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Wheat production in Tunisia: Progress, inter-annual variability and relation to rainfall

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ABSTRACT

During the second half of the last century, average wheat yields have increased in most parts of the world, including in areas subject to drought. As a case study of factors affecting yield in drought-prone areas, we have studied durum wheat yields and their relation to rainfall in Tunisia, where from north to south there is a gradient in severity and frequency of drought. The mid 1960s delimited two periods: from the early 1900s to the 60s the rate of increase was rather low; after the 60s yields increased at a higher rate. However, yields were quite variable and extremely low in dry years. Recently the rate of yield increase has been slowing down. In northern Tunisia, yield was highly correlated with autumn rainfall, indicating the importance of the early growth stages, whereas variation in the extent of terminal drought was poorly correlated with yield. In the centre and south, where drought occurs frequently, the area sown was highly variable, because farmers often cancel sowing if the first significant autumn rainfalls do not occur. Wheat production was also diminished through a reduction of harvested areas with respect to sown areas, a consequence of severe drought and crop failure. Water use efficiency (yield/growing season rainfall) was stable for durum wheat in northern Tunisia until the late 60s and since then has significantly increased. Given the identified sensitivities to drought, the main factors limiting wheat yield are discussed and analysed in order to give way to more genetic and crop management progress.

1. Introduction

During the second half of the last century, a significant increase in cereal yield was observed in most regions of the world as a consequence of genetic and agronomic improvements. This highly documented trend is related to release and adoption of new cultivars, better crop management and higher level of inputs both for weed and disease control and plant nutrition (Mifflin, 2000; Anderson et al., 2005; Reynolds et al., 2009). The rate of increase, however, differed among the different climatic areas, mainly in relation to drought occurrence (Araus et al., 2002). In developing countries, the so-called "green revolution" allowed significant increase in yield in relation with new cultivars, a high level of inputs and the development of irrigation: between 1970 and 1995, cereal production doubled in Asia, while the area increased only by 4%; in sub-Saharian Africa the increase was less significant (IAASTD, 2009; Evenson and Gollin, 2003; Rosegrant and Hazell, 2001). Nevertheless, it seems that in most countries this trend is slowing down, either in percentage or in absolute values. With a reduction in land available for cereals, due to the loss of agricultural land (IAASTD, 2009) and to a lesser extend to biofuel production (FAO, 2009), the current trends and prospects are alarming for total world production. Increases of prices are already observed, generating more poverty, hunger and malnutrition in some countries. Given that the need for food is expected to rise by at least 70% by 2050 (FAO, 2009) and that the main part of the diet comes directly or indirectly from cereals, the increase in cereal production will depend even more on yield since land and water scarcity is growing (FAO, 2006; IAASTD, 2009; IPCC, 2007).

In the three countries of the Maghreb (Tunisia, Algeria and Morocco) the proportion of the national territory dedicated to agriculture differs: in Tunisia a much higher proportion of the area is cultivated than in Algeria and Morocco (characterized by vast Saharan and mountainous areas). The main agricultural areas are used for non-intensive cereal production. Climatic uncertainty determines farm and crop management as well as crop yields. Fallow still occupies a significant place although a reduction in its area has been recently observed (Skouri and Latiri, 2001). In these countries, cereal production is a priority and its increase a major technical preoccupation as well as a political necessity due to a still growing population.

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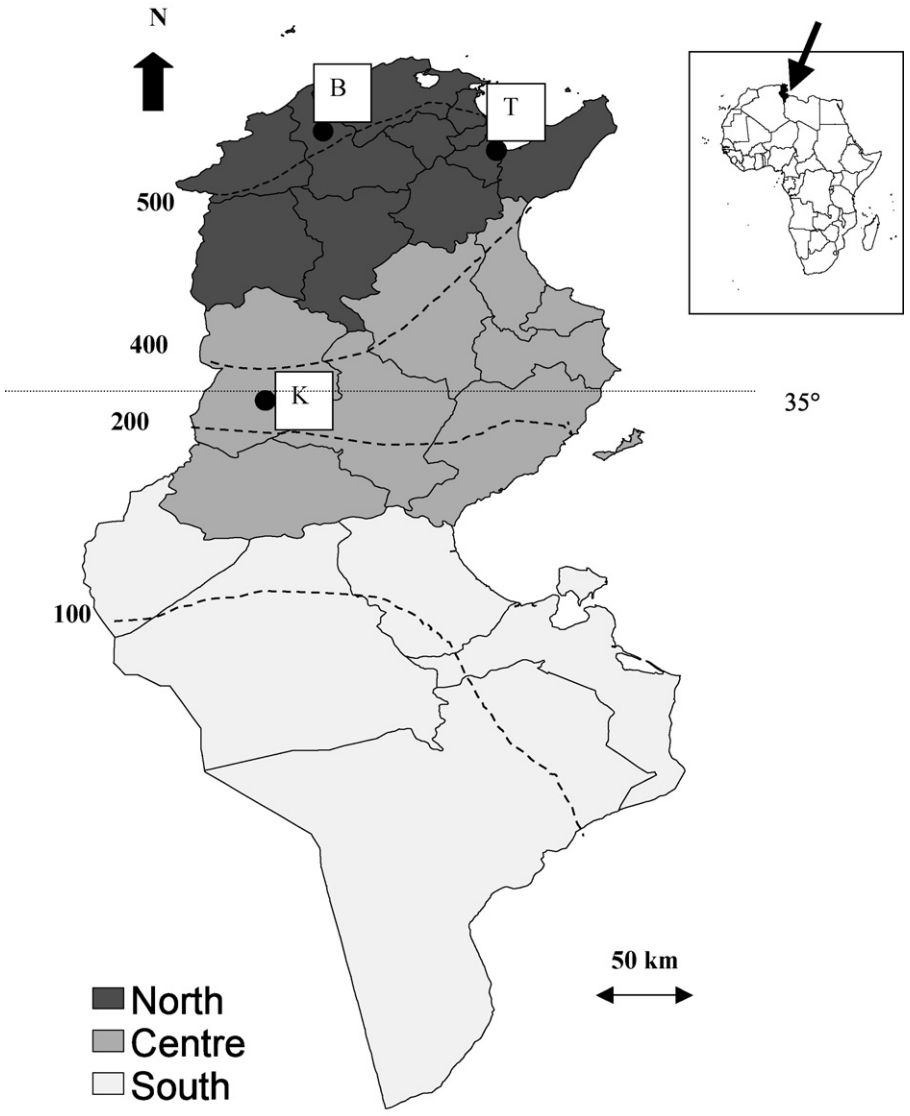

Fig. 1. Map of Tunisia with the three main regions (north, centre, south), the limits of the governorates, the main isohyets and the locations of Beja (B), Tunis (T) and Kasserine (K).

Historically, cereal production has always been an important component of Tunisian agriculture. In the Roman Empire, Tunisia was considered the granary of Rome. More recently, when Tunisia was a French protectorate (1881–1956), colonial agriculture was mainly oriented towards cereal production and wheat was exported to France because of its high quality. Nowadays, cereals are sown every year in Tunisia between October and December in most of the rain-fed farms (on about 1.5 million hectares), predominantly in the northern third of the country, called "northern Tunisia", but also in more arid parts of the country. Durum wheat is the major crop and the most widely cultivated cereal. Yields vary greatly from year to year and even in rainy years they remain much lower than those in other regions of the world with similar climatic characteristics. The country has to import cereal because production is unable to satisfy an increasing demand, linked to a growing population and to the development of animal protein consumption.

In this study, our objective is to identify trends of wheat yields in Tunisia over the past century and in the recent years and to compare them with other countries with similar or more favourable climatic conditions. Emphasis is put on durum wheat given its much larger cultivated areas in Tunisia. As water appears to be the first limiting factor of cereal production in semi-arid regions, quantitative relationships between wheat production and rainfall are also elucidated from its two components: yield per hectare and total harvested area. The final aim is to identify the main limiting factors of wheat production and to specify where progress can be made in the rain-fed areas of North Africa.

2. Materials and methods

2.1. Data sources and analysis

The statistical analysis of wheat production and yields in Tunisia was made with yearly values at different scale: from the governorate, which is the administrative division of the Tunisian territory, to the whole country. The information on durum wheat and bread wheat (production, yield, sown area and harvested area for the most recent years) is organised either by region (north, centre and south) or by governorate (Fig. 1). The north region, situated in the north of the mountain range called "La Dorsale", comprises 11 governorates with a sub-humid to semi-arid climate. The centre is a steppe region with a semi-arid climate and comprises eight governorates. The south region (five governorates) is essentially arid with rangelands and oases and with very little wheat produc-