Disease Buildup with Continuous Cereal Cropping in Northern Syria: Observations on Common Root Rot (*Cochliobolus sativus*) in Long-term Crops Rotation Trials

Seid Ahmed, Amor Yahyaoui, John Ryan and Mustafa Pala
International Center for Agricultural Research in the Dry Areas (ICARDA), P.O. Box 5466, Aleppo, Syria, Email: s.a.kemal@cgiar.org

Abstract

Ahmed, S., A. Yahyaoui, J. Ryan and M. Pala. 2011. Disease Buildup with Continuous Cereal Cropping in Northern Syria: Observations on Common Root Rot *(Cochliobolus sativus*) in Long-term Crops Rotation Trials. Arab Journal of Plant Protection, 29: 267-272.

Yield declines commonly observed under cereal monoculture are invariably attributed to disease buildup as well as nutrient and moisture depletions. While many long-term trials in the West Asia and North Africa region, especially in northern Syria rainfed cereal production belt, have assessed various cropping alternatives in comparison with fallow and continuous cereal cropping, few trials have involved measurement of fungal diseases. This paper reports observations made on the incidence of common root rot *(Cochliobolus sativus)* from long-term trials at the International Center for Agriculture Research in the Dry Areas involving wheat and barley. With both cereals, crop rotation with legumes was shown to reduce the incidence of root rot. The results clearly indicated the need for a more comprehensive phytopathological assessment of the implications of continuous cereal cropping, especially considering the effects of residue management and nitrogen fertilization.

Keywords: Common root rot, *Cochliobolus sativus*, cereal monoculture, Mediterranean agriculture.

Introduction

The Mediterranean region is where agriculture developed about 10,000 years ago and the center of origin of some of the world's major crops, notably cereals and legumes (4). Despite this cultural and historical antiquity, the region is now largely a food-deficit one, especially in West Asia and North Africa (WANA). Agricultural production is mainly constrained by drought as the prevailing crop production system is dependent on rainfall. In WANA region, annual rainfall is relatively low and ranges between 200 mm to 600 mm (10). As the Mediterranean climate involves two distinct seasons, rainfed cropping is possible in the "wet" fall to late spring period, with irrigated cropping only possible in the hot dry summer season. As rainfall varies seasonally and within seasons (18), drought is a common occurrence particularly at the end of the cropping season.

Cropping systems in the Middle East region have traditionally centered around cereals in association with animal production (1), both bread wheat (*Triticum aestivum* L.) and durum wheat (*T. turgidum var durum*) tend to dominate where seasonal rainfall is above 350mm, while barley (*Hordeum vulgare* L.) predominates in the drier areas (200-350 mm). In recent years the practice of fallow, which traditionally helped stabilize cereal yields due to carryover of residue moisture from the non-cropped fallow-year, has decreased due to land-use pressure. This trend has led to continuous cropping of barley or wheat (8); however, such monoculture has long been recognized as being unsustainable due to build-up of fungal diseases. Rotations that involved a non-cereal host crop were seen as an antidote to continuous cereal cropping (11).

The quest to finding an acceptable economic and biological alternative to monoculture as a replacement of fallow underpinned most of the long-term trials initiated at the International Center for Agriculture Research in the Dry Areas (ICARDA) during the 1980's (16). As both food and forage legumes are native to the Mediterranean region (5), it was natural that such legumes would be seen as alternatives to monocropping. While many of the long-term cropping system trials showed that continuous cropping of wheat (17) and barley (8, 9) was lowest in terms of grain and straw yields, the factors responsible for such declines were not addressed. Reduced soil moisture was cited as the reason for yield declines for wheat (12) and barley (6). However, no consideration was given to the possible buildup of fungal diseases in continuous cereal cropping in such long-term trials despite the common assumption that diseases are a key factor in affecting crop production under rainfed agriculture.

During the course of the long-term rotation trial at ICARDA, parallel studies had indicated the possible significance of the soil-borne disease, common root rot (CCR) caused by *Cochliobolus sativus,* which is common in many parts of the world (3) and is often associated with wheat and barley cropping system (19). While recognizing differences between cereal cultivars and cropping seasons, van Leur *et al.* (21) found highest barley yield reduction in northern Syria from root rot under dry conditions, as well as a significant yield increase for two susceptible lines grown under adequate moisture. Earlier works had also shown some inconsistency with respect to the effects of cereal root rot where Wildermuth (22) found that root rot was promoted by monoculture, while Peining *et al.* (13) found that fallow increased root rot but that fertilizer restricted its development.

Given the potential importance of root rot for widespread of cereal cultivation in Mediterranean dryland cropping systems and minimal assessment of phytopathological investigations within the context of the cereal long-term trials conducted by ICARDA in northern Syria, this paper reports on observations of root rot intensity on wheat (including N fertilizer and residue treatment) and barley at two contrasting rainfall locations during two cropping seasons.

Materials and methods

The investigation of wheat and barley root rot diseases was conducted at ICARDA's experimental stations in northern Syria, on the long-term trials under dryland conditions. The wheat trial was at Tel Hadya (350 mm average rainfall) and two barley trials were conducted at Tel Hadya and also at a drier location (280 mm) at Breda. Agroclimatic information on the testing sites was previously described (15); the main difference was in rainfall.

Wheat-based two-course rotation

This trial began in 1983/84 and terminated in 2007/08. The trials were described by Harris (7) and Ryan *et al.,* (15). The trial involved durum wheat in rotation with chickpea (*Cicer arietinum*), lentil (*Lens culinaris*), vetch (*Vicia sativa*), medic (*Medicago* spp.), melon (*Citrullus vulgaris*) as a summer crop, cultivated fallow, and wheat (i.e. continuous wheat). Nitrogen fertilizer application (0, 30, 60, 90 kg N/ha) while grazing intensity (high, medium, and no-grazing) comprised the sub-sub-plots in a split-split-plot design. Both cereal and non-cereal phases were present each year. Disease data were collected from two replicates of each treatment.

Barley-based two-course rotation

This trial (8) established in 1982/83 at Tel Hadya and Breda involved barley with fallow, continuous barley, common vetch (*V. sativa*), norbon vetch (*V. narbonensis*) and grasspea (*Lathyrus sativus*) with various combinations of N (ammonium nitrate) and P as triple super phosphate (0:0, 0:60, 40:60, and 80/60 at Tel Hadya, and lower N rates at Breda) applied to the barley phase.

Residue management: Barley/Vetch rotation

This trial at Breda, established in 1989/90 involved five residue management (straw removed or grazing stubble) treatments in combination with tillage. As in other trials, both N and P fertilizer were applied.

Fungi isolation and disease assessments

Roots (10-15 plants per plot) were washed for 20 minutes in running tap water and gently scrubbed to remove closely adhering soil. Sub-crown internodes (10 mm) were excised and surface sterilized with 10% Chlorox (0.5% NaOCl) for 5 minutes and rinsed five times in sterile distilled water, dried then blotted on sterile filter paper. Root segments were plated on potato dextrose agar (39 g Difco/liter) and incubated for 10 days at room temperature on a laboratory bench (12-h fluorescent light) at 20-22°C.

Cochliobolus sativus was identified directly on the medium using a compound microscope. Disease assessment was made for the 1995/96 cropping season on roots collected from standing stubbles after harvest. Disease evaluations (at GS 92 growth satge) were made on all barley-based rotation trials for the 1996/97 cropping season and in the wheat-based trial, for the 1996/97 and 1997/98 cropping seasons.

Sub-crown internodes sampled from barley and wheat roots were assessed for disease incidence and severity. Disease severity was assessed on 0-5 rating scale where: 0= no symptoms; 1= <10% light brown lesions, <1% black lesions; 2= 10-50% light brown lesions, 1-10% black lesions; 3= >50% light brown lesions, 10-50% black lesions; 4= 50-99% black lesions and 5= completely covered with black lesions (22).

Disease intensity (DI) was calculated using the formula:

DI= Incidence (%) x Severity/5 (maximum disease score)

DI was used to evaluate the effect of different treatments on root rot in 1997/98.

Data Analyses

Analysis of variance was performed for percent disease intensity for root rot. When appropriate, data were either arcsine or square root transformed (x+1) to homogenize the variance. Correlation analyses were done between percent isolation frequency of *C. sativus* and disease intensity for some of the rotation trials.

Results

Fungi isolation

Barley rotation - Contrary to expectations, the mean percent isolation frequency was higher in barley-legume and barley-fallow rotated plots than in the continuous barley in both seasons at Tel Hadya (Figure 1). In 1995/96 cropping season, the highest mean isolation frequency (16.8%) was observed in plots receiving 80 kg N/ha, in contrast to 1996/97 where the highest isolation frequencies were from plots without N fertilization. In 1996/97 cropping season, other fungi associated with barley root rots and their frequency of recoveries (n= 757 SCI pieces) were *Fusarium nivale* (6.6%), *F. culmorum* (0.3%), *F. oxysporum* (0.4%), *F. solani* (4.4%), *Rhizoctinia bataticola* (1.1%) and other *Fusarium* spp (25.6%).

Residue management – Barley-Vetch - Despite the various management variables involving stubble management (removal or retention), tillage (in October or June, and no. till), and combination of N and P, the result (Table 1) showed no consistent effects on mean percent isolation frequency of *C. sativus* at Breda. Reflecting the variability within individual treatments, means showed no consistent trend, though in 3 of the 5 residue management treatments nitrogen fertilizer tended to reduce the mean isolation frequency compared to the unfertilized control.

In the barley-vetch rotation (Table 2), the highest mean isolating frequency (28.8%) was observed in treatment 1 and the lowest (6.8%) were observed in treatment 4. When the effect of nitrogen fertilizer application was compared, low mean percent isolation frequency was observed in plots receiving 20 kg N/ha. In the barley-barley rotation, fungi associated with barley roots and their frequency of recoveries (n = 593 SCI pieces) were *C. sativus* (9.4%), *F. nivale* (0.8%), *R. bataticola* (0.2%) and other *Fusarium* spp (8.3%). In the barley-vetch rotation, the fungi associated and their frequency of recoveries (n = 615 SCI pieces) were *C. sativus* (21.2%), *F. nivale* (5.8%), *F. solani* (3.7%), *R. bataticola* (3.9%) and other *Fusarium* spp (8.3%).

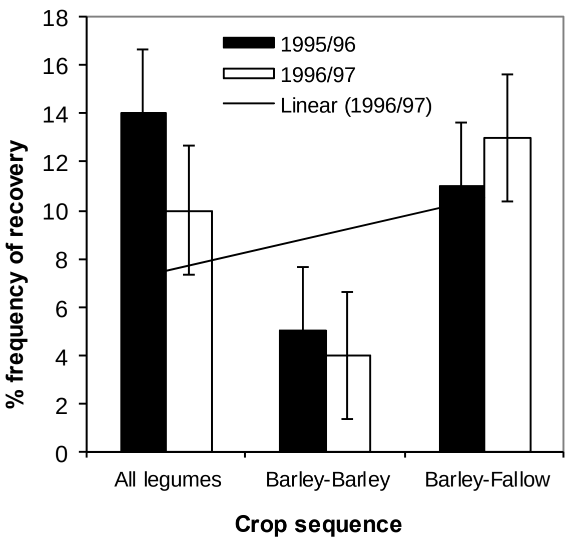

Figure 1. Effect of crop sequence on mean percent isolation frequency of *Cochliobolus sativus* from barley roots, Tel Hadya, northern Syria. The bars showed standard errors of the means.

Wheat based two-course rotation - In 1996/97 cropping season, the highest mean percent isolation frequency (45%) was observed in wheat-fallow and wheat-melon rotations and the lowest (16.4%) value was from wheat-chickpea rotation (Figure 2). The highest isolation frequency (34.3%) was observed in plots fertilized with 30 kg N/ha and the lowest (27%) was observed in plots without fertilizer applications. The fungi associated with wheat roots and their frequency of recoveries (n = 957 SCI pieces) were *C sativus* (32.3%), *F. nivale* (1.8%), *F. culmorum* (0.1%), *F. solani* (1.5%), *R. bataticola* (1.8%), and other *Fusarium* spp. (11.5%) in the experimental plots.

Disease Intensity

Barley rotation - In 1996/97 cropping season, significant differences (p≤0.05) were observed among treatments in affecting percent CRR intensity at Breda but not at Tel Hadya. At both locations, the mean percent of CRR intensity was lowest in legume rotation than in barley-fallow rotation and continuous barley (Figure 2). On average, the lowest mean values of CRR intensity were observed in plots fertilized only with phosphorous (data not shown). However, nitrogen fertilization did not show clear trend in affecting root rot intensity at both locations.

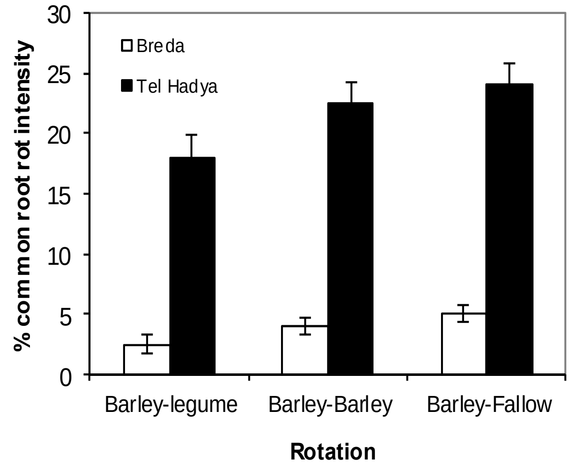

Figure 2. Effect of cropping sequence on mean intensity of common root rot of barley at two locations in northern Syria, during 1996/97 cropping season. The bars showed standard errors of the means.

Residue management: barley-barley and barley-vetch - In the continuous barley rotation, significant differences (p≤0.05) were observed among N levels and their interactions with residue management practices in affecting disease intensity but not in the barley-vetch rotation. In the barley-barley rotation, the highest and lowest mean root rot intensity were observed in treatment 2 and 4, respectively, which differed only in planning or not planning (Table 2). In the barley-vetch rotation, however, the highest and lowest values were from T2 and T5, respectively. In the barley rotation, the non-fertilized plots had the lowest root rot intensity compared to the ones in the vetch rotation.

Wheat-based two-course rotation: Significant differences (p≤0.05) were observed among nitrogen levels for percent root rot in 1996/97 cropping season but not in the following season. Based on the two season results, the highest percent intensity was in wheat-fallow rotation and the lowest was in plots rotated with chickpea (Table 3). The highest mean disease intensity was observed in plots receiving the highest nitrogen application.

Correlation analysis

The correlation between mean percent root rot and the frequency of isolation of *C. sativus* was positive (r = 0.73 and r = 0.63, respectively) for the residue management in barley-barley and wheat-based rotations. However, the correlation was only significant in the residue management in barley-vetch rotation (r = 0.94).

Table 1. Effect of residue management practices and fertilizer application on mean percent isolation frequency of *Cochiobolus sativus* in barley-barley rotation at Breda (1995-97) in northern Syria.

	NP kg/ha			
Treatment	**0:0**	**20:60**	**40:60**	**Mean**
	1995/96			
1. Straw (-), graze stubble, plow (Oct.)	14.4	14.4	25.0	17.9
2. Straw (-), stubble (+), low (Oct.)	6.2	18.5	5.8	10.2
3. Straw (-), graze stubble, plow (June)	19.4	21.2	5.8	15.5
4. Straw (-), stubble (+), no plow	2.6	18.5	3.6	8.2
5. Straw (+), stubble (+), no plow	24.0	4.4	6.2	11.5
Mean	**13.3**	**15.4**	**9.3**	
	1996/97			
1. Straw (-), graze stubble, plow (Oct.)	21.2	6.8	2.9	10.3
2. Straw (-), stubble (+), low (Oct.)	29.2	1.0	14.4	14.9
3. Straw (-), graze stubble, plow (June)	7.3	1.0	1.0	3.1
4. Straw (-), stubble (+), no plow	4.4	1.0	15.2	6.9
5. Straw (+), stubble (+), no plow	7.3	12.2	8.4	9.3
Mean	**13.9**	**4.4**	**8.4**	

+/- = leave or remove straw/ stubble

Table 2. Effect of residue management practices and fertilizer application on mean percent intensity common root rot, 1996/97 cropping season, at Breda in northern Syria.

	NP kg/ha			
Treatment	**0:0**	**20:60**	**40:60**	**Mean**
	Barley/Barley			
1. Straw (-), graze stubble, plow (Oct.)	10.3	15.2	35.0	20.2
2. Straw (-), stubble (+), low (Oct.)	23.5	18.0	45.0	28.8
3. Straw (-), graze stubble, plow (June)	3.9	5.5	19.0	9.5
4. Straw (-), stubble (+), no plow	5.7	9.8	1.3	5.6
5. Straw (+), stubble (+), no plow	6.3	16.7	3.8	8.9
Mean	**9.9**	**13.0**	**20.8**	
LSD (0.05) = 6.61 for fertilizer.				
	Barley/Vetch			
1. Straw (-), graze stubble, plow (Oct.)	13.7	14.6	14.6	14.3
2. Straw (-), stubble (+), low (Oct.)	17.3	30	27	24.8
3. Straw (-), graze stubble, plow (June)	22	8.7	12.9	14.5
4. Straw (-), stubble (+), no plow	8.8	20.7	11.3	13.6
5. Straw (+), stubble (+), no plow	12.5	10.1	10.0	10.9
Mean	14.9	16.8	15.2	
LSD (0.05) = NS.				

+/- = leave or remove straw/ stubble

Discussion

The rationale for this study of continuously cropped barley and wheat in the context of on-going long-term trials in northern Syria was that monocropping would result in low or declining yields due to disease buildup. While several fungal species are associated with cereal diseases, our observations centered around *C. sativus*, the causal agent of common root rot, as this pathogen was shown to be associated with cereal cropping in Syria, particularly barley (20, 21). It was assumed that root rot incidence would be influenced by non-cereal rotations to break the disease cycle and that it would also be influenced by residue or stubble management and by N fertilization. It was anticipated that the various crop rotations and management factors would be reliably expressed by the percent isolation frequency of the organism and by the intensity of infection of *C. sativus* on the cereal roots. The data sets in this study confirmed the expectations in some aspects and were inconsistent in others. The study showed that legumes in rotation with barley reduced the incidence of *C. sativus*. While differences between legumes were not consistent, barley after vetch tended to have lowest disease incidence. Differences with respect to rotation are likely to be accentuated with longer rotations, i.e., more years with a non-cereal (14). Regardless of whether barley straw was removed, grazed or left in the field, no particular pattern with respect to root rot was observed. Similarly, despite expectations, no conclusion could be made on the effect of N fertilizer, thus being unable to resolve the conflicts in the literature regarding nitrogen effect on root rot disease (2, 13, 22). While there were differences between the two cropping seasons with respect to root rot, we could not detect any major differences due to season as noted by van Leur *et al.* (21) since rainfall in both years was relatively similar.

In conclusion, this study adds further to the overall body of knowledge of cropping systems in northern Syria's dryland cereal zone. It provided another element of support for using legumes as a substitute for fallow and an alternative to continuous cereal cropping which is not sustainable since such rotations lead to greater yields (17) and greater water use efficiency (12) as well as additional benefit in terms of soil quality (16). Given the sparse information on soil borne root diseases of cereals, this preliminary phytopathological investigation should be a catalyst for further in-depth cropping association with soil borne diseases and quantification of the influence of root diseases in cereal cropping systems.

Table 3. Effect of crop rotation and nitrogen fertilization on mean percent intensity of common root rot of wheat at Tel Hadya (Mean of two cropping seasons, 1996/97, 1997/98) in northern Syria.

	N kg/ha				
Crop Sequence	**0**	**30**	**60**	**90**	**Mean**
Wheat-wheat	13.1	9.4	9.5	12.1	11.0
Wheat-chickpea	13.0	4.0	5.0	8.5	7.6
Wheat-fallow	18.2	16.5	18.0	16.5	17.3
Wheat-medic	6.1	7.5	14.0	22.5	12.5
Wheat-watermelon	7.4	5.3	8.5	18.5	9.9
Wheat-lentil	8.7	12.5	13.0	14.5	12.2
Wheat-vetch	14.5	11.8	9.5	14.0	12.4
Mean	11.6	9.6	9.6	15.2	

الملخص

أحمد، سعيد، عمر يحياوي، جون رايان ومصطفى بالا. 2011. تزايد المرض مع الزراعة المستمرة لمحاصيل الحبوب في شمالي سورية. مشاهدات على التعفن الشائع للجذور (*Cochliobolus sativus*) في تجارب دورات زراعية طويلة الأمد. مجلة وقاية النبات العربية، 29: 267-272.

يعزى انخفاض الإنتاجية تحت ظروف الزراعة أحادية المحصول بمحاصيل الحبوب دائماً إلى تزيد المرض بالإضافة إلى استنزاف العناصر المغذية ورطوبة التربة. وفي حين قدرت دراسات عديدة في منطقة غرب آسيا وشمال إفريقيا (وانا)، البدائل المحصولية المختلفة وبخاصة في حزام إنتاج النجيليات البعلي في شمالي سورية بالمقارنة مع البور والزراعة المستمرة لمحاصيل الحبوب، فإن تجارب قليلة شملت قياس الأمراض الفطرية. وتسجل هذه المقالة مشاهدات عن سيادة مرض تعفن الجذور الشائع (*Cochliobolus sativus*) من تجارب طويلة الأمد منفذة في المحطة الرئيسية للمركز الدولي للبحوث الزراعية في المناطق الجافة (إيكاردا) شملت القمح والشعير. ومع كلا المحصولين، أظهرت الدورة الزراعية مع البقوليات الحبية انخفاضاً في معدل الإصابة بالتعفن الشائع للجذور. وتشير النتائج بوضوح إلى الحاجة لإجراء تقدير مرضي نباتي أكثر شمولية للآثار المترتبة على الزراعة أحادية المحصول المستمرة من الحبوب، ولا سيما تلك المتعلقة بتأثيرات إدارة المخلفات المحصولية والتسميد النيتروجيني.

كلمات مفتاحية: تعفن جذور شائع، *Cochliobolus sativus*، الزراعة أحادية المحصول، الزراعة المتوسطية.

عنوان المراسلة: سعيد كمال، مخبر الأمراض، المركز الدولي للبحوث الزراعية في المناطق الجافة (ايكاردا)، ص.ب. 5466، حلب، سورية، البريد الإلكتروني: s.a.kemal@cgiar.org

References

المراجع

1. **Cooper, P.J.M., P.J. Gregory, D. Tully and H.C. Harris.**1987. Improving water-use efficiency of annual crops in the rainfed farming systems of West Asia and North Africa. Experimental Agriculture, 23: 113-158.
2. **Daris, R.A., D.R. Huggins, R.J. Cook and T.C. Paulits.** 2009. Nitrogen and crop rotation effects on fusarium crown root rot in no-till spring wheat. Canadian Journal of Plant Pathology, 31: 456-467.
3. **Duveiller, F. and G. Altamirano**. 2000. Pathogenicity of *Bipolaris sorokmiana* isolates from wheat roots leaves and grains in Mexico. Plant Pathology, 19: 235-242.
4. **Harlen, J.R**. 1992. Crops and Man. 2nd Ed., Crop Science Society of America, Madison, WI, USA. 248 pp.
5. **Harrison, J.G., G.W. O'Hara and S.J. Carr**. 2000. Changing rates of legumes in Mediterranean agriculture: developments from an Australian perspective. Field Crops Research, 65: 107-122.
6. **Harris, H.C**. 1994. Water-use efficiency of crop rotations in a Mediterranean environment. Aspects of Applied Biology, 38: 165-172.
7. **Harris, H**. 1995. Long-term trials on soil and crop management at ICARDA. Advances in Soil Science, 19: 447-469

8. **Jones, M.J. and M. Singh**. 1995. Yields of crop dry matter and nitrogen in long-term barley rotation trials at two sites in northern Syria. Journal of Agriculture. Su. Cambridge, 124: 389-402.
9. **Jones, M.J. and M. Singh**. 2000. Long-term yield patterns in barley-based cropping systems in northern Syria. 3. Barley monocropping. Journal of Agriculture. Su. Cambridge, 135: 251-259.
10. **Kassam, A.H**. 1981. Climate, soil and land resources in North Africa and West Asia. Plant and Soil, 58: 1-29.
11. **Karlen, D.L., G.E. Varvel, D.G. Bullock and R.M. Cruse**. 1994. Crop Rotations for the 21st Century. Advances in Agronomy, 53: 1-45.
12. **Pala, M., J. Ryan, H. Zhang, M. Singh and H.C. Harris.** 2007. Water-use efficiency of wheat-based rotation systems under a Mediterranean environment. Agriculture and Water Management, 93: 136-144.
13. **Piening, L., R. Edwards and D. Walker.** 1969. Effect of some cultural practices on root rot of barley in central Alberta. Canadian Plant Diseases Survey, 49: 95-97.
14. **Peining, L.J. and D. Orr.** 1988. Effect of crop rotation on common root rot of barley. Canadian Journal of Plant Pathology, 10: 61-65.
15. **Ryan, J., S. Masri, S. Garabet, J. Diekmann and H. Habib**. 1997. Soils of ICARDA's agricultural experiment stations and sites: climate, classification, physical and chemical properties and land use. Tech. Bull., International Center for Agricultural Research in the Dry Areas, Aleppo, Syria.
16. **Ryan, J., M. Singh and M. Pala**. 2008. Long-term cereal-based rotation trials in the Mediterranean region: implications for cropping sustainability. Advances in Agronomy, 97: 273 - 319.
17. **Ryan, J., M. Singh, M. Pala, R. Makhbail, S. Masri, H.C. Harris and R. Sommer**. 2010. Nitrogen fertilizer and grazing intensity in relation to wheat yields in rainfed systems. Journal of Agricultural Science, Cambridge, 148: 1-12.
18. **Smith, R.G. and H.C. Harris**. 1991. Environmental resources and constraints to agricultural production in a Mediterranean-type environment. Plant and Soil, 58: 31-57.
19. **van Leur, J.A.G. and S. Ceccarelli**. 1990. Subsistence farmer strategies in response to drought and biotic stress uncertainty. Pages 169-174. In: Proceedings of the International Symposium on Basic Stresses of Barley in Arid and Semi-Arid Environments. ICARDA and Montana State Universal, Bozeman.
20. **van Leur, J.A.G., W.E. Grey, L. Qu and M. Z. Alamdar**. 1991. Occurrence of root rot in barley in an experimental site in north west Syria and varietal differences in resistance of *Cochlibolus sativus*. Arab Journal of Plant Protection, 9: 129 - 139.
21. **van Leur, J.A.G., M.Z. Alamder and S. Khawatmi**. 1997. Effect of common root rot (*Cochlibolus sativus*) on yields of barley under experimental continuous in northern Syria. Australian Journal of Agricultural Research, 48: 351-357.
22. **Wildermuth, G.B**. 1986. Geographic distribution of common root rot and *Bipolaris sorokiniana* in Queensland wheat soils. Australian Journal of Agricultural Research, 26: 601-606.

Received: June 29, 2010; Accepted: June 21, 2011

تاريخ الاستلام: 2010/6/29؛ تاريخ الموافقة على النشر: 2011/6/21