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# Effect of the Genotype × Environment Interaction on the main Components of Yield in Chickpea (*Cicer arietinum .L*) in Tlemcen, Algeria.

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**Abstract**

As part of the characterization and identification of varieties of chickpeas, we have undertaken prospecting and collection of plant material through the Wilaya of Tlemcen.In the present work two landrace Garbaansa and Bled, were used where the goal was to characterize and analyze the effect of the genotype environment interaction. The analysis of the morphometric data showed that the height of the plant depends in its expression of the genotype × environment interaction, the total number of pods per plant is unique to the genetics of the species and its expression is dependent on the genotype × environment interaction. The number of seeds per pod is a genotype-specific trait that is influenced by the environment and is the result of interaction between the latter two. The size of the chickpea grain is related to the environment, the genotype and the expression of which comes from the interaction of the medium × genotype.

**Keywords:** Algeria; chickpea; genotype x environment interaction; morphometric characterization**;** Tlemcen.

## Introduction

Around the world, chickpea (*Cicer arietinum* L.) is one of the most important grain legumes. It occupies the third position (FAO.2007). Considered as staple food (Berger et al., 2003).Its legume composition is very rich in digestible protein and contains a lipid fraction which contains unsaturated acids such as linoleic and oleic acids. It is also known as a medicinal plant for its cosmetic and dietary virtues (Slim et al., 2006).

Chickpea (*Ccer arietinum L)* is grown on a wide range of agroclimatic zones that range from subtropical in India and northeastern Australia, to the arid and semi-arid areas of the Mediterranean Basin and South Australia. Chickpea can symbiotically bind more than 140 kg / ha of atmospheric nitrogen and satisfy more than 80% of its nitrogen requirement (Pacucci et al., 2006).

In Algeria, this species has received little interest in the field of plant genetic resources preservation. Cultivars, populations or local varieties are not currently known, although they have been the subject of several characterization studies in the 1960s (Laumont and Chevassus, 1956).

In this context a preliminary study aimed at preserving and conserving plant genetic resources by prospecting and collecting local varieties of "*Cicer arietinum"* chickpea in Tlemcen was carried out (Bouri et al.2018). The present work aims to evaluate the effect of genotype environment interaction on some agronomic character in chickpea. Another objective is to identify the most important component of yield in this species.

## Materials and methods:

***Plant material:***

For this study we took two landraces Garbansa and Bled that were cultivated in two different sites (site1) Sidi Abdeli and (site 2) Sidi Senoussi in the wilaya of TELMECEN during the 2013-2014 crop year. For the cultural conditions, the extensive method was chosen in which no additions of fertilizers, pesticides or herbicides were made. Only mechanical weeding was practiced.

According to the objective of this part of our study, which is the morphological characterization of chickpea cultivars; we chose a random device with 15 plants / genotype. So for each parameter we have taken 15 whole plants which give for statistical analysis 15 repetitions, the plant material consists of whole seedlings of chickpeas with pods and seeds. A total of 60 whole plant samples and 60 mature pods and seeds were used and served as a tool for the morphological study. Our samples are composed of two landraces (Bled and Garbansa) from two different regions) Sidi Abdeli (site1) and Sidi Senoussi (site2)).

Fifteen whole plant/ site/genotype:

15 whole plant/ Garbansa/ Sidi Senoussi
15 whole plants/Bled/Sidi Senousi
15 whole plants/ Garbansa/ Sidi Abdeli
15 whole plants/Bled/Sidi Abdeli

The biometric measurements were carried out using calipers. These measures relate to the following characters:

- Height of the plant (HP) cm: at the end of the crop cycle the height of the plants was measured from the neck to the upper end.
- Pods: The total number of pods per plant (NGTP).
- Seed: The total number of grains per plant (NgTP), } NGTP/NgTP
- Length of the seed (Lseed) (mm) and the width of the seed (Wseed) (mm).
- Size of the seed ( results of Log X Lag)

***Data analysis:***

ANOVA was carried out using a GensStat discovery program, Edition 3 whose purpose was to determine the genotype x enviroment interaction on agronomic traits.

## Results:

The effect of the genotype × environment interaction on the HP of both varieties was statistically significant at f prob <0.01 (Fig.1) (Table 1).

Garbansa variety behavedbetter in Sidi Abdeliwhereas Bled variety behaved better in Sidi Senoussi

Environnement x Genotype with respect to NgTP/NGTP was statistically significant (f prob <0.01) (Fig.2), (Table 2). The results show that the Garbansa variety behaved better in Sidi Senoussi compared to Sidi Abdeli. However, there was no difference in Bled variety at two locations.

The interaction of the environment and the genotype of the total number of seeds per plant/total number of pods per plant NgTP/NGTP is statistically highly significant (f prob <0.01) (fig.2) (Table 2). The results show that the Garbansa variety behaves better concerning the total number of seeds per plant/total number of pods per plant NgTP/NGTP in Sidi Senoussi compared to Sidi Abdeli, the distinction between the behavior of the Bled variety in the two zones in terms of the number of seeds per pod is statistically insignificant.

The effect of the genotype × environment interaction on the size of the chickpea grain of the Bled and Garbansa varieties at Sidi Abdeli and Sidi Senoussi indicated that there is an effect of the environment on this trait (f prob <0.01). The statistical study showed the effect of the genotype of the variety on the size of the chickpea grain (f prob <0.01). The genotype × environment interaction is statistically significant (f prob <0.01) (Fig.3) (Table 3). The Garbansa variety behavedbetter at Sidi Abdeli whereasthe Bled variety showed no difference statistically at two locations.

With regard to the effect of the genotype × environment interaction on the total number of pods per chickpea plant (NGTP) of the Bled and Garbansa varieties at Sidi Abdeli and Sidi Senoussi, the statistical study showed that effect of genotype on the number of pods per chickpea plant (f prob <0.01); The genotype × environment interaction is statistically significant (f prob <0.01) (Fig.4) (Table 4). Here the Bled variety behaved better in Sidi Senoussi compared to Sidi Abdeli while no statistical difference could be observed for the other variety.

## Discussion:

It appears that average plant height contributes positively and indirectly to high seed yield in chickpea, Carter and Boerma (1979) reported that in late planting, there are significant positive correlations between seed yield and flowering date and between flowering date and plant height. So there is a positive correlation betxeen seed ytield and plant heigh Saccardo and Calcagno (1990) found a positive correlation between plant height and seed production.

Omar and Singh (1994) found that chickpea genotypes with high height have a harvest index more important than in plant genotype with short height plant. On the other hand, Bouslama et al. (1990b) noted that height is inversely proportional to seed yield. It is probably due to the interaction between aerial biomass and seed yield, which have to give a different expression according to genotypes and environment.

Slama (1988) reported that the height of the chickpea plant depends on the conditions of environment and the plant genotype; according to Ben Mbarek et al. (2011), the height of chickpea plants seems to have negligible direct effects on yield. According to the results of the statistical test that we obtained, the plant height character results in its expression of the interaction between the genotype and environment

The number of seed per pod is specific to the chickpea genotype, influenced by the environment and its response is based on the interaction between them. Our result was the same as that obtained by Graf and Rowlard (1987) who reported that the number of seeds per pod is one of the most important components of seed yield in seed legumes, while Ben Mbarek et al. (2011) indicated that the number of seed per pod trait is independent of seed yield and other components and that it is probably a character that depends on the genetics of the species.

As for the size of the chickpea grain according to Laumont and Chevassus (1956), this trait is dependent on the variety and conditions of the environment, in fact,they indicate that large-seeded genotypes are susceptible to have seeds with small size than other varieties when crop and weather conditions are poor during vegetation and maturation. Depending on the result of the statistical test, it can be said that the size of the chickpea grain is related to the medium, to the genotype and whose expression is derived from the interaction between environment × genotype.

The pod is a significant photosynthetic organ for carbon fixation at the pericarp in the form of hydrocarbons that will subsequently be transferred to the seed (Ma et al., 2001, Furbank et al., 2004). The number of pods per plant depends mainly on the variety and cultural conditions which results of the date and density of seeding. This character is the component of the yield most negatively affected by drought (Mohouche et al., 1998).

According to Laumont and Chevassus (1956), the number of pods per plant (NGTP depends on the environmental conditions and on the genetic of plant; it undergoes genotype × environment interaction. According to the statistical test we found that the total number of pods per plant (NGTP) character depends on the genetic of plant, independent of the environment conditions, but its response is the result of the environment × genotype interaction.

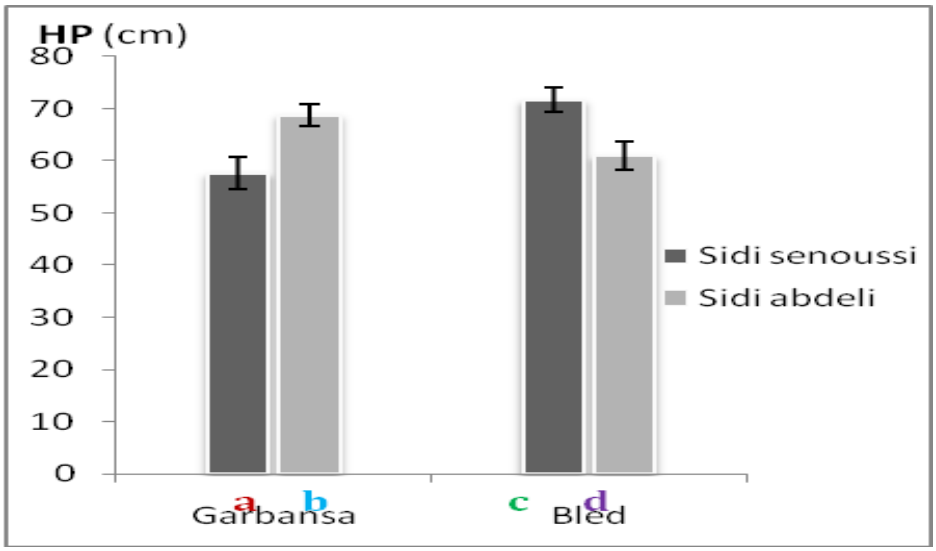


**Figure 1**: Effect of genotype x environment interaction on the height of plant (HP) of two genotypes of chickpea Bled and Garbansa at Sidi Abdeli and Sidi Senoussi.

*(The bars with different letters indicate a significant difference between the means (l.s.d) according to the ANOVA statistical test at a significance level (5%) The vertical bars show the standard error of the mean).*

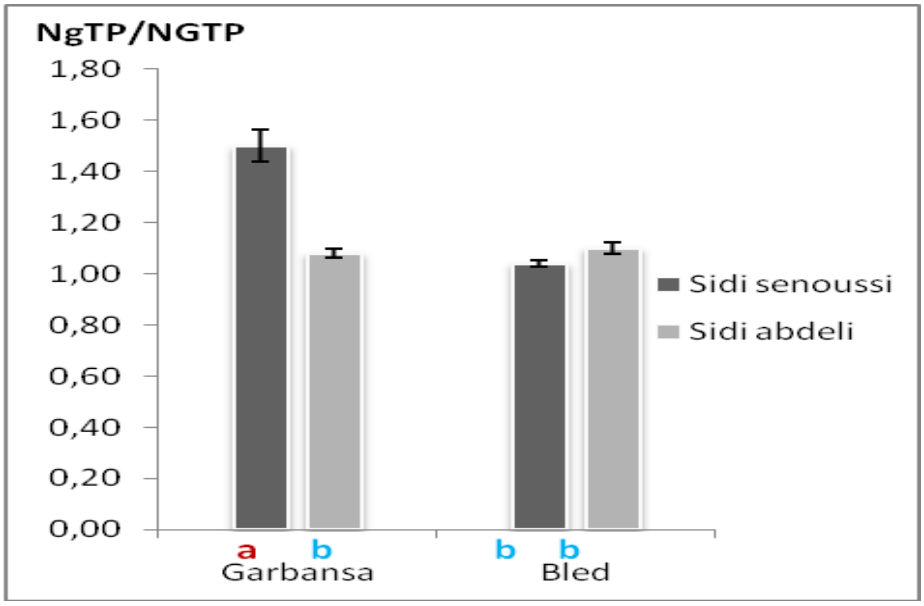


**Figure 2**: Effect of genotype x environment interaction on the total number of seeds per plant/total number of pods per plant NgTP/NGTP of two genotypes of chickpea Bled and Garbansa at Sidi Abdeli and Sidi Senoussi *(The bars with different letters indicate a significant difference between the means (l.s.d) according to the ANOVA statistical test at a significance level (5%) The vertical bars show the standard error of the mean).*

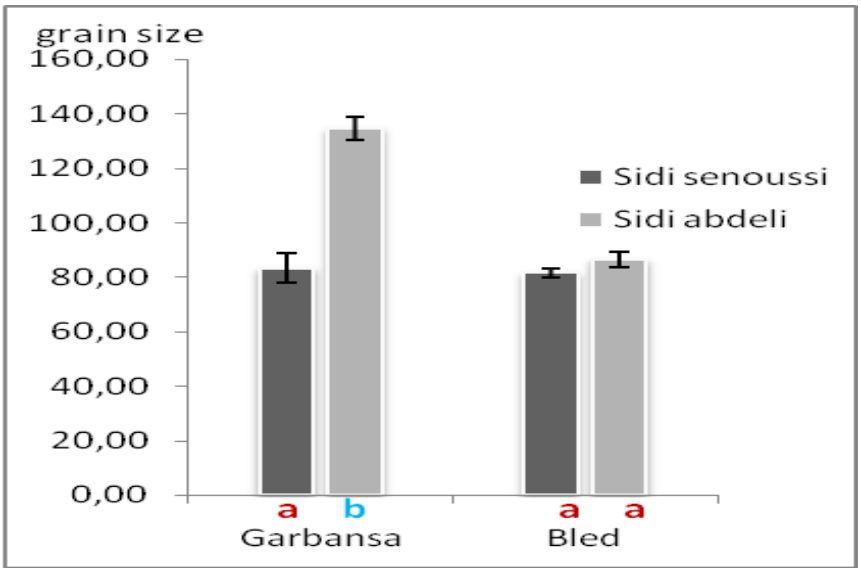


**Figure 3:** Effect of genotype x environment interaction on grain size ( $mm^2$)of two genotypes of chickpea Bled and Garbansa at Sidi Abdeli and Sidi Senoussi *(The bars with different letters indicate a significant*

*difference between the means (l.s.d) according to the ANOVA statistical test at a significance level (5%). The vertical bars show the standard error of the mean).*

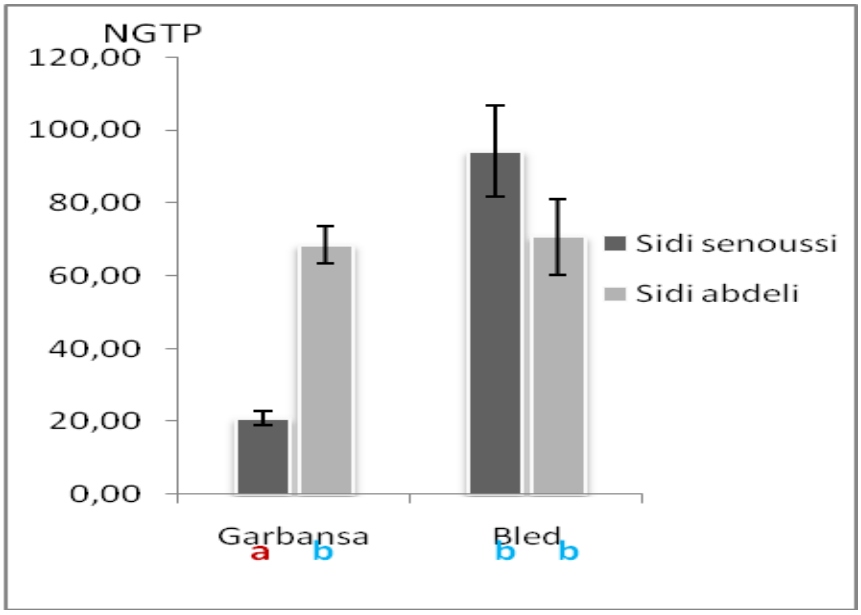


**Figure 4**: Effect of genotype x environment interaction on the total number of pods per plant (NGTP) of two genotypes of chickpea: Bled and Garbansa at Sidi Abdeli and Sidi Senoussi. *(The bars with different letters indicate a significant difference between the means (l.s.d) according to the ANOVA statistical test at a significance level (5%) The vertical bars show the standard error of the mean).*

## Conclusion:

This work is a part of the characterization of plant genetic resources in the Wilaya of Tlemcen. In fact since the work of Laumant and Chevassus (1956) no study of identification of genetic material of chickpea has been undertaken in Algeria. Among a set of diversity indicators, we first opted for the biometric study of morphological characters in order to estimate the behavior of some chickpea cultivars. At the end of the results obtained, we recommend the plantation of the Garbansa variety at Sidi Abdeli level and the plantation of the Bled variety at Sidi Senoussi. This work signifies that experiment blocks through all the national territory (at least at the level of regions with an agricultural vocation of chickpea) would be very important and even urgent; such experience allows us to know the varieties and the appropriate environment for each. The result of such an experiment can help in increase in chickpea yields throughout Algeria.

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