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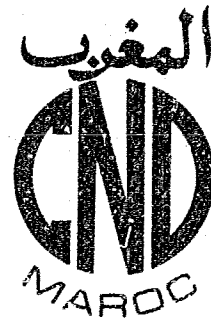
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مصلحة الطباعة والتصوير
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Triticale in diverse moroccan dryland zones: 25/10/93 93-393

the need for balances fertilization

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(Received March 11, 1992; Accepted June 18, 1992)

ملخص

إن الأبحاث الحديثة التي أجريت بالمناطق الشبه الجافة بالمغرب ودات تهاطلات مطرية دون 450مم أكدت أهمية الأزوت وبدرجة أقل الفسفور للقطنيات. هذه الدراسة الميدانية أجريت على أتربة ذات نقص في الأزوت والفسفور بمنطقة سطات وصخور الرحامنة. خمس كميات من الأزوت (120,90,60,30,0 كلغ أزوت للهكتار) وأربعة من الفسفور (30,20,10,0 كلغ فسفور للهكتار) وبكيفية عاملية تامة أسهمت (triticosecal). رغم أن التهاطلات المطرية كانت دون عادية وذات توزيع غير متكافئ، فقد كانت ملائمة بعد الزرع وفي مرحلة بعد الوالبة في فبراير و مارس. كما تأثرت المردودية بالأزوت والفسفور في كلتا الأتربتين. أما تجاوب لأحد العنصرين يزداد بوجود الآخر. الكميات المرتفعة للأزوت زادت في محتوى الحبوب من الأزوت بصخور الرحامنة جد جاف (225مم) وكما كانت المردودية جد ضعيفة بسطات (277مم). هذه النتائج تؤكد ضرورة الأزوت والفسفور في التربة التي تفتقر لهذين العنصرين. كما أن تحليلات التربة تمكن من تحديد متطلبات الزراعة وتطوير استعمال فعال واقتصادي للأسمدة.

الكلمات المفتاحية: القطناني - منطقة جافة - الأزوت - الفسفور - التريتيكال - المغرب.

Résumé

Les recherches récentes dans les zones semi-arides du Maroc, à précipitations inférieures à 450 mm, ont établi l'importance de l'azote, et à moindre degré, du phosphore pour les céréales en sec. Ces recherches ont concerné surtout le blé (*Triticum aestivum* L.) et l'orge (*Hordeum vulgare* L.). Dans le passé, la plupart des essais ont considéré les deux éléments séparément. Cette étude au champ a été conduite sur des types de sols très représentés dans les régions de Serrat et de Skhour Rehamna. Les deux sols sont carencés en azote et en phosphore. Cinq doses d'azote (0, 30, 60, 90, 120 Kg N/ha) et quatre de phosphore (0, 10, 20, 30 Kg P/ha), en factoriel complet, ont été apportées à une triticale (X Triticosecale). Bien que les précipitations aient été en dessous de la normale et comme d'habitude inégalement réparties, elles ont été favorables après le semis et au stade critique de post-tillage en février et mars. Les rendements ont été influencés par l'azote et le phosphore dans les deux sites. La réponse à l'un des deux éléments a été accentuée en présence de l'autre. Les doses élevées d'azote ont augmenté la teneur des grains en azote à Skhour Rehamna, plus sec (225 mm) et où les rendements ont été plus faibles qu'à Serrat (277 mm). Ces résultats soulignent la nécessité de fournir l'azote et le phosphore au sol quand il en est pauvre. Les analyses du sol permettent de déterminer les besoins de la culture et promouvoir une utilisation efficiente et économique des engrais.

Mots clés: Céréales en sec - Azote - Phosphore - Triticale - Maroc - Serrat - Skhour Rehamna

Summary

Recent research in Morocco's low rainfall zone, i.e., <450 mm., has established the importance of nitrogen and, to a lesser extent, phosphorus for dryland cereals. The main effort has been with wheat (*Triticum aestivum* L.) and barley (*Hordeum vulgare* L.). Most trials have, in the past, considered each element separately. This on-farm study on widespread soil types in the Serrat and Skhour Rehamna areas has deficient levels of both elements. (0, 30, 60, 90, 120 Kg N/ha) and P (0, 10, 20, 30 Kg P/ha) were applied to triticale (X Triticosecale). While rainfall was lower than normal and, as usual, erratically distributed, rains were favorable after planting and at the critical post-tillering stage in february and march. Total biomass and grain yield were recorded along with grain N content. Yield data were significantly influenced by both N and P at both sites. Responses to one element were accentuated in the presence of the other. The higher N rates increased grain N content at the drier Skhour Rehamna site (225 mm), where yields were lower than at Serrat (277 mm). The results underline the necessity of both N and P where both are deficient. Soil tests can establish such needs and promote efficient and economic fertilizer use.

Key words: Dryland cereals - Nitrogen - Phosphorus - Triticale - Morocco - Serrat - Skhour Rehamna

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♦ À qui toute correspondance doit être adressée

INTRODUCTION

Despite the modest increases in cereal output in Morocco in the last few decades (1), per capita production has persistently declined, largely as a result of increased population growth. Efforts to address this situation have hinged upon improved management as a result of research and technological development. The dryland semi-arid zone, i.e., 250-450 mm, was seen as having the most potential to improve cereal yields. Among the main strategies proposed to enhance output are fertilization and the use of improved cereal varieties or species (2).

Field research has established the almost universal occurrence of N deficiency and marked yield increases from N fertilization (3;4). Responses to applied P are less common and depend on the soil test level of available P (5). While the main focus of the soil fertility research associated with the dryland applied Agricultural Research Project in Settât has been with wheat (*Triticum aestivum* L.), attention has been recently centered on other cereals, i.e., barley (*Hordeum vulgare* L.), the dominant one in the dryland zone, and a comparative newcomer in Morocco, triticale (X Tritocosecal).

The region's development and global agronomic potential of triticale have been discussed in authoritative reviews, e.g. (6). Its potential in Morocco has been described by MERGOUM *et al.* (7); what limited information available suggests that it is adaptable and yields well in a range of stressed environments, i.e., sandy soils, cold mountainous areas, and under shallow droughty soils. It responds well to N and even outyields barley in relatively favorable conditions (8). In a separate trial with P, triticale responded well in comparison with other cereals (9). However, as economic fertilizer recommendations require that optimum responses of both N and P be established, and as these are influenced by environment - specifically rainfall, the foregoing trial involved combined N and P application rates for triticale at two varying rainfall locations.

MATERIALS AND METHODS

The sites for this on-farm trial were adjacent to Settât in the normally more favorable rainfall zone (386 mm) and about 70 Km south near Skhour Rehamna (270 mm). The soil types (table I) were representative of these respective cereal-growing areas. Actual rainfall for the season (Nov.-June) was lower than normal, but was well-distributed, especially at critical growth periods. The fields chosen were low in both N and P.

Table I. Site details

Characteristics	Settat	Skhour Rehamna
Soil type	Petrocalcic Palixeroll	Xeralf ¹
NaHCO ₃ -P (ppm)	4.0	3.1
Nitrate-N (ppm)	2.8	2.0
Mean annual rainfall (mm)	386	260
Season's rainfall (mm)	261	225
Previous crop	Barley	Fallow

¹ Probable classification

After disc-harrowing, the field plots (4 x 5 m) were laid out in triplicate in a split-plot design with N the main plots and P the sub-plot. Then fertilizers were hand-broadcasted, with N (0, 30, 60, 90, 120 Kg/ha) as ammonium nitrate and P (0, 10, 20, 30 Kg/ha) as triple superphosphate. Potassium was not applied since Morocco's dryland zone soils are seldom K-deficient. Soil test values for the two sites were above the critical value. A relatively new triticale cultivar, "juanillo", was hand-broadcasted at 132 Kg/ha and mixed in with a disc harrow along with the fertilizer (Nov. 28 at Settât, and Dec. 4 at Skhour Rehamna).

During the subsequent growing period, weeds were controlled at Settât by conventional spraying with "Certrol H". The Skhour Rehamna site was practically weed-free. At maturity, the crop was hand-harvested (May 24, Settât, June 4, Skhour Rehamna). The entire 5 x 5 m in each plot was taken in order to reduce variability due to sub-sampling. Total biomass and grain yields were recorded along with grain N content after total N analysis by the standard kjeldahl procedure.

RESULTS

While both N and P had overall significant effects on biomass and grain yields and quality, location had a major influence as well. Mean dry matter or biomass yields were considerably higher (6.29 t/ha) at the more favorable rainfall Settât site (277 mm) than at the drier Skhour Rehamna (225 mm) site. Normally, rainfall is higher at both locations (table I) with about a 100 mm rainfall differential between them.

The main factor contributing to yield increases was N (table II). At Settât, biomass yields significantly increased with each 30 Kg N increment, from 4.1 to 7.9 t/ha. Grain yields followed a similar pattern and ranged from 1.3 to 2.6 t/ha. However, at the Skhour Rehamna site, biomass yield did not increase beyond the 60 Kg N rate; grain yield increased only slightly with a further increase in applied N. In terms of grain N concentration, applied N had a variable effect depending on location. The higher N rates decreased grain N at the Settât location, but N consistently increased grain N at the Skhour Rehamna site, up to 90 Kg N/ha.

Table II. Mean* effects of nitrogen application rates on triticale parameters at two sites **

Nitrogen Kg/ha	Biomass		Grain		Grain N concentration	
	S. (t/ha)	S. R. (t/ha)	S. (t/ha)	S. R. (t/ha)	S. (%)	S. R. (%)
0	4.1e	3.1c	1.3d	1.1c	1.2a	1.4d
30	5.4d	4.1b	1.8c	1.4b	1.2a	1.6c
60	6.7c	4.5a	2.2b	1.6a	1.2a	1.8c
90	7.4b	4.5a	2.4a	1.6a	1.2ab	2.0b
120	7.9a	4.3ab	2.6a	1.5ab	1.1b	2.2a

* Within columns, means with different letters are significantly different
 ** S. = Settat; S.R. = Skhour Rehamna

The overall effect of P was also pronounced (table III), but to a lesser extent. Biomass yields at Settat increased from 5.0 t/ha up to 7.0 t/ha with 20 Kg P/ha; the corresponding increase in grain yield was from 1.7 to 2.3 t/ha. However, at the Skhour Rehamna site, biomass and grain yields increased up to the 30 Kg applied P rate. Contrary to N, the application of P had no effect on grain N concentration.

Table III. Mean effects* of phosphorus application rates on triticale parameters at two sites **

Phosphorus Kg/ha	Biomass		Grain		N content	
	S. (t/ha)	S. R. (t/ha)	S. (t/ha)	S. R. (t/ha)	S. (%)	S. R. (%)
0	5.0c	3.2c	1.7c	1.1d	1.21a	1.71a
10	6.0b	4.2b	2.0b	1.5c	1.20a	1.84a
20	7.0a	4.4b	2.3a	1.6b	1.18a	1.81a
30	7.1a	4.8a	2.4a	1.7a	1.22a	1.81a

* Within columns, means with different letters are significantly different
 ** S. = Settat; S.R. = Skhour Rehamna

The relative biomass yield responses of both N and P (figure 1) show that N response was higher at the more favorable Settat site than at Skhour Rehamna. It was clear that the higher N rates tended to decrease growth response. Response to P was relatively lower than to N with no obvious difference between the sites.

As there was a significant interaction between N and P, biomass yields are presented as a function of increasing rates of both elements (table IV). Without N, the response to P was significant at Skhour Rehamna at 10 Kg/ha with no further yield increase with increasing P. However, at Settat significant response occurred at 20 Kg/ha with no further increase above the rate. Without added P, the response to N was significant at the Settat site but not at the Skhour Rehamna site. With increasing levels of P, the response to N increased. Consequently, maximum yields were recorded at the 120 Kg N and 20 - 30 Kg P rates for Settat and at 90 Kg N/ha at Skhour Rehamna with the same range.

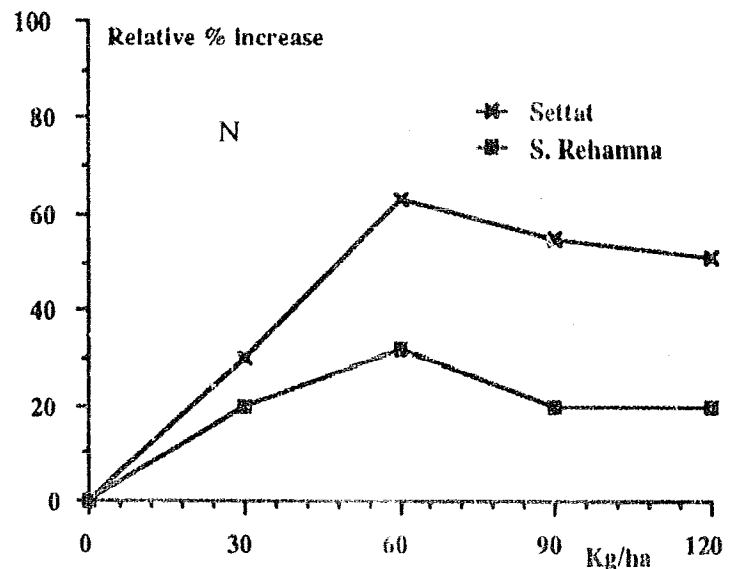
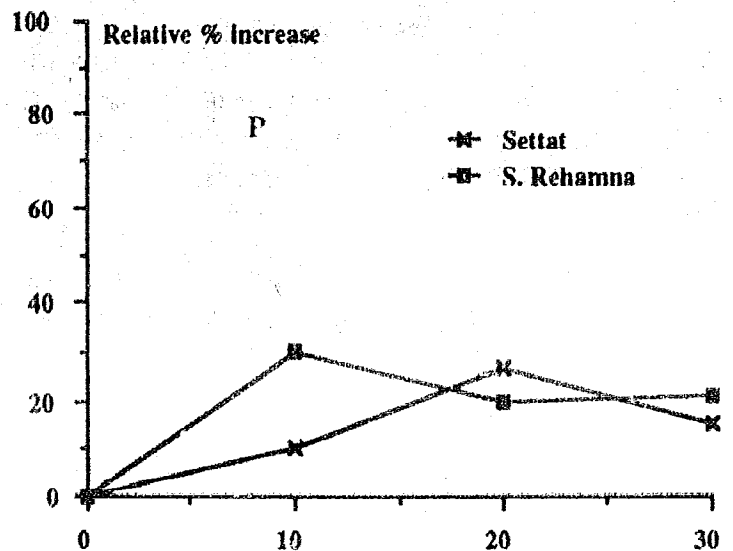


Figure 1. Relative increases in biomass yield from addition of P or N alone at two sites

Table IV. Interactions between N and P levels on triticale biomass yield at two sites

Nitrogen (Kg/ha)	Settat P - Kg/ha				Skhour Rehamna P - Kg/ha			
	0 (t/ha)	10 (t/ha)	20 (t/ha)	30 (t/ha)	0 (t/ha)	10 (t/ha)	20 (t/ha)	30 (t/ha)
0	3.6	4.0	4.5	4.1	2.7	3.4	3.2	3.2
30	4.7	5.5	6.0	5.5	3.2	3.9	4.8	4.6
60	5.9	6.3	6.9	7.7	3.5	4.8	4.6	5.2
90	5.5	6.8	8.2	8.9	3.2	4.5	5.0	5.4
120	5.4	7.7	9.5	9.1	3.2	4.2	4.6	5.4

LSD (5 %); Settat = 0.52; Skhour Rehamna = 0.30

DISCUSSION

The data from this trial demonstrate the potential impact of N on growth of triticale. As such, this crop responds in a generally similar manner as does wheat (3;10) and barley (8)

under the normal range, distribution and amount of rainfall in the semi-arid (250-450 mm) zone. While previous work had shown that all cereals, including triticale, respond well to applied P when levels of available P are deficient (8), this work underlines the importance of applying both N and P when both are deficient in the same field.

The synergistic N-P interaction can be established from a combination of field response data along with appropriate soil tests. Virtually all fields in the dryland area are deficient in N, except those where a legume was grown the previous year although this is not always the case (11). As the soil test for N, i.e. $\text{NO}_3\text{-N}$, indicates deficiency when values are less than 10 ppm, the test is not always reliable since NO_3 is dependent on mineralization, which is the outcome of soil and environmental factors, and is influenced by NO_3 mobility in the soil profile.

Thus for N, recommendations for N application rates have to be based on response data from field trials and projected grain yields. Such data suggest a range of 30 to 40 Kg N/ha in the lower rainfall zone, i.e., less than 300 mm, to about 90 Kg/ha in the more favorable areas of the zone. A general "rule of thumb" developed here is that about 3 Kg N is required for each 100 Kg grain. However, there are indications that this value may be as high as 4.5 Kg/100 Kg grain for Morocco conditions. Fertilization should consider N from the soil itself and as added fertilizer; in addition, fertilizer N is normally about 50%.

Phosphorus deficiency is less frequent than N; over half the samples in a recent survey of cereal fields in Chaouia (3) were lower than the critical P range of 6 to 7 ppm by the Olsen ($\text{NaHCO}_3\text{-P}$) test, which is a reliable indicator for Moroccan soils. This test is simple and can establish whether P is needed or not. If P is deficient, one can apply P at 10 to 20 Kg/ha as either triple superphosphate along with a single N source or as a combined N-P source such as diammonium phosphate. While many farmers use complete compounds involving N P K, the latter element is generally not needed for cereals in the dryland zone.

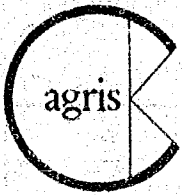
As balanced fertilization is necessary for economic grain and straw production, the impact on grain protein is debatable as the increased protein at higher N rates is not reflected in the pricing system for cereal grains. Clearly, other quality tests and millability have to be considered with N fertilization of triticale. Nevertheless, the prime contribution of this study is that it indicates for triticale the potential benefits of fertilization, a basis for applying needed fertilizer elements, and a general range of application.

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Auteur (s) Personne physique (Affiliation (s))		100	Ryan, J.; Mergoum, M.; Nsarellah, N.; Ouassou, O. (Aridoculture Center, Settat (Maroc))
Collectivité(s) auteur(s)		110	
Titre universitaire		111	
Titre anglais	Titre principal	200	Triticale in diverse Moroccan dryland zones: the need for balanced fertilization
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	Date	213	
Titre original (Translit.)	Titre principal	230	Le triticale dans différentes zones semi-arides marocaines.
	Éléments secondaires	231	
Édition (N°)		250	
No. Rapport/brevet		300	
Nos. secondaires		310	
ISBN/IPC		320	
Adresse bibliographique	Lieu de publication	401	
	Éditeur	402	
	Date de publication	403	
Collation		500	
Langue (s) du texte		600	(En) Résumés (Ar, Fr, Et)
Notes		610	4 tableaux. 1 fig. 11 réf.

2 009 **S**
NIVEAU

Titre de publication en série	Titre principal	230	Actes de l'Institut Agronomique et Vétérinaire Hassan 2 (Maroc)
	Éléments secondaires	231	Revue Sa... (Maroc)
ISSN		320	ISSN 0251-0466
Date de publication		403	(1992)
Collation		500	v. 12(2) p. 33-36
Notes		610	

Sections 3 à 5 au verso

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009 9 / EN 009 9 / ES 009 9 / (FR)

Code de langue des descripteurs (cerclez obligatoirement celui qui convient)

	Éti- quette	Notes (à dactylographier)
Descripteurs AGROVOC pour l'index maîtères dans Agrindex	800	TRITICALE, ARIDOCULTURE; FERTILISATIONS; (PRIMAIRE) ENGRAIS AZOTE; ENGRAIS PHOSPHATÉ; MAROC (Séparer les descripteurs par un point virgule (;) et un espace. Faire précéder les propositions de nouveaux descripteurs par un point d'interrogation (?))
Autres descripteurs AGROVOC		/
Commentaires sur les descripteurs existants ou proposés	810	

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009 9 /

Code de langue des termes d'indexation

Termes d'indexation du vocabulaire local	820	
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009 X / FR

Code de langue du résumé

Langue du résumé en clair	850	
Résumé	860	Présentation des résultats de essais relatifs à l'étude de l'importance des engrais, azote et phosphate, sur le rendement du triticale dans les zones semi-arides du Maroc

FIN

النهاية

8

مشاهد

VUES