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Effects of Nitrogen and Potassium Fertilization on Septoria Tritici Development

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ABSTRACT

Cultural practices, such as agronomic nitrogen and potassium fertilization, affect vegetation growth cover which causes microclimate variations and generating changes in the development of fungal diseases.The experimentation was conducted in open field to study the effect of four fertilization modalities, combining various doses of nitrogen and potassium fertilizers, applied during the sensitive stages of durum wheat culture (*Vitron* variety) on septoria leaf blotch disease.The ratings of disease severity after artificial inoculation with *Septoria tritici* on 3 leafs stage, have shown that applications of nitrogen fertilizers increase the severity of the disease, especially in terms of inputs without potassium. Foliar supply of potash fertilizer in stem extension stage minimizes yield losses of 14%, avoiding the spread of the disease on the flag leaf.

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INTRODUCTION

Septoria tritici Roberge in Desmaz. (teleomorph *Mycosphaerella graminicola* (Fuckel) Schröter in CONH), the causal agent of Septoria leaf spot of wheat. This disease is answered in the world and causes considerable yield losses.

In North Africa, Septoria leaf spot is considered among the most important wheat disease, particularly in Algeria, where it is common to all the Northern regions [15]. This disease causes yield losses of up to 30% in wet years, especially when the spring rains persist, after the emergence of the flag leaf [6].

These losses vary with climatic conditions, varieties and earlier attacks [7] the severity of the disease is compounded by the deficiency of soil nutrients [17,14].

No agricultural system seems to be complete without the optimum plant population and adequate nitrogen applications [1]. Fertilization of culture appears to influence the severity of *S. tritici*, the level of infection reflects the nitrogen content of a soil and when the potassium is deficient, the severity of the disease is more pronounced when it is adequate content in soil.

In Algeria, few studies have been conducted concerning the development of a system for growing cereals that values the positive effects of nutrient intake on reducing the severity of *S. tritici*, which will avoid excessive applications of fungicides.

Recent studies have shown synergistic effects between fertilization, *S. tritici* severity and fungal treatment on grain yield [3,11]. The objective of this work is to study the effect of several fertilization modalities combining nitrogen and potassium inputs on the resistance of durum wheat variety to septoria to develop a strategy to fight against this disease wheat.

MATERIALS AND METHODS

The experiment was conducted at the experimental station of ENSA (El Harrach – Algiers). Vitron variety of durum wheat (sensitive *S. tritici*) was tested with four modalities of fertilization (**Tab. 1**). The experiment was conducted using a device in complete randomized block with four repetitions.

The used *S. tritici* was isolated from the collected symptoms "Vitron" variety. The *S. tritici* suspension was obtained from a colonies culture of 10 days older on YMA medium (Yeast Malt Agar), having the appearance of a slightly pinkish cream. The conidia suspension was adjusted to 10^6 conidia/ml. 1 drops/liter of suspension of Tween 20 were added. The inoculation was performed at 3-leaf stage.

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Table 1: Fertilization modalities.

Modalities	Composition
Modality 1	Control, without nitrogen and potassium fertilization.
Modality 2	2 quintals per hectare (q/ha) before sowing of a compound fertilizer (8-10-22).
Modality 3	3 q/ha before sowing of compound fertilizer (8-10-22) + 1 q/ha of nitrogen fertilizer (46% urea nitrogen) at tillering stage and 1 q/ha in early bolting stage.
Modality 4	"Modality 3" and 5 liters per hectare (l/ha) of a liquid solution containing potassium (33% = 500 g/l of K_2O); 2.5 l/ha at one node and the remainder after 15 days.

The severity of the disease was estimated at different physiological stages: full tillering, stem extension and grain filling; based on the parameters:

- The number of affected leaves (NAL);
- The number of lesions per leaf (NL);
- The height of the disease (H), following the 0-9 scale described by Saari and Prescott;
- The estimated percentage of disease extent(P), according to Eyal and Ziv (1974) cited by Eyal *et al.* (1987), based on the pycnidien recovery on damaged leaves;
- The average attack index (IAM), in the case of our study, this index is calculated to assess the severity of the disease and quantify the aggressiveness of the isolates against various forms fertilizer.

To better estimate of the yield losses caused by *S. tritici*, a comparison between inoculated plots and the plots without inoculation was performed. Variance analysis was performed using the software "STATISTICA". The comparison of means by the method of least significant difference (LSD).

Results:

Typical symptoms of septoria leaf blotch appeared as chlorotic spots with the presence of small black dots that are pycnidia. Initially, the spots are spread over the ends of the leaf blade and over time, the damage is more extensive, irregular shapes are distributed throughout the limb with a more brownish color and pycnidia more apparent, or small and localized.

Statistical analyzes of the notations made in full tillering stage revealed no significant effect of feeding for the parameters studied except for NL, the effect is highly significant. In the stem extension stage, the terms fertilization had significant effects on the estimated parameters.

The grain filling stage was characterized by severe onset of the last sheet in modality 3 conditions, which resulted in a yield loss of about 26%. Foliar potassium intake at the modality 4, resulted in a 14% reduction in yield losses. At this stage, fertilization effect is highly significant for all parameters.

The results are noted in Table 2 and the evolution of the average attack index is shown in Figure 1.

Table 2: Average values of the parameters studied and homogeneous groups.

Modalities		Stade de notation				
		Full tillering				
		NAL	NL	H	P	IAM
Modality 1		2,50	2,50^{a}	2,25	28,75	4,32
Modality 2		1,50	1,50^{b}	1,50	18,75	1,22
Modality 3		2,75	3,25^{c}	1,75	35,00	2,14
Modality 4		2,50	3,25^{c}	1,75	25,00	3,28
		Stem extension				
		NAL	NL	H	P	IAM
Modality 1		4,00^{a}	1,75^{a}	3,00^{a}	7,50^{a}	0,51^{a}
Modality 2		1,00^{b}	1,25^{a}	1,75^{b}	5,00^{a}	0,14^{a}
Modality 3		4,50^{c}	5,50^{b}	4,50^{c}	45,00^{b}	23,43^{b}
Modality 4		3,25^{ac}	5,25^{b}	4,00^{c}	40,00^{b}	19,39^{b}
		Grain filling				
		NAL	NL	H	P	IAM
Modality 1		4,25^{a}	1,50^{a}	3,50^{a}	3,75^{a}	0,66^{a}
Modality 2		1,25^{b}	0,50^{a}	1,75^{a}	1,25^{a}	0,12^{a}
Modality 3		7,50^{c}	7,25^{b}	8,50^{b}	70,00^{b}	60,49^{b}
Modality 4		3,75^{a}	4,25^{c}	8,50^{c}	47,50^{a}	26,75^{c}

Discussion:

Projected global demand for small grain cereals emphasizes the need for sustainable intensification with higher crop yields [4]. Disease severity is more pronounced in the plants that undergoes nitrogen fertilizer inputs. The results are similar to those of several authors [12,10].

The attacks, in the early stages of wheat growth, affect the number of tillers, fertile ears and grain quality; they destroy a large leaf tissue surface causing a reduction in the plant photosynthetic potential. The attacks in the last stages of growth are more serious, they have to consequences, loss of vigor and productivity [16].

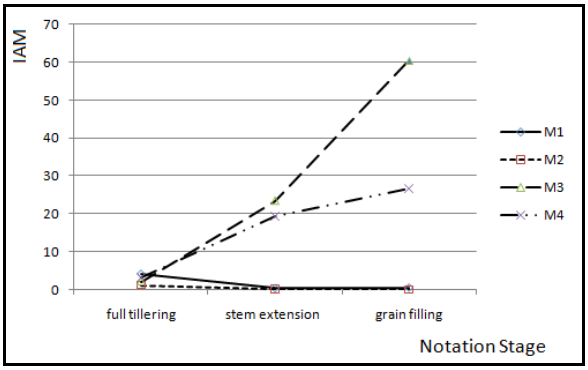

Fig. 1: The average attack index evolution.

The increased expression of *S.tritici* according nitrogen (N) increasing doses may be explained through the role of the N element in the culture of wheat as a factor that leads to both morphological and physiological changes in the host cells. Indeed, the nitrogen improves the vegetative growth and results in a high potential inducing tillering increase in the density of the culture. In this case, the plant architecture increases the risk of attack by pathogens [3].

Severe attack at the last leaf to modality 3 conditions caused significant yield reductions following the latter's role. According to Auriau *et al.* [2], the majority of assimilates in stored grain is from the last leaf photosynthesis.

Sharma *et al.* [17] noted that grain yield and average grain weight increase with the application of potash fertilizers with or without fungicide applications. The results are in agreement with Ben Muhammad *et al.* [3], who used inputs to soil potash fertilizers. Sharma *et al.* [17], working on the relationship between the severity of *S. nodorum* and the rate of the element "potassium" in the soil, have reached similar results.

Various works on the synergistic effects between nitrogen fertilization, fungicide application and septoria leaf blotch on wheat yield were recently conducted [4,11]. Nevertheless, our study demonstrated that potassium fertilization hinders the development of the disease, thus improving performance. The result of our study can be developed in integrated pest management strategy while reducing fungal inputs.

Conclusion:

Based on previous findings, we can see that the nitrogen fertilizers increase the severity of Septoria leaf spot, which can cause a reduction in yield and its components. Moreover, nitrogen being the most important element in the development of performance; deficiency of this element can have negative consequences on production.

We can remedy this by using potassium contributions to the soil before sowing and foliar application on stem extension and heading stages. This permit considering a new strategy against Septoria leaf blotch and minimizing the use of fungicides.

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