	Started in 1993 Monitored in: 99		left in place. Wheat straw that passes through the combine removed. Wheat straw chopped and left in place; maize stover removed for fodder.			MAIZE Lower incidence on permanent beds, regardless of the type of straw management (burn or retain).	(straw incorporated) than permanent beds with or without straw retention.	MAIZE Yields obtained were not statistically different; spikes/m^2 yield component was significantly higher in permanent beds retaining straw.
ME1	**402–Obregon Disease status in summer maize wheat rotation with different straw and tillage practices.** Started in ? Monitored in: 99	Permanent beds Beds with conventional tillage	Straw retained Straw burned With or without solarization after wheat harvest.	Winter wheat Summer maize	275	WHEAT No significant differences among treatments. MAIZE Significantly higher incidence in conventional-tilled beds regardless of straw management No effect of solarization observed.	*P. thornei* numbers higher when straw is burnt than retained. Trend for nonparasitic nematodes to be higher under conventional till (with or without straw incorporation) than permanent beds with or without straw retention.	WHEAT Yields better with residue retention, but minor tillage effect. MAIZE Yield not determined in all years.

To date some generalized conclusions are:

Tillage and straw management. In wheat, zero and conventional tillage with straw removal increases root disease symptoms, while straw retention decreases. The effect of straw management under continuous maize rotation was not clear; it sometimes increases and other times decreases root disease. The number of nonparasitic nematodes (including fungal and bacterial feeders) was generally higher with straw retention than straw removal. For continuous wheat, there was little difference in yield with zero or conventional tillage. The yield of maize, averaged over the different rotation, tillage, and residue management treatments, was better under conventional tillage than zero tillage, but much larger, significant interactions between the management treatments occurred for maize as compared to wheat. A lower incidence of weeds also was found in zero tillage compared to conventional tillage.

Crop rotation. The crop rotations investigated so far did not clearly affect the incidence of disease on root systems of both maize and wheat. The numbers of the root lesion nematode were generally found to increase under continuous wheat than a maize/wheat rotation. The wheat–maize rotation gave better yields than continuous wheat or continuous maize. The use of vetch in winter in rotation with wheat also gave better yields compared to the use of rape.

Nutrition. Effects of nutrition on root disease incidence were variable. Obregon tended to have a higher number of root lesion nematodes and greater root disease incidence with increasing nitrogen fertilizer application.

Crop management practices in some cases obviously have a marked effect on the incidence of root diseases. To date, none of the changes in the incidence or presence of the root diseases monitored in these experiments appeared to be correlated with yield. However, trends indicated that both factors have increased with certain management practices. More time is needed for these trials to show evidence of yield losses associated with root pathogens that are correlated with environmental conditions and soil chemistry. Work will continue to determine the most appropriate crop management practices for a range of MEs.

Exploiting synthetic hexaploids for improving wheat resistance to crown rot (Fusarium graminearum – Group 1) and common root rot (Bipolaris sorokinana).

J.M Nicol and A. Mujeeb-Kazi.

Background. Root rots caused by *F. graminearum* and *B. sorokinana* are common and are implicated in causing significant yield losses of wheat (Tinline et al. 1988; Wildermuth et al. 1992; Diehl et al. 1983). The fungi are particularly important in marginal environments of low rainfall and poor soil nutrition, such as large regions in west Asia and North Africa. CIMMYT has begun a new program for screening and breeding resistance for these soilborne pathogens. These pathogens are difficult to work with, because they are soilborne and cannot be screened easily in the field; hence, a laboratory/field breeding strategy

Table 17. Mean resistance scores for roots (RS), shoots (SS), coleoptile (CS), and an overall total score (TS (RS+SS+CS/3)) for synthetic derivatives and the resistant and susceptible check lines when inoculated with crown rot and common root rot fungi. Data based on a 0–5 ranking of lesioning; 0 = no lesions, 1 = 0–25 %, 2 = 25–50 %, 3 = 50–75 %, 4 = 75–100 % and 5 = dead.

	Crown rot				Common root rot			
Material	RS	SS	CS	TS	RS	SS	CS	TS
PEDIGREE OF SYNTHETIC DERIVATIVE								
Sabuf/3/BCN//Ceta/*Ae. tauschii* (895)	0.38	0.31	0.63	0.44	0.81	0.44	3.0	1.42
Altar 84/*Ae. tauschii* (224)//YACO/6/ CROC 1/*Ae. tauschii* (205)/5/BR12*3/4/... 224)	0.31	0.94	1.95	1.09	1.19	1.06	3.12	1.79
MAYOOR/TKSN1081/*Ae. tauschii* (222)	1.25	0.81	1.38	1.15	0.69	0.56	3.5	1.58
CHECK LINES FOR RESISTANCE								
2-49 for crown rot	0.63	0.81	1.13	0.85	2.00	0.31	3.88	2.10
302-5 for common root rot	1.06	0.69	1.22	0.68	1.50	0.44	3.50	1.90
CHECK LINES FOR SUSCEPTIBILITY								
Batavia for crown rot	1.06	1.19	1.75	1.33	2.30	0.88	3.88	2.19
Timgalen for common root rot	1.44	1.81	2.11	1.77	3.31	1.19	4.00	2.71
Durati durum wheat for crown rot and common root rot	2.88	2.69	3.25	2.77	2.38	1.19	3.75	2.44
SED (standard error for difference of the means)	0.47	0.48	0.62	0.44	0.47	0.41	0.32	0.29

has been established. Select groups of germ plasm have been screened. In particular, the synthetics (*T. turgidum/Ae. tauschii*) have been emphasized, because they provide a wide array of resistances to a range of other biotic stresses including *F. graminearum* group 2, *S. tritici*, and *H. sativum*.

Methodology. In controlled greenhouse conditions, 46 synthetic derivatives (synthetic wheats crossed with improved bread wheats) were screened against both soilborne pathogens. A randomized, complete block design with eight replicates per genotype was used. Plants were grown in open-ended, electrical conduit tubes (12.5 cm x 2.5 cm) in a large tray of sterile soil. Plants were inoculated 1 week after planting with a prepared, cultured, oat-seed inoculum (initially derived from monosporic cultures of these pathogens), which was applied above the ungerminated sterile seeds (one per tube) and covered with soil. After 1 month, the plants were scored visually for lesion development (on roots (RS), shoots (SS) and coleoptiles (CS)) using a qualitative scale adopted from the methods developed by Wildermuth (1994) and (Wallwork, pers. comm.). The scale is based on a 0–5 rating of lesions on either the roots, shoots, or coleoptiles; where 0 = no lesions, 1 = 0–25 %, 2 = 25–50 %, 3 = 50–75 %, 4 = 75–100 %, and 5 = dead. Data was analyzed with and ANOVA. Known resistant and susceptible checks were included to identify promising new lines.

Results and conclusions. The data are illustrated in Table 17. Certain synthetic hexaploid derivatives appear to be potential sources of resistance to the root pathogens studied. Three derivatives indicated resistance as good as currently available; 'Sabuf/3/BCN//Ceta/*Ae. tauschii* (895)' against both crown rot and common root rot, 'Altar 84/*Ae. tauschii* (224)//YACO/6/CROC1/*Ae. tauschii* (205)/5/BR12*3/4/... 224)' for crown rot, and 'MAYOOR/TKSN1081/*Ae. tauschii* (222)' for common root rot. Interestingly, these three lines also offer good resistance to *F. graminearum* Group 2 (Mujeeb-Kazi et al. 1999), perhaps inferring some association between the different *Fusarium* pathogens (foliar and root). We now plan to confirm these results in the field, to verify their resistance under those conditions and in the adult plant stage.

References.

Diehl JA, Tinline RD, and Kochhann RA. 1983. Perdas em trigo causadas pela podridao comum de raizes no Rio Grande do Sul, 1979-1981. Fitopatol Bras **8**:507-511.

Mujeeb-Kazi A, Gilchrist LI, Fuentes-Davila G, Velazquez C, and Delgado R. 1999. *Fusarium graminearum* resistance in alien germplasm and in a bread wheat/alien species derivative with multiple biotic stress resistances. Ann Wheat Newslet **45**:107-108.

Tinline RD, Wildermuth GB, and Spurr DT. 1988. Inoculum density of *Cochliobolus sativus* in soil and common root rot of wheat cultivars in Queensland. Aust J Agric Res **39**:569-577.

Wildermuth GB, Tinline RD, and McNamara RB. 1992. Assessment of yield loss caused by common root rot in wheat cultivars in Queensland. Aust J Agric Res **43**:43-58.

Wildermuth GB. 1994. Testing wheat seedlings for resistance to crown rot caused by *Fusarium graminearum* group 1. Plant Dis **78**:949-953.

Cultivar susceptibility to the root-lesion nematode Pratylenchus thornei and wheat yield loss in the state of Sonora, Mexico, and wider implications.

Julie M Nicol and Ivan Ortiz-Monasterio.

Background. The root-lesion nematode *P. thornei* is a polyphagous, migratory, endoparasitic nematode causing necrotic lesions on the root system. A known pathogen of wheat in many parts of the world, *P. thornei* was reviewed by Nicol et al. (2000) and has been shown to cause major yield reductions on susceptible, intolerant, wheat cultivars of up to 32 % in Sonora, Mexico (Van Gundy et al. 1974) and 44–85 % in various states of Australia (Doyle et al. 1987; Thompson and Clewett 1986; Thompson et al. 1993; Eastwood et al. 1994; Nicol et al. 1999).

One of the roles of CIMMYT, to improve wheat germ plasm for developing countries, is achieved through a shuttle-breeding program between central and northern Mexico. Although this process has been occurring for about 30 years in some areas infested with *P. thornei,* there is little knowledge of the resistance (ability of the plant to limit the multiplication of the nematode) or tolerance (ability of the plant to yield despite attack by the nematode) of CIMMYT cultivars to *P. thornei.* Tolerance, although effective, does not necessarily reduce nematode numbers, and sources of resistance coupled with tolerance are recommended. Reports in the literature also suggest that water limitation is an important factor in determining yield loss with *P. thornei* and closely related species (Grandison 1972; Orion et al. 1984).

Attempts are made here to:
- establish whether CIMMYT has been involuntarily selecting for resistant and tolerant germ plasm against the nematode,
- determine susceptibility of various CIMMYT cultivars to *P. thornei* and yield loss, and
- establish the importance of water availability, i.e., drought, or sufficient irrigation on yield loss.

Methodology. Two experiments were established at CIMMYTs experiment station in Cd. Obregon, Sonora, during the 1998–99 wheat crop cycle. The experiments were designed as two split-plots, one under drought (one irrigation) and the other with full irrigation (five irrigations). Each trial consisted of three replicates with the main plots being with and without chemical fumigation of the soil, and the subplots included a selection of seven CIMMYT wheat cultivars released over the past 30 years plus one known, susceptible variety from Australia.

Five weeks prior to planting, the fumigant Basamid® (60 g/m^2) was applied to moist soil on the specified areas and incorporated with a disc plough to 30 cm. The trial was planted in plots of eight rows (20 cm apart) by 5 m. To establish the initial nematode density, six individual soil and root samples were taken from each plot at two depths (0–20 cm and 20–40 cm) 1 month after planting between plant rows 2 and 3, 4, and 5, and 6 and 7 at 1.5 and 3.5 m of the plot length. The *P. thornei* were extracted from one composite, homogenous, 200-g sample using the Whitehead tray extraction method for 3 days at room temperature. The numbers of *P. thornei* were counted from a water suspension using a 1-ml dilution with a Doncaster dish. All numbers were converted to numbers of *P. thornei* per 200 g oven-dried soil. A similar sampling was conducted 4 months later (after harvest) to determine the final density of nematodes per plot. Throughout the growing season, a number of plant variables were measured. Three meters of the six central rows were harvested for yield determination. The trial was analyzed as a split plot in conjunction with the use of orthogonal comparisons to compare CIMMYT cultivars against the Australian check variety Warigal.

Results and discussion. The application of the fumigant effectively controlled the nematode by significantly lowering numbers under drought (82 %) and irrigation (91 %). Under irrigation, yield and most other plant parameters for all varieties were not affected by the density of *P. thornei,* suggesting that the importance of *P. thornei* is limited under full irrigation. However, the yield of some cultivars was affected significantly under drought conditions with and without Basamid® application (Fig. 1). Yield losses varied from 2–40 % with no indication of a relationship to time of release of the various CIMMYT cultivars, which suggests that CIMMYT has not been selecting for or against tolerance over time.