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DETECTION OF TRAITS AFFECTING CANOLA YIELD UNDER DROUGHT STRESS BY MULTIVARIATE ANALYSIS

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ABSTRACT

Development of new rapeseed (*Brassica napus* L.) cultivars requires efficient tools to monitor traits relationship in a breeding program. The objective of this study was to detection of traits affecting canola yield under drought stress by multivariate analysis, at Dezful, Province in the agricultural year in 2014–2015. A randomized complete block design with four replications was used. The results of stepwise regression analysis revealed that 1000-grain weight, number of pods per plant, duration of flowering and days to maturity significantly had more decreasing and increasing effects respectively on seed yield. According to the results of the principal component analysis, the estimated canola variables grouped into two main components that accounted for 97.36% of the total variations of the grain yields in the water stress condition. PC_1 was moderately correlated with number of pod per plant, number of seeds per pod, 1000-seed weight and seed yield. PC_2 was moderately correlated with days to flowering, days to maturity and plant height. The results of factor analysis exhibited three factors including sink factor (number of pod per plant, number of seeds per pod, 1000-seed weight and seed yield), fixed capital factor (phenological traits) and secondary fixed capital factor (duration of flowering). It seems that the results of stepwise regression as a selecting method together with principal component and factor

analysis are stronger statistical methods to be applied in breeding programs for screening important traits.

Keywords: Canola, factor analysis, principal component analysis and stepwise regression

INTRODUCTION

Rapeseed is grown as a high quality source of vegetable oil for the food industry and supplies protein to the animal feed market (Mahasi and Kamundia, 2007). Drought stress often causes yield reduction, which is an important agricultural research subject (Zhang *et al*., 2008). Improvement of seed yield in rapeseed (*Brassica na*pus L.) has been the primary objective of rapeseed breeders for many years. To increase the yield, study of direct and indirect effects of yield components provides the basis for its successful breeding program, and hence, the problem of yield increase can be more effectively tackled on the basis of performance of yield components, and selection for closely related characters (Aytac *et al.,* 2008; Marjanovic- Jeromela *et al.*, 2009). The multivariate analysis, particularly factor analyses are utilized for evaluation of germplasm for various traits in a large number of accessions. The morphological characters viz., days to flowering, plant height, secondary branches per plant and 1000-seed weight contributed maximum towards genetic divergence (Leilah and Al-Khatee 2005, Aytac and Kynaci 2009). In plant breeding factor analysis is mainly applied as structure detection method, and sometimes it can be used as index selection for improving more than one trait. Factor analysis was used to determine structural factors related to growth trait and yield components in Brassica napus (Naderi and Emam, 2010). The objectives of the present study were to detection of traits affecting canola yield under drought stress condition by multivariate analysis, and also classify the genotypes via factor and cluster analyses for these characters under drought stress condition.

MATERIALS AND METHODS

The study was conducted in field under water stress regimes(irrigated after 120±5 mm evaporation from class A pan) at dezful in Khuzestan province, Iran (32°22′ N and 48°23′ E, 82 m above sea level) in the year 2014-2015. The type of soil found at this location is clay loam, and its pH = 7.4 with EC= 1.2 mmhos/cm. The experimental material comprised seventhin spring rapeseed (S-83, Hyola401, RG4403, Amica, RGAS0324, RGS006, Kimberley, RG405/02, RG405/03, Sarigol, Hysun110, RGS003, Hyola420,Hyola308, Hyola60, pF and Option500). A randomized complete block design with four replications was used. four rows of five meter length and 30 cm apart were planted for each genotype in each replication. The experiment received all the agronomic and cultural treatments throughout the season. During the growth season, traits such as days to flowering and days to maturity were recorded. Grain yield was obtained in ten-percent humidity of seeds after removing half meters from the side and two rows of each plot. Measured traits were including plant height, number of pods per plant, number of seeds per pod and 1000-seed weight which on ten randomly selected plants from each plot were measured. Oil content from seeds was measured with NMR methods. Stepwise regression (Draper and Smith, 1966) was used in order to determine the most important variables significantly contributed to total yield variability. Principal components analysis is a mathematical procedure used to classify a large number of variables (items) into major components and determine their contribution to the total variation. The first principal component is accounted for the highest variability in the data, and each succeeding component accounts for the highest remaining variability as possible (Everitt and Dunn, 1992). All statistical analyses were performed using SAS-9.1 (2004). The factor analysis method is consisted of the reduction of a large number of correlated variables to a much smaller number of uncorrelated variables. After extracting main factors, the matrix of factor loading was used to a varimax orthogonal rotation, and the communality or variance of uncorrelated variables was estimated by the highest correlation coefficient in each array as suggested by Seiller and Stafford (1985).

RESULTS AND DISCUSSION

Stepwise regression analysis is a multiple statistical method that can screen or select themost important variables through a dependent variable such as the grain yield The results of stepwise regression analysis indicated 1000-grain weight, number of pods per plant, plant height and days to maturity, respectively had decreasing and increasing effects on seed yield (Table 1). Rameeh, (2013 and 2014) also based on stepwise regression analysis indicated that pods per plant, number of branches, and duration of flowering had considerable effects on seed yield.

According to the results, the estimated canola variables grouped into two main components that accounted for 97.36% of the total variations of the grain yields for the water stress condition(Table 2). The first principal component (PC1) accounted for 73.42% of the variance. This portion of variation was mainly due to the variations in number of pod per plant, number of seeds per pod, 1000-seed weight and seed yield. The second principal component (PC2) accounted for about 23.94% of the variation in the accessions. This component was moderately correlated with days to flowering, days to maturity and plant height. Similar results, i.e., recognition of patterns in variability in barley traits via principal component, were obtained by(Naderi and Emam, 2010; Rameeh, 2010, Rameeh, 2013 and Rameeh, 2014).

With due attention to the complex relations of the traits with each other the final judgment cannot be done on the basis of simple correlation coefficients and it is necessary to use multivariable statistical methods in order to perceive deeply the reactions among the traits. In the meantime factor analysis is an effective statistical method in decreasing the volume of data and getting results of the data which showed a high correlation among the primary variables (Cooper, 1983) In factor analysis by means of major factors analysis and on the base of specific numbers larger than 1, three factors were identified and they all together justify 84.00 percent of existent variations among the traits (Table 3). The eigen values for factor one to three were 4.35, 2.58 and 1.37, respectively. The cumulative variation for these factors was 0.86 and also it's portions for factor one to three were 0.43, 0.23 and 0.19, respectively. Factor one was detected as " Sink Factor" in which, number of pod per plant, number of seeds per pod, 1000-seed weight and seed yield had high coefficients for factor loading. So, the existent coefficients indicate that this factor was an effective factor in increasing yield for the cultivars. The second and third factors were named "Fixed Capital Factor" for phenological traits and "Secondary Fixed Capital Factor" for duration of flowering, respectively. Various researchers have been done by means of factor analysis and considering different traits in canola cultivars. In this case we can mention that researches which have been done by some researchers including Rameeh, (2014) also based on factor analysis showed three factors including factor 1 (phenological traits), factor 2 (primary yield components), and factor 3 (secondary yield components). In earlier studies (Naderi and Emam, 2010; Rameeh, 2013, Rameeh, 2014) factor analyses were used to determine structural factors related to growth trait and yield components, and also for detecting factors relating to environmental stress including drought tolerance in *B. napus* L.

Table 1: stepwise regression for Grain yield (dependent variable) with other traits in canola under water stress condition

Step	Variable entered	Partial R^2	Model R^2	F-test
1	1000-grain weight	0.437	0.437	13.21**
2	Number of pods/plant	0.214	0.651	7.18**
3	Plant height	0.121	0.772	10.52**
4	days to maturity	0.104	0.876	8.12*

***, ** Significant at p=0.05 and 0.01, respectively.**

Table 2: Eigen values and the accumulative share of special vectors by the first and two principal components in water stress condition

Component	Eigen values	Accumulative	days to flowering	days to maturity	plant height	no. of pods /plant	no. of seeds/ pod	1000-seed weight	Oil content	Grain yield
1	4.857	73.42(%)	0.086	-0.064	0.072	0.624	0.562	0.702	0.013	0.586
2	1.954	97.36(%)	0.524	0.517	0.487	0.012	0.024	0.213	0.354	0.329

Table 3: Factor analysis by principal components in genotypes of canolaunder water stress condition

Traits	First factor	Second factor	Third factor
Days to flowering	-0.31	**0.63**	-0.59
Days to maturity	0.07	**0.87**	0.08
Duration of flowering	0.28	0.18	**0.92**
Plant height	-0.02	0.15	0.36
No. of pods /plant	**0.92**	0.07	-0.09
No. of seeds/ pod	**0.86**	0.03	-0.02
1000-seed weight	**0.61**	-0.19	0.31
Oil content	0.08	-0.13	0.56
Grain yield	**0.87**	-0.05	0.10
Eigen values	4.35	2.58	1.37
Cumulative%	0.43	0.22	0.19
Cumulative	0.43	0.65	0.84

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