIO-6, VRIO-1, VRIO-4, Red Nasik and Desi Black were found moderately susceptible against the disease. VRIO-9, Pak-10321, Fsd Red, Pusa Red and Red Imposta gave susceptible response, while VRIO-3, VRIO-5, VRIO-8, VRIO-7 and VRIO-2 exhibited highly susceptible response. Phulkara exhibited maximum yield followed by other tested varieties whereas minimum yield was recorded in case of VRIO-2. Regarding the mineral and proximate analysis, leaf of purple blotch susceptible variety (VRIO-2) exhibited lower quantity of fiber, crude protein, ash and fat as compared to Phulkara leaves. Carbohydrate and moisture contents in Phulkara (resistant variety) leaves were lower as compared to VRIO-2 leaves. Mineral contents in VRIO-2 leaves were lower as compared to Phulkara leaves. Mineral contents increased in resistant (Phulkara) leaves and decreased in susceptible (VRIO-2) leaves during 2nd year. However proximate contents increased in both resistant and susceptible leaves during 2nd year. It was concluded that Phulkara exhibited resistance against purple blotch as compared to other varieties with greater yield and mineral contents. © 2019 Friends Science Publishers

Keywords: Minerals and proximate; Onion; Purple blotch; Yield

Introduction

Onion (*Allium cepa* L.) which belongs to family Alliaceae ranks among the five most profitable vegetable crops round the globe (Cramer, 2000). Onion adds specific taste to dishes and also has various medicinal properties like antibacterial, antifungal, mitigating, germicide and antispasmodic (Griffiths *et al.,* 2002). Onion contributes substantially in country's economy due to its high exports. China and India are the two important countries among the onion producing regions on the globe both in area and production. Regarding revenue, round the globe, onion is at 2nd place after tomato crop (Griffiths *et al.*, 2002; Mallor *et al*., 2011). Based on the production criteria, Pakistan ranked at 6th position. In Pakistan, area under onion cultivation is 135.1 thousand ha and average yield of 1763 thousand tons (ESP, 2014–15). Onion leaves are utilized as supplementary nourish for poultry birds, rabbits and cattle. Besides the importance of accurate nutrient content of foods, the knowledge of nutrient inhibitors and enhancers are increasingly brought into focus due to their influence on bioavailability of nutrients (Abubakar and Naqvi, 1996; Mba and Akueshi, 2001).

Onion is attacked by 66 diseases in the world, in which fungal diseases are the most damaging. The most destructive foliar disease of onion at present is purple blotch caused by *A. porri* that occurs in almost all onion growing areas of the world, causing severe losses under field conditions (Kumar and Palakshapra, 2008). The pathogen is soil-borne and its inoculum can remain viable in soil for a long time (Yar'adua, 2003). The pathogen (*A. porri*) destructs the leaf tissue and use their nutrients as their energy source. It also destroys the stimulus for bulb initiation and delays bulbing and maturation (Ravichandran *et al.*, 2017). The occurrence of infectious maladies is high in onion because it may transmit at various stages between farm and consumer (Yar'adua, 2003; Abubakar *et al.*, 2006).

Numerous conventional approaches such as plant extracts, non-sensible use of non-biodegradable chemicals and destruction of diseased plant residues etc. are available for the management of this disease (Turkkan and Dolar,

To cite this paper: Mansha, M.Z., S.T. Sahi, A. Habib and S. Ahmed, 2019. Variations in yield and nutritional profile of onion germplasm under the influence of purple blotch disease. *Intl. J. Agric. Biol*., 21: 120–124

2009). Among these strategies, some are not commonly applicable for farmers owing to high cost while others have direct or indirect degrading and deteriorating effect on human health such as non-judicious application of chemicals (Iglesias *et al.*, 2010). Therefore, the perfect method to battle the maladies is the utilization of resistant onion germplasm. For this purpose, screening from available germplasm under natural conditions is pre-requisite to detect the source of resistance (Thaxton and Zik, 2001). Hence, the current research was conducted to find out the source of resistance in onion for the management of purple blotch disease under natural field conditions and to investigate the impact of *Alternaria porri* on the minerals and proximates in leaves of resistant as well as susceptible onion varieties.

Materials and Methods

Screening of Onion Germplasm Against Purple Blotch under Field Conditions

Twenty-five onion varieties were collected from Ayub Agriculture Research Institute Faisalabad (AARI), Institute of Horticultural Sciences, University of Agriculture Faisalabad and local seed market, Faisalabad. Onion nursery was grown in the experimental research area of Department of Plant Pathology, University of Agriculture Faisalabad for two years 21st October 2014 and 23 October 2015, while transplanting was done after 45 days to screen out resistance source against purple blotch of onion. Disease free seeds of all the twenty-five varieties were used for nursery of onion. Seeds were not treated with any chemical before sowing in nursery. All the collected germplasm was grown in randomized block design with three replications. Distance between plants was 22 cm and between rows was 60 cm. When the disease was at its peak, observations regarding disease intensity were noted for a period of two and half month after transplanting by using a 0–5 scale (Sharma, 1986), whereas the percent disease index (PDI) was examined by the following formula given by (Wheeler, 1969). Furthermore, the cultivars were ranked in different groups according to their resistance and susceptibility to disease (Pathak *et al*., 1986).

$$\mathrm{PDI} = \frac{\text{Total sum of numerical ratings}}{\text{Number of observations}} \times \frac{100}{\text{Maximum disease rating}}$$

Disease rating scale of 0–5 as described by Sharma (1986) is as follows:

0. No disease symptom.
1. A few spots towards tip covering 10% area of leaf.
2. Several purplish brown patches covering up to 20% area of leaf.
3. Several patches with paler outer zone covering up to 40% area of leaf.
4. Leaf streaks covering up to 75% area of leaf or breaking of the leaves from center.
5. Complete drying of the leaves or breaking of leaves from center.

Crop was harvested manually during 10 and 17 June, 2014 and 2015 respectively while yield (t/h) of onion was calculated by using the given formula mentioned by Muhammad *et al.* (2017).

$$\text{Yield (t/h)} = \frac{\text{yield of single bulb (g)} \times \text{number of plants/h}}{1000{,}000}$$

Collection and Preparation of Samples

Resistant and highly susceptible varieties were selected from the screened onion germplasm for proximate and mineral analysis. Leaves of purple blotch susceptible (VRIO-2) and resistant (Phulkara) varieties were taken from field area of Department of Plant Pathology, University of Agriculture, Faisalabad-Pakistan. For attaining the constant weight of the leaves, they were washed with distilled water and then dried in an oven at 55°C. The samples were then grinded in a wearing blender separately and sieved via 20-mesh sieve. Powdered samples were used for proximate and mineral analyses.

Proximate and Mineral Analysis

Proximate content of onion leaves was determined by using the standard protocols of (AOAC, 1998). The moisture contents were analyzed by using the leaves (10 g each) of resistant (Phulkara) and susceptible (VRIO-2) varieties that were oven dried at 55°C to attain the constant weights. Muffle furnace (550°C) was used for incinerating the leaf samples for 30 min to obtain the ash contents. Crude protein contents were assessed by using the Kjeldahl technique. The amount of fat was recorded with gravimetrically after extracting the ammoniacal solution of the samples with diethyl ether. Acid base digestion was used with 1.25% NaOH and 1.25% H_2SO_4 (w/v) solution to assess the crude fibers and carbohydrates. Hydrochloric acid was used for the digestion of ashed residue and filtered with Whatman filter paper. Mineral contents were determined by using this solution (Mba and Akueshi, 2001). The contents of K and Na were analyzed by using flame photometer (flame photometer 410, UK)**.** Phospho–vanadolybdate method was used to assess the Phosphorus with atomic absorption spectrophotometer (Jenway, 6100UK). Concentrations of Fe, Zn, Ca and Mg were estimated with the help of atomic absorption spectrophotometer (PU 9400 X Philips Scientific, Cambridge UK). Magnesium, calcium, iron and zinc contents were determined by using atomic absorption spectrophotometer (PU 9400 X Philips Scientific, Cambridge UK).

Statistical Analysis

Data collected from each experiment were analyzed using Statistix 8.1 software. Least significant difference (LSD) test at 5% probability level was applied to compare the treatment means.

Results

Evaluation of Onion Germplasm for Resistance and Yield against Purple Blotch Disease

The results regarding screening trial showed that no variety was found immune against purple blotch disease during the both experimental years (2014–2015). However, during 2014 five varieties viz. Phulkara, XP-Red, Ceylon, Sunset and TI-172 were found resistant against purple blotch disease with percent disease index (PDI) of 6.47, 7.45, 7.98, 8.12 and 9.02 respectively. The varieties namely Desi Red (11.22%), Early Red (12.19%), Robina (14.56%), Dark Red (16.98%) and Mirpukhas (17.66%) along with their respective disease index values came under the moderately resistant category of disease rating scale. Moreover, the varietal response of VRIO-6 (21.41%), VRIO-1 (28.73%), VRIO-4 (30.87%), Red Nasik (34.47%) and Desi Black (37.25%) was moderately susceptible against the disease. However, the higher PDI values of varieties (VRIO-9: 41.20%), (Pak-10321: 43.87%), (Fsd Red: 48.66%), (Pusa Red: 53.46%) and (Red Imposta: 56.36%) made them susceptible against the purple blotch disease. Furthermore, among the screened varieties (VRIO-3, VRIO-5, VRIO-8, VRIO-7 and VRIO-2) demonstrated highly susceptible nature against the disease with PDI of 63.47, 66.85, 68.69, 73.49 and 75.18%, respectively (Table 1).

The results of the 2nd year (2015) experiment revealed that all the tested varieties were consistent in their response (resistant, moderately resistant, susceptible and highly susceptible) to 1st year trial against the purple blotch disease. However, an increased percent disease index was observed in all the tested varieties during 2nd year of the experiment as compared to the 1st one.

During the first-year resistant varieties showed high yield as compare to moderately resistant, moderately susceptible, susceptible and highly susceptible varieties. Decreasing trend in the yield response was observed in the second year due to increase in PDI. During the first year, Phulkara exhibited maximum response (32.67 t/h) regarding yield and VRIO-2 showed minimum yield (7.68 t/h) while Phulkara express 30.67 t/h yield and VIRO-2 showed lower yield (6.67 t/h) during the second year.

Table 1: Response of onion varieties against purple blotch under field conditions during 2014–2015

Variety	2014 PDI (%)			2015 PDI (%)		
	PB	Reaction	TY(t/h)	PB	Reaction	TY(t/h)
Phulkara	6.47 o	R	32.67 a	7.84 o	R	30.67 a
XP-Red	7.45 o	R	32.47 ab	8.11 o	R	30.45 a
Ceylon	7.98 no	R	32.25 ab	8.61 no	R	30.07 ab
Sunset	8.12 no	R	32.18 a-c	9.21 no	R	30.00 ab
TI-172	9.02 m-o	R	31.44 a-c	9.69 m-o	R	29.82 ab
Desi Red	11.22 l-n	MR	29.22 a-d	12.05mn	MR	28.23 a-c
Early Red	12.19 lm	MR	28.55 b-d	13.49 lm	MR	27.64 bc
Robina	14.56 kl	MR	28.25 c-e	16.38 kl	MR	27.20 c
Dark Red	16.98 k	MR	27.44 de	18.25 k	MR	26.92 c
Mirpurkhas	17.66 k	MR	24.55 ef	19.79 jk	MR	23.25 d
VRIO-6	21.41 j	MS	22.65 fg	23.35 j	MS	21.77 de
VRIO-1	28.73 i	MS	21.12 fg	28.73 i	MS	20.52 ef
VRIO-4	30.87 hi	MS	21.56 fg	32.40 i	MS	20.19 ef
Red Nasik	34.47 gh	MS	20.65 fg	36.51 h	MS	19.58 ef
Desi Black	37.25 g	MS	20.24 g	39.64 gh	MS	19.04 f
VRIO-9	41.20 f	S	11.66 h	41.81 g	S	10.00 g
Pak-10321	43.87 f	S	10.97 hi	45.62 f	S	9.76 gh
Fsd Red	48.66 e	S	10.75 hi	50.38 e	S	9.56 g-i
Pusa Red	53.46 d	S	10.55 hi	55.37 d	S	9.23 g-i
Red Imposta	56.36 d	S	9.25 hi	58.25 d	S	8.09 g-j
VRIO-3	63.47 c	HS	8.74 hi	66.00 c	HS	7.62 g-j
VRIO-5	66.85 bc	HS	8.52 hi	68.90 bc	HS	7.50 g-j
VRIO-8	68.69 b	HS	8.38 hi	70.53 b	HS	7.34 h-j
VRIO-7	73.49 a	HS	8.18 hi	75.43 a	HS	7.06 ij
VRIO-2	75.18 a	HS	7.68 i	77.21 a	HS	6.67 j
LSD ($p \leq 0.05$)	3.70		3.97	3.80		2.53
SE ±	1.84		1.97	1.89		1.25

Means followed by same letters within a column are not significantly different at $p \leq 0.05$

Minerals and Proximate Analysis for Two Years

In the present study, proximate and minerals mean contents of analyzed leaf samples during 2014–15 are given in Table 2 on the basis of dry weight. The amount of K, P and Ca were 208 mg, 43 mg and 37 mg respectively for purple blotch resistant (Phulkara) leaves while quantity of these minerals was 138 mg, 36 mg and 21 mg respectively in purple blotch susceptible (VRIO-2) leaves. During second year potassium, phosphorus and calcium contents were 213.16 mg, 45.44 mg and 40.35 mg respectively for purple blotch resistant leaves while in purple blotch susceptible leaves quantity of these minerals was 135 mg, 33 mg and 19 mg respectively. Similarly, the concentrations of Mg, Na, Zn and Fe in in the resistant onion leaf samples were 25 mg, 9.23 mg, 2.2 mg and 0.36 mg respectively compared with the 18.7 mg, 5 mg, 1.77 mg and 0.18 mg respectively in purple blotch susceptible onion leaves. During second year magnesium, sodium, zinc and iron contents were 27.22 mg, 11.89 mg, 2.65 mg and 0.41 mg respectively as compared with 16.93 mg, 3.42 mg, 1.68 mg and 0.15 mg respectively in purple blotch susceptible onion leaves. Mineral contents were higher significantly ($p \leq 0.05$) in resistant onion leaves as compared to susceptible leaves in both years.

The contents of ash (5.06%), fat (3.33%), crude protein (8.87%) and fiber (3.16%) were high significantly ($p \leq 0.05$) in purple blotch resistant leaves while 2.96%, 1.23, 3.89 and 2.16% respectively in purple blotch susceptible leaves. During second year ash (5.13%), fat (3.83%), crude protein (9.53%) and fiber (3.35%) were high significantly ($p \leq 0.05$) in purple blotch resistant leaves while 2.98, 1.25, 4.37 and 2.37%, respectively in purple blotch susceptible leaves. Carbohydrates (82%) and moisture (93.2%) contents were higher significantly ($p \leq 0.05$) in purple blotch susceptible leaves whereas 75.8 and 84.7% respectively in purple blotch resistant leaves. Carbohydrates (84.33%) and moisture (95.25%) contents were higher significantly ($p \leq$

Table 2: Mineral and proximate contents of onion leaf as influence of purple blotch during 2014–15

	2014				2015			
	Resistant leaf	Susceptible leaf	SE	LSD	Resistant leaf	Susceptible leaf	SE	LSD
Minerals (mg/100 g)								
Potassium	208 a	138 b	1.30	3.60	213.16 a	135.46 b	1.56	4.33
Phosphorus	43 a	36 b	1.29	3.58	45.44 a	33.87 b	1.68	4.68
Calcium	37 a	21.0 b	0.81	2.26	40.35 a	19.21 b	1.63	4.52
Magnesium	25 a	18.7 b	0.87	2.42	27.22 a	16.93 b	1.26	3.51
Sodium	9.23 a	5.0 b	0.57	1.59	11.89 a	3.42 b	0.93	2.60
Zinc	2.2 a	1.9 b	0.12	0.35	2.65 a	1.68 b	0.16	0.44
Iron	0.36 a	0.18 b	0.02	0.07	0.41 a	0.15 b	0.02	0.06
Proximates (mg/100 g)								
Ash	5.06 a	2.96 b	0.18	0.50	5.13 a	2.98 b	0.01	0.05
Fat	3.33 a	1.23 b	0.37	1.04	3.83 a	1.25 b	0.09	0.26
Carbohydrate	75.8 b	82 a	1.30	3.61	76.90 b	84.33 a	1.28	3.57
Moisture	84.7 b	93.2 a	1.10	3.05	86.45 b	95.25 a	1.31	3.66
Fiber	3.16 a	2.16 b	0.23	0.65	3.35 a	2.37 b	0.02	0.05
Crude Protein	8.87 a	3.89 b	0.10	0.28	9.53 a	4.37 b	0.27	0.76

Means followed by same letters within a row are not significantly different at $p \leq 0.05$

0.05) in purple blotch susceptible leaves during second year whereas 76.90 and 86.45% respectively in resistant leaves.

Discussion

Purple blotch inflicts severe damage to aerial parts of the plant and lower the yield to a great extent. Susceptible genotype of onion and favourable environmental conditions facilitate the pathogen to cause epidemic. Under such scenario the best possible and long lasting way to protect a crop from the pathogen (*A. porri*) is to use the resistant varieties. Though the foremost probable solution of the problem is the development of resistant variety by presenting the resistant genes into the onion cultivar, but it is a time taking procedure. Therefore, screening of available cultivars is the short term and easy way to sort out the resistant varieties. Keeping in view the above points, in the present study, twenty five varieties of onion were examined against purple blotch of onion under field conditions for two years (2014 and 2015). Results revealed that not a single variety was found immune against purple blotch disease. Phulkara showed resistance response whereas VRIO-2 exhibited highly susceptible response against the disease. Yield showed negative response as disease became severe during both years. Maximum yield was observed in case of Phulkara (Resistant) and minimum yield was assessed in VRIO-2 (Highly susceptible). The results were also in line with the findings of Behera *et al.* (2013) who evaluated twenty two varieties against purple blotch of onion under field condition and found no variety was immune to disease. However, only one variety *viz*., VG-18 is the best among all the tested cultivars which displayed resistant response to purple blotch while its comparative yield (288.18 q/ha) also remained at top. Our results were further supported by Agarwal and Tiwari (2013) who evaluated 21 garlic cultivars against purple blotch under natural conditions and found significantly different response of each cultivar against purple blotch. Nine genotypes showed resistant response, five were moderately resistance, four were moderately susceptible and three cultivars showed susceptible response against purple blotch. Genotype PGS-313 exhibited maximum yield (199.6 quintal/ha) followed by PGS-99-2 (154.9 quintal/ha). Similarly, Haq *et al.* (2014) screened 22 onion varieties against purple blotch disease and found no immune variety. However, during their experiment variety Phulkara showed resistant response while VRIO-2 was found highly susceptible against the disease. Results further supported by Pandey *et al.* (2000) who examined and screened 35 different genotypes of garlic and described the PDI value from 5.4 to 10.0% among G-1, G-323 and G-282. However, four varieties of garlic had PDI value 84.3 to 96.8% showing their high susceptibility to disease. Decrease in yield and weight of bulb during 2^{nd} year was due to the heavy attack of purple blotch on leaves due to which leaf area index reduced.

Results of the present study exhibited that mineral and proximate contents of purple blotch susceptible leaves (VRIO-2) were lower as compared to resistant leaves (Phulkara). This may due to the fact that infection due to *A. porri* significantly reduced the nutrient level in leaves of onion. Decreased level of proximate and mineral contents was an evidence that *A. porri* utilized these nutrients during infection process as described by Shehu and Aliero (2010). Moreover, the present findings also showed that carbohydrate and moisture contents of susceptible leaves (VRIO-2) were more as compared to disease resistant leaves (Phulkara). These results were also in line with the findings of Shehu and Aliero (2010) who stated that increase in moisture contents in purple blotch susceptible leaves could be attributed to maceration of cell wall pectin and cellulose components by *A. porri* during invasion and leaf tissue infection. High carbohydrate contents in purple blotch susceptible leaves might be due to reducing sugar accumulation during pathogenesis or due to fungal lipolytic activities or oil metabolism in tissues of leaf. It may also be due to fat conversion into carbohydrates. High carbohydrate content correlated with reduction in total oil level. Ataga and Ota-Ibe (2006) found consistent reduction in use of oil as a source of carbon with increased ether free extract in some fungal pathogens. Mba and Akueshi (2001) investigated the fat content of diseased seed and found reduction in fat content to microbial enzymatic catalysis and metabolism of fat. The present study reveals that infection caused by *A. porri* significantly minimize the nutrition level of onion leaf. Nutritional properties of leaves can be enhanced by proper and careful handling before and after harvesting. Dark green, disease free and healthy (resistant) leaves have more nutrients as compared to diseased purple green (susceptible) leaves.

From the above findings of screening, the assessed resistant varieties can be used in various breeding techniques as a base of resistance against purple blotch. Furthermore, the resistant varieties with all agronomic attributes can also be introduced throughout the country at commercial level.

Conclusion

Resistant cultivar showed positive response against disease as compared to susceptible cultivar reflected in term of mineral and proximate contents except moisture and carbohydrate contents. Moderately resistant varieties lines of onion identified through screening in the present study might be used in future breeding programs for evolving resistant commercial cultivars which could be released directly as commercial cultivar provided that other desirable agronomic characters were incorporated. Quantitative and qualitative properties of onion may also be enhanced by avoiding the *A. porri* through cultivation of resistant varieties.

Acknowledgements

The research team is highly thankful to Higher Education Commission, Pakistan for financial support as Indigenous Scholarship to the first author.

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(Received 06 July 2018; Accepted 30 August 2018)