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ORIGINAL ARTICLE

Evaluation of Important Germination Traits of Soybean Genotypes through Factor Analysis in Osmotic Drought Stress Conditions

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ABSTRACT
In order to grouping the soybean genotypes based on germination indices, a factorial experiment was performed in a randomized complete block design in a lab environment with three replications. 6 germination indexes were evaluated in laboratories. 2 factors were selected with high specific values in the parsing factor that included 88.17 percent of the initial variance of the data. Based on the results of factor analysis, the subscription coefficients of most traits are high and these results indicate that numbers of factors have been appropriate and selected factors have been able to justify attributes changes in an appropriate manner. The first factor justified about 47.80 percent of the original variables that traits such as MTG, MDG, GRI and FGP had large positive and negative coefficients. Thus, this factor can be introduced as the germination indices. The second factor justified 40.37 percent of the variance. Attributes RS and CVG had effect on this factor. This factor can be named as the speed factor. Overall, these two factors evaluated a specific trait in contrast other characteristics.
Key words: *soybean germination indices, analysis to factors*

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INTRODUCTION

Soybean (Glycine max L.) is a plant of the family Fabaceae which is considered as the most important crop in terms oil and protein production in worldwide. Valuable position for this product is due to high oil and protein of seed that includes respectively 20 and 40 percent of the grain weight. The concept of stress in plants is that severe negative impact on a number of living or non-living factors in the environment on natural mechanisms of plant that will can result in impaired production of dry matter and yield loss [1]. Drought as the most important non biological stress has important role in reducing crop production in the world [2]. Drought is a widespread phenomenon that is unpredictable in many areas can severely reduce yield and forage and yield stability. Germination is one of the critical stages of drought, in the areas where successful establishment of plants under drought is encountered difficult, modification of traits related to germination is considered as an important breeding objective [3]. Germination process is controlled by hormonal and the light, oxygen, temperature and water availability are important among environmental factors [4]. Germination ability under moisture stress caused to the higher establishment and density of the plants which is resulting to increase the yield. Some physiological characteristics of crop plants plays a role in drought tolerance and these characteristics are used in the selection of drought tolerant genotypes. One of the most important characteristics related to drought resistance is the germination power of seeds and seedlings development under low available water because the appropriate establishment of seedling in the farm and produce strong seedling are related indirectly with crop yield [5].

Factors analysis is an effective statistical method in reducing the large number of variables correlated in to a few main hypothetical factors. Factor analysis effectively has been used to understand the relationship between structure and function of components and morphological characteristics of crop [6]. Due to the communication with each other in complex traits, final judgment cannot be performed based on simple correlation coefficients. And it is necessary to understand deeper relationships between traits

using multivariate statistical analysis techniques. Factor analysis is one of the statistical techniques are effective in reducing the size of data. And it is conclusions from the data that show a high correlation between the original variables [7]. The purpose of this research is to find how to connect the different characteristics utilize them in the selection and presentation of the data.

MATERIALS AND METHODS

The experiment was performed in the laboratory of Islamic Azad University of Ardabil in 2013. Herbal ingredients were including 5soybean genotypes. The experimental design used as a randomized complete block with three replications. 5 seeds were planted in each Petri dish. Germination tests were performed in germinator with 25 ° C, 70% relative humidity and 16 h light and 8 h dark lighting conditions. In order to measure the germination indices, germinated seeds were counted daily. At the end of the last day of germination indices and seedling growth including final germination percentage (FGP), the coefficient of velocity of germination (CVG), germination index (GI), germination rate index (GRI), the mean germination time (MGT), Germination speed (Gs) And the mean of daily germination (MDG) were calculated using the following formulas:

1) The coefficient of velocity of germination (CVG):

$$CVG = 100 \times \sum Ni / \sum NiTi$$

Ni = Number of germinated seeds per day
Ti = Number of days from the start of the experiment

2) Germination index (GI):

$$GI = (13 \times N_1) + (12 \times N_2) + ... + (1 \times N_{13})$$

N1, N2 and … are the number of germinated seeds at first day, second and other days and numbers 9, 10 and ... are respectively the weights imposed on the number of seeds germinated at first day, second and other days.

3) Germination rate index (GRI):

$$GRI = G_1 / {}_1 + G_2 / {}_2 + ... + G_x /_X$$

G_1 = Germination percentage at first day
G_1 = Germination percentage at the second day and so on

4) The mean of germination time (MTG): [8]:

$$MGT = \sum NiTi / \sum Ni = 100 / CVG$$

Ni = Number of seeds germinated per day
Ti = Number of days from the starting the experiment

5) The final germination percentage (FGP): [9 and 10].

$$FGP = Ng / Nt \times 100$$

Ng = Total number of seeds germinated
Nt = Total number of seeds evaluated

6) Germination speed (Gs) was calculated according to the method of Magour:

$$Gs = \sum Si / Di$$

Si = Number of seeds germinated at i th day
Di = Number of days to counting n th

7) Mean daily germination (MDG) that is an indicator from daily germination was calculated from the following equation:

$$MDG = FGP/d$$

FGP = Final germination percentage (viability)
d = Number of days to reach the maximum final germination

In this study the methods of factor analysis was performed using SPSS software.

RESULTS AND DISCUSSION

Complex traits due to the communication with each other in final judgment cannot be performed based on simple correlation coefficients. And it is necessary to understand deeper relationships between traits using multivariate statistical analysis techniques. Factor analysis is one of the statistical techniques are effective in reducing the size of data. It is conclusions from the data that show a high correlation between the original variables. The analysis on the traits was performed in the principal component method. Then the rotation of factors was performed through Varimax method. As seen in Table 1, factors analysis was performed based on specific values larger than 1 and with considering three factors. Four factors generally explained 83.17 percent of the variation. Selection criteria for number of factors have been based on the number of roots was larger than 1 and since the number of primary variables used in the factor analyses is equal to 6, according to the formula $F < (P + 1) / 2$ (that P and F, respectively, indicate the number of variables and factors), selecting two factors for this experiment correspond to the principles [8]. Two factors with eigenvalues were selected in analysis of factors which was including 88.17 percent of the initial variance of the data. Based on the results of factor analysis, the subscription coefficients of most traits are high and these results indicate that numbers of factors have been appropriate and selected factors have been able to justify attributes changes in an appropriate manner. The first factor justified about 47.80 percent of the original variables that traits such as MTG, MDG, GRI and FGP had large positive and negative coefficients. Thus, this factor can be introduced as the germination indices. The second factor justified 40.37 percent of the variance. Attributes RS and CVG had effect on this factor. This factor can be named as the speed factor. Overall, these two factors evaluated a specific trait in contrast other characteristics. Mir Mousavi et al (2006) reported that at factor analysis according to the least root shows the four factors for14 traits mentioned is appropriate [11].

Table 1 - Factor coefficients of laboratory traits in evaluation of 5 soybean genotypes after Varimax rotation in drought conditions

Subscription rate	Second	First	Factor / Traits
0.89	0.728	0.425	CVG
0.95	0.835	0.925	GRI
0.652	0.704	-0.835	MDG
0.952	-0.758	-0.543	RS
0.765	0.258	0.725	MTG
0.862	0.582	0.825	FGP
	3.767	5.697	Stagnant root
	40.37	47.80	Percentage of variance
	88.17	47.80	Cumulative Variance

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