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Grouping and studying storage capacity and remobilization of assimilates in wheat genotypes by cluster analysis and detection function

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Abstract

In order to study and group a few of wheat genotypes, an experiment was conducted in random block design with three replications at Agricultural Research Station in Islamic Azad University in Ardebil in the crop year of 2013. In this study the traits including remobilization of stored assimilates, contribution of stem reserves in yield, Eigen-weight of stem in maturity, carbohydrates transport efficiency, stem efficiency in transporting the stored materials and seed weight were measured. Average random samples were used to analyze data. After standardization of data, distance modulus squared Euclidean distance cluster analysis was done in WARD method and genotypes were categorized in 2 groups. The best cut place was chosen using detection function. First group with 6 genotypes including Sabalan, Fengkang, Trakia, Alamout, Bezostaia and Garak 79 genotypes which were the highest considerably all studied characteristic except for eigen-weight of stem at maturity. So this group can be introduced as the best one in measured traits (Table 1 and Figure 1). The second group with 4 genotypes including Azar, Pishtaz, Siosson and Konica2002 were low value genotypes in measured traits. The results from ANOVA and discrimination function analysis show validity of studied genotypes grouping.

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Introduction

Wheat is one of the main crop production in both Iran and world and had a critical role in supplying food and survival of the inhabitants on the earth from prehistoric times, and is grown over all the other plants in the world. Among dark grain plants wheat is the highest global production. Its high value and yield, ease of conversion, storage and transportation, affordable range of farm and its less necessity compared to other crop plants (Rashed Mohasel *et al.,* 1998) and providing more than half of universal protein consumption has made it to be grown all over the world (Khodbandeh, 1996). Today food shortage reveals its face due to environment enhancing, lower yield per unit area, lack of equitable distribution and consumption of food in developing and developed countries, so that more than 1/3 million people are hungry or suffer from malnourished in the world. However, more than nine thousand people are added to the world population per hour.

According to the world conference on Environment and Development, the population of developing countries will be 8.5 milliard people by 2025. Also according to studies, Iran population will be in a range between 87 to 93 million people by 1400. So, food production is one of the main concerns of human. No doubt all the needs of human food come directly or indirectly from plants. Due to limited resources, especially water, of agricultural soil, higher yield per unit area is considerably important compared to increasing the area under cultivation (Hashemi Dezfooli *et al*, 1999). According to FAO statistics, wheat planted area (dry-farming and acqua-culture) in 2011, around 704 million tons hectare, namely it makes 16% make 16% of the worldwide total cultivated lands and it is produced for 601.5 million tons. During this year major wheat-producing countries range in order of value importance including china (120 million tons), India (68.7 million Tons), U.S.A (68.2 million tons), Russia (42 million tons). Hectare yield of wheat worldwide in 1669-1998 is 223776000 tons which around 16% of total lands are arable. Wheat planted area in Iran in crop years 75-76 was around 2.27 million hectors, that is, it is produced 10 million tons, in which 7.1 million tons is related to acqua farming and 2.9 million tons is related to dry-culture. During the mentioned crop year, wheat yield averaged 1595 kg ha (aqua and dry farming) which represents 60% of the average world production (FAO, 2011). After distributing to different plant organs, phono-assimilates are converted to the several compounds carbohydrates constitute the most storage compounds. Transferring material from previously storage area to another area is called remobilization. The loading area of assimilates in the plant is called a resource and the unloading site of assimilate in plant is called a tank or using place (Salibori and Roos, 1992). Since two physiological stages; current photosynthesis and remobilization of accumulated material, form the final yield before flowering, so this part of yield is supplied through remobilization from stem and other organs. That is why one of appropriate approaches to get acceptable yield is using physiological indices such as measuring the remobilization of carbohydrates and estimating their contribution in wheat yield during stress (Tahmasebi, 1999; Naderi and Moshref, 2000).

Knowing the physiological traits affecting yield limiting factors and their inheritance for designing more exact plans and for improving yield potential genetically is really necessary (Haul, 2001). Among several multi-variant analysis methods, principal components analysis, cluster analysis and principal coordinate analysis are the main methods (Muhammadi and prasana, 2003). Breeding specialist is going to classify different varieties and cultivates to find their genetic distance and use their diversity in breeding program. Cluster analysis methods use mathematical formulas to classify (Farshadfar, 2000 and Brayan and Manly, 2004). Since the numbers in each group have a less genetic distance than the numbers in different groups, vessel can be done based on numbers of different groups and mean values of character for each group for more efficiency of some phenomena such as Heterosis and transgressed segregation. A research on 36genotypes of winter bread wheat for morphologic divides the cluster

analysis of genotypes into 7 groups (Khodadadi *et al*, 2011).

This study aims at grouping and studying the storage capacity and remobilization of assimilates of wheat genotypes by using cluster analysis and detection function.

Materials and methods

Position of Test Location

The test was conducted at farmland of Islamic Azad University in Ardebil in the crop year of 2013 with geographical coordinates 48 degrees 30 minutes east longitude and 38 degrees and 15 minutes north latitude and 1350 meters height above sea level. The climate of the region was semi-arid and cold and has a long dry season in summer, and the soil is clay loam which is poor in organic matter and is of 7%. The place of performing the test in the crop year of 91 was in fallow.

Test profile

Ten varieties (Table 1) of wheat were cultured in a randomized block design with three replications under favorable conditions of moisture and drought ending in the fall in 2013 at farmland in Islamic Azad University in Ardabil each plot consisted of 7 lines of 3 meters length and the planting was done manually with density of 300 seeds per square meter.

Remobilization indicators

In order to determine the amount of remobilization of dry matter to seed, in main lines of each plot a number of similar plant were marked at heading stage and every 5 days, 5 plants from each plot were taken at each stage from heading to physiologic maturity. The harvested plants after drying, were weighed and the attributed related to TDM transport were calculated through the relationships proposed by Ehdayi *et al*, 1999 and Shakiba *et al* 1996

And the attributes related to TDM transport through relationships proposed by Ehdayi *et al* (1999) and Shakiba *et al* (1996) were calculated as following.

Dry weight of stem at maturity stage, the maximum dry weight of stem after pollination, Remobilization of storage material from stem to grain.

100* (seed weight/ Remobilization of storage material from stem to grain) = contribution amount of stem reserves in grain yield (percent).

100* (maximum dry weight of stem after pollination / (Remobilization of storage material from stem) = efficiency of stem in the transfer of reserves to the seed.

100* (maximum weight of stem/ (the special weight of stem at maturity- maximum weight Special to stem) = efficiency of carbohydrates transfer from stem to seed.

Statistical Computations

To determine the genetic affinity of studied hybrids and group them, cluster analysis was performed using the squared Euclidean and WARD method (Hoque and Rahman, 2006). Average standardized date was used for cluster analysis and diagnosis function was used to determine where to cut the dendrogram. Statistical calculations were used using SPSS and Minitab software.

Results and discussions

In this research to cluster studied genotypes we used cluster analysis based on standardized data and WARD method. In a breeding program, the more parents are genetically far from each other, their offspring will be more aggressive, the main objective of cluster analysis is to determine the extent of genetic affinity or distance of genotypes from each other so the researcher could get an ideal genotype by accident rather append energy and time to a host of hybridization, he first cluster studied genotypes based on cluster analysis and then selects limited blocks of hybrid by choosing a hybrid of the best from far cluster considering desirable traits. So by hybrid between two a part genotypes which have been chosen from far cluster, the possibility of getting favorable results increases. The resulted Dendrogram was cut from the maximum space among groups

based on discrimination function and 10 breed wheat genotypes were categorized in two groups (Figure1). Discrimination function analysis is given in Table 2 for determining the cut place of Dendrogram from cluster analysis based on a; traits. The results from cluster analysis are placed in group 2 by minimum variance method into studied genotypes so that the first group with 6 genotypes including Sabalan, Fengang, Trakia, Alamout, Bezostaia and Garak79 genotypes which were the highest in a; studied traits except for Eigen weight of stem at maturity time. So this group can be considered as the best one in measured traits (Table 2 and Figure 1). The second group with 4 genotypes including Azar2, Pishtaz, Siosson and Konika 2002 were low value genotypes in all measured traits. To ensure of more accurate cut off of dendrograph and in order to compare group average in measured traits for all groups, multi-variant of variance analysis was performed based on random unbalanced design. Results from this analysis indicate the greatest significant difference among groups in studied traits, as well it shows the analysis of diagnosis function of classification accuracy of the studied genotypes (Tables 2 and 3). The most desired result from cluster analysis is gotten if the variance within the groups is the least one and the variance among groups is the most one (Johnson and Wichern, 1988).

Table 1. The names of studied genotypes.

Number	Genotypes	Number	Genotypes
1	Sabalan	6	Siosson
2	Azara2	7	Alamout
3	Fengkang	8	Bezostaia
4	Trakia	9	Garak79
5	Pishtaz	10	Konia2002

Table 2. Average number of genotypes to separate the two study groups.

Cluster	Number of genotypes	Average Traits					
		Remobilization of stored materials	Contribution of stored materials in stem to grain yield	Eigen weight of stem at maturity	Efficiency to transport Carbohydrates	Stem efficiency to transport stored materials	Grain weight
1	6	316.7	18.52	17.03	18.13	21.03	1786.47
2	4	261.10	11.28	18.65	14.45	17.65	2280.23
Average total		298.62	15.61	17.67	16.64	19.67	1983.97
F test		*	**	ns	*	*	**

Table 3. Analysis of the detection function is based on cluster analysis group.

Functions	Wilks' Lambda	Chi-square	df	Prob.
1 to 2	0.026	18.289	6	0.006

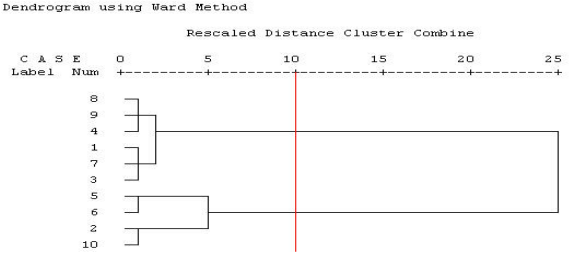

Fig. 1. Genotypes divided in resulted groups from cluster analysis.

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