Trial Protocol and Report

Title: Effect of arbuscular mycorrhizal fungi on yield of different trees and shrubs.

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1. Rationale and background information:

It is widely accepted that majority of plants will benefit from mycorrhizal symbiosis that results in resistance to drought and biotic and abiotic stress factors as well as improved nutrient transfer to host plants (Akhtar *et al.,* 2011; Fitter *et al.,* 2011; Sawers *et al.* 2008; Shenoy and Kalagudi, 2005). Increased nutrient uptake in mycorrhizal crop plants can allow for a reduction of mineral fertilisers (Fitter *et al.,* 2011; Weber, 2014) This would mean a reduction in ecological issues such as pollution and energy consumption, as well lowering the negative economical and geopolitical impact of reliance on mineral fertilisers (Cordell and White, 2015; Weber, 2014).

Read et al (1976) assessed the major vegetation types of east-central England and concluded that all of the most important species of grassland, scrub and woodland were mycorrhizal and each individual of any species normally carried a heavy arbuscular mycorrhizal infection.

The millennium wood at Detling, Kent, called ‘White Horse Wood’ was selected to be the case study site. This site is owned and managed by Kent County Council. As the

site was once used for arable production the soils organic content is likely to be low and therefore the numbers soil organisms is also likely to be low.

2. Goals and objectives:

The aim of this trial is to assess effect of arbuscular mycorrhizal fungal inocula on tree establishment and growth.

3. Materials:

- Various tree plants includimg crataegus, prunus plants, holly plants
- Rootgrow mycorrhizal inoculum
- Vernier gauge

4. Methodology:

Two areas from White Horse Wood site were selected for trial and were marked as area 1 and area 2 (Figure 1). The map clearly shows that the survey areas are very close and have the same soil geology, aspect, rainfall levels, light levels and were planted at the same time by the same contractor using the specification provided by Jacobs UK Ltd.

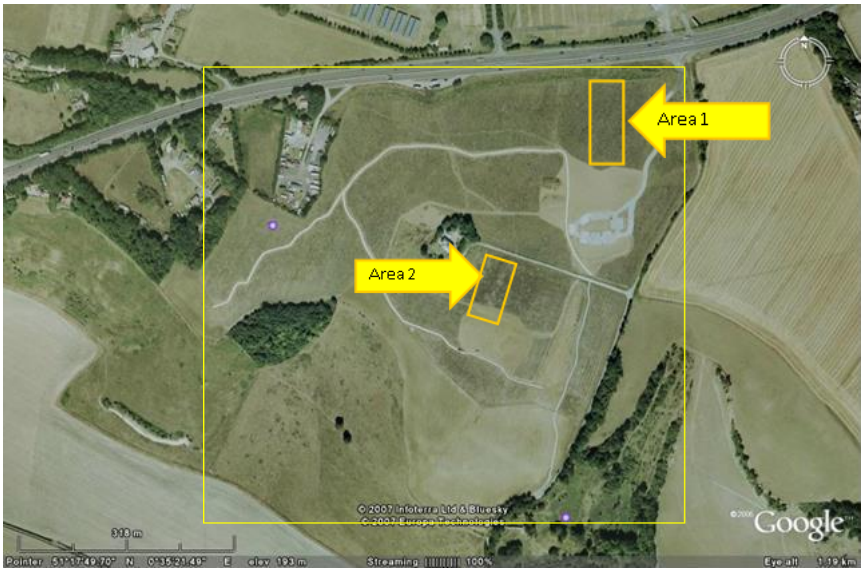

Figure 1. White Horse Wood trial site. Area 1 – treated with rootgrow mycorrhizal fungi, area 2 – non- treated area.

Trees from “White Horse Wood” were treated with rootgrow mycorrhizal fungi at application rate 7 ml per plant. Particular attention was paid that plants’ roots are in direct contact with rootgrow granules. No fertilizer was used on any of the trees at the time of planting. All the trees on the entire site were planted and protected by a Tubex Tube tree shelter, this would provide physical protection to the trees from herbivores and maintenance operations like herbicide treatments to the surrounding vegetation, trimming or grass cutting and most importantly provide the trees with a micro climate, which has been shown to increase the trees chances of survival greatly.

All the planting works were carried out in accordance with: BS4428. Recommendations for general landscape operations, and the trees complied with BS 3936 Part 1 Specifications for Nursery Stock when they were supplied. Best horticultural practices were used, i.e. ground preparation, good quality trees, careful plant handling, roots protected from sunlight & wind during planting.

Stem diameter measurements were made using a Vernier gauge at 1m from ground level on all the trees within the survey area. A 1m measuring pole was used to ensure accuracy.

If tree stems were slightly oval to oval in shape the average stem diameter between the thinnest and thickest part of these tree stems was recorded.

A total of 530 trees were surveyed at White Horse Wood representing 2.65% of the total population of trees. The first survey presents an average diameter of all plant species, whereas in the second survey stem diameter of single plant species was recorded. The number of failed trees was also recorded.

4.1 Quality assurance:

All materials were assessed prior to set-up to ensure homogeneity and general good quality.

4.2 Data management and statistical analysis:

Trial data was analysed and reported on in form of charts and tables as appropriate using Excel or similar statistical tools.

5. Trial Assessment

Plants’ stem measurements were obtained in 2004 (4 years after planting) and 2007 (7 years after planting). A total of 530 trees were surveyed at White Horse Wood representing 2.65% of the total population of trees. The first survey presents an average diameter of all plant species, whereas in the second survey stem diameter of

single plant species prunus, crataegus and holly was recorded. The number of failed trees was also recorded.

6. Results

The one-way ANOVA testing method was considered an appropriate assessment tool given the relative width of data. Both surveys demonstrated significant difference between treated and untreated plots with treated plants diameter 2.3 times bigger than untreated (Figure 2 and 3).

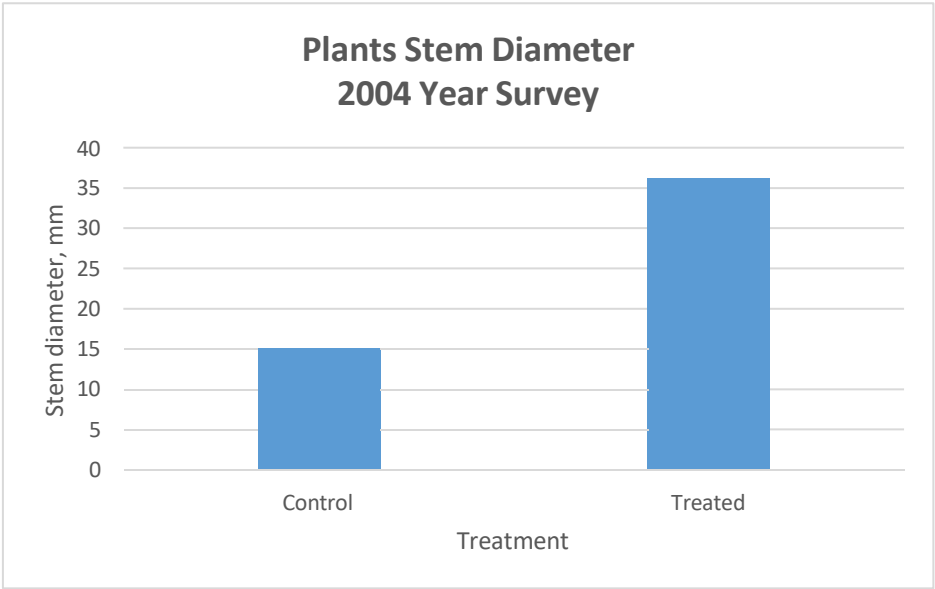

Figure 2. Average plant diameter of surveyed plants treated with rootgrow mycorrhizal fungi and untreated. There is a significant difference between treated and untreated plants with $P<0.0001$.

Figure shows that all plants regardless there taxonomical position benefited from the mycorrhizal treatment. Diameter of treated holly, prunus and Crataegus was bigger than untreated plants in 2.8, 2.5 and 2.1 times representatively.

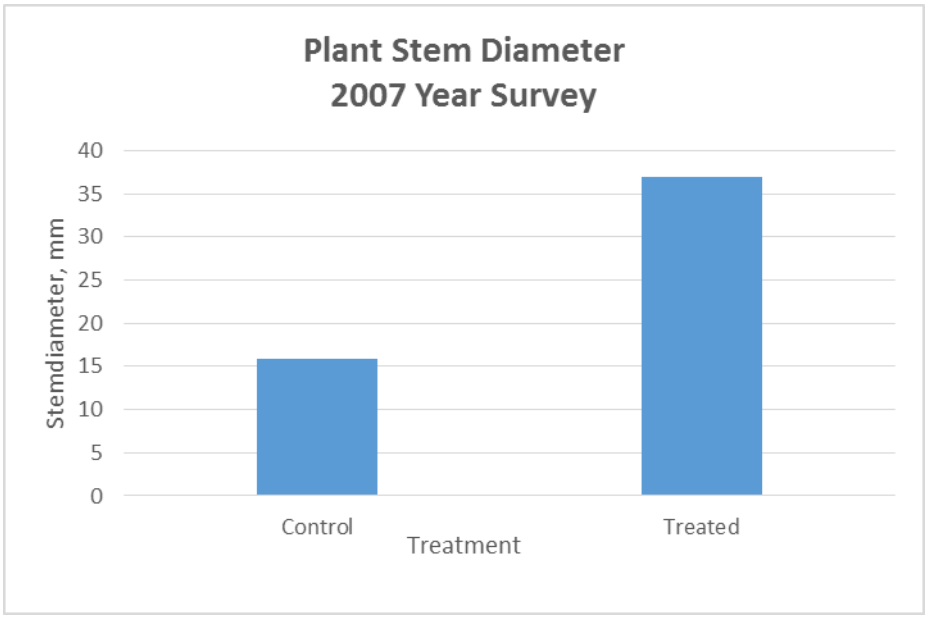

Figure 3. Average plant diameter of surveyed plants treated with rootgrow mycorrhizal fungi and untreated. P=0.162113.

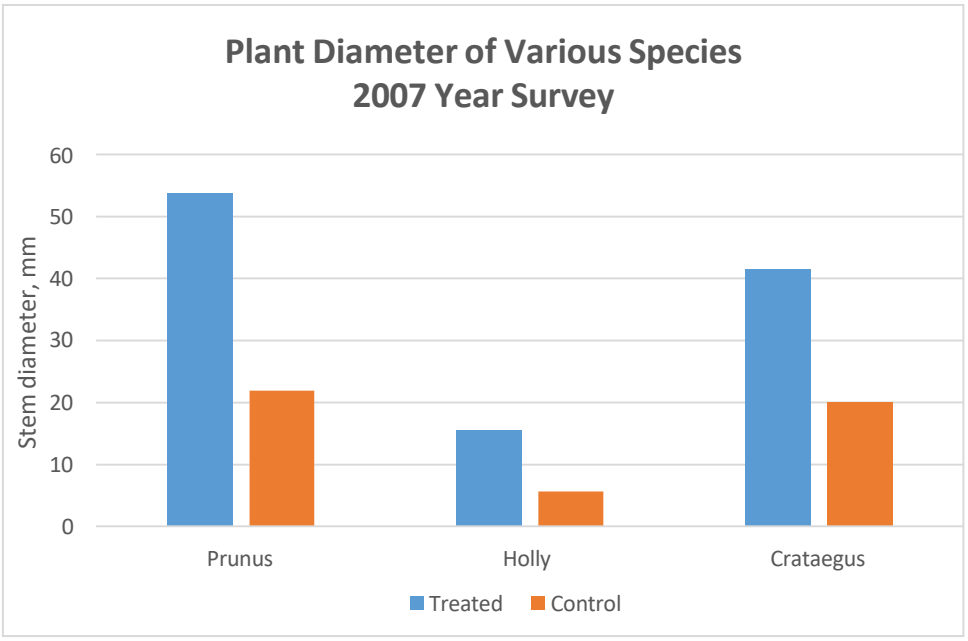

Figure 4. Average plant diameter of different tree/shrub species treated with rootgrow mycorrhizal fungi and untreated. There is a significant difference between treated and untreated plants with P<0.0001 for all conditions.

To determine failure rate the trees which were found to be dead within the treated and untreated survey areas in White Horse Wood were recorded. There was no dead trees found in treated area in 2004 year survey and only one in 2007 year survey. However, in the untreated area 23 plants didn't survive transplanting and this number increased to 25 in 2007-year survey. Figure 5 shows failure rates in 2004 and 2007 years.

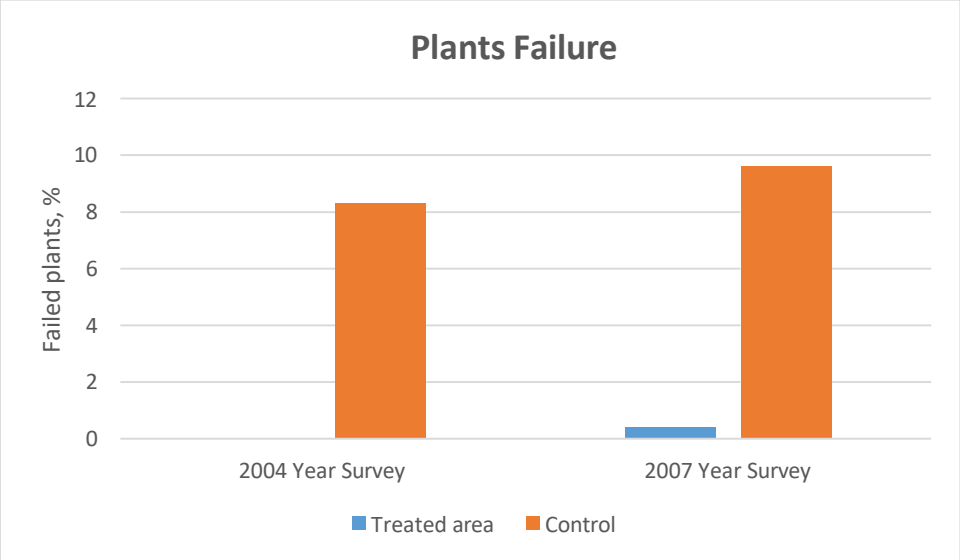

Figure 5. Tree/shrub failure of treated with rootgrow mycorrhizal fungi and untreated.

Conclusion

White Wood Horse project clearly demonstrates value of rootgrow mycorrhizal fungi in planting trees and shrubs. Mortality rate has a greater significance to the cost benefit of a scheme than anything else. High planting rates have been the answer in the past 40 years to high failure rates, high being 10% - 20% of the total number planted. This higher planting rate is ironic as most roadside and woodland schemes are selectively thinned from year 7 after planting. Therefore, the use of mycorrhizal fungi reduces the failure rate and subsequently reduces the high numbers to be planted at the beginning of these schemes. This more open planting allows the trees to form more natural crowns and not tall thin forest type stems which relies on each other to prevent wind damage.

Moreover, treated plants were observed being higher, booshier, with thicker stem diameter than untreated plants. The results clearly show that all the species within the survey had the same trend as the overall results with significant differences in the stem diameters between the treated and untreated trees. These results clearly show that all the species benefited from the mycorrhizal inoculation.

References

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Appendix 1.

Birch tree – left untreated, right – treated with mycorrhizal fungi

Oak tree – left untreated, right – treated with mycorrhizal fungi

Hawthorn tree – left untreated, right – treated with mycorrhizal fungi