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SUMMARY – During the 1999-2002 period olive growing faced a very severe drought in Tunisia. The rainfall deficit reached in some regions more than 50% of the normal amount. In order to quantify the drought effects, a severity scale was established. This scale was based on plant status and has three levels which are: 1- normal state, 2- growth halt without vanishing and 3- wilting. Using this scale and field investigations the map of olive trees reaction to drought was drawn for all Tunisian olive groves. The regional maps of severity and rainfall deficit did not show a good superposition. On the other hand, a good superposition was observed between olive reaction and plantation ages maps. Thus, under the same drought conditions, the senescent orchards are less resistant.

Key words: *Olea europaea,* olive growing, drought, tree behavior, GIS.

***RESUME –** "Evaluation de l'impact du changement climatique sur la croissance des oliviers en Tunisie, à l'aide d'instruments GIS". L'oléiculture tunisienne a été confrontée durant la période 1999-2002 à une sécheresse sévère. Le déficit pluviométrique durant cette période a atteint 50% de la normale. Afin de quantifier les effets de la sécheresse sur l'oliveraie tunisienne, une échelle d'affection des plantations a été établie. Cette échelle comprend trois niveaux : 1- état normal, 2- arrêt de la croissance végétative sans flétrissement et 3- flétrissement ou dessèchement. En se basant sur cette échelle et sur une enquête de terrain, une carte nationale de l'affection de l'oliveraie par la sécheresse a été établie. Par ailleurs, nous n'avons pas observé une bonne superposition des cartes de la sévérité de l'affection et du déficit hydrique. Par contre, une meilleure superposition a été obtenue pour les cartes d'affection et de sénescence des oliviers. De ce fait, l'âge des plantations semble être un facteur primordial de la résistance de l'olivier au déficit hydrique.*

Mots-clés : Olea europaea*, oléiculture, sécheresse, SIG.*

Introduction

It is well known that olive tree is drought resistant and it is strongly connected with Mediterranean environment. In addition, all over the world, olives have proven to grow successfully in marginal and less favorable areas due to their minimal requirements in water (Bonazzi, 1997; Spennemann and Allen, 2000; Loumou and Giourga, 2003). The Mediterranean basin faces climate change due to human activity with warming and rainfall disturbing especially in the southern part. The agricultural production has to adapt to this situation for sustainability. The more vulnerable cultivations in this case are those slow to adapt like perennial cropping system, which include long-live crops and therefore change much more slowly than annual systems (Lobell *et al.*, 2006). Olive tree is a perennial crop cultivated in rainfed conditions under the minimum viable rainfall. For this reason it is indubitably one of the more at risk crops. Thus, it seems necessary to study the impact of the climate change, especially drought, on olive growing in arid zones. During the 1999-2002 period the Tunisian olive grove faced a very hard drought induced by a rainfall deficit of more than 50%. The olive trees had different reactions even under the same climatic conditions. Indeed, in the same region with the same water deficit one can observe well being olive trees (normal vegetative growth), suffering ones with stopped growth and even fading or totally dry trees. The objectives of this work are first of all to assess the impact of 1999-2002 drought on Tunisian olive growing and then to fine tune, using GIS tools, the impact of other parameters (in addition to water deficit) on the capacity of the olive tree to face this natural phenomenon.

Materials and methods

Mapping of the impact of drought on the Tunisian olive growing

A digital map of Tunisia was drawn involving polygons corresponding to small administrative localities. Then the database was created for the impact of drought on local olive groves. This database contains data for the total number of olive trees, the surface covered by olive orchards, climatic data and the olive tree status. This last was quantified according to a scale established for this aim. This scale has three levels which are: 1- normal state, 2- growth stop without vanishing and 3- fading or vanishing reaching death. We reported then on the digital map the percentage of third category according to the whole number corresponding to every polygon.

Assessment of the factors acting on olive resistance capacity

In order to assess the factors influencing the olive capacity to face drought the work was continued at smaller level (Sfax region in the Center). The survey was realized using the GIS tool by the superposition of the olive tree status map involving the three levels and maps of rainfall, rainfall deficit in comparison with the normal amount, olive tree age and planting density. This approach gives a clear idea on the importance of each parameter when a good superposition is obtained.

Results and discussion

The major part of the Tunisian olive orchards in the main producing regions was affected by the drought of the 1999-2002 period (Fig. 1). However, the olive orchards showing the higher percentage of vanishing trees are located in the eastern part of the country in two locations. The first one is in the Center covering the regions called Sahel and Sfax which produce about 50% of the national olive production. The second is located in the third more important producing region located in the South. The whole number of fading olive trees was more than 7.8 millions of a total of about 60 millions trees. This drought had important impact on population especially rural one due to the fact that the concerned trees are located were the olive growing is the only economically viable agricultural crop (Gargouri, 2007). In the North, were the water deficit was less important, no suffering trees were detected due to the resistance capacity of the olive tree. On the other hand, cultivated in the same area under an equal water deficit within the suffering olive tree well being ones of the same cultivar were detected. This raise the fact that other parameters than water deficit and genotype act on the capacity of the olive tree to resist to water shortage. For this reason we tried to elucidate this factors using GIS tool by the superposition of maps of the different parameters. We did not detect a good superposition between the importance of rainfall deficit and the olive tree status (Fig. 2). Indeed, a polygon with high deficit did not show automatically the higher proportion of suffering trees i.e. Sfax el Madina polygon has less than 15% of deficit but no well being trees while Ghraiba polygon has more than 25% of deficit and about 60% of well being trees. For this reason the olive tree status map involving the three levels and maps of rainfall, olive tree age and planting density. No good superposition was found with neither rainfall nor planting density. However, the maps of olive tree behavior and tree age were well connected (Fig. 3). The polygons having the higher percentage of old trees (more than 80 years) presented the higher proportion of class three trees (fading). For instance, Agareb polygon with more than 25% of old tree has about 50% of fading trees while Ghraiba polygon were the deficit was more accentuated did not shown vanishing olive trees. In this polygon the percentage of old trees was less than 5%. The old olive trees seem to be less able to resist to water shortage than the young ones. This may be due to the decrease of the capacity of the old olive tree to develop the resistance mechanisms against abiotic stress. These mechanisms were deeply described by Sofo *et al.* (2007).

Conclusion

The olive tree showed an important capacity to resist to water shortage during the drought occurred in Tunisia in 1999-2002. The GIS permitted to detect the more vulnerable zones and the importance of olive age in the capacity of facing drought.

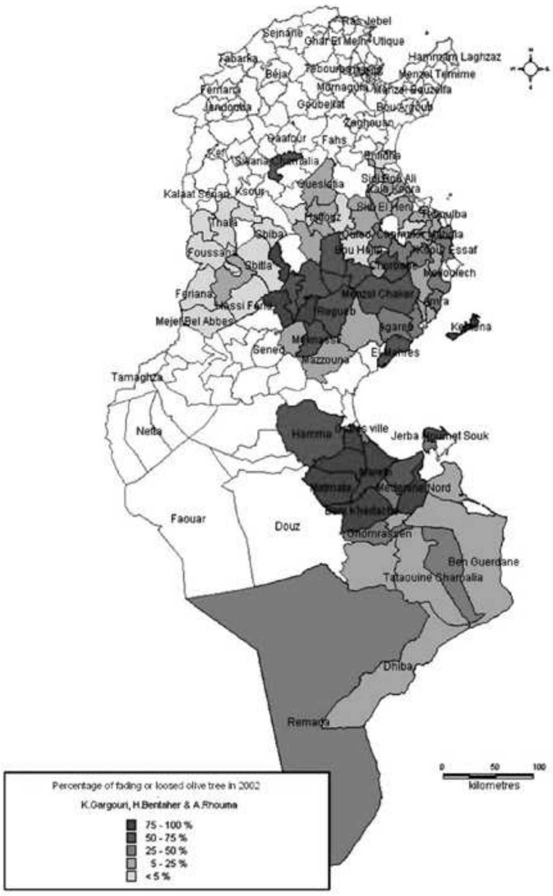

Fig. 1. Tunisian map of the percentage of fading or loosed olive trees in 2002.

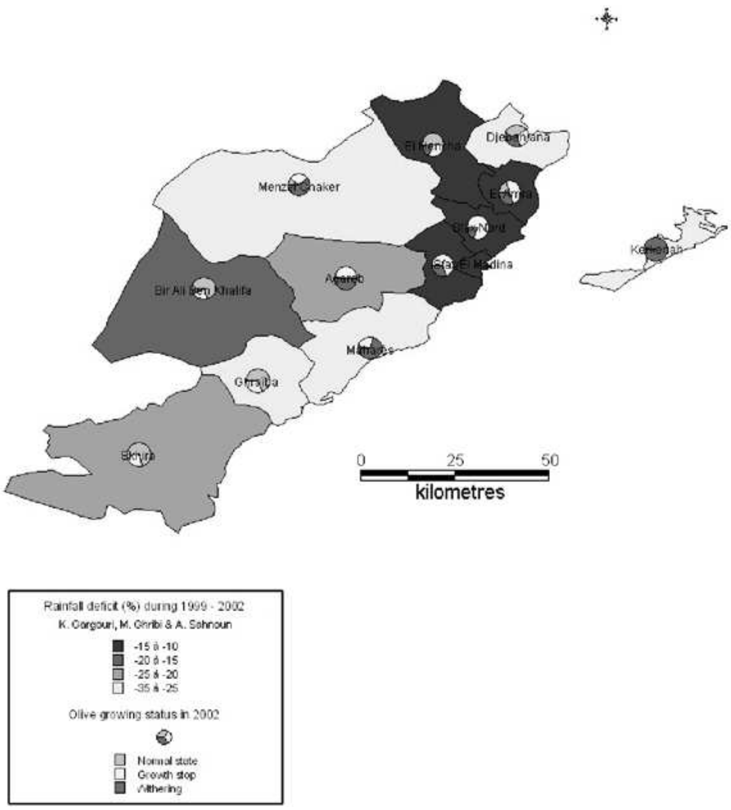

Fig. 2. Superposition of rainfall deficit and olive tree behavior maps.

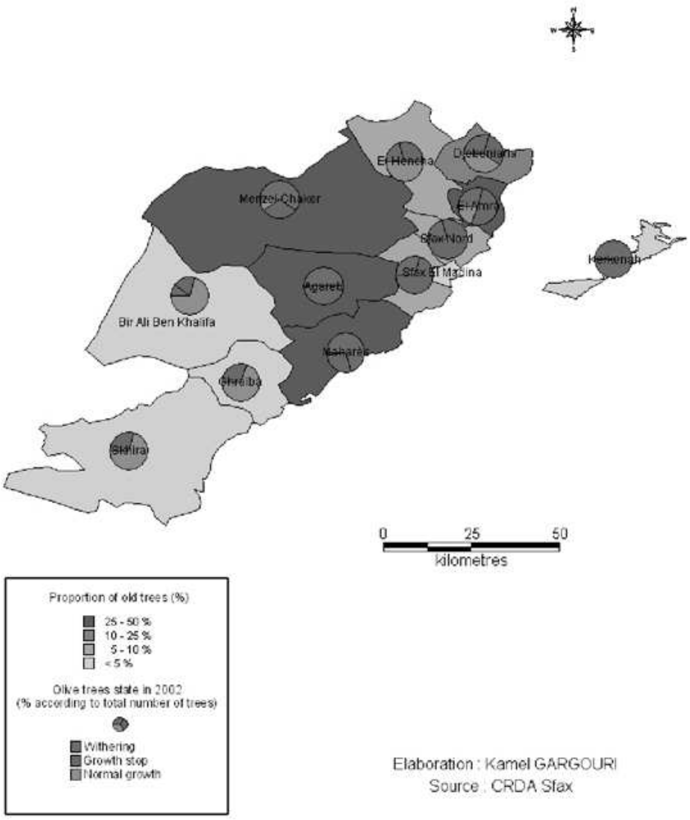

Fig. 3. Superposition of olive tree oldness and olive tree behavior maps.

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