NITROGEN AND PHOSPHORUS FERTILIZATION OF TRITICALE VARIETIES IN THE SETTAT AREA OF CHAOUIA

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ملخص

يعتبر التريتكال كبديل للحبوب في المناطق التي تتميز بقلة التساقطات المطرية، وذلك إعتمادا على مؤهلاته من حيث المردودية الهائلة ومقاومته الفعالة، زيادة على قدرة التلاؤم مع المناطق الغير الخصبة. وخضع التريتكال خلال السنوات العشر الماضية، لدراسات شملت التحسين الوراتي وطرق الزراعة في شمال إفريقيا وغرب آسيا، غير أن تلك البحوث لم تتطرق لاحتياج هذه الغلة إلى العناصر المغذية.

وتطرق البحث التالي إلى مدى تجاوب ثلاثة أصناف من التريتكال مع إستعمال الأسمدة، فتبين أن كمية السماد التي تتراوح بين 100 إلى 150 كلج/هكتار من الأزوط، مع 30 كلج/هكتار من الفسفور أعطت أكبر محصول. ورغم هذا كله يوجد تفاوت من حيث تجاوب الأصناف الثلاثة لاستعمال السماد. أما فيما يرجع للازوط أعطى خوانيلو (*Juanillo*) أكبر محصول متبوعا بـ دريدا أوتروس (*Dridaouteross*).

أما فيما يرجع للفسفور فأن دريدا جاءت في الدرجة الأولى متبوعة بخوانيلو بينما إحتل بيكل (*Beagle*) الصف الأخير في الأراضي ذات الخصوبة الدنيا خاصة، كما يمكن لمحصولي الحب والتبن أن يتزايدا بكيفية إيجابية نتيجة إستعمال الفسفور.

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RESUME

Due à son potentiel de rendement élevé, sa résistance aux maladies et son adaptabilité aux zones marginales, le triticale peut être un alternative ou au moins un céréale complémentaire dans les zones à faible précipitation.

Durant la dernière décinie, le triticale a fait l'objet de recherche surtout en amélioration et agronomie dans la région du Nord de l'Afrique et l'Asie occidentale mais rien ne s'est fait concernant les besoins de cette culture en éléments nutritifs. Cette étude était donc initiée pour étudier les réponses de trois variétés de triticale aux engrais azotés et phosphatés dans les zones arides et semi-arides du Maroc. Une augmentation significative du rendement des trois variétés dû aux apports d'engrais a été obtenue. Les doses de 100 à 150 kg N/ha et 30 kg P/ha ont donné le meilleur rendement. Cependant, les trois variétés diffèrent dans leur réponse aux apports d'engrais. En ce qui concerne l'engrais azoté, la réponse des trois variétés à la dose 100 kg N/ha était de l'ordre suivant : Juanillo a produit plus que Drira Outcross qui elle même a produit plus que Beagle. Alors que pour la réponse de ces variétés à la fertilisation phosphatée on a constaté que Drira Outcross était toujours mieux que Juanillo qui elle même était mieux que Beagle.

Le rendement en grain et en paille du triticale peut être augmenté d'une manière significative par l'apport d'engrais azotés et phosphatés et surtout dans les sols pauvres.

ABSTRACT

Because of high potential yields, disease resistance, satisfactory nutritional components, and adaptability to a wide range of marginal or stressed environments, triticale, a novel cereal with considerable commercial potential, is seen as an alternative, or at least a complementary cereal crop, particularly in low rainfall areas of the world. In the past decade, it has been the subject of breeding and agronomic research in the rainfed west Asia-North Africa zone. This study from the dryland area of Morocco involved a range of N and P rates in separate trials with three triticale varieties grown in a drought-prone shallow Petrocalcic Palexeroll.

The mean effects of N and P were significant ; for N, maximum responses were between 100 to 150 kg ha^{-1}, while the maximum P rate was 3C kg ha^{-1}. Varieties differed in grain and DM yields without N and P, and in their response to these elements. At 100 kg N ha^{-1}, the order was Juanillo > Drira outcross > Beagle. with P fertilization Drira Outcross consistently outyielded Juanillo, with both being superior to Beagle; Where soils are deficient in N and P, economic responses to both elements are likely. Thus adequate fertilization can markedly increase both grain and straw yields of triticale in Morocco's dryland zone.

KEY WORDS : cereal fertilization, soil test calibration.

INTRODUCTION

Triticale, a cross between wheat (*Triticum* spp. L.) and diploid rye (*Secale cereale* L.) has been in existence for well over a century. Through the efforts of plant breeders and agronomists, triticale has evolved from a "biological curiosity" to a major commercial crop now cultivated on over a million ha worldwide (Skovmand *et al.*, 1984). A number of genetic drawbacks (e.g., steriligy, seed shriveling, and pre-harvesss, sprouting) have militated against its more widespread attention. Ability to yield well under stress conditions, e.g., acid soils or drought, as well as its high grain protein content and disease resistance, have underlined continued efforts to develop triticale.

Its apparent adaptability to drought conditions has generated a lot of research interest in triticale in semi-arid regions. In the rainfed west Asia-North Africa area, Nachit and Malik (1983) focused on the importance of tillering for grain yield. Apparently, yield is related to early growth vigour, which is better for larger-seeded varieties (Nachit, 1982). Currently, efforts are being made to promote triticale in Turkey in environnemnents unsuited to wheat (Genc *et al.*, 1989). Progress in yield improvement and disease resistance has contributed significantly to an increasing area planted to triticale in another semi-arid area zone, Australia (Matheson, 1984).

Despite the plethora of studies on triticale cited by Skovmand *et al.*, (1984), few have dealt with its response to N and P -- the primary fertilizer inputs in semi-arid areas. The trials reported suggested that triticale and rye adsorb more N from the soil than wheat, while triticale and wheat appear to accumulate more P in their straw than rye. Greenhouse pot trials indicated that triticale was more efficient in absorbing N that either wheat or rye. Shoud these indications of increased nutrient utilization effeciency express themselves at field level it would be a major boost for triticale in dryland agriculture, which is characterized by low inputs of both N and P.

In Morocco, which is plagued by low and erratic rainfall and has large areas of marginal land for cereal growing, triticale has attracted a lot of interest. Here, efforts have been made to identify a nich for triticale in cereal-growing areas. Its high straw yield relative to other cereals has obvious attractions as an animal feed, especially in dryland farming systems where the animal component is a dominant one. Initial trials in Morocco its response to fertilizers has not been considered. Therefore, this study examined the impact of N and P fertilize rates on dry matter and grain yield components of three major triticale varieties grown on a shallow drought-prone soil.

MATERIALS AND METHODS

The location of the trial was 5 km east of Settat in the semi-arid Chaouia region of Morocco (mean annual rainfall, 386 mm). The soil was a shallow (< 35 cm) Petrocalcic Palexeroll which was cropped to barley (*Hordeun vulgare* L.) the previous year. Initial levels of $NaHCO_3$-P and NO_3 were low, ans such that a response to either element would be likely, i.e., 4.5 and 2.0 ppm, respectively (Ryan and Matar, 1990). The site was tilled in late Oct. 1988 with an offset disc harrow. Two separate P and N trials were laid out. The plots (1.8 x 5 m) were broadcast fertilized. Where P was a variable, it was applied at 0, 15, 30 and 60 kg P ha^{-1} as triple superphosphate, while a blanket application of N at 120 kg ha^{-1} was applied as ammonium nitrate. where N was a variable, it was applied as ammonium nitrate at 0, 50, 100, and 150 km N ha^{-1}, while P was applied at a blanket rate of 40 kg ha^{-1}. The fertilizers were incorporated by the "disc harrow" - this time at right angles to the plot length.

Subsequently, on Nov. 14, 1988, three varieties of triticale (Beagle, Drira Outcross, and Juanillo) were drilled at 80 kg seed ha^{-1}. In order to control Hessian fly (*Mayetiola destructor* Say), a major endemic pest of cereals in the dryland area of Morocco and indeed in other similar areas of the Middle East, carbofuran (Furadan 5G) was drilled with the seed at 1 kg a. i. ha^{-1}. A split plot desing was used with three replications ; varieties were the main plots and N or P rates the sub-plots. The only other subsequent cultural practice involved spraying to control weeds with "Cetrol H", i.e., Isoxynil (4-hydroxy-3, 5-diiodobenzonitril) at 4L active ingredient per ha at the tillering stage. The plots were harvested on June 12, 1989 by hand-cutting two inner 5-m rows.

Though rainfall for the season (370 mm) was close to average, it was erratically distributed. Following initial rains in Octo.-Nov. period, the first three months after planting witnessed below normal rains, i.e., precipitation for Dec., Jan., and Feb. was 25, 7, and 36 mm, respectively, during which time growth was negligible. The latter part of the season received above average monthly rain with resultant satisfactory yields from the harvested plots.

In order to economically assess the effect of N and P fertilization on triticale, prices were obtained for both inputs, N (124 Dh per 100 kg ammonium nitrate) and P (97 Dh per 100 kg as triple superphosphate) as well as prices for other inputs. Market prices per 100 kg of triticale grain (190 Dh) and straw (about 30 Dh) at harvest time were also obtained. Subsequently, gross and net revenues were calculated for each variety along with benefit-cost (B/C) ratios.

RESULTS

Statistical analysis of the date showed no significant interactions by fertilize and cultivars. However, individual effects of N and P were significant, as were cultivar differences. For the N trial, Drira Outcross and Juanillo consistently outyielded Beagle in terms of dry matter and grain yield (Table I). Juanillo was slightly higher for both measurements, but not significantly, so. For the P trial, mean effects of cultivars followed a similiar pattern except that Juanillo was not significantly better than Beagle.

The mean separate effects of N and P averaged over all three triticale cultivars were consistent and significant (Table II). For the N trial each 50 kg N increment increased dry matter up to the 100 kg level. Increasing N to 150 km ha^{-1} produced a further thought non-significant yield increase. Grain yield followed a similar trend with a maximum of P was less than that of N, both dry matter and grain yields increased significantly with added P, with maximum values at 30 kg P kg^{-1}.

Tableau I : Mean cultivar effects over all nitrogen and phosphorus rates.

Variety	y ieled			
	Dry Matter		Grain	
	N	P	N	P
	Mg ha-1			
Beagle Drira Outcress Juanillo	4.15 5.17 5.21	4.64 5.26 4.70	1.33 1.67 1.86	1.59 1.87 1.72
L . S . D . 5%	0.66	0.37	0.34	0.25

Tableau II : Mean dry matter and grain yield response of triticale cultivars to separately applied nitrogen and phosphorus.

Trials With		yield			
		Dry Matter		Grain	
N	P	N	P	N	P
kg ha-1		Mg ha-1			
0 50 100 150	0 15 30 60	3.31 4.56 5.56 5.37	4.30 4.55 5.24 5.37	1.15 1.60 1.84 1.89	1.49 1.64 1.82 1.96
L. S. D. 5%		0.78	0.51	0.29	0.19

Though these data demonstrate the importance of N and P fertilization of triticale, regardless of cultivar, the most important question is whether such responses to fertilizer inputs were profitable or not. That B/C date of Table III indicate that at most levels of N and P fertilization responses were indeed economical. With the exception of Drira Outcross, 150 kg N a-1 more than doubled the return on fertilize investment. Similarly, the use of 60 km P ha-1 was economical in all cases. As yield diminished with increasing fertilizer inputs, the highest returns on investment were at the lower application rates (30 kg Beagle ; 15 kg Juanillo, Drira Outcross).

Tableiau III : Estimated benefit-cost ratios form nitrogen and phosphorus fertilization of three triticale cultivars :

Treatment		Beagle		Drira Outcross		Juanillo		Average	
N	P	N	P	N	P	N	P	N	P
Kg ha $^{-1}$		B/C							
0	0	-	-	-	-	-	-		
50	15	5.2	3.6	3.0	8.2	6.1	7.2	4.8	6.3
100	30	2.7	5.6	2.2	7.7	7.0	5.1	4.0	6.1
150	60	2.3	2.4	1.6	5.7	3.4	2.3	2.4	3.5

B/C = Benefit-Cost (B/C) Ratios

DISCUSSION

Though preliminary in nature, this study revealed several positive aspects of triticale which should augur well for its widespread adoption in Morocco. While the early months of this trial were relatively dry, triticale adapted well to the drought stress. This was contrary to indications of lower drought resistance of several other triticale lines compared to wheat (*Sinha et al.*, 1986). While no quantitative measure of seedling vigour was made, both triticale trials were greener and more advanced, according to visual assessment, than any other cereal planted at the same date at the same site. This site included trials with five barley varieties (Ryan *et al.*, 1991), three durum (*Triticum turgidum* var. *durum* L.) lines (Jones et al., 1991), and a new Hessian fly-resistant breadwheat, (*T. aestivum* L.), Saada (Ryan et al., 1990). Furthermore, while these cereals were atacked by the normal range of fungal diseases and insects, there was no evidence of any significant disease incidence on any triticale variety. However, some sawfly (*Cephus* spp.) damage was evident.

From the earliest growth stages, visual differences due to both N and P fertilization were evident. While triticale yielded well by comparison with other cereals at that site, what is noteworthy here is the magnitude of the response to N. It is evident that up to 100 kg N ha^{-1} could be profitably used on triticale. This is in constrast to a maximum of 40 kg ha^{-1} with Saada wheat at the same site (Ryan *et al.*, 1990) and at several sites throughout the dryland zone in Morocco (Ryan *et al.*, 1991). The higher N requirement for triticale is hardly surprising in view of its relatively high yields, i.e., about two tons of grain and six tons of dry matter. These yields indicate triticale's potential for grazing and for animal feeding as straw. In deeper ans more productive soils, it is likely that, based on wheat yields with similar low low levels of N (Abdel Monem *et al.*, 1990a,). much higher triticale yields could be achieved. The yield responses of triticale to N achieved in this study could be generalized to most of the cereal growing area of Morocco since most soils are deficient in N. According to a survey (Abdel Monem *et al.*, 1990b), few fields had adequate nitrate levels to sustain growth without fertilization.

This trial clearly showed how essential P is for maximum yields of triticale. This was in contrast to the P trial with Saada wheat where a response was observed in the early growth stages but not reflected in final grain and straw yield in the early growth stages but not reflected in final grain and staw yield data (Abdel Monem and Ryan, 1990). Similiarly, trials with the common breadwheat Nesma at several locations the previous year revealed no P response (Abdel Monem et al., 1990 a). In the present study, the soil P level was 4 ppm as measured by the Olsen $NaHCO_3$ procedure. This is marginally lower than the accepted critical level for rainfed cereals in the Mediterranean zone (Ryan ans Matar, 1990). Since triticale did respond to added P and Saada wheat did not, it is obvious that a higher critical level of P applies to triticale.

Though Beagle produces satisfactory yields (Skovmand *et al.*, 1984), this study suggests that more emphasis be placed on Drira Outcross and Juanillo, as they were consistent better than Beagle. Our study coincided with two year trial date at low moisture sites in Syria (Nachit and Malik, 1983) which also showed Juanillo and Drira Outcross to be superior to Beagle. Beagle is one of the early triticale cultivars with large and shriveled seeds, whereas Juanillo is a more improved and well adapted cultivar.

Based on Yau's (1987) comparison of triticale and barley, one should, however, reserve judgment until these varieties are tested under poorer management conditions of farmers' fields ; triticale was shown to be inferior to barley as a dual-purpose crop in representative barley-growing areas of Syria. Factors such as seed rate and environment offset triticale's relative performance ; for optimum yield, a higher seed rate than for barley is required to compensate for seed size of triticale. Where environment is more favorable, i.e., better moisture and fertility (Nachit, 1983, the gap between barley and triticale narrows. Triticale narrows. Triticale's longer maturing time allows it to take advantage of such conditions.

In conclusion, this was the first study to show the importance of N and P fertilization of triticale in Morocco. Clearly, triticale has a complimentary role in the semi-arid cereal-producing zone. While many other factors involved with the adoption of triticale as a major commercial cereal in Morocco need to be considered, fertilizer trials are planned for a wide range of marginal environments to compare triticale with barley, the dominant cereal is such areas.

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