Nitrogen Fertilization in relation to durum wheat and Tan Spot *(Pyrenophora tritici - repentis)*⋆ development

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Abstract

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Tan spot, caused by *Pyrenophora tritici-repentis* (Died) Drechs, is a major disease of cereals in Morocco, especially durum wheat *(Triticum durum* L.) Chemical control is not a feasible approach for most farmers. Development of resistant varieties is the most attractive solution. Furthermore, there have been reports that nitrogen fertilizers, especially ammonium forms, reduce the incidence of tan spot. This on-farm trial on a Petrocalcic Palexeroll soil examined N response (0,40, 80 and 120 Kg ha^{-1}) of one resistant and two susceptible durum wheat lines. All lines responded to N depending on rate. While disease counts were high for the susceptible lines, the «resistant» one was moderately infected also. The respond of these lines to N was inconsistent; however, one susceptible line showed less infection with added N. mechanisms involved in the differential response are not clear.

Key words: cereals, N fertilizers, resistant varieties, Morocco.

Introduction

Cereal production on a global scale plagued by a range of fungal and viral diseases; these invariably contribute to reduced yield potential. Treatment broadly falls into two categories- resistant or tolerant varieties and chemical control by seed treatment or foliar sprays. In developing countries, which are often characterized by low inputs and uncertain yields, the former approach to disease control is the most desirable one (Raymond **et al.,** 1985) despite the research efforts involved in varietal selection. Given the low and precarious cereal yields in the rainfed West Asia-North Africa zone, a strategy to combat diseases is all the more crucial.

Though barley *(Hordeum vulgare* L.) is the principal cereal in Morocco followed by bread wheat (T. *aestivum* L.), a considerable area is devoted to durum wheat (Shroyer **et al.,** 1990). In fact, a similar distribution exists between these major cereals in most countries of the Mediterranean region. Durum wheat is an important staple food in the Maghreb, being used mainly for couscous and pastries, etc. Though having several diseases in common with breadwheat and barley, durum wheat has some relatively specific diseases, e. g., tan spot. Known also as yellow leaf spot or eyespot of wheat, tan spot is of worldwide occurence (Hosford 1972; Hosford and Busch, 1974). Under a severe epidemic, this pathogen can cause yield losses up to 50% (Rees **et al.,** 1982, Sharp **et al.,** 1976).

Prior to the establishment of the Aridoculture Center in Settat, which focused research on cereal growing in Morocco's low rainfall (200-350 mm/yr) zone, little was known of tan spot in terms of occurrence and impact on yield. However, Lyamani **et al.,** (1986) showed that tan spot had a higher incidence than other diseases; 52% of fields surveyed had 30-100% of plants infected. No incidence of tan spot was reported for either breadwheat or barley. In the following year, Toufiq **et al.** (1987) found that, following leaf rust, tan spot had the highest disease incidence for durum wheat; 89% of field suveyed were infected. The discrepancy between the data for the two years illustrate the importance of season on disease incidence, which is more severe with higher humidity and rainfall (Rees and Platz, 1980).

The absence of chemical control of tan spot in Morocco raises the question of varietal resistance to the disease. Possibilities in this direction are encouraging; Raymond **et al.** (1985) showed that a resistant winter wheat cultivar showed 7.2% yield loss to tan spot compared to 27.7% for a susceptible cultivar. Fortunately, screening for resistance in the greenhouse shows a good relationship with field conditions (Cox and Hosford, 1987). Though crop rotations or incorporating plant residues are some cultural practices known to mitigate tan spot's effects, a recent report (Huber **et al.,** 1987) indicates that N fertilization may reduce the incidence of the disease. As current research in Morocco's rainfed zone is aimed at providing a basis for, and promoting, N fertilizer use (Abdel Monem **et al.,** 1988. Abdel Monem **et al.,** 1990), the increased yields envisioned from widespread adoption of N fertilization may simultaneously solve a major disease problem with no extra cost. Therefore, this field experiment examined the impact of various rates of N on yield and tan spot incidence in some resistant and susceptible durum wheat lines.

Materials and Methods

The site for this on-farm trial was about 5 km east of Settat

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on the Ben Ahmed road. Average rainfall for the area is about 370 mm/yr. This falls mainly between November and April. The soil was a fine, mixed, thermic, shallow Petrocalcic Palexeroll. The pH was 8.1 and organic matter about 4.3%; available N as NO_3, $NaHCO_3$-P, and K values were 2, 4.5, and 230 ppm, respectively. Both N and P levels were deficient. The previous crop at the site was barley.

The site was prepared by cultivating with an offset disc or «covercrop». Subsequently, the plots which were 5m long × 1.8m wide, were laid out. The design was a randomized split plot with varieties the main plots and fertilizer N the sub plot. Three durum wheat lines were tested; these were BD-15 and BD-28, both susceptible to tan spot, and a resistant line, BD-25. All three which produce similar yields in the absence of the disease, were from the National Durum Wheat Breeding Program. These lines were drilled at 100 Kg seed h^{-1} in mid- November, 1988, with rows 30 cm apart. Since Hessian fly (*Mayetiola destructor* Say.) is an endemic cereal pest in the region, a chemical to control it (Carbofuran or «Furadan») was also drilled with the seed at 0.4 Kg a. i. ha^{-1}. The fertilizer treatments were N at 0, 40, 80 and 120 kg ha^{-1} hand broadcasted as ammonium nitrate with a blanket P application of 40 kg ha^{-1} on all plots as triple superphosphate. These were incorporated by the «covercrop» prior to seeding.

Subsequently, routine cultural practices were followed after emergence. This included weed control with spraying of Certrol H, i.e., Isoxynil (4-hydroxy -3,5- diiodo benzonitril), at tillering using 4 L ha^{-1}. However, few, if any, farmers in this dryland region use any form of chemical for weed control. Stand establishment in each plot was determined by counting emerged seedlings in 1-m lengths of two center rows. Disease estimates were made on April 14 and 21 (1989) at the 11.0-11.2 Feekes growth stage. This involved taking 10 samples of flag leaves from each plot and using the James scales for septoria leaf blotch (James, 1971). Area Under Disease Progress Curves (AUDPC) were calculated from both readings. Harvesting took place on june 12, 1989 by hand cutting two inner 5-m rows. The material was subsequently weighed, threshed, and grain weight recorded. The relevant data were then analyzed statistically using analysis of variance.

Results

As the first half of the growth period was characterized by lower than average rainfall, there were only a few rains in December, January, and February, which gave 35,7 and 36mm, respectively. The period from then to harvest had, however, higher than usual rainfall; March, April and May had 77, 85, and 55mm, respectively. Early indications showed that there were no significant effects on seedling emergence of variety of N fertilizer level.

Yield data showed that N had a significant effect (Table 1). For BD-15 and BD-25, the 40 kg rate significantly increased dry matter yield. However, there was no further significant increase with addition of the 80 and 120 Kg rates except at the highest rate for BD-25. For BD-28, the increases were significant up to 80 kg ha^{-1}. Grain yield followed a more or less similar pattern with some discrepancies. The lowest rate did not produce a significant response in the case of BD-28, while no further increases occurred with N rates for BD-15, maximum responses occurred at 80 and 120 kg N ha^{-1} for BD-28 and BD-25, respectively.

The corresponding tan spot disease indicators, i. e., area under disease progress curve, are presented for the individual durum lines (only control plots without N fertilization) in Fig. 1, along with relative changes in disease incidence AUDPC rating in response to N fertilization rate. As anticipated, there was a significant difference in disease incidence between the two susceptible lines, BD-15 and BD-28, which had AUDPC values of over 85, while the «resistant» line BD-25, had a rating of about 25%.

When the relative effect of N on disease incidence was calculated, the three durum lines appeared to behave differently. The two susceptible lines responded in opposite ways; one, BD-15, tended to increase in disease incidence with relative increases of 12 and 32% at N levels of 40 and 80 Kg ha^{-1}, while the other, BD-28, showed consistent AUDPC decreases after the lowest increment of N. The «resistant» line BD-25, tended to have higher disease incidence with N fertilization, but the effect was not consistent. Despite these trends with N application, none were significant except the reduced ratings for BD-28 at the highest N level.

Table 1. Yield of durum wheat lines in response to applied nitrogen.

جدول 1. غلة سلالات القمح القاسي عند مستويات مختلفة من الآزوت.

السلالات Line	كمية الآزوت / هـ N Kg ha^{-1}	Yield Dry matter المادة الجافة Qx Ha^{-1} كنتال / هـ	الغلة Grain الحبيّة
BD-15	0	24.4	7.7
	40	39.1	9.1
	80	30.2	9.8
	120	33.3	10.6
BD-28	0	26.4	8.7
	40	29.5	8.7
	80	38.4	12.2
	120	36.1	11.2
BD-25	0	26.0	8.1
	40	32.2	9.9
	80	33.8	10.6
	120	38.4	12.3
L.S.D. أقل فرق معنوي	5%	3.0	1.1

QX = Quintals = 100 kg　　الكنتال = 100 كغ

Discussion

While this study produced yield responses consistent with expectations based on previous strudies, it showed no con-

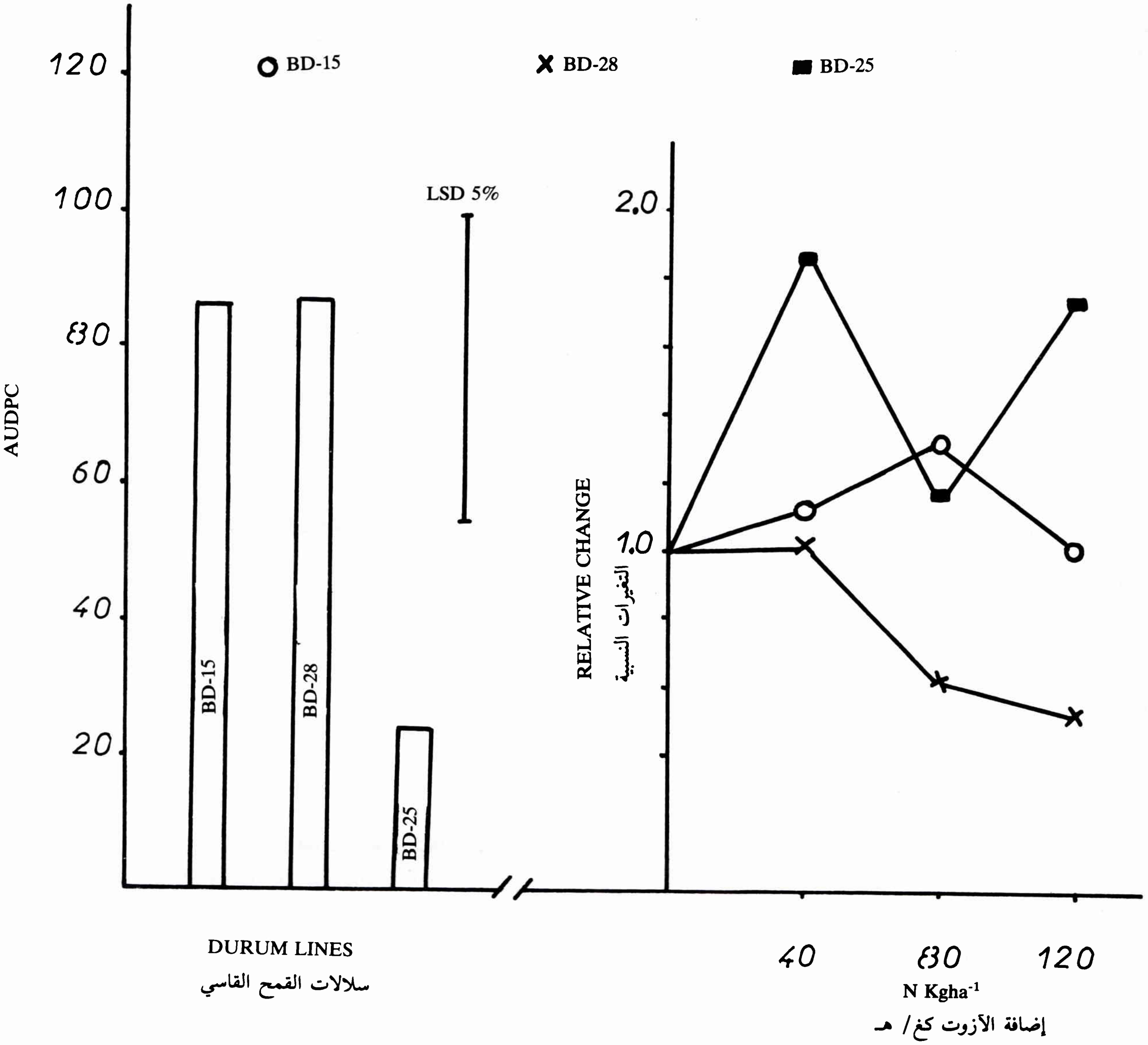

Fig. 1 Tan spot AUDPC disease ratings for unfertilized durum wheat lines and changes with N fertilization rates relatives to those controls.

شكل 1. تقييس «المساحة تحت منحنى تطور المرض» لمرض التبقع الأصفر على سلالات القمح القاسي غير المسمدة، والتغيرات في هذه المساحة عند إضافة معدلات آزوت مختلفة مقارنة بالشاهد.

sistency with the literature with regard to N and tan spot incidence. As with a similar study on Hessian flyresistant wheat Saada, at the same site (Ryan **et al.**, 1989), and both Saada and Nesma in several locations in the semi-arid zone of Morocco (Shroyer **et al.**, 1989) significant increases beyond the 40 kg ha^{-1} rate were few and inconsistent. Therefore the effect of N on disease incidence is of greater interest in the present context.

Though the three lines had similar yields without N, they differed in AUDPC rating. While the susceptible line were highly infected, the «resistant» one also showed a moderate degree of infection; thus the latter was not completely resistant to tan spot. The data of Cox and Hosford (1987) and Raymond **et al.** (1985) suggest that few wheat varieties show complete resistance in the field. Not withstanding such difference in degree of susceptibility, the data provide no conclusive support for the contention of Huber **et al.** (1987) that N fertilization can indeed reduce the severity of tan spot infection and thus reduce a major source of yield loss, especially in durum wheat. However, the trends exhibited here are intriguing. That two susceptible varieties should respond differently to N-one positively and one negatively-suggest that different physiological mechanisms are involved.

It is not clear why N appeared to increase disease incidence in the «resistant» line. However, a possible explanation between our results and those of Huber **et al.** (1987) may be that they ensured that ammonium N was the only form used, while in our study it is safe to assume that most of the N take up was as NO_3 since conditions were favorable for nitrification of the ammonium added as NH_4NO_3. Unless nitrification inhibitors are used, NO_3 is the major N form absorbed especially in warmer climates. Therefore, while such differential disease responses to applied N may tantalize the physiologist, the enthusiasm for control of tan spot with N fertilization has to be tempered by the data presented. With respect to N and plant diseases in general, it is important to bear in mind that even more cases of disease increases than decreases have been cited in the literature. Kommedahl (1984) concluded that N affects disease more by its effect on plant growth and vigor than by its effect on plant pathogens, especially if the N is in the NO_3 from.

الملخص

جونز، ج وم. عبد المنعم وجون ريان. 1990. علاقة التسميد الآزوتي بنمو القمح وتطوّر مرض التبقع الأصفر (*Pyrenophora tritici - repentis*). مجلة وقاية النبات العربية 8 (2): 113 - 110 .

يعتبر مرض التبقع الأصفر على أوراق القمح والذي يسببه الفطر *Prenophora tritici-repentis* (Died) Drechs. من الأمراض الهامة على محاصيل الحبوب في المغرب، وبخاصة على القمح القاسي *Triticum durum* L. ويعتبر تطوير أصناف مقاومة واستخدام الأسمدة الآزوتية وبخاصة النشادرية منها حلا واعدا للاقلال من حدوث المرض، وذلك بالنظر للصعوبات التي تواجه المزارعين في تطبيق المكافحة الكيميائية. وتهدف الدراسة الحالية، التي أجريت في حقول المزارعين، إلى دراسة استجابة صنف مقاوم وصنفين حساسين من القمح القاسي لمستويات مختلفة من الآزوت (0، 40، 80، 120 كغ/هـ). وقد أظهرت النتائج أن الأصناف الثلاثة استجابت جميعها للآزوت تبعا لمعدل استعماله. وكان تطور المرض عاليا على الأصناف الحساسة ومعتدلا على الأصناف المقاومة. وكانت استجابة تلك الأصناف للآزوت غير ثابتة. على أن مستوى الاصابة بالمرض انخفض على أحد الأصناف الحساسة عند تسميده بالآزوت.

كلمات مفتاحية: نجيليات، التسميد الآزوتي، أصناف مقاومة، المغرب.

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