Quest Journals
Journal of Research in Agriculture and Animal Science
Volume 5 ~ Issue 2 (2018) pp:18-22
ISSN(Online) : 2321-9459
www.questjournals.org

Research Paper

Path and Correlation Analysis in Turkish Onion Accessions for Soluble Solid Contents

Fatih HANCI[1] and Ali Fuat GOKCE[2]
[1]*(Faculty of Agriculture, Erciyes University, Kayseri, Turkey)*
[2]*(Faculty of Agricultural Sciences and Technologies, Nigde Omer Halisdemir University, Turkey)*
Corresponding Author: Fatih HANCI

ABSTRACT: *In this paper, correlation and path coefficient analysis for bulb soluble solids content and its components were determined in fifty-six Turkish onion accessions. Correlation coefficient analysis revealed that the diameter of pseudostem and the length of the tallest leaf had a positive significant correlation with bulb weight. Also, the high negative correlation coefficient was observed for soluble solids content with the length of the tallest leaf and bulb weight. Path coefficient analysis revealed that the width of the neck of bulbs and the number of the epidermal ring in bulbs exhibited a positive direct effect on soluble solids content. In addition to these results, the maximum positive indirect effect on soluble solids content was the diameter of pseudostem through the diameter of bulb and length of pseudostem through the diameter of bulb. At the end of the study, it was be concluded that the selection of these traits can be contributed to efficiency for the breeding of the onion varieties.*

KEYWORDS: *Allium, Onion, breeding, path analysis*

Received 14 December, 2018; **A**ccepted 31 December, 2018 © The author(s) 2018. Published with open access at **www.questjournals.org**

I. INTRODUCTION

Onion (*Allium cepa* L.) is a diploid species with 2n = 16 chromosomes. It is a high degree cross-pollinated crop and belongs to the family *Amaryllidaceae*. *Alliums* are a diverse taxon encompassing nearly 500 species, including onion, leek, garlic, shallot etc. [1]. Bulbs of onion and other *Alliums* accumulate fructans, fructose polysaccharides formed by the cumulative addition of a fructosyl group to a sucrose molecule. These also operate as protectants against cold and drought stress [2]. Among varieties of bulb onions, dry matter content consists mostly of fiber, starch, and sugars. The dry matter content is an important quality factor determining bulb uses. High dry matter content has importance for dehydration and better storage quality in onion bulbs [3; 4]. Also, dry matter content indicates the pungency level which is an important factor affecting onion flavor [5].

A broad-sense heritability (estimates of 0.6–0.83) for bulb soluble solid content and significant correlation with other traits such as bulb size and pungency have been reported by different authors [6; 7; 8; 9; 10]. Mild, high-moisture (low solids) onions were found lower storage quality than pungent, low-moisture (high solids) onions by Jones and Bisson [11]. In accordance with this study, Owen et al., demonstrated that pungency onions have been determined as more susceptible to storage rots such as neck rot [12]. Schwimmer and Guadagni also found a medium correlation (r = 0.57) between total solids and pungency [13]. Warid (1952) reported high heritability (71%) and concluded that four to ten gene pairs and partial dominance of low soluble solid content were involved in his cross, studied in the greenhouse [14]. Opposite of this study, it was reported that the heritability of soluble solid content was high and that there was a negative genetic correlation between soluble solid content and bulb size [9]. Owen reported that cumulative gene action and a relatively small number of genes were involved in soluble solid contents inheritance [15]. Many dehydration onion breeding programs have also made substantial progress in raising dry matter through selection [16].

Correlation coefficients specify the magnitude of the relationship between or among characters. The correlation coefficients give details about interrelatedness among a character and its components, which is very helpful for the development of efficient selection strategy. Moreover, path coefficient analysis divides up the correlation coefficients into its direct and indirect effects, so that the contribution of each character to investigated character could be estimated for picking up proper traits for indirect selection [17]. This analysis technique was applied for different traits in earlier studies such us Hosamani et al. and Awale et. al for equatorial diameter [18; 19] Awale et. al. and Saini and Maurya for polar diameter [19; 20]; Hosamani et al and Saini and Maurya for neck thickness [18; 20]; Haydar et al., Awale et al and Saini and Maurya for plant height [21;19; 20].

Development of onion breeding lines for the high or low soluble solid content is made difficult by the complex nature of this character. Consequently, understanding the magnitude and type of relationship between soluble solid content and its components will considerably help in evaluating the allowance of different component traits towards high-quality onion varieties. The objective of this study was to assess the variability, analysis of path coefficient and correlation of seventeen characters for soluble solid content of onion genotypes.

II. MATERIAL AND METHODS

The fifty-six accessions which had been collected from different regions of Turkey were used as plant material. The seeds were sown in viols in February and the seedlings were transplanted 10-11 weeks after on the field. The seedlings were planted on raised beds in three rows per bed with a spacing of 15 cm between plants within each row and 30 cm between rows. All accessions were each planted in 1.2×1.6 m plot that consisted of at least fifty plants in Randomized Complete Block Design with two replications. All cultural practices were performed during vegetation period. These practices were repeated for two growing seasons (2015 and 2016). Data on different agronomic characters were recorded on individual plant basis from thirty plants randomly selected in each plot according to the International Union for the Protection of New Varieties of Plants (UPOV) (Table 1). The soluble solid contents (SSC, %) were determined with refractometer calibrated using distilled water. Numbers of seventeen traits for accessions were transformed into standardized units. The correlation and path coefficient was calculated according to Singh and Choudhary and Dewey and Lu respectively [22; 23]. The concept behind path analysis is that, Y: the soluble solids content (SSC) is the function of various components like X1, X2, X3 … X16 a path diagram is constructed using simple correlation coefficient among various characters under study. The direct path coefficient was obtained by regression analysis. The indirect effect of a particular character through other character was obtained by multiplication of direct effect and their correlation coefficient. All analysis was held using Microsoft Office Excel program.

III. RESULTS AND DISCUSSION

Analysis of variance revealed significant variation among the accessions for some traits indicating a wide variability in the collection. Destructive statistics for traits are shoed in Table 1. that presented a considerable variability in bulb weight, length of leaf and days between seed sowing and harvest.

Table 1. Basic statistics for seventeen traits of fifty six onion accessions.

Characters	Mean	SD	SE	Min.	Max.	Variation
Y - Soluble solids contents of bulb (%)	11,438	2,590	0,346	5,400	16,350	6,709
X1 -Bulb weight (g)	58,100	33,136	4,428	19,370	149,523	1.097,984
X2 -Diameter of pseudostem (mm)	10,378	2,874	0,384	5,569	17,918	8,260
X3 -Diameter of the tallest leaf (mm)	6,182	1,554	0,208	2,688	10,838	2,414
X4 -Length of the tallest leaf (cm)	37,134	6,218	0,831	22,613	58,012	38,658
X5 -Length of pseudostem (cm)	4,018	1,429	0,191	0,524	7,195	2,042
X6 -Number of leaves per pseudostem	7,275	1,520	0,203	3,725	10,177	2,309
X7 -Attitude of leaves (1-5 scale)	2,741	0,798	0,107	1,000	3,500	0,636
X8 -Waxiness of leaves (1-9 scale)	4,536	1,321	0,176	1,000	7,000	1,744
X9 -Diameter of bulb (cm)	4,498	1,017	0,136	2,552	6,808	1,034
X10 -Height of bulb (cm)	5,333	1,288	0,172	3,367	8,552	1,660
X11 -Width of neck of bulb (cm)	0,887	0,204	0,027	0,532	1,512	0,042
X12 -Diameter of root disc of bulb (cm)	1,008	0,274	0,037	0,549	2,239	0,075
X13 -Number of dry skin on bulb	5,339	0,996	0,133	4,000	8,000	0,992
X14 -Number of epidermal ring in bulb	5,509	0,592	0,079	4,500	7,500	0,350
X15 -Number of growing points in bulb	1,491	0,592	0,079	1,000	3,000	0,350
X16-Days until the harvest	262,196	6,520	0,871	242,500	288,500	42,515

SD: Standard deviation, SE: Standard error, Min.: Minimum value, Max.: Maximum value

Table 2. Correlation coefficients of different morphological characters of 56 onion accessions

	Y	*X1*	*X2*	*X3*	*X4*	*X5*	*X6*	*X7*	*X8*	*X9*	*X10*	*X11*	*X12*	*X13*	*X14*	*X15*
Y	1,000															
X1	**-0,445**	1,000														
X2	-0,334	**0,792**	1,000													
X3	-0,274	0,681	**0,757**	1,000												
X4	**-0,529**	**0,739**	0,542	0,528	1,000											
X5	-0,397	0,189	0,134	0,153	0,441	1,000										
X6	-0,165	0,585	**0,710**	0,414	0,369	0,046	1,000									
X7	***0,311***	-0,386	-0,181	-0,275	-0,429	-0,041	-0,130	1,000								
X8	***0,384***	**-0,473**	-0,320	-0,056	-0,421	-0,103	-0,235	0,281	1,000							
X9	-0,390	0,674	0,513	0,470	0,520	0,148	0,449	-0,397	-0,195	1,000						
X10	-0,002	0,281	0,157	0,116	0,276	0,046	0,042	-0,231	-0,192	0,007	1,000					
X11	-0,302	0,695	0,490	0,431	0,614	0,174	0,393	-0,417	-0,363	**0,756**	0,395	1,000				
X12	-0,108	0,517	0,455	0,338	0,288	-0,039	0,285	-0,244	-0,261	0,574	0,322	0,589	1,000			
X13	-0,054	0,405	0,313	0,329	0,262	0,019	0,257	-0,322	-0,072	0,319	0,307	0,359	0,317	1,000		
X14	0,073	0,335	0,376	0,123	0,240	0,007	0,386	-0,024	-0,134	0,229	0,130	0,181	0,178	0,226	1,000	
X15	0,076	0,197	0,036	0,233	0,112	-0,136	-0,026	-0,101	-0,098	0,140	0,124	0,234	0,132	0,098	0,000	1,000
X16	0,058	0,129	0,146	-0,081	0,024	-0,129	0,336	0,082	0,019	-0,009	0,007	0,105	0,013	0,089	0,212	0,059

* Abbreviations as in Table 1.

The estimates of correlation coefficients showed in Table 2. The interrelationship of bulb weight (X1) was significantly positive with the diameter of pseudostem (X2) and length of the tallest leaf (X4); diameter of pseudostem (X2) with the number of leaves per pseudostem (X6), the diameter of the tallest leaf (X4); and diameter of the bulb (X9) with the width of the neck of the bulb (X11). The high negative correlation coefficient was observed for soluble solids content with the length of the tallest leaf (X4) and bulb weight (X1). The attitude of leaves (X7) and waxiness of leaves (X9) had positive correlation with soluble solid contents in onion bulbs. Also, no relationship was being detected between soluble solid content and height of the bulb. The direct relationship between yield and vegetative growth represented by plant height and number of leaves/plant might be assigned to photosynthetic factors [24]. Soni et al. reported that of for neck thickness which furnished a significantly positive association with bulb yield, diameter and weight of bulb [25]. The findings are in consonance with the observations of these authors [24; 26; 27].

Path coefficient analysis of sixteen traits indicated that width of the neck of bulbs had the highest positive direct effect, followed number of the epidermal ring in bulbs on soluble solid content. The highest negative direct effect was observed for the diameter of the bulb (Figure 1).

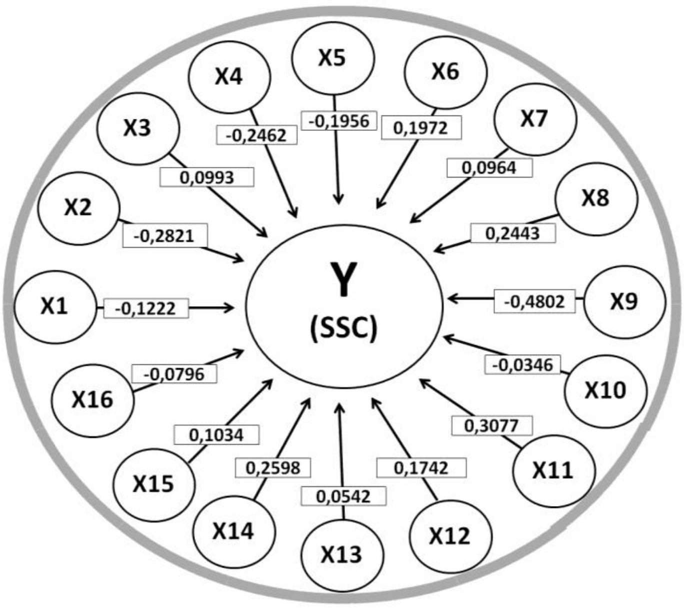

Figure 1. Partitioning of direct effects of morphological traits of onion accessions by path coefficient analysis
* Abbreviations as in Table 1.

Faculty of Agriculture, Erciyes University, Kayseri, Turkey

Table 3. Partitioning of indirect effects of morphological traits of onion accessions by path coefficient analysis

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16
X1		0,125	-0,033	0,067	0,103	-0,078	-0,016	0,076	-0,184	0,013	-0,001	-0,053	-0,006	-0,014	0,008	-0,006
X2	0,054		0,079	-0,168	-0,144	0,037	0,056	-0,094	**0,227**	-0,023	0,086	0,121	0,028	0,105	0,035	-0,016
X3	0,041	**-0,223**		-0,186	-0,106	0,026	0,068	-0,044	0,154	-0,018	0,048	0,085	0,025	0,081	0,039	-0,003
X4	0,033	-0,192	0,075		-0,103	0,030	0,040	-0,067	0,027	-0,016	0,036	0,075	0,018	0,085	0,013	-0,019
X5	0,065	**-0,208**	0,054	-0,130		0,087	0,036	-0,105	**0,202**	-0,018	0,085	0,107	0,016	0,068	0,025	-0,009
X6	0,049	-0,053	0,013	-0,038	-0,086		0,004	-0,010	0,049	-0,005	0,014	0,030	-0,002	0,005	0,001	0,011
X7	0,020	-0,165	0,071	-0,102	-0,072	0,009		-0,032	0,113	-0,016	0,013	0,068	0,015	0,067	0,040	0,002
X8	-0,038	0,109	-0,018	0,068	0,084	-0,008	-0,013		-0,135	0,014	-0,071	-0,073	-0,013	-0,084	-0,002	0,008
X9	-0,047	0,133	-0,032	0,014	0,082	-0,020	-0,023	0,069		0,007	-0,059	-0,063	-0,014	-0,019	-0,014	0,008
X10	0,048	-0,190	0,051	-0,116	-0,102	0,029	0,043	-0,097	0,094		0,002	0,132	0,031	0,083	0,024	-0,011
X11	0,000	-0,079	0,016	-0,029	-0,054	0,009	0,004	-0,056	0,092	0,000		0,069	0,017	0,080	0,013	-0,010
X12	0,037	-0,196	0,049	-0,106	-0,120	0,034	0,038	-0,102	0,174	-0,026	0,122		0,032	0,093	0,019	-0,019
X13	0,013	-0,146	0,045	-0,083	-0,056	-0,008	0,027	-0,059	0,125	-0,020	0,099	0,103		0,082	0,018	-0,011
X14	0,007	-0,114	0,031	-0,081	-0,051	0,004	0,025	-0,079	0,034	-0,011	0,094	0,063	0,017		0,023	-0,008
X15	-0,009	-0,094	0,037	-0,030	-0,047	0,001	0,037	-0,006	0,064	-0,008	0,040	0,031	0,010	0,059		0,000
X16	-0,009	-0,056	0,004	-0,057	-0,022	-0,027	-0,002	-0,025	0,047	-0,005	0,038	0,041	0,007	0,025	0,000	

* Abbreviations as in Table 1.

Path analysis was carried out on sixteen phenotypic component traits and the results were shared in Table 3. The results of the path analysis indicated that the maximum positive indirect effect on soluble solids content was the diameter of pseudostem (X2) through the diameter of bulb (X9) and length of pseudostem (X5) through the diameter of bulb (X9). Besides, among the indirect effects of sixteen traits studied, diameter of the tallest leaf (X3) through the diameter of pseudostem (X2) was negative and the highest. Also, the indirect effect of length of pseudostem (X5) through the diameter of pseudostem (X2) was negative. The results are in agreement with earlier findings of Singh et al. and Ashok et al. [28; 29]

Path coefficient analysis measures the direct and indirect influence of a variable on the dependent trait and is an effective device for meritorious characters to be used in selection programs to get maximum yield [30]. Consequently, these characters could be given priority while practicing selection which aimed at the improvement of soluble solids contents in an onion breeding program.

IV. CONCLUSION

It can be concluded from this study that the characters such as the number of the epidermal ring and the width of the neck of bulb showed a positive direct effect on soluble solids contents. Also, the diameter of the bulb has a negative direct effect on soluble solids contents. Therefore the selection of these traits can be attributed to efficiency for the improvement of the quality of onion genotypes.

The investigation exhibited the presence of wide variability for important attributes, which can be exploited to improve quality in onion. The research also pointed out the nature of the relationship between different attributes which need to be considered by the plant breeders engaged in improving for onion material with high quality in terms of soluble solids content. The correlation and path analysis could make the selection easier and studied the characters found could help to set up appropriate selection strategies in onion breeding programs.

Acknowledgements. This research was supported by the Atatürk Central Horticultural Research Institute. This publication is produced from data of the PhD thesis: "Development of candidate inbred lines and their molecular characterization in onion (*Allium cepa* L.) breeding program".

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**Corresponding Author: Fatih Hanci*
Faculty of Agriculture, Erciyes University, Kayseri, Turkey

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Fatih HANCI. " Path and Correlation Analysis in Turkish Onion Accessions for Soluble Solid Contents."Quest Journal of Research in Agriculture and Animal Science , vol. 05, no. 02, 2018, pp. 18-22.