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# Yield Stability Analysis of Potato Cultivars in Spring Cultivation and after Barley Harvest Cultivation

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**Abstract:** This study was done to evaluate the possibility of potato after barley harvest cultivation and selected stability cultivars. This experiment conducted on the 12 cultivars of potato in early group (Marfona, Sinora, Fontane, Oshina and Natasha), moderately late group (Satina, Markies and Arcona) and late group (Luta, Agria, Savalan and Caesar) on randomized complete block design in three replicates in two separate experiments (spring cultivation and after barley harvest cultivation) during two years (2009 and 2010) in Ardabil, Iran. Luta, Savalan, Agria, Satina, Markies, Caesar and Fontane cultivars had high total and marketable tuber yield in spring cultivation and Luta, Savalan and Agria in after barley harvest cultivation. The results AMMI method showed that Savalan, Luta, Satina, Markies and Fontane (late and moderately late group) as high yield and stable cultivar; Agria cultivar (moderately late group) as high yield but unstable cultivar; Caesar cultivar (late group) as low yield but stable cultivar and Sinora, Oshina, Arcona, Natasha and Marfona as low yield but unstable cultivar selected.

**Key words:** AMMI · Potato · Cultivation · Yield

## INTRODUCTION

Potato (*Solanum tuberosum* L.) is grown and eaten in greater countries more than some other crops [1]. Among the most important crops in the world [2], potato is ranked in fourth grade in annual production after the cereal species rice, wheat and barley. Iran is the world's 12$^{th}$ potato producer and the third biggest producer in Asia, after China and India as mentioned above [3].

Genotype by environment interactions are important sources of variation in any crop and the term stability is sometimes used to characterize a genotype, which shows a relatively constant yield, independent of changing environmental conditions. On the basis of this idea, genotypes with a minimal variance for yield across different environments are considered stable [4]. In plant breeding, genotypes are evaluated in multi-environment trials to test their performance across environments and to select the best genotypes in specific environments. Variance due to G×E is an important component of the variance of phenotypic means in selection experiments [5].

The stability methods can be divided into two major groups: univariate and multivariate stability statistics [6]. Among multivariate methods, the additive main effect and the multiplicative interaction analysis (AMMI) are widely used for G×E investigation. This method has been shown to be effective because it captures a large portion of the G×E sum of square, it clearly separates main and interaction effects that present agricultural researchers with different kinds of opportunities and the model often provides agronomically meaningful interpretation of the data [7]. The results of AMMI analysis are useful in supporting breeding program decisions such as specific adaptation and selection of environment [8]. Usually, the results of AMMI analysis shown in common graphs are called biplot. The biplot shows both the genotypes and the environment value and relationships using singular vectors technique. The AMMI model has been extensively applied in the statistical analysis of multi-environment cultivar trials [8-15].

The objective of this study, therefore, was to determine the yield performance and to assess the yield stability of the 12 cultivars of potato in spring cultivation and after barly harvest cultivation by using the AMMI statistical model for two years study.

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## MATERIALS AND METHODS

This experiment conducted on the 12 cultivars of potato in early group (Marfona, Sinora, Fontane, Oshina and Natasha), moderately late group (Satina, Markies and Arcona) and late group (Luta, Agria, Savalan and Caesar) on randomized complete block design in three replicates in two separate experiments during two years (2009 and 2010) in Ardabil, Iran. One experiment planted in spring (in May as conventional cultivation) and other expriment after barley harvest cultivation in Agusut. In the growth period and after harvesting, some of characters were measured such as main stem number, plant height, tuber number and weight per plant, total and marketable tuber yield and dry matter percent. Mean tuber yield was estimated for each cultivars and different cultivation. Combined analysis of variances were done and comparison of means were done by Dancan test with MSTATC software, Cluster analysis with SPSS software and Path analysis by AMOS software. AMMI analysis of variance and principal component analysis into a single model with additive and multiplicative parameters. All analyses were carried out using the CropStat software.

## RESULTS AND DISCUSSION

Combined analysis of variance showed significant differences between cultivation, cultivars and their interaction on tuber yield. Because of their significant differences interaction for tuber yield, the below mentioned AMMI analysis were used to estimate the highest stable cultivars. The analysis of variance for the AMMI model of tuber yield showed that type cultivation, cultivars and their interaction and AMMI component1 were significant (Table 1).

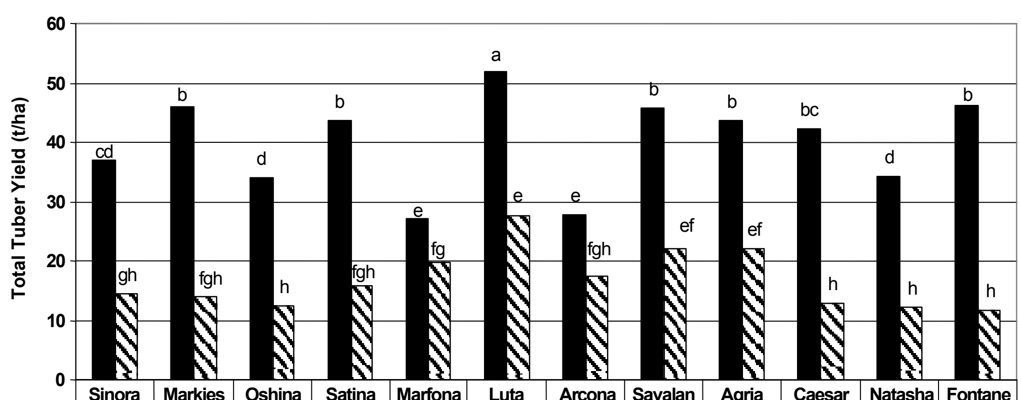
The Savalan, Luta and Agria cultivars had the highest yield in both cultivations (Fig. 1). Farmers are more interested in the cultivars that produce consistent yields under their growing conditions and breeders want to meet these needs [16].

In Figure 2 the PCA1 scores for both the cultivars and cultivation were plotted against the tuber yield for the cultivars and the cultivation. The graphs space is divided into 4 quadrants from lower yielding in quadrants 1 and 4 to high yielding in quadrants 2 and 3.

AMMI biplot PCA1 vs. tuber yield mean for potato cultivars and cultivation showed that Savalan, Luta, Satina, Markies and Fontane (late and moderately late group) located in quadrant II (high yield and stable cultivar). The Agria cultivar (moderately late group) located in quadrant II (high yield but unstable cultivar), Caesar cultivar (late group) located in quadrant III (low yield but stable cultivar) and Sinora, Oshina, Arcona, Natasha and Marfona (early group) located in quadrant IV (low yield and unstabile cultivars) (Fig. 2).

Table 1: Analysis of variance for the AMMI model

| Source | d.F. | S.S. | M.S. |
|---|---|---|---|
| Cultivars (A) | 11 | 608.43 | 55.32 |
| Cultivations (B) | 1 | 3209.75 | 3209.75 |
| A × B | 11 | 342.91 | 31.17 |
| AMMI Component 1 | 11 | 342.91 | 31.17** |
| Total | 23 | 4161.08 | |




| | Sinora | Markies | Oshina | Satina | Marfona | Luta | Arcona | Savalan | Agria | Caesar | Natasha | Fontane |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ■ Spring cultivation | 36.99 | 46.02 | 34.03 | 43.72 | 27.17 | 52.02 | 27.92 | 45.7 | 43.7 | 42.34 | 34.22 | 46.18 |
| ◻ Cultivation after barley harvest | 14.49 | 14.05 | 12.38 | 15.8 | 19.79 | 27.62 | 17.37 | 22.08 | 22.1 | 12.88 | 12.26 | 11.64 |

Fig. 1: Mean of tuber yield of potato cultivars in spring and after barley harvest cultivation

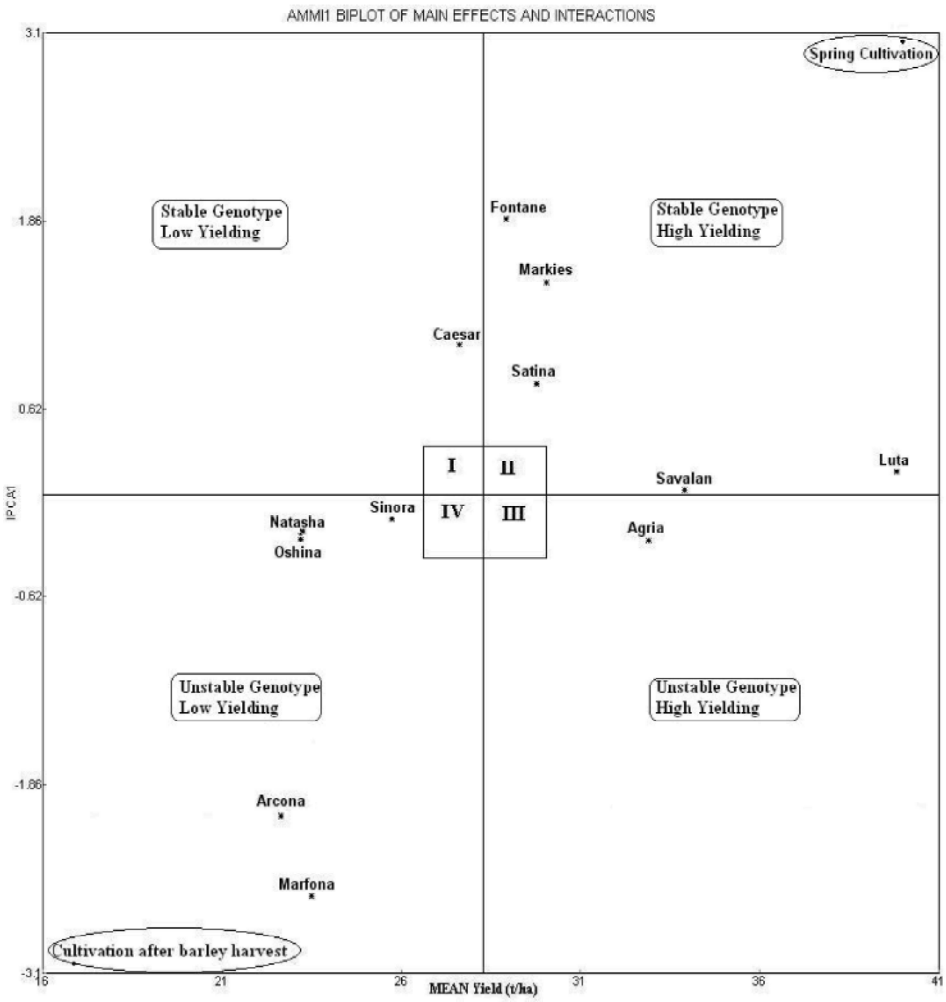



Fig. 2: Grouping of potato cultivars in spring and after barley harvest cultivation by AMMI stability method

The AMMI model has been extensively applied in the statistical analysis of multi-environment cultivar trials [8-15].

AMMI analysis should provide (i) an enhanced understanding of G×E interaction, (ii) increasingly accurate yield estimates using means for multiplicative interaction effects and (iii) the increased probability of identifying the next royalty paying genotype. The interaction of the 12 cultivars with two cultivations was best predicted by the first 2 principal components of genotypes and cultivations. Consequently, biplots generated using genotypic and environmental scores of the AMMI 1 components can help breeders have an overall picture of the behavior of the genotypes, the environments and G×E interaction [17-19].

To evaluate the possibility of predicting tuber yield through other characters and to investigate the effect of each trait on the tuber yield was used by multivariate linear regression stepwise between the tuber yield as the dependent variable (y) and other traits as independent variables (x). With enter traits of marketable tuber yield and weight and number of tuber per plant to the regression model was $R^2$ coefficient rate 98 percent and the best model was fitted. Traits were selected in multiple regression were used in correlation analysis (Path). Results of path analysis showed that tuber weight per plant had the most direct positive effect on the total tuber yield. Direct effect tuber weight per plant on total tuber yield was allocated 0.70 of the correlation coefficient. Indirect effect of tuber weight per plant had the most effect through marketable tuber yield on total tuber yield (Fig. 3).

Results of cluster analysis of total tuber yield based on "Ward" method showed that cultivars in spring cultivation was in three cluster. The first cluster were included two sub-cluster. First sub-cluster including

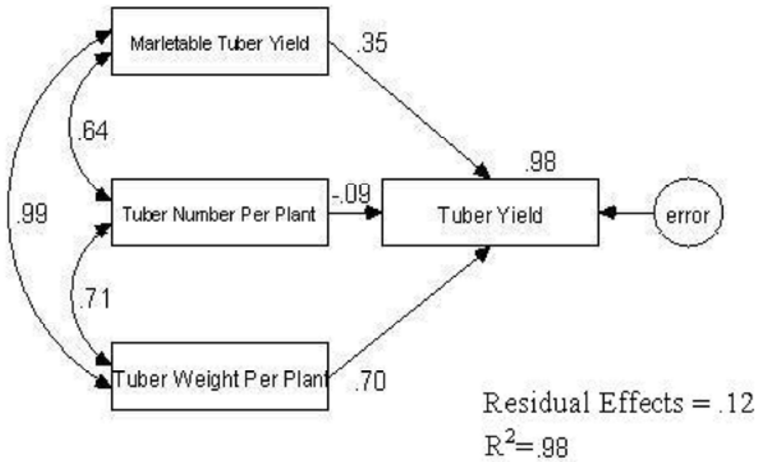



Fig. 3: Path analysis diagram based on the attributes selected in stepwise multivariable regression analysis

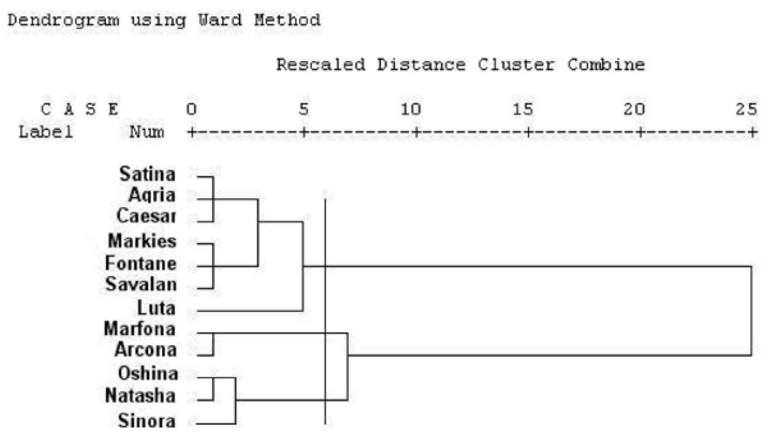



Fig. 4: Grouping of potato cultivars in spring cultivation by Ward method

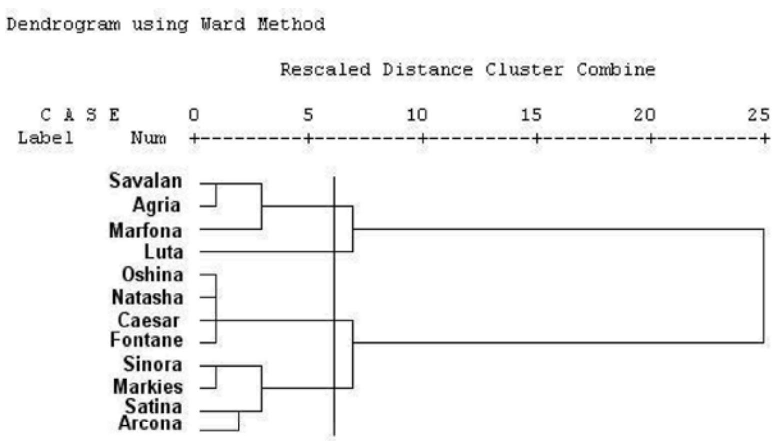



Fig. 5: Grouping of potato cultivars in after barley harvest cultivation by Ward method

Satina, Agria and Caesar cultivars, second sub-cluster including Markeis, Fontane and Savalan cultivars; second cluster including Luta and third cluster including two sub-clusters that first cluster including Marfona and Arcona cultivars and second sub-cluster including Oshina, Natasha and Sinora cultivars (Fig. 4). Cultivars grouped in first and second clusters had high total and marketable tuber yield.

Cultivars in after barley harvest cultivation were four clusters. The first cluster includes Savalan, Agria and Marfona cultivars, second cluster includes Luta cultivar, the third cluster included Oshina, Natasha, Caesar and Fontane and the fourth cluster includes Sinora, Markeis, Satina and Arcona cultivars were (Fig. 5). The first cluster the highest and second cluster the lowest total and marketable tuber yield were.

## CONCLUSION

Savalan, Luta, Satina, Markies and Fontane cultivars (late and moderately late groups) as high yield and stable cultivar, Agria cultivar (moderately late group) as high yield but unstable cultivar, Caesar cultivar (late group) as low yield but stable cultivar and Sinora, Oshina, Arcona, Natasha and Marfona (early group) as low yield and unstabile cultivars were selected for spring cultivation and after barley harvest cultivation in Ardabil region of Iran.

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