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Assessment of Septoria Effects on Durum Wheat Cultivars Using Stimulators of Natural Defense (SND) in North Western Tunisia

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Abstract: Four durum wheat (*Triticum turgidum* var. *durum* L.) cultivars with various susceptibility levels were assessed for their respective response to *Zymoseptoria tritici* using two Stimulators of Natural Defense (SND) derived from algae extract and a polysaccharides. The test was carried out at two locations in North Western Tunisia representing sub-humid (Beja) and semi-arid (Oued Mliz) climatic zones. Disease severity, assessed using double digit scale, and thousand kernel weights were measured. Preliminary results showed that the resistant cultivar Salim had 6% yield advantage over the susceptible cultivar (Karim). The increase in thousand kernel weights associated with SND treatments t varied from 5 to 18% with Salim and Karim, respectively. The SND treatments showed that the severity to *Z. tritici* of resistant (Salim) and susceptible (Karim) cultivars was reduced by 11% and 9% than the controls. This result suggests that both elicitors tested could be perceived as key factors of the pathogenicity of *Zymoseptoria tritici* of durum wheat.

Key words: Karim, Salim, SDN, *Triticum durum*, *Zymoseptoria tritici*

1. Introduction

Zymoseptoria tritici is a hemibiotrophic filamentous ascomycete causing foliar blotch disease commonly known as *Septoria tritici* blotch (STB) on wheat worldwide [1-3]. Under favourable growing-conditions, yield losses can reach 30-53% [4, 5], especially with high-yielding and susceptible cultivars [6]. This particular yield loss could be reached in regions with high relative humidity (85%) and optimum temperate (between 20 and 28 degrees C) [7]. In Tunisia, the importance of STB continues to increase due to increased virulence of *Zymoseptoria tritici* on durum wheat [8] coupled with cultivation over large areas of the susceptible variety Karim [9] that occupies over 45% of the cultivated durum wheat areas. Furthermore, the increase of STB intensity is enhanced by the wide genetic diversity in the *Z. tritici* population attributed to sexual recombination and most importantly to gene flow [10]. Extensive fungicide application led to the emergence of fungicide resistant *Z. tritici* strains against certain molecules [11]. So far fungicide treatments are the most efficient disease control methods practiced by farmers. Several biocontrol tools were developed such as Natural Defences (SND) which is becoming an important research subject as it presents an interesting alternative to phytosanitary products. This study focus on the manipulation of host natural defences through the use of the SND as a

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preventive treatment against major durum wheat diseases such as *Zymoseptoria tritici*.

2. Material and Methods

Field experiments were carried out during 2014-2015 growing season at two experimental station of Regional Fields Crop Research Center at Oued-Beja (Fig. 1) (governorate of Beja, Tunisia) and at Oued-Mliz (Fig. 2) (governorate of Jandouba, Tunisia), which are located in northwest Tunisia. Oued-Beja represents the sub-humid bioclimatic zone with an average annual rainfall ranging from 500 to 850 mm and a daily mean temperature ranging between 10 and 28°C. Oued-Mliz represents the semiarid bioclimatic zone with annual rainfall 530 mm and a daily mean temperature ranging between 8 and 28°C. These sites are as hot spot for STB in Tunisia.

The experiments were hand-planted at the stations of Oued Beja and Oued Meliz on November 15 and December 1st. respectively, under rainfall conditions. Random Block (RCB) with three repetitions was used.

Fig. 1 Experimental station of Oued Beja characterized by humid sub climate and vertisol soil with pH 7.2-7.5.

Fig. 2 Experimental station of Oued Mliz characterized by semiarid climate and silty clay soil with pH 7.4.

Four modern cultivars (Karim, Razzak, Maali and Salim) were planted into 6 rows of 10 m long and 1.5 m width and the lines are spaced 25 cm apart at a rate of 30 gram seeds per row. These genotypes were among the predominant cultivated varieties in Tunisia and are known to have different levels of susceptibility to the Tunisian population of *Z. tritici*.

During the growing season, plots were fertilized (33.3 kg/ha of N) at tillering and stem elongation stages. Fungicides and herbicides were respectively applied at the seedling growth stage between first and second node stage (21-32 in the scale of Zadocks growth stage [12]).

2.1 Application of SND

The effectiveness of SND product was tested under natural infections on four most common durum wheat varieties grown in Tunisia (Karim, Razzak, Maâli and Salim). The first two cultivars are sensitive to Septoria and Leaf Rust, Maâli is moderately resistant [9] and Salim is tolerant [13]. SND's were provided by the department of agronomy and plant biotechnology of the National Institute of Agriculture of Tunisia. The products are sprayed at two growth stages: late tillering and stem elongation. Two molecules PF4 and PF5 (Table 1) was mixed and used respectively.

Analysis of variance using the procedure "PROC ANOVA" of the SAS program (1985) to detect the treatment effect on varieties and on the severity was achieved.

2.2 Physiological Measurements

Septoria leaf blotch was assessed on 12 plants per plot using double digit score 00-99, The first digit (D1) indicates disease progress on the plant height 1st-to flag leaf and spike and the second digit (D2) refers to severity measured based on diseased leaf area. Both D1

Table 1 Composition of SND product.

Product	Active Molecule	Dose
PF4	Algae extract containing 30% of *Ascophyllum nodosum*	2 ml/L
PF5	plant polysaccharide and amino acids	3 ml/L

and D2 were scored on a scale of 1-9 [14]. Disease evaluation was repeated three different times: before applying SDN (at the tillering growth stage), after 15 days of the first application and after 15 days of the last application (stem elongation). These stages were selected because the period between them is considered critical for grain yield production, and a reduction of the green leaf area during this period may result in significant yield losses especially when flag leaf is infected [15].

At harvest, twenty five randomly selected spikes per replication were chosen to determine the 1000 kernel weights (TKW).

3. Results and Discussion

Results (Fig. 3) of the algae extract and polysaccharides indicated that thousand kernel weight (TKW) increased in the most sensible variety Karim by 18%. TKW recorded for Razzak was 13%. Taher et al. (2013) [16] found a highly significant difference on TKW between the untreated and the control plots at the three trials. The significant increases in this agronomic trait were observed with different treatments from 88.1 to 88.3% compared to the untreated control [17]. The fungicide application effect reported by Rezgui et al. (2008) [18] was adequate in reducing Septoria leaf blotch disease impact on grain yield between 10 to 20% especially when the severity exceeds 51%. Yield reduction might be a consequence of a loss of green leaf area due to disease that would induce necrosis and reduce photosynthesis [19].

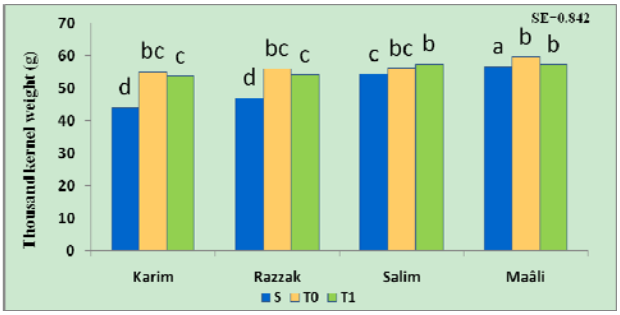

Fig. 3 Frequency distribution of TKW on four common varieties of durum wheat, S: Healthy cultivars, T0: Control, T1: Traitment.

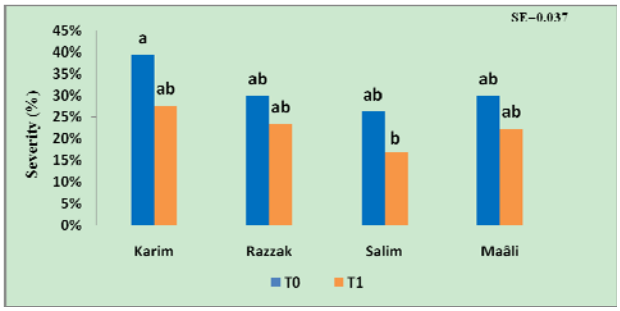

Fig. 4 Frequency distribution of *Zymoseptoria* severity on four common varieties of durum wheat.

The interaction variety — SND showed that the severity was reduced. This reduction ranged from 4% to 5% than the controls (Fig. 4). Berrais (2014) [20] noted that fungicide treatments on Salim and Maâli varieties have a significant effect in reducing septoria as compared to Karim. Karim was the most affected by Septoria during these two cropping seasons 2008-2009 and 2009-2010. Such control was used by Fakhfakh et al. (2009) [21] showing that the spray mixture of fungicide and herbicide, applied at tillering growth stage reduced the severity attack of Septoria leaf blotch between 65 and 90% during two years. The efficacy of fungicide treatments on reducing severity caused by *Z. tritici* was more than 50 % [15]. At 40% and 50% severity the treatments had a higher efficacy on disease development but did not prevent infection [18]. However, Stocco et al. (2015) [22] reported the effect of four isolates of *Trichoderma harzianum* decreased the severity with low percentage of pycnidial coverage and an increase of the serine-protease activity in the susceptible wheat cultivar.

4. Conclusion

Preliminary results of SND applications showed a relative dose-efficiency to reduce disease severity. The effect of various factors (i.e., Temperature, relative humidity, plant development stage) on the elicitation potential of SND and develop a formulation require further testing under field conditions. These practices would assume a comprehensive understanding of the complex host-pathogen interaction, and may lead to generate suitable technologies within an integrated pest

management program to better manage foliar diseases particularly Septoria leaf blotch.

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