INTERIM PROGRESS REPORT TO THE MAIZE TRUST

October 2012

"A comprehensive audit and monitoring of non-parasitic and plant parasitic nematodes as bio-indicators of biodiversity and dynamics of living organisms in systems where soil quality is being improved through accepted conservation-agriculture practices."

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CA study setup

The CA study is carried out at two trial sites managed by the ARC-GCI, Potchefstroom. The two locations are Buffelsvlei in the North-West and Erfdeel in the Free State Province. The Buffelsvlei trial commenced in 2008/2009, while the Erfdeel trial started in the 2010/2011 growing season. A comparison is being made between conventional tillage and CA practices under with different maize-based crop rotations (Table 1). Each treatment is replicated four times.

Table 1: Summery of the different maize-based crop rotation treatments at the two CA trial sites.

Treatments	
Buffelsvlei	**Erfdeel**
Monoculture maize - conventional tillage (MM/CT)	Monoculture maize - conventional tillage (MM/CT)
Monoculture maize - CA (MM/CA)	Monoculture maize - CA (MM/CA)
Maize * sunflower/legume - CA (MSL/CA)[1]	Maize * legume - CA (ML/CA)
Maize * babala * sunflower/legume - CA (MBSL/CA)*	Maize * babala * legume - CA (MBL/CA)

[1]Sunflower and legumes grown in a split-plot design.

Actions to date

Six nematode root- and soil samples were collected at 60 days after planting in every replicate at both CA trials. The total number of samples taken at each instance mentioned above was 288 at the Buffelsvlei and 168 at the Erfdeel trial, which corresponds with the respective trial layout at each. For extraction of non-parasitic nematodes (NPN) 200-g soil samples are required and for plant-parasitic nematodes (PPN) 50-g, 5-g root and 200-g soil samples are required. A decanting and sieving method, followed by a sugar-centrifugal flotation method was used for extraction of PPN as well as NPN from the 200-g soil samples. A modified NaOCl method was followed with the 50-g root samples for the extraction of root-knot nematodes. A sugar-centrifugal flotation method was used for the 5-g root samples for the extraction of the wider spectrum of PPN, including root-knot juveniles.

Results achieved

Buffelsvlei trial

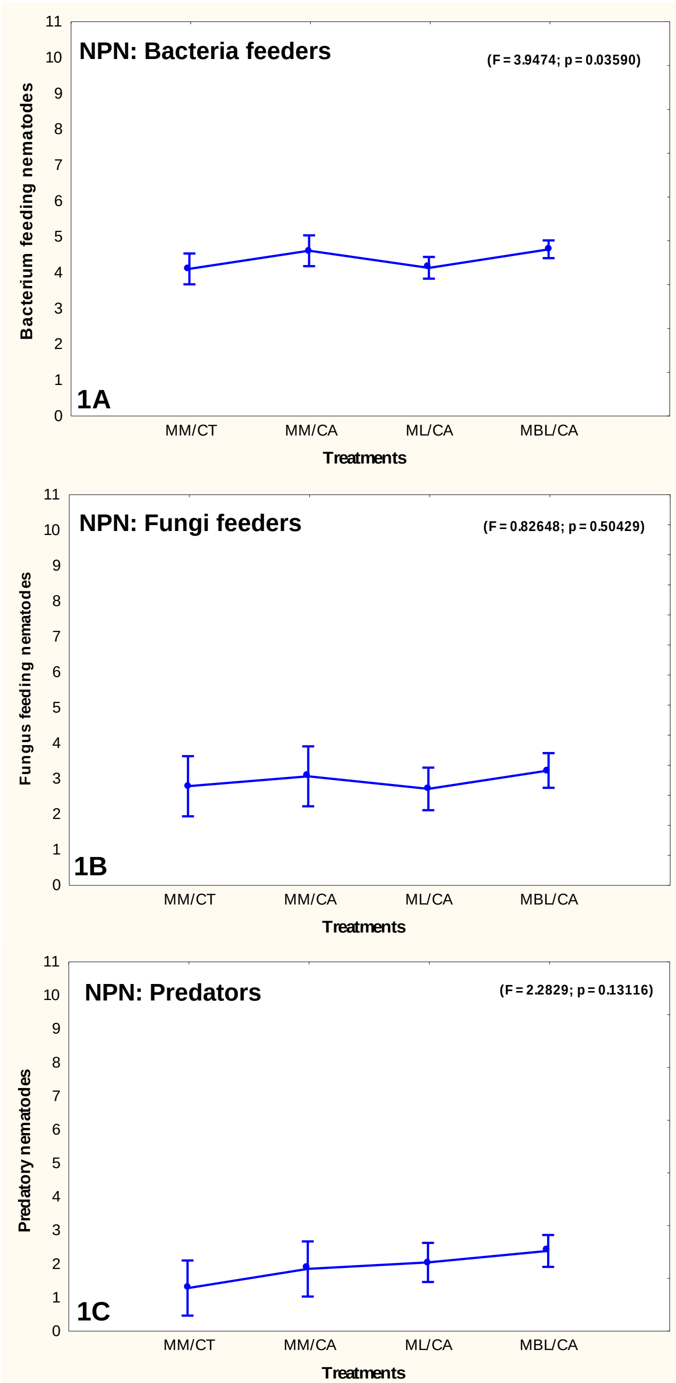

Figure 1. Mean bacterium-feeding (1A), fungus-feeding (1B) and predatory (1C) nematode numbers for the four different treatments at the Buffelsvlei trial. For statistical purposes numbers have been transformed $\log_e(x+1)$.

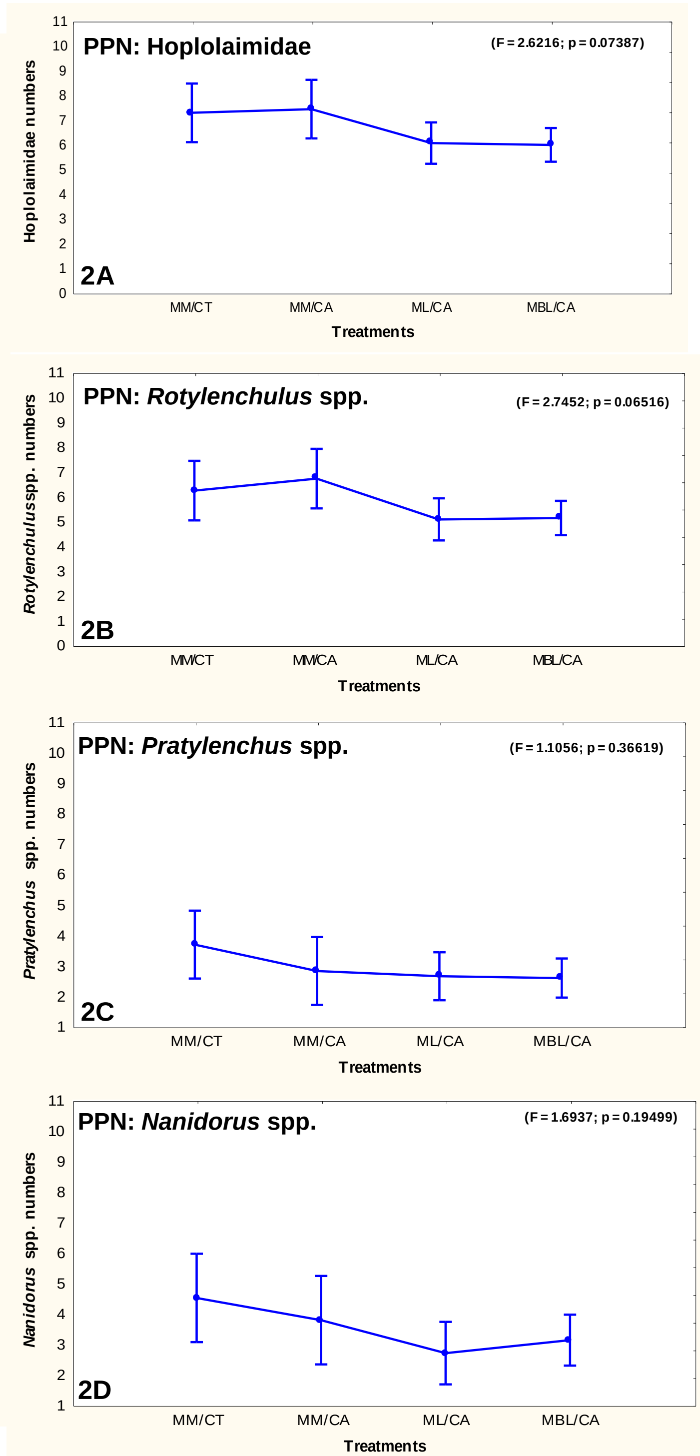

Figure 2. Mean Hoplolaimidae (2A), *Rotylenchulus* spp. (2B), *Pratylenchus* spp. (2C) and *Nanidorus* spp. (2D) numbers for the four different treatments at Buffelsvlei trial. For statistical purposes numbers have been transformed $\log_e(x+1)$.

Non-parasitic nematodes (NPN)

This category of nematodes can be grouped according to feeding habits into bacterium- or fungus-feeding and predatory nematodes. All three groups were present in the CA trial at Buffelsvlei.

No significant differences were observed between bacterium-feeding nematode numbers in the four respective treatments at this trial (Fig. 1A). The MBL/CA treatment, however, showed reduced variation in numbers and a rising trend in the presence of bacterium-feeding nematodes. In-treatment variation the ML/CA treatment was also smaller than those of the MM/CT and MM/CA treatments.

With regard to fungus-feeding nematodes no significant differences occurred between the four different treatments (Fig. 1B) too. The MBL/CA treatment also showed a rising trend in the numbers of these nematodes relative to the rest of the treatments. Variation in numbers for ML/CA and MBL/CA treatments was again smaller compared to the MM/CT and MM/CA treatments.

Although the predatory nematode numbers also showed no significant differences between the four treatments, the increasing trend towards the MBL/CA treatment in predatory nematode numbers was noticeable as well (Fig. 1C). Variation in predatory nematode numbers in the MBL/CA, as well as ML/CA treatments was also smaller than those in the MM/CT and MM/CA treatments.

Plant-parasitic nematodes (PPN)

In this category of nematodes different species of the family Hoplolaimidae, collectively also known as “spiral nematodes”, *Rotylenchulus* spp. (kidney nematodes), *Pratylenchus* spp. (root-lesion nematodes) and *Nanidorus* spp. (stubby-root nematodes) were present at this trial site.

Hoplolaimidae numbers showed no significant differences between the four treatments in this trial (Fig. 2A). There was, however, a declining trend in these numbers in the

ML/CA and MBL/CA compared to the MM/CT and MM/CA treatments. The ML/CA and MBL/CA treatments also showed smaller variation in nematode numbers than the MM/CT and MM/CA treatments, as had been the case with NPN.

Rotylenchulus spp. numbers showed a very similar trend to the Hoplolaimidae, the only difference being that they occurred at slightly lower levels than the spiral nematodes in this trial (Fig. 2B).

No significant differences occurred between *Pratylenchus* spp. numbers in the four treatments at this trial but the MM/CT treatment tended to contain higher numbers of root-lesion nematodes (Fig. 2C). The ML/CA and MBL/CA treatments showed less variation in lesion nematode numbers than the MM/CT and MM/CA treatments once more.

Nanidorus spp. numbers in the Buffelsvlei trial (Fig. 2D) showed similar trends to the lesion nematodes although in-treatment variation was greater, with ML/CA and MBL/CA showing less variation.

NPN vs. PPN

Although the data so far showed no significant differences between the four treatments in this trial both for NPN and PPN, two trends are seemingly starting to be develop. The first is that NPN numbers seem to have increased in the MBL/CA treatment and that the variation in nematode numbers in this treatment is decreasing (Fig. 1A, B and C). Secondly, PPN numbers show a decrease in the MBL/CA treatment. Variation in PPN numbers in this treatment is decreasing as well (Fig. 2A, B, C and D).

Comparing NPN numbers the bacterium-feeding nematodes (Fig. 1A), followed by fungus-feeding nematodes (Fig. 1B) were higher than those of the predatory nematodes (Fig. 1C). With regard to PPN the Hoplolaimidae and *Rotylenchulus* spp. numbers were much higher (Fig. 2A and B) than those of *Pratylenchus* (Fig. 2C) and *Nanidorus* spp. (Fig. 2D).

Between NPN and PPN bacterium-feeding nematode numbers (Fig. 1A) were much lower than those of the parasitic Hoplolaimidae and *Rotylenchulus* spp. (Fig. 2A and B) but the former were more than *Pratylenchus* and *Nanidorus* spp. (Fig. 2C and D). The fungus-feeding nematodes (Fig. 1B) were also fewer than the Hoplolaimidae and *Rotylenchulus* spp. (Fig. 2A and B) but were similar in numbers to *Pratylenchus* and *Nanidorus* spp. (Fig. 2C and D). Predatory nematode numbers (Fig. 1C) were much lower at this stage compared to the other NPN and PPN numbers (Fig. 1A, B, 2A, B, C and D).

Erfdeel trial

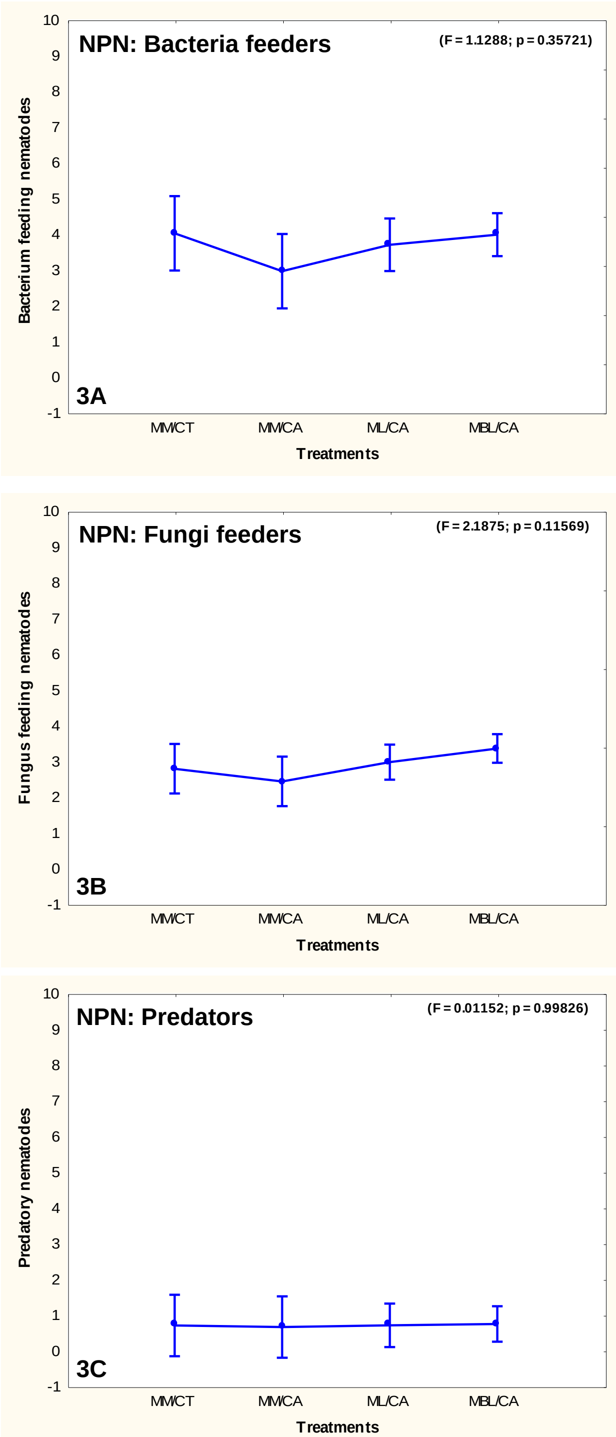

Figure 3. Bacterium-feeding (5A), fungus-feeding (5B) and predatory (5C) nematode numbers for the four different treatments at Erfdeel trial. For statistical purposes numbers have been transformed loge(x+1).

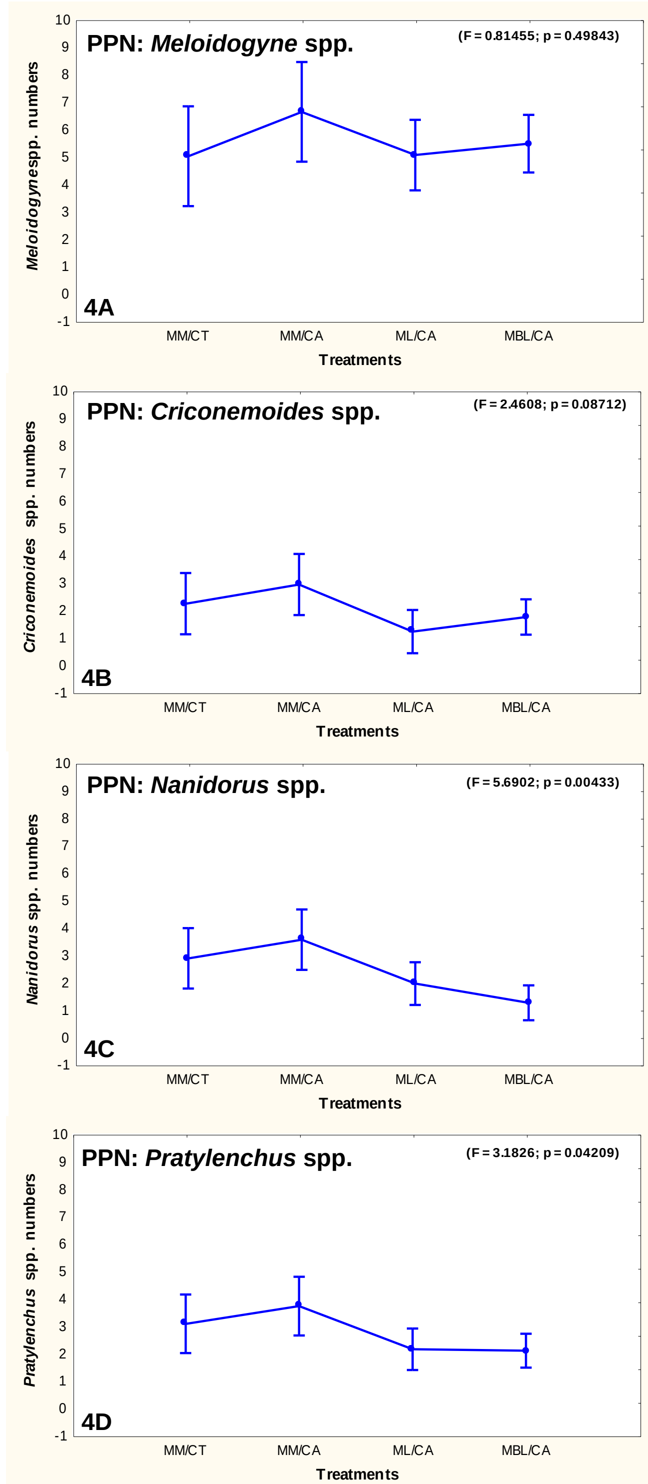

Figure 4. *Meloidogyne* spp. (6A), *Criconemoides* spp. (6B), *Nanidorus* spp. (6C) and *Pratylenchus* spp. (6D) numbers for the four different treatments at Erfdeel trial. For statistical purposes numbers have been transformed $\log_e(x+1)$.

<u>Non-parasitic nematodes (NPN)</u>

All three bacterium-, fungus-feeding and predatory nematode groups were present in the CA trial at Erfdeel. No significant differences were observed between bacterium-feeding nematode numbers in the four respective treatments at this trial (Fig. 3A). The MBL/CA treatment, however, showed reduced variation as well as a rising trend in bacterium-feeding nematode numbers. In-treatment variation in ML/CA was also smaller than those in the MM/CT and MM/CA treatments.

Fungus-feeding nematode numbers also showed no significant differences between the four treatments in this trial (Fig. 3B). The MBL/CA treatment showed a rising trend in these nematode numbers too, relative to the rest of the treatments. Variation in numbers in the ML/CA and MBL/CA treatments was also smaller compared to MM/CT and MM/CA.

Predatory nematode numbers also showed no significant differences between the four treatments (Fig. 3C). Variation in numbers in the ML/CA, as well as MBL/CA treatments was also smaller than those in MM/CT and MM/CA.

<u>Plant-parasitic nematodes (PPN)</u>

Meloidogyne spp. (root-knot nematodes), *Criconemoides* spp. (ring nematodes), *Nanidorus* spp. (stubby-root nematodes) and *Pratylenchus* spp. (root-lesion nematodes) were present at this trial site.

Meloidogyne spp. numbers showed no significant differences between the four treatments in this trial (Fig. 4A). There was a declining trend in these numbers in the ML/CA and MBL/CA treatments compared to MM/CT and MM/CA. ML/CA and MBL/CA also showed smaller variation in *Meloidogyne* numbers than the MM/CT and MM/CA treatments.

Criconemoides spp. numbers showed a very similar trend to *Meloidogyne* spp., the only difference being that they occurred at lower levels than the root-knot nematodes in this trial (Fig. 4B).

A significant difference occurred between *Nanidorus* spp. numbers in the four treatments at this trial (Fig. 4C). The MBL/CA treatment had significantly fewer stubby-root nematodes than the MM/CA treatment. ML/CA and MBL/CA also showed less variation in these nematode numbers than the MM/CT and MM/CA treatments.

Pratylenchus spp. numbers in the Erfdeel trial (Fig. 4D) showed no significant differences between the four treatments. There was a declining trend in these numbers in the ML/CA and MBL/CA treatments compared to MM/CT and MM/CA. The ML/CA and MBL/CA treatments showed less variation in lesion nematode numbers than MM/CT and MM/CA.

<u>NPN vs. PPN</u>

Although the data so far showed no significant differences between the four treatments in terms of NPN and PPN, except *Nanidorus* spp., similar trends to those at Buffelsvlei are seemingly starting to develop. NPN, except predatory nematode numbers seem to be increasing in the ML/CA and MBL/CA treatments and variation in these treatments is also decreasing (Fig. 3A, B and C). PPN numbers also show a decrease in the ML and MBL/CA treatments, as well as variation in nematode numbers (Fig. 4A, B, C and D).

Comparing NPN numbers the bacterium-feeding nematodes (Fig. 5A) and fungus-feeding nematodes (Fig. 3B) had higher numbers than the predatory nematodes (Fig. 3C). With regard to PPN the *Meloidogyne* spp. numbers were much higher (Fig. 4A) than those of *Criconemoides* (Fig. 4B), *Nanidorus* (Fig. 4C) and *Pratylenchus* spp. (Fig. 4D).

Bacterium-feeding nematode numbers (Fig. 3A) were much lower than *Meloidogyne* spp. (Fig. 4A) but they were higher than *Criconemoides*, *Nanidorus* and *Pratylenchus* spp. numbers (Fig. 4B, C and D). The fungus-feeding nematodes numbers (Fig. 3B) were fewer than *Meloidogyne* spp. (Fig. 4A) but similar in numbers to *Criconemoides*, *Nanidorus* and *Pratylenchus* spp. (Fig. 4B, C and D). Predatory nematode numbers (Fig. 3C) were much lower at this stage compared to the other NPN and PPN numbers (Fig. 3A, B, 4A, B, C and D).

Problems that have been encountered with the project

No problems have been encountered with the project thus far.

Milestones that have not been achieved

A detailed CA survey in the North West and Free State provinces in fields where farmers practice CA and those where conventional agriculture is practiced had been planned. Soil and root samples for nematode analyses as described above, would be collected. For each CA and conventional plot where nematode samples would be collected, a nearby natural field where no agricultural practices took place for at least 10 years would be sampled too, to determine a benchmark against which the results of the two agricultural practices in question could be compared. The CA survey would provide key information in terms of essential nematode-crop-environment interactions and thus reduce limitations in data collected at the two main trial sites in terms of time and repeatability.

Monitoring of the two CA trials in question needs to be continued, particularly now that tendencies start to become discernable. Comparison of nematode population dynamics with changes to the soil environment and crop responses to the induced treatments is essential for interpretation of soil quality status and wider application of technology that promotes agricultural soil conservation.

Statement of expenditures attached

Estimated duration

The study should continue for at least three more summer seasons for the results to be publishable in a reputable scientific journal. Should this not be achieved the results will remain speculative.