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INTERRELATIONSHIP AMONG YIELD AND YIELD CONTRIBUTING CHARACTERS IN ONION (*ALLIUM CEPA* L.)

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ABSTRACT
Knowledge of interrelationships between grain yield and its contributing components will improve the efficiency of breeding programs through the use of appropriate selection indices. The objective of this study was to evaluate of interrelationships among seed yield and related characters in onion. Height of flowering stem, umbel diameter, number of capsule per plant, number of seed per capsule, and yield per umbel correlated positively with total seed yield. The highest correlation was shown by number of capsule and number of seed per capsule with total seed yield. The results of stepwise regression analysis showed that, number of capsule, umbel yield, and thousand seed weight remained in the final model. Path analysis was used to partition the genetic correlations between seed yield and related characters. Yield per umbel, number of capsule, height of flowering stem, number of seed per capsule, and thousand seed weight showed positive direct effect on seed yield. The highest indirect effect belonged to number of capsule, height of flowering stem, number of seed per capsule and via yield per umbel. Consequently, the results of this study revealed that, the characters such as the number capsule per plant, number of seed per capsule, and yield per umbel were the most important yield contributing characters and maximum emphasis should be given on these characters.

KEY WORDS: yield. Correlation coefficient, multiple regression, Onion, path analysis, seed.

INTRODUCTION

Onion (*Allium cepa* L., 2n=16) is a bulb crop, belonging to the family *Alliaceae*. It is a cross-pollinated and biennial short type vegetable and most of the important spice as well as vegetable crops throughout the world. This vegetable crop grown in Iran for local consumption or for export in fresh or dried condition it has good return and income for farmers, also it provide hard currency for local income. Out of 15 vegetables listed by FAO, onion falls second only to tomato in terms of total annual world production (Teshome *et al.*, 2014). Onion production sometimes hampers due to scarcity of seed. A lot of work has been conducted on onion bulb production but a little information is available on onion seed production.

A little attention has been given to improve the yield potentials if this crop. Yield could be regarded as a complex character, which is dependent on a number of agronomic characters and is influenced by many factors, which could be genetic or environmental (Uddin *et al.*, 1985). Thus, for this reason direct selection for yield can be misleading. Relationship studies are useful in disclosing the magnitude and direction of these relationships between the different characters and grain yield. Multiple linear regression analysis is a method that used to estimate the value of a quantitative variable regarding its relation with one or some other quantitative variables. Stepwise regression method is used to determine the role of yield components in increasing the yield and selection efficiency by means of few traits as the effective indicator to obtain breeding aims (Farshadfar, 2004; Poursiahbidi *et al.*, 2013a).

Correlation between various agronomy and morphological traits results from complex interrelationships between grain yield and the traits and among the traits themselves (Poursiahbidi *et al.*, 2013a). But it does not give an exact picture of the relative importance of direct and indirect effects of the various yield attributes (Bhatt, 1973). Path coefficient analysis has been widely used in crop breeding to determine the nature of relationships between grain yield and its contributing components, and to identify those components with significant effect on yield for potential use as selection criteria (Puri *et al.*, 1982; Kang *et al.*, 1983; Milligan *et al.*, 1990; Williams *et al.*, 1990; Zarei *et al.*, 2012; Khalili *et al.*, 2013a; Khalili *et al.*, 2013b; Poursiahbidi *et al.*, 2013b; Ahmadi *et al.*, 2015). Path analysis showed direct and indirect effects of cause variables on effect variables. In this method, the correlation coefficient between two traits is separated into the components which measure the direct and indirect effects (Farshadfar, 2004). Generally, this

method provides more information among variables than do correlation coefficients since this analysis provides the direct effects of specific yield components on yield, and indirect effects via other yield components (Garcia Del Moral *et al.*, 2003). Our objective was to determine the relationship between seed yield and related characters. Also, one of the goals this study was founding the direct and indirect effects of morphological traits on seed yield.

MATERIALS AND METHODS

Experimental design and Plant materials

This study was conducted at Center of Vegetable and Irrigated Pulses Research, Karaj, Iran (longitude 51° 36′ E, latitude 35° 48′ N, altitude 1300 m above sea level) during 2012-2013 cropping seasons. The soil is clay loamy of 7.85 and 0.76 electric conductivity (Ec.). The maximum and minimum temperature was 21.48°C and 9.09°C, respectively. The experiment was arranged as split plot on the basis of randomized complete block in three replicates, with planting time treatments (P1, P2, P3 and P4 for 22 September, 7 October, 22 October and on 6 November and respectively) in main plots and two cultivars (Texas Early Grano 502, and Iranshahr local cultivar) in sub plots. Sowing was done by hand in plots with four rows 4 m in length and 50 cm apart. Cultural practices, such as weeding and irrigation were done when necessary.

Statistical analysis

The following agronomic characteristics were recorded: plant height, number of leaves per plant, height of flowering stem, number of flowering stem, number of umbel per plant, umbel diameter, number of capsule, number of seed per capsule, 1000-seed weight, seed yield per umbel, and seed per hectare. Fifteen plants from each plot were selected randomly at harvest for collection of data on growth characters and seed yield. The dataset were first tested for normality by SAS statistical software. Simple correlation coefficients and multiple linear regressions were performed between the various characters. As well as, direct and indirect path coefficients were considered as described by Dewey and Lu (1959). Data analysis was conducted on the mean of data. Finally, data analyzed using SAS software (1987).

RESULTS AND DISCUSSION

The coefficient correlations among the seed yield and various characters are presented in Table 1.

Table 1. Correlation coefficients among grain yield and related characters in onion

Character	PH	HFS	NFS	NL	NU	UD	NC	NSC	TSW	YU	SY
PH	1										
HFS	0.187	1									
NFS	-0.243	-0.646**	1								
NL	0.373	0.237	-0.468*	1							
NU	-0.233	-0.663**	0.777**	-0.484*	1						
UD	0.156	0.763**	-0.574**	0.274	-0.608**	1					
NC	0.185	0.893**	-0.699**	0.17	-0.675**	0.815**	1				
NSC	0.233	0.816**	-0.653**	0.314	-0.614**	0.772**	0.860**	1			
TSW	-0.11	0.23	-0.166	-0.035	-0.072	0.332	0.182	0.387	1		
YU	-0.037	0.714**	-0.229	-0.168	-0.186	0.656**	0.771**	0.677**	0.27	1	
SY	0.091	0.886**	-0.590**	0.055	-0.530**	0.768**	0.924**	0.865**	0.355	0.862**	1

*** and ** Significant at 5% and 1% probability levels, respectively.**
PH, PHF, NFS, NL, NU, UD, NC, NSC, TSW, YU and SY indicate: plant height, height of flowering stem, number of flowering stem, number of leaves per plant, number of umbel, umbel diameter, number of capsule, number of seed per capsule, thousand seed weight, yield per umbel and seed yield.

The height of flowering stem showed positive and significantly correlation with umbel diameter, number of capsule, number of seed per capsule, yield per umbel and seed yield but negative correlation with number of flowering stem and

number of umbel. On the other hand, the number of flowering stem only showed positive and significantly correlated with number of umbel. The number of leaves per plant had negative correlation with number of umbel. Also, correlation between number of umbel and seed yield was negative. The capsule diameter showed positive and significantly number of number of capsule, number of seed per capsule, yield per umbel and seed yield. Furthermore, correlation the number of capsule with number of seed per capsule, yield per umbel and seed yield was significant. Also, the number of seed per capsule showed positive and significantly correlation with yield per capsule and seed yield. However, correlation between thousand seed weight with other characters was not significant.

Total Seed yield = -1007.630 + 0.649 number of capsule + 0.321 seed yield per umbel + 0.150 thousand seed weight

Table 2. Result of stepwise regression analysis for total seed yield in onion

Model	Unstandardized Coefficients		Standardized Coefficients		
	Beta	Std. Error	Beta	R^2	R_{Adj}
Constant	-1007.63	327.85			
Number of capsule per umbel	3.15	0.45	0.649		
Seed yield per umbel	24.03	7.14	0.321	0.95	0.91
Thousand seed weight	469.66	193.42	0.150		

Table 3. Direct and indirect effects on total seed yield via characters various in onion

Character	number of capsule per umbel	thousand seed weight	Seed yield per umbel	Correlation with seed yield
number of capsule per umbel	**0.649**	0.0273	0.247	0.924
thousand seed weight	0.118	**0.150**	0.086	0.355
Seed yield per umbel	0.500	0.040	**0.321**	0.862
				Residual effect = 0.035

Finally, the seed yield per umbel positive correlated with seed yield. The highest correlation was shown by number of capsule (0.924) and number of seed per capsule (0.865) with total seed yield. The strong correlation among three characters namely; number of capsule, number of seed per capsule, and yield per umbel indicated that these characters were governed by the same genetic system; that is the characters were expected to be liked to each other. Consequently, selecting plants for good characters may lead to an improvement of seed yield in onion (Aliyu et al., 2007). Significant positive correlation of onion yield and other yield characters such as plant height, number of leaf per plant, number of capsule and number of seed per capsule were reported by Vavidel *et al.* (1981), Pandian and Muthukrishnan (1982), Rahman and Das (1985), Rahman *et al.* (2002) and Aliyu *et al.* (2007).

Multiple linear regression analysis also, is a method that used to estimate the value of a quantitative variable regarding its relation with one or some other quantitative variables (Pour-Siahbidi *et al.*, 2013). The results of stepwise regression analysis were calculated by considering the seed yield as the dependent variable and other characters as the independent variables. Results showed that, number of capsule, umbel yield, and thousand seed weight remained in the final model and explaining 91% of variation in the seed yield (Table 2). The coefficient correlations were analyzed further by the path coefficient technique, which involves partitioning the correlation coefficients into direct and indirect effects via alternative characters or pathways. The direct and indirect effects of the grain yield related characters are shown in Table 3. Yield per umbel, number of capsule, height of flowering stem, number of seed per capsule, and thousand seed weight showed positive direct effect on seed yield. Plant height, number of flowering stem, number of leaves, number of umbel, and umbel diameter indicated negative direct effect on seed yield. The lowest direct effect belonged to the plant height followed by number of umbel, and number of leaves per plant. Also, the highest direct effect belonged to

yield per umbel (0.399), followed by number of capsule (0.235). The highest indirect effect belonged to number of capsule (0.307), height of flowering stem (0.284), number of seed per capsule (0.270) and via yield per umbel. The finding of Fatema (2001) is in agreement with this result. Rahman and Das (1985) reported that higher positive direct effect was exerted by number of capsule per plant followed by number of seed per capsule. In generally, the correlation and path analysis study of onion showed that the characters namely; number capsule per plant, number of seed per capsule, and yield per umbel were the most important yield contributing characters and maximum emphasis should be given on these characters.

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