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PRODUCTIVE AND QUALITATIVE EVALUATION OF ONION CULTIVARS UNDER AGRO-CLIMATIC CONDITIONS OF FAISALABAD

Salman Mushtaq[1], Muhammad Amjad[1], Khurram Ziaf[1,*], Kaiser Latif Cheema[2], Muhammad Ammar Raza[1] and Osama Bin Abdul Hafeez[1]

[1]Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan;
[2] Vegetable Research Institute, Ayub Agricultural Research Institute, Faisalabad, Pakistan
[*]Corresponding author's email: khurramziaf@uaf.edu.pk; kziaf78@yahoo.com

Onion varieties are very specific in their photoperiod and vernalization requirements and therefore vary for yield, yield related traits and bolting in a specific agro-climate. Therefore, performance of nineteen onion varieties for these traits was evaluated at Vegetable Research Institute, Faisalabad. The maximum bolting percentage was recorded in Desi Red (46.67%) that indicates less vernalization requirement of this variety while it was the minimum in Faisal Red and VRIO-6 (13.33%). The cultivar Phulkara produced larger size bulbs (73.22 mm diameter) as well as highest yield (21.90 t ha^{-1}) and bulb to neck diameter ratio (6.75). Similarly, minimum weight loss during curing was observed in Desi Red (4.64%), Pusa Red (4.76%) and Phulkara (4.83%), indicating higher dry matter contents while maximum weight loss (6%) was recorded in VRIO-6. Overall results revealed that both Phulkara and Desi Red are excellent for processing while Dark Red for cooking purpose under agro-climatic conditions of Faisalabad.

Keywords: *Allium cepa*, bolting, bulb diameter, neck diameter, curing

INTRODUCTION

Onion *(Allium cepa* L.) belongs to the family Amaryllidiaceae is one of the most important vegetable crop of Pakistan. It contains carbohydrate, protein, vitamin A, thiamine, riboflavin, niacin, ascorbic acid (Hanen *et al*., 2012), beta-carotene and lachrymatic compounds having antioxidant activity that helps to fight against cancer and chronic diseases (Karadeniz *et al*., 2005; Jorjandi *et al*., 2009). The green leaves, immature and mature bulbs are eaten raw in the form of salad or used in preparation of staple dishes (Fidan and Koc, 2001). The annual world production of onion is about 55 million tonnes and Pakistan ranked 8th in onion production with an area of 147.6 thousand hectares and production of 1939.6 thousand tonnes (FAO, 2011). Lack of quality seed, insect/pest and disease attack, inadequate availability of water and labor, poor quality of water and other factors are responsible for low yield of onion in Pakistan (GOP, 2010).

Genetic makeup and environment are the factors which depict the performance of a variety by affecting all important traits (Brewster, 1994; Khan *et al*., 2001). Response of a variety varies under different agro-ecological conditions and several varieties of the same species behave different even grown under same environment. Bolting (formation of seed stalk followed by the initiation of flowering) is a highly undesirable character for bulb crop. Temperature and photoperiod are considered to be the main factors for bolt initiation in onion (Diaz-Perez *et al*., 2003) and different varieties have different bolting percentage in a specific agro-climatic condition. Storage is essential at the time of glut in market to increase availability of onion over a period of months. Moreover, excess of onion crop at the time of glut can be dehydrated but all varieties are not suitable for this purpose. Normally, varieties for dehydration should have less water contents and higher dry matter (17-21%) (Brewster, 2008). During storage, bulb to neck diameter ratio (B/N) should be given more importance as it directly affects the weight loss during curing process and also determines the storage potential of a particular onion variety as smaller necks provide lesser sized entry point for pathogens which cause post-harvest decay (Maw and Mullinix, 2005). Many lines of onion were developed by the Vegetable Research Institute, Faisalabad (VRIO 1 to7) but their performance was not evaluated in agro-climatic conditions of Faisalabad. There is dire need to characterize different onion varieties on the basis of their vernalization requirement to avoid pre-mature bolting as well as to identify varieties suitable for processing and fresh consumption. Therefore, present study was planned to compare onion varieties for yield and yield related traits under agro-climatic conditions of Faisalabad.

MATERIALS AND METHODS

A field experiment was conducted to assess the response of different onion varieties at the experimental area of Vegetable Research Institute, Ayub Agricultural Research Institute, Faisalabad, Pakistan during 2010-11. Experiment was laid out in a Randomized Complete Block Design with

three replications. Nursery of nineteen cultivars viz. Robina, Mirpur Khas, Early Red, Desi Large, Pusa Red, Desi Red, Pk- 10321, Red Imposta, Red Nasic, Faisal Red, Phulkara, Dark Red, VRIO-1, VRIO-2, VRIO-3, VRIO-4, VRIO-5, VRIO-6 and VRIO-7 was sown during the first week of October. Seedlings were transplanted in the last week of November on both sides of the ridge about 70 cm apart keeping plant to plant distance at 10 cm. Well decomposed farm yard manure at the rate of 20 tons per hectare was applied at the time of land preparation. Chemical fertilizers were applied at the recommended dose of 110:75:60 kg ha^{-1} of NPK. All phosphorus, potassium and half of the nitrogen was applied at the time of final land preparation; whereas, the other half nitrogen dose was applied 30 days after transplanting. All recommended agronomic and plant protection measures were followed during the crop season. Data on bolting percentage, bulb weight before and after curing, weight loss during curing (%), bulb and neck diameter, number of rings per bulb, bulb to neck diameter ratio (B/N) and yield were collected. All data were analyzed statistically using the computer software MSTAT-C and Duncan's Multiple Range test (DMR) at 5% probability level was used to compare the treatment means (Steel *et al*., 1997). Monthly meteorological data is given in Fig. 1.

RESULTS AND DISCUSSION

Growth and Yield Parameters: Bolting is a problem of physiological nature and is undesirable for better bulb production as it causes mobilization of reserves towards the developing inflorescence, at the expense of bulb development. Such bulbs cannot be marketed because of hard center of the bulb (Rabinowitch, 1990). The data regarding bolting percentage depicted significant diversity among onion cultivars (Table 1) and it was maximum in Desi Red (46.67%). However, minimum bolting percentage (13.33%) was observed in both Faisal Red and in VRIO-6. This variation in bolting percentage between onion cultivars could be attributed to differences in their genetic makeup. Bolting occurs only when plant has certain number of leaves at the time of exposure to low temperature for vernalization (Brewster, 1985); so further studies are required to find out the effect of late sowing on various varieties notorious for bolting.

Bulb weight is very important parameter that contributes towards the yield and also determines the suitability of an onion variety for salad purpose. All onion cultivars showed significant variation for bulb weight before curing (Table 1). The cultivar Phulkara (156.92 g) and Dark Red (154.33 g) yielded the highest bulb weight before curing while it was lowest (66.65 g) in VRIO-7. Similarly, bulb weight after curing was maximum in Phulkara (148.43 g) and Dark Red (145.88 g) while it was minimum (62.63 g) in VIRO-7. Results relating to change in onion bulb weight after curing were similar to that of Bahnasawy (2000) who found reduction of 4% in the onion bulb weight. The change in bulb weight was due to genetic differences among the genotypes and their adaptability to prevailing environmental conditions as also observed by Naz and Amjad (2004).

Out of nineteen onion varieties, maximum weight loss (6.35%) was observed in Pk-10321 followed by VRIO-6 (6.33%) and both these cultivars behaved statistically alike. However, the minimum weight loss (4.64%) was recorded in Desi Red. These results revealed that all lines of VRIO, Early Red, Robina, Faisal Red, Red Imposta, Pk-10321, Desi Large, Dark Red and Mirpur Khas have more water and less dry matter contents are fit for fresh consumption (cooked and salad purpose). On the other hand, Phulkara, Desi Red, Pusa Red and Red Nasic are suitable for processing because of their low moisture contents. Moisture loss from onion bulbs during curing is found to be directly correlated with bulk density of onion (Maw and Mullinix, 2005). Fleshy bulbs showed more weight loss as compared to bulbs having less water contents (Abd-el-Rahman and Ebeaid, 2009). Onion varieties containing high dry matter contents loose less moisture and thus are suitable for storage (Currah and Proctor, 1990).

Bulb diameter is an important trait that predicts its marketability and usage of crop. A perusal of data showed largest bulb diameter (73.22 mm) for Phulkara followed by Mirpur Khas (61.96 mm), Dark Red (61.52 mm) and Desi Red (61.17 mm) respectively while it was on the lower side (52.00 mm) in VRIO-6. Lines VRIO-7, VRIO-3 and VRIO-4 were found statistically alike for bulb diameter. Larger bulb size of Phulkara, Desi Red and Dark Red make these varieties fit for salad purpose as rings of large size can be prepared. Differences in bulb diameter are mainly due to variation in the genetic makeup of varieties as was also reported by Yang *et al*. (2004) but is also affected by environment and management practices.

Neck diameter is an important parameter that determines the storage potential of onion. Thin necked varieties of onion have more storage life as compared to the thick necked onion varieties (Gautam *et al*., 2006). Mirpur Khas and Desi Red exhibited the maximum neck diameter 13.80 mm and 13.67 mm respectively while, minimum neck diameter (8.70 mm) was recorded in Red Nasic. Generally, neck thickness indicates the failure of crop to complete the bulbing process and such bulbs do not become dormant. This problem usually arises because of slow growth of plants or because of short growing season (Brewster, 1997). To cope up this problem, further studies are needed to evaluate sowing time of varieties with thick necks.

Bulb to Neck ratio is the ratio between the bulb and neck diameter. The importance of this trait is to get clear picture whether thickness is of physiological nature or due to increased diameter of the bulb. Data regarding B/N ratio showed significant differences between onion cultivars with

Table 1. Response of different onion varieties to curing under agro-climatic conditions of Faisalabad

Onion Varieties	Bolting percentage	Bulb weight before curing (g)	Bulb weight after curing (g)	Percent wt. loss during curing
Phulkara	26.67 bcd	155.92 a	148.43 a	4.83 bcd
Mirpur Khas	40.00 ab	101.69 bc	96.06 bc	5.553 abcd
Dark Red	27.67 bcd	154.33 a	145.88 a	5.46 abcd
Desi Large	26.67 bcd	76.79 d	70.78 d	5.64 abcd
Desi Red	46.67 a	105.39 b	100.41 b	4.64 d
Pusa Red	33.33 abc	88.38 bcd	84.21 bcd	4.76 cd
Pk-10321	40.00 ab	84.93 bcd	79.54 bcd	6.35 a
Red Imposta	20.00 cd	85.98 bcd	81.62 bcd	5.22 abcd
Red Nasic	40.00 ab	86.35 bcd	81.81 bcd	4.88 bcd
Faisal Red	13.33 d	86.88 bcd	82.52 bcd	5.22 abcd
Robina	33.33 abc	82.78 bcd	77.16 cd	5.27 abcd
Early Red	33.33 abc	82.78 bcd	78.30 bcd	5.43 abcd
VRIO-1	40.00 ab	84.99 bcd	80.42 abcd	5.36 abcd
VRIO-2	40.00 ab	79.15 cd	74.60 cd	5.62 abcd
VRIO-3	33.33 abc	79.37 cd	74.70 cd	5.7 abcd
VRIO-4	33.33 abc	75.25 d	71.17 bcd	5.34 abcd
VRIO-5	20.00 cd	82.99 bcd	78.16 bcd	5.82 abcd
VRIO-6	13.33 d	72.28 d	67.70 d	6.33 a
VRIO-7	20.00 cd	66.65 d	62.63 d	6 abc
LSD value	15.82	24.23	23.15	1.26

Table 2. Yield and yield related traits of different onion cultivars under agro-climatic conditions of Faisalabad

Onion Varieties	Bulb diameter (mm)	Neck diameter (mm)	B/N ratio	No. of rings/ bulb	Yield (ton ha^{-1})
Phulkara	73.22 a	10.29 bcde	6.75 a	6.77 cdef	21.90 a
Mirpur khas	61.96 b	13.80 a	4.51 cde	8.20 a	18.11 cd
Dark Red	61.52 bc	9.86 de	6.25 ab	7.57 abcd	19.52 b
Desi Large	53.93 gh	11.98 abcd	4.52 cde	7.57 abcd	19.52 b
Desi Red	61.17 bcd	13.67 a	4.49 cde	7.60 abcd	18.57 c
Pusa Red	59.59 bcde	11.60 abcd	5.14 cd	7.83 ab	19.52 b
Pk-10321	56.60 bcde	11.19 abcde	5.11 cd	7.53 abcde	15.24 f
Red Imposta	58.42 cdefgh	11.58 abcd	5.05 cde	7.10 bcdef	12.86 i
Red Nasic	53.81 gh	8.70 e	6.22 ab	7.13 bcde	15.24 f
Faisal Red	60.68 bcd	12.14 abcd	5.13 cd	7.77 abc	16.67 e
Robina	58.89 bcdef	12.51 abc	4.72 cde	7.23 abcde	14.76 fg
Early Red	56.39 defgh	10.67 bcd	5.34 bc	6.53 ef	13.9 h
VRIO-1	55.71 efgh	11.38 abcd	4.97 cde	7.53 abcde	11.43 j
VRIO-2	54.15 fgh	11.94 abcd	4.56 cde	6.70 def	16.19 e
VRIO-3	52.19 h	12.94 ab	4.09 e	6.83 bcdef	17.71 d
VRIO-4	55.59 h	12.81 ab	4.43 cde	7.07 bcdef	15.24 f
VRIO-5	58.32 bcdefg	12.42 abcd	4.71 cde	6.67 def	14.76 fg
VRIO-6	52.00 h	12.30 abcd	4.27 de	7 bcdef	10.48 k
VRIO-7	52.10 h	9.94 cde	5.35 bc	6.1 f	14.29 gh
LSD value	4.95	2.67	1.04	1.03	0.5653

maximum B/N ratio (6.75) in Phulkara which was at par with Dark Red (6.25) and Red Nasic (6.22). However, it was minimum (4.09) in VRIO-3 (Table 2). It has been reported that in thick necked onions, bulb size was also large, as bulb size appeared to follow the pattern of neck size (Lancaster *et al*., 1996) but correlation analysis revealed non-significant relation between neck thickness and bulb diameter (Data not shown).

Number of rings per bulb is a selection criterion for salad onions because varieties with more number of rings per bulb are preferred over varieties with less number of rings per bulb for salad purpose. Onion cultivars showed significant differences with respect to number of rings per bulb (Table 2). Results showed that Mirpur Khas had maximum number of rings per bulb (8.20) followed by 7.83 in Pusa Red. Minimum number of rings per bulb was observed in VRIO-7 (6.1). Our findings are contradicted from the work of Cheema *et al*. (2003a) that number of rings per bulb among various onion cultivars was non-significant.

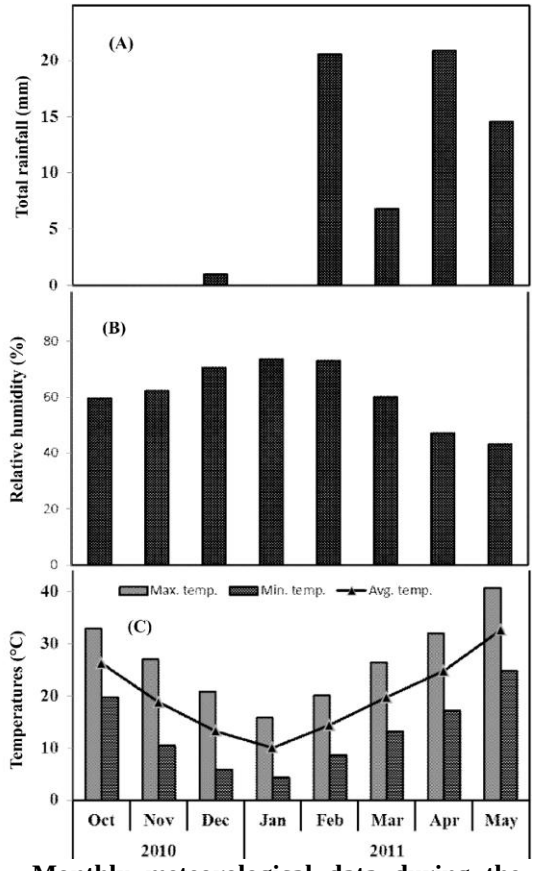

Fig.1. Monthly meteorological data during the crop season 2010-11 (A) total rainfall (B) average relative humidity and (C) maximum, minimum and average temperatures

Final bulb yield of onion crop is an expression of combined effect of various yield components. All onion cultivars showed significant variation with respect to bulb yield ha^{-1} (Table 2). The highest yield (21.90 t ha^{-1}) was recorded in Phulkara while it was lowest (10.48 t ha^{-1}) in VRIO-6. The growth and yield components of onion cultivars were significantly different for varieties (Shah *et al.,* 2012). This may be due to superiority of genotype and suitability to the local conditions of Faisalabad (Naz and Amjad, 2004). Our findings are in complete agreement with that of Cheema *et al.* (2003b) and (2003c) who reported difference in yield potential of different varieties of onion.

Conclusion: Present results revealed significant diversity in different onion cultivars. Both Phulkara and Dark Red performed better under the agro-climatic conditions of Faisalabad than other commercial onion cultivars and locally developed lines; so these two cultivars are recommended for cultivation.

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