DOI : 10.5958/0974-0112.2017.00016.0

Indian J. Hort. 74(1), March 2017: 67-70

Variation in various antioxidant biochemicals and morphological traits in *kharif* onion

Sabina Islam*, Neelam Patel, Anil Khar, Arpita Srivastava, Pritam Kalia and Yogesh Khade*****

Division of Vegetable Science, ICAR-Indian Agricultural Research Institute, New Delhi 110 012

ABSTRACT

Eight onion genotypes with different scale colour were studied for yield, and related traits during rainy season. Non-significant differences for the morphological traits and significant differences for bulb quality traits and yield were observed. There was 2.08 and 1.44-fold difference between lowest and highest yielding genotypes for yield and TSS, respectively. Agrifound Dark Red was found superior for yield and total phenols content. Antioxidant activity, as measured by CUPRAC and FRAP, had 1.73- and 3.09-fold difference between highest and lowest performers and ranged between 1.70-2.95 µmol and 0.30-0.93 µmol Trolox/g FW, respectively. Bulb yield had positive association with total phenols content, but negative association with TSS, CUPRAC and FRAP values. No single variety/ selection were found consistently superior for all the traits.

Key words: Anti-oxidant activity, *kharif* onion, quality traits, yield.

INTRODUCTION

Onion (*Allium cepa* L.) occupies prime position in Indian vegetable production scenario contributing 11.9% (NHB, 10). Major onion crop is grown during *rabi* or winter season (60%) and rest is produced during *kharif* or monsoon season (20%) and late *kharif* or late monsoon season (20%). The growing season of *kharif* onion is marked by high temperature and high humidity, which hinders successful cultivation of *kharif* onion in north and north western plains of India due to paucity of suitable varieties. Bulb quality is affected by the climatic conditions. Higher soil temperature of around 34ºC has been reported to affect the growth of plant root system, TSS, sulphur allocation to the flavour biosynthetic pathways and pungency of the bulb adversely (Coolong and Randle, 4). Apart from yield, onions are also regarded as one of the major functional food due to presence of three families of compounds-fructans, flavonoids and organosulfur (Manach *et al*., 9). There are numerous reports on evaluation of yield and functional value of different onion genotypes grown during winter season (Cheng *et al*., 3; Dalamu *et al*., 5; Lee *et al*., 8) but little information is available on evaluation of *kharif* onion genotypes for bulb quality parameters for functional food value (TSS, total phenolics, antioxidants). In this study, our objective was to study the variation in different morphological traits, TSS, total phenolics and antioxidant capacity: FRAP and CUPRAC and study the association between yield and bulb quality parameters for further progress in breeding *kharif* onion genotypes.

MATERIALS AND METHODS

Eight promising genotypes of four different scale colours; Sel. 106 and Sel. 131 (white); Sel. 102 and Sel. 121(Light red); Sel. 157 (Red); Sel. 383, Sel. 402 and Agrifound Dark Red (ADR, Dark Red) were used in the present study. Bulb sets of 1.5-2.0 cm diameter were planted in August under drip irrigation in raised beds in three replicates in randomized block design at IARI, New Delhi (28°38´42˝ N, 77°09´17˝ E; elevation ~ 725 ft a.m.s.l.). Bulbs were harvested in the month of November and properly cured under ambient condition for 7 days. Plant height, pseudostem height and 4th leaf length was measured on 20 plants in each replication excluding the border row using standard metre scale and number of leaves were counted simultaneously excluding the dried leaves 15 days before harvest. Yield per ha was calculated based on per plot yield and neck thickness, bulb equatorial and polar diameter was measured using digital Vernier calipers. For quality analysis, from each cultivar, three replicates of 9 bulbs were used for analysis. The bulbs were skinned and 1/4th quarter from periphery to center of each bulb were cut and pooled for analysis for single replicate. Total soluble solids were measured using a digital refractometer (Atago, Model Pal-1). Total phenolics content was estimated spectrophotometrically using Folin-Ciocalteu reagent, as described by Singleton *et al*. (11). The amount of total phenolics was expressed as mg gallic acid equivalents (GAE)/100 g fresh weight. Antioxidant activity (AOX) as expressed by

*Corresponding author's E-mail: tokumkum@gmail.com
**Water Technology Centre, ICAR-IARI, New Delhi
***Directorate of Onion and garlic Research, Rajgurunagar, Pune, Maharashtra

Cupric Reducing Antioxidant Capacity (CUPRAC) was estimated following the method developed by Apak *et al*. (1). Results were expressed as μmol Trolox/g fresh weight. The Ferric Reducing Antioxidant Power (FRAP) assay for antioxidant activity was estimated following Benzie and Strain (2). Results were expressed as μmol Trolox/g fresh weight. Data were analyzed using SAS software 9.3. Genotype mean for different traits were compared through t-test (LSD) and relationship among yield and quality parameters were investigated using correlation analysis.

RESULTS AND DISCUSSION

The genotypes under study differed in the expression of different horticultural traits (Table 1). Longest plants and maximum number of leaves were exhibited by Sel. 102 followed by Sel. 106 and Agrifound Dark Red. Dark red coloured onion selections and variety (Sel. 402, Sel. 383 and Agrifound Dark Red, respectively) had the desired minimum neck thickness, while white coloured selection, Selection 106 had the maximum neck thickness. Greater neck thickness is associated with more water accumulation in the neck region forcing the growers of such varieties to dispose of the varieties at the earliest possible time as they cannot be stored. The length of fourth leaf was highest in Sel. 102 (Light red), Sel. 106 (white) and Sel. 402 (Dark red) while the lowest in Sel. 157 (Red). However, there was no significant difference across the varieties for these morphological traits. There was highly significant variation for bulb diameters (both polar and equatorial) with widest bulbs in Sel. 102, Sel. 131 and Agrifound Dark Red and the longest bulb in Sel. 131, Sel. 102 and Agrifound Dark Red. Highly significant difference for yield was also observed (Fig. 1).

In the present study, highly significant variation was noticed among genotypes for total soluble solids content. Sel. 402, a dark red coloured selection, though had lowest yield yet accumulated higher total soluble solids and it alone formed a class, while rest seven genotypes were categorized in different class. The genotype wise performance for TSS is presented in Fig. 1. High TSS genotypes are desired in white colour background as they are most suitable for drying and processing and no blackening or discoloration is noticed in the processed products. In the present experiment, white coloured genotypes were moderate performers. Dark red genotypes exhibited highest TSS, followed by white, light red and red. Phenol content in food offer a variety of health benefits to human because of their antioxidant nature. The Folin-Ciocalteu assay (F-C) or total

Table 1. Onion genotype, scale colour and their morphological traits mean and standard deviation.

Genotype	Scale colour	Plant height (cm)	No. of leaves	Neck thickness (mm)	Pseudostem height (cm)	4^{th} leaf length (cm)	Bulb equatorial dia. (mm)	Bulb polar dia. (mm)
Sel. 106	White	47.47 ± 5.3.7 ab	10.53 ± 0.61 a	10.22 ± 0.32 a	5.53 ± 0.77 a	39.60 ± 5.82 ab	47.41 ± 1.63 c	48.96 ± 4.16 c
Sel. 131	White	43.53 ± 1.36 b	10.07 ± 0.23 a	8.56 ± 0.29 abc	5.01 ± 0.59 a	34.87 ± 2.41 bc	51.13 ± 1.48 a	55.70 ± 1.75 a
Sel. 102	Light Red	53.13 ± 0.61 a	10.33 ± 0.31 a	10.00 ± 1.52 ab	4.76 ± 0.42 a	41.63 ±2.32 a	51.54 ± 0.78 a	53.65 ± 0.04 ab
Sel. 121	Light Red	46.87 ± 3.52 ab	9.33 ± 1.33 a	8.59 ± 1.76 abc	5.07 ± 0.25 a	35.02 ± 3.50 bc	46.85 ± 0.44 c	49.26 ± 3.04 c
Sel. 157	Red	45.33 ± 4.74 b	9.67 ± 0.83 a	9.22 ± 1.18 abc	4.86 ± 0.49 a	31.40 ± 2.25 c	48.96 ± 3.24 abc	51.76 ± 1.67 bc
Sel. 383	Dark Red	43.07 ± 2.84 b	8.60 ± 2.27 a	7.95 ± 0.53 bc	4.86 ± 0.66 a	36.07 ± 4.91 abc	46.49 ± 2.24 c	49.84 ± 3.22 c
Sel. 402	Dark Red	46.37 ± 4.33 b	9.60 ± 3.06 a	7.59 ± 0.52 c	4.69 ± 0.37 a	38.80 ± 6.81 ab	47.52 ± 0.78 bc	50.53 ± 1.65 bc
ADR	Dark Red	47.47 ± 2.40 ab	10.17 ± 0.15 a	7.68 ± 2.02 c	5.07 ± 0.85 a	37.60 ± 4.34 abc	50.50 ± 0.42 ab	53.64 ± 0.85 ab
$CD_{0.05}$	-	6.48	NS	NS	NS	NS	3.06	3.52

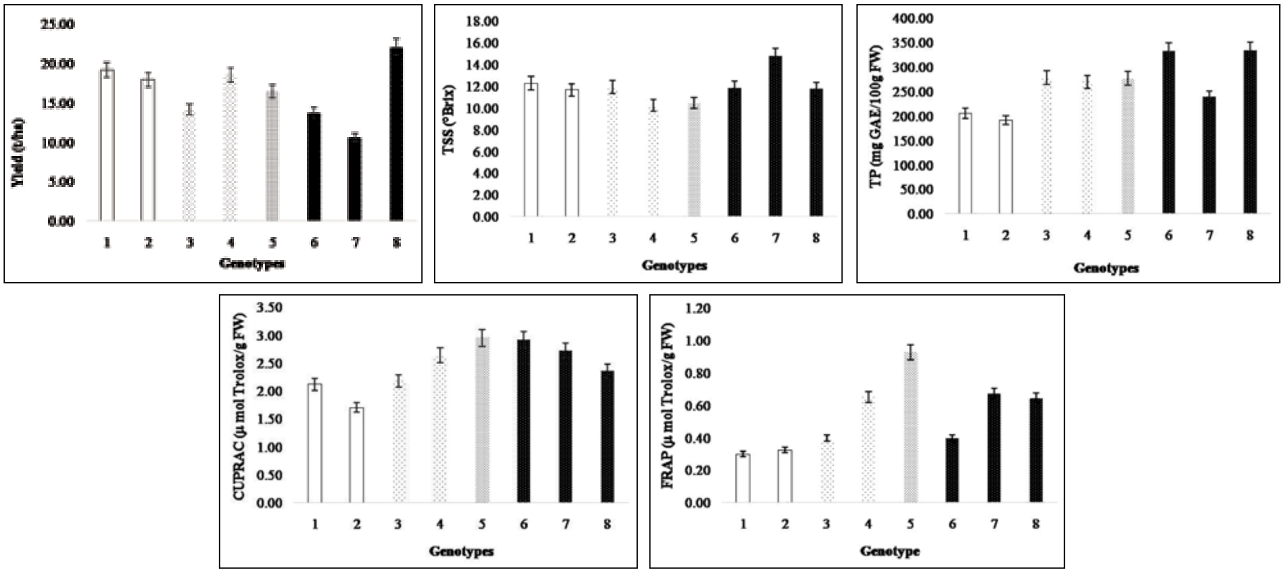

Fig. 1. Yield, TSS, total phenolics (TP), CUPRAC and FRAP assays in eight onion genotypes during *kharif* season.

(□) White scale colour. (□) Light red skin colour, (▦) Red skin colour and (■) Dark red skin colour. Vertical bar indicated standard error

phenols assay was used to identify superior *kharif* onion variety. It ranged from 191.35 mg GAE/100 g in Sel. 106 to 333.21 mg GAE/100 g in Sel. 383 with a 1.7-fold variation (Fig. 1). Growing onion during *kharif* (rainy) season of subtropical climate of India, accumulate higher amount of total phenols to beat the stress conditions. Dalamu *et al*. (5) observed a range from 60.1 to 1094.8 mg gallic acid equivalents/ kg for total phenolic content in onion genotypes grown in winter season. Varietal differences for total phenols as measured by F-C method has been reported by Cheng *et al*. (3) and Lee *et al*. (8). In the present study, there was an overall significant difference in TP ($P \leq 0.05$) among the cultivars. However, there was no significant difference between genotypes of the same colour group except Sel. 402, a dark red coloured line, which had lower average total phenols content than the mean of light red colored genotypes and it was statistically at par with white coloured Sel. 106. The dark red colour group had a distinct advantage over red, light red and white skin colour group. The findings suggest that onion genotypes should be analyzed over several growing seasons to breed phenol rich onion *kharif* onion varieties.

Antioxidant measurement is a good indicator for functional food value estimation of vegetables and fruits. In the present study, we used two *in-vitro* assays, namely, FRAP and CUPRAC. The antioxidant properties as estimated by FRAP and CUPRAC showed around 3.09- and 1.73-fold increase, respectively over the highest and the lowest performers (Fig. 1). CUPRAC measurement was highest in red coloured selection, Sel. 157 followed closely by dark red coloured selection, Sel. 383 and light red coloured selection Sel. 121. Much difference was observed for FRAP content. White coloured selection, Sel. 106, had the lowest FRAP content (0.300 µmol Trolox equivalent/g), while red coloured Sel. 157 had the highest (0.927 µmol Trolox equivalent/ g). Red colour group was found superior for antioxidant activity than dark red, light red and white colour group. Dalamu *et al*. (5) reported AOX in red genotype (expressed as µmoles trolox/g) ranges from 1.97 to 5.45 in ferric reducing antioxidant power and from 3.60 to 6.61 in cupric ion reducing capacity assays. Gökçe *et al*. (7) also reported lowest value of FRAP (5.3 µmol TE/g dw) in white scale colour genotypes.

The relationship among yield and bulb quality attributes was investigated by correlation analysis (Pearson) (Table 2). Yield exhibited positive association with bulb diameter and total phenols content and negative association with TSS, CUPRAC and FRAP. Dhotre *et al*. (6) reported positive correlation between yield and TSS. Equatorial and polar diameter had significant positive association among themselves, but negative association with TSS, total phenolics, CUPRAC and FRAP. Total phenols content had positive association with CUPRAC and FRAP and CUPRAC also had positive association with FRAP. Gökçe *et al*. (7) reported positive correlation between bulb width and soluble solids and total negative association between bulb length and soluble solids. There was positive correlation between bulb size

Table 2. Correlation coefficients (r) for yield, bulb diameters (equatorial and polar), TSS, total phenolics content (TP), CUPRAC and FRAP of onion genotypes in *kharif* season.

Trait	Yield	Bulb equatorial dia.	Bulb polar dia.	TSS	TP	CUPRAC
Bulb equatorial dia.	0.246^{NS}	1				
Bulb polar dia.	0.188^{NS}	0.935^{**}	1			
TSS	-0.582^{NS}	-0.086^{NS}	-0.059^{NS}	1		
TP	0.046^{NS}	-0.087^{NS}	-0.086^{NS}	-0.223^{NS}	1	
CUPRAC	-0.391^{NS}	-0.633^{NS}	-0.592^{NS}	-0.054^{NS}	0.602^{NS}	1
FRAP	-0.033^{NS}	-0.119^{NS}	-0.111^{NS}	-0.201^{NS}	0.350^{NS}	0.681^{NS}

and yield and negative correlation between yield and TSS, but positive correlation between yield and total phenols content under adverse growing conditions. Antioxidant activity as measured by CUPRAC and FRAP had negative correlation with yield and TSS, but positive correlation among themselves and total phenol content. Categorization on the basis of scale colour put white genotypes as superior for yield, though individually, red genotype (ADR) exhibited the highest yield. The dark red genotypes were better for functional food value under *kharif* season but individual variation was observed for all the traits.

REFERENCES

1. Apak, R. ,Güçlü, K., Ozyürek, M. and Karademir, S.E. 2004. Novel total antioxidant capacity index for dietary polyphenols and vitamins C and E, using their cupric ion reducing capability in the presence of Neocuproine: CUPRAC method. *J. Agric. Food Chem.* **52**: 7970-981. DOI: 10.1021/jf048741x.
2. Benzie, I.F. and Strain, J.J. 1996. The ferric reducing ability of plasma (FRAP) as a measure of "antioxidant power": The FRAP assay. *Anal. Biochem.* **239**: 70-76. DOI: 10.1006/abio.1996.0292.
3. Cheng, A., Chen, X., Jin, Q., Wang, W., Shi, J. and Liu, Y. 2013. Comparison of phenolic content and antioxidant capacity of red and yellow onions. *Czech J. Food Sci.* **31**: 501-08.
4. Coolong, T.W. and Randle, W.M. 2006. The influence of root zone temperature on growth and flavor precursors in *Allium cepa* L. *J. Hort. Sci. Biotech.* **81**: 199-204. DOI:10.1080/14620316.2006.11512050.
5. Dalamu, Kaur, C., Singh, M., Walia, S., Joshi, S. and Munshi, A.D. 2010. Variations in phenolics and antioxidants in Indian onions (*Allium cepa* L.): Genotype selection for breeding. *Nutr. Food Sci.* **40**: 16-19. DOI: http://dx.doi.org/10.1108/00346651011015863.
6. Dhotre, M., Allolli, T.B., Athani, S.I. and Halemani, L.C. 2010. Genetic variability, character association and path analysis studies in *Kharif* onion (*Allium cepa* var. *cepa* L.). *Asian J. Hort.* **5**: 143-46.
7. Gökçe, A.F., Kaya, C., Serçe, S. and Özgen, M. 2010. Effect of scale color on the antioxidant capacity of onions. *Scientia Hort.* **123**: 431-35. DOI:10.1016/j.scienta.2009.11.007.
8. Lee, E.J., Patil, B.S. and Yoo, K.S. 2015. Antioxidants of 15 onions with white, yellow, and red colors and their relationship with pungency, anthocyanin, and quercetin. *LWT – Food Sci. Tech.* **63**:108-114. DOI: 10.1016/j.lwt.2015.03.028.
9. Manach, C., Marand, C., Crespy, V., Demigne, C., Texier, O., Regerat, F. and Remesy, C. 1998. Quercetin is recovered in human plasma as conjugated derivatives which retain antioxidant properties. *FEBS Lett*. **26**: 331-36. DOI: 10.1016/S0014-5793(98)00367-6.
10. NHB Database - 2015. *Indian Horticulture Database*, National Horticulture Board, Gurugram GoI. 2014. xii + 286 p.
11. Singleton, V.L., Orthofer, R. and Lamuela-Raventos, R.M. 1999. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent. *Methods Enzymol.* **299**: 152-78.

Received : May, 2016; Revised : January, 2017;
Accepted : February, 2017