ICFR KZN Midlands Regional Field Day
Tuesday 31st May 2016
Sutton, Ixopo and Highflats areas

Thanks are extended to Sappi, NCT and Merensky for sponsorship
ICFR KZN Midlands Regional Interest Group Field Day

Date: Tuesday, 31 May 2016  
Venue: Sutton, Ixopo and Highflats areas  
Time: 08h00 for 08h30

PROGRAMME

Please note: All of the presentations will take place in-field  
PPEs (closed shoes, high visibility vests and hardhats) are required  
The route requires off road vehicle capability, so no cars please

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<tr>
<th>Time</th>
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<th>Speaker</th>
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| 08h00 | Meet at Sappi Sutton Ixopo office for tea & coffee  
(30° 09.640’ S/ 30° 01.231’ E) – DDM (Degrees, decimal minutes) | Paul Viero,  
Regional Chairperson |
| 08h30 | Welcome | |
| 08h35 - 08h50 | Drive to Field Stop 1: Sutton, Ixopo  
(30° 08.527’ S/ 29° 59.679’ E) – DDM (Degrees, decimal minutes) | Diana Rietz  
(ICFR)  
Jacob Crous  
(Sappi)  
Brett Hurley  
(TPCP)  
Keith Little  
(NMMU)  
Louis Titshall  
(ICFR) |
| 08h50 - 11h20 | The interaction between pitting method and fertiliser application in pines and eucalypts: Some early results  
Review of the use of hydrogels to improve establishment success and results from a field trial  
Research update: Blue gum chalcid, Leptocybe invasa  
Towards reduced chemical use within South African forest plantations  
Non-target effects of systemic herbicides: 13 month results | |
| 11h20 - 12h00 | Drive to Field Stop 2: Highflats  
(30° 15.968’ S/ 30° 15.446’ E) – DDM (Degrees, decimal minutes) | Andrew Morris  
(ICFR)  
Louis Titshall  
(ICFR)  
Nkosinathi Kaptein  
(ICFR) |
| 12h00 - 12h30 | Lunch | |
| 12h30 - 14h30 | Site productivity and hardwood species performance in relation to lithology and slope position on Sappi Highflats Plantation  
The importance of regolith for stand production  
Hydrological monitoring: An overview of the approach being used at Highflats | |
The interaction between pitting method and fertiliser application in pines and eucalypts: Some early results

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Recently, there has been an increase in the mechanisation of forestry operations in South Africa. One of the main areas currently being mechanised where different options are being considered and tested is that of silviculture operations. Pitting is no longer a purely manual operation, and there are now options to have either a semi-mechanised or fully mechanised pitting operation. Although manual pitting operations are well understood in South Africa, there are considerable concerns that the other pitting options may impact tree survival, growth and uniformity. Furthermore, the application of fertiliser in pits created by semi-mechanised or fully mechanised operations is problematic as pits are often narrower than manually created pits. Should fertiliser be placed closer to trees, there is a risk of fertiliser burn. To circumvent this issue, as well as improving operational efficiencies, a fertiliser tablet that contains nutrients as well as a pesticide, that can be placed in the pit prior to, or at the same time as planting has been developed.

As a result, a trial was implemented that investigated the effect of manual, semi-mechanised and fully mechanised pitting, as well as fertiliser application (none, 10 cm either side of the tree, 20 cm either side of the tree, and a fertiliser tablet) on Eucalyptus grandis x nitens and Pinus elliottii x caribaea tree survival, early growth and uniformity. This presentation details the early results (4 months old) of this trial.
Review of the use of hydrogels to improve establishment success and results from a field trial

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The quantity of available water in soil is crucial for plant growth, especially after transplanting as this water will enable the growth of new roots to facilitate nutrient and water uptake. Water absorbed by a hydrogel (superabsorbent polymer) has the potential to reduce drought stress after planting and to improve seedling survival. This article provides an overview of the concepts of post-plant water stress, a review of trials that tested application of hydrogels to forest tree species, and discussion on probable reasons for failure or success in the use of hydrogels.

Hydrogels applied in pot trials, under controlled conditions, tended to have a higher frequency of positive survival responses compared to field trials (14 studies of the 17 (82%) in pot trials vs. 15 of the 25 (60%) in field trials). In field trials, the application of hydrogels at planting had no effect on survival in 7 of the 25 (28%) trials and had a negative effect in 3 of the 25 (12%) field trials included in this review. In the trials showing a positive response a hydrogel and water application improved survival by 18% and across all trials by 8%. The efficiency of hydrogels was probably influenced by the 1) chemicals present in the soil, 2) hydrogel quantity applied, 3) type of polymer, 4) hydrogel particle size distribution, 5) soil texture, 6) physical restrictions to hydrogel expansion, 7) hydrophilic nature of hydrogels, 8) unsaturated hydraulic conductivity between the substrate and the hydrogel particles, 9) application method, and 10) planting conditions and re-watering. Due to this complexity and interactions between these factors it is difficult to provide site-specific recommendations for successful application of hydrogels in a forestry field setting.

A field trial was established during February 2014 at Sappi’s Hodgsons plantation to test methods of hydrogel application and hydrogel quantity. The trial was located on a very sandy soil as hydrogel would be most beneficial on these soils and it would simplify root studies. Assessments of tree height and stem ground line diameter (GLD) were conducted at 90 and 180 days after planting (DAP). A biomass index was calculated as the sum of GLD² x Height of all live plants per plot.

Despite the fact that there was a relatively dry period after planting when hydrogel should have improved survival in theory, at 180 DAP hydrogel application had no effect on survival of the trees in this trial. In addition, the hydrogel also had no effect on tree GLD or tree height. However, there was some evidence that the hydrogel application increased the biomass index, the root weight and the shoot weight.

The orthogonal contrasts indicated that this response was mainly due to the difference in growth between trees that received hydrogel compared to those that were dry planted (Figure 1). Although not statistically significant, the application of larger quantities of hydrogel resulted in the largest absolute response.
Figure 1: The mean biomass index across all hydrogel treatments was significantly greater than that of the control (dry planting) at 180 DAP.

Conclusions
Both the review of previous research and the results from the trial reported here indicate that hydrogel could improve survival and/or growth of plants. However, the response is generally unpredictable and might be influenced by interactions with site preparation and soil texture.

In general, application of hydrogels has been found to be more beneficial in sand or clay soils and to be of limited benefit in loam soils. Use of a hydrogel is not a replacement for good silviculture and has limited use as insurance against short periods of low rainfall. All efforts should be made to plant when environmental conditions are favourable for tree growth (i.e. wet soil and high probability of rainfall).

The complete review will be available soon:
Research update: Blue gum chalcid, *Leptocybe invasa*

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The blue gum chalcid, *Leptocybe invasa* (Hymenoptera, Eulophidae), is a gall-forming wasp that infests *Eucalyptus* species. Native to Australia, this minute insect (1.1-1.4mm long) has been accidentally introduced to all eucalypt-growing continents. In South Africa, the gall wasp was first detected in 2007 and has now spread across the country where it causes severe damage to susceptible eucalypt species, where it results in stunted growth, deformation and possibly tree mortality.

Planting more resistant eucalypt genotypes is an important approach to manage populations of the pest. Early research by the TPCP as well as trials carried out by various forestry companies, have clearly shown variability in susceptibility to wasp infestation between eucalypt genotypes. However, environment and pest population can influence plant resistance, and it is thus important to include other management options into an integrated management approach. One such option is the use of classical biological control, where natural enemies from the native range of the pest are introduced into the invaded range, with the objective of these natural enemies to establish and spread within the new environment. The parasitic wasp *Selitrichodes neseri* (Hymenoptera, Eulophidae) is a natural enemy of *Leptocybe invasa*, that was discovered in Australia and subsequently reared and released in South Africa. In total, around 25 000 of these wasps have been released throughout the country. Post-release monitoring has shown that the wasp has established well and spread to other areas. However, further research is needed to assess the impact of the biocontrol agent on the pest population and its role in reducing losses from the pest.

Of concern is that a new species (or lineage) of *Leptocybe* was discovered in South Africa last year. This is the same species (currently also referred to as *Leptocybe invasa*) previously recorded in Asia and Ghana. It is possible that this new species will show different host preferences for eucalypt species / hybrids and potentially not be as susceptible to the biocontrol agent.

The recently initiated National Leptocybe Monitoring will provide data to map spatial and temporal trends in the activity of *L. invasa*. In addition, parasitism levels of the biocontrol agent will be determined and this data can be used to prioritise further releases of the agent. DNA-based tools will be used to distinguish between the *Leptocybe* species and thus investigate differences in host preference and susceptibility to the biocontrol agent between the two species. Material collected from the national monitoring will also be used to determine the distribution of two other wasp species (*Megastigmus* spp.) that emerge from the *Leptocybe*-induced galls, and assist in clarifying the role of these wasps in the galls. This monitoring can potentially be expanded to include other insect pests and diseases of eucalypts, and thus become a very valuable tool to detect and monitor current and new pests.
Towards reduced chemical use within South African forest plantations

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The South African forest industry subscribes to the Forest Stewardship Council (FSC) principles associated with responsible environmental, social and economic management (FSC, https://ic.fsc.org; accessed June 2014), with ca. 95% of the afforested area certified according to FSC criteria. One of the components within any of these certification schemes in terms of the management of forest growth per se (those practices mostly associated with silvicultural management), relates to chemical use. Silvicultural practices make use of chemicals in a number of different areas, stages of stand development and for different reasons, although most chemical usage can broadly be grouped in terms of tree protection, enhancing tree growth, or for the amelioration of some site or environmentally limiting attribute (for example fertilisers, hydrogels). As such, any chemical used in forestry needs to conform to any environmental and/or ecological constraints. To ensure this, the FSC (as would any other certification body that subscribes to sustained forest management) has a process regarding chemical use in forestry, with three main objectives:

• The identification and avoidance of ‘highly hazardous’ pesticides;
• The promotion of ‘non-chemical’ methods of pest management as an element of an integrated pest and vegetation management strategy; and
• The appropriate use of the pesticides that are used.

Chemicals used in forestry

Chemicals (in their broadest sense) are used throughout the ‘forestry chain’. For example:

• Within nurseries:
  - fertilisers; fumigants; pesticides; sterilants; detergents; etc.
• As site ameliorants during site preparation and planting:
  - fertilisers; hydrogels; pesticides (insecticides/fungicides); stress relievers.
• For tree protection throughout the rotation:
  - Abiotic (fire): encapsulators; emulsifiers; wetting agents; foaming agents; gelling agents; penetrators; etc.
  - Biotic (weed, insect + mammalian pests and diseases):
    o Pesticides (herbicides; fungicides; insecticides; rodenticides; etc.);
    o Additives (stickers; spreaders; buffers; drift retardants; penetrants; etc.).

Chemicals by their very nature will have a potential impact on the target, as well as non-target, biotic and abiotic components, with the following generalisations made regarding their use:

• Chemicals are generally used in forestry to reduce any negative impacts and/or to improve forest production of the target species;
• Any chemical used within the forestry context has the potential to be toxic and/or shift ecosystem dynamics;
• In general, chemical use within forest stands;
  - is highly regulated (in terms of type and management); and
  - is part of a planned action to bring about a desired response, and as such is not an *ad hoc* process.
• Where chemicals are used, their application is directed;
• Many forest stands receive minimal chemical treatment, and of those that do, typically no more than two or three applications are made during an entire tree rotation;
• Despite the low rate of applications in an area, chemicals can still accumulate within a watershed because there may be many forest sites that receive applications.

Whilst obtaining and subsequently retaining high levels of responsible governance is of importance, what we also need to understand is that certification only highlights and sets standards regarding chemical use, it does not contribute to solving any issues that result from their use/non-use.

Over the years, much effort has been focussed on the process and getting certified, but not nearly enough effort has been invested into understanding and finding solutions where existing standards have been compromised. As a consequence, meeting the goals of certification, whilst retaining cost-effective yet sustainable forestry practices, will remain one of our biggest challenges!

Another important consideration is that any management strategy or decision should not necessarily be driven by certification, but rather by an inbuilt desire by that company to ensure that any forest practices used, are both responsible and sustainable. As such any chemical-related research must rather be guided by the forest industries inherent desire to ensure responsible and reduced chemical use as part of a planned and informed process, and not necessarily according to criteria as laid down by the chosen certification body (although they are both intrinsically linked). In this regard one will need to be proactive, rather than reactive.

Any strategies developed to prevent, maintain, or improve forest production and health, must subscribe to the principles underlying good management practices. Research and its application are key factors for addressing these challenges, with the greatest challenge being the development of a strategy for the incorporation of current knowledge into practical management tools to minimise loss, whilst finding
alternatives to currently available, but undesirable chemicals. The challenge going forward will be to invest as much effort into understanding and finding solutions where existing standards are no longer adequate, or where they have been compromised. This process will need to be:

- strategic (objective and planned);
- collaborative;
- proactive (not reactive); and
- will probably need to include a mind shift (different way of doing things).

The consequences of not having a well-developed strategy, supporting structures, or being proactive so as to respond accordingly, could prove costly.

**Conclusions**

In conclusion, a more comprehensive and inclusive understanding will be required before informed management decisions can be made. In this presentation, key research areas are first noted and actions suggested that will need to be dealt with in order to first understand and then successfully deal with any chemical-use issues in an informed manner. However the following principles associated with this proposal need to be understood:

- This work is not meant to replace any work that is currently being carried out, rather it is aimed at firstly collecting and understanding chemical use and potential impacts from a productivity perspective (longer term focus), and secondly, the practical management of any such problems (shorter immediate term focus).

- Although a number of research areas are suggested, together with associated actions, the priority of the different areas still needs to be determined, and in all likelihood it will mean that a number of different areas will run concurrently.

The work in this proposal will need to be a combined and collaborative effort if it is to succeed, with total integration between various disciplines (spatial technologies, pest and disease research, silviculture, financial studies, growth and yield modelling, planning etc.) and therefore different organisations (research, commercial and private) where expertise is available, being involved.
Non-target effects of systemic herbicides: 13 month results

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Weed growth during plantation establishment has been demonstrated to negatively affect tree production due to increased competition for light, nutrients and water. Weed removal prior to planting and during early growth is essential for the optimal growth of trees. Commonly weeds are controlled by the application of the non-selective systemic herbicide, glyphosate. A concern associated with the use of glyphosate is damage caused by overspray or drift onto young trees that may negatively affect growth. Coning during spraying operations is recommended to avoid tree damage, but increases the operational cost and is thus frequently not done. To ensure best practice it is necessary to quantify the effects of sub-lethal glyphosate on tree performance.

This study evaluated the effect of sub-lethal doses (three levels) of glyphosate on early eucalypt tree growth when applied directly to the canopy (simulated over-spray/drift) as compared to an untreated control. Additionally, two selective herbicides; namely clopyralid (a systemic broad-leaf selective) and quizalofop-p-tefuryl (a systemic grass selective) are also tested at the recommended rates on the young eucalypt trees to evaluate their effect on early growth relative to the other treatments.

Thirteen month (after herbicide application) growth data show that at all levels of glyphosate eucalypt growth is significantly stunted. At the highest glyphosate rate there were also a significant increase in tree mortality. While three and seven month tree damage scores were significantly higher than the control, at 13 months the surviving trees no longer had observable damage. The glyphosate treatments also tended to significantly increase variability between trees (loss of stand uniformity). Thus while sub-lethal glyphosate did not result in severe tree mortality by 13 months, the stunted growth and increased variability will result in lower stand uniformity which could negatively impact on production and harvest efficiency at rotation end. Overspray and drift must thus be avoided.

No negative effects on growth measures of the selective herbicides were found and they may offer an alternative for overspray applications.
Site productivity and hardwood species performance in relation to lithology and slope position on Sappi Highflats Plantation

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Sappi Highflats Plantation is situated on a plateau at 900 – 1000 m a.s.l. with 800 – 900 mm/yr mean annual precipitation and 17°C mean annual temperature (ICFR site type WT4). The lithology consists mainly of sandstone and tillite that give rise to distinctly different soils. There are four main Sappi Forest Land Types mapped; two on each lithology above and below 1000 m a.s.l. Forest Land Types map areas with similar recurring patterns of soils, terrain and climate that are practically useful for the application of site-specific forestry practice.

The Highflats Plantation provides pulpwood to the Sappi Saiccor pulpmill. Considering this market, site-species choice is based on Land Type, local knowledge and historical production records. In 1997 a set of twelve species trials were planted to determine if slope position within Land Type could be used to refine site-species matching on Highflats. This presentation provides results at the end of a 12-year-rotation.

The performance of five hardwood species (Eucalyptus grandis, E. dunnii, E. smithii, E. macarthurii and Acacia mearnsii) were compared in randomised complete block trials on crest, cool midslope, warm midslope and bottom slope terrain positions on both sandstone and tillite lithologies.

At the end of rotation, differences in stand productivity existed due to lithology and slope position within lithology. Relative production of species on a site differed between trials in association with Land Type (lithology) and slope position within Land Type. These results are considered in the context of species planting choice.

The observed differences in productivity indicated:
1. Sandstone is generally more productive than tillite lithology.
2. Slope position influenced productivity on sandstone sites with superior production on crest and cool midslope positions.
3. Tillite sites suffered waterlogging during re-establishment that impacted the survival of some species.
4. On average the most productive species were E. dunnii and A. mearnsii but slope position, lithology and differential pulpwod prices could modify species choice decisions aimed at maximum sales revenue.
This Sappi Forests Research trial series forms a key input and motivation for the current ICFR Forestry Sector Innovation Fund project exploring the variation, role and importance of regolith characteristics in determining plantation productivity. Access and use of these data is gratefully acknowledged.
The importance of regolith for stand production

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The production potential and drought risk associated with South African forest plantation sites is dominated by water and nutrient supply. To predict potential productivity, drought risk and nutrient supply potential at a compartment or finer scale requires knowledge of potential rooting depth and water/nutrient storage and supply capacity of the regolith. Mapping at this scale is necessary if site-specific forestry practice is to reap the full benefit available from such practices as site-species matching and deployment of genetically superior planting stock. Existing site classification and mapping for forestry sites in South Africa has developed little in more than two decades and inclusion of regolith water and nutrient supply may contribute significantly to improved site management for improved production.

Regolith is the unconsolidated layer overlying bedrock and consists of soil and underlying saprolite/saprock, and colluvial and alluvial layers. The depth and degree of weathering of regolith in South Africa varies considerably across the landscape. This variation has not been mapped for any of the forestry areas in South Africa and its importance in determining site productivity, drought risk and nutrient resilience has not been quantified. Rooting has been reported to depths beyond 20 m in plantation forests which has implications for both water and nutrient supply. That tree roots extend into, and obtain water and nutrients from the deeper regolith, is now recognised as an important component of water and nutrient supply to forests. In South Africa, several studies show this is important for forest plantations. Although deep rooting to access water stored in the regolith has been demonstrated, and post-drought surveys indicate this factor plays a role the importance of spatial variation in regolith characteristics has not been quantified. The contribution of regolith to nutrient resilience is also not understood.

An introduction to the role of regolith in plantation production for the purpose of better site and stand management is presented.
Hydrological monitoring: An overview of the approach being used at Highflats

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A key aspect of integrating the role of regolith on water flux and effects on plantation production is a clear understanding of the hydrological processes that occur across the hillslopes being investigated. We visit one of the hydrological monitoring points on the sandstone hillslope at Highflats and provide a short overview and description of:

1) The purpose of the measurements
2) The approach that has been adopted
3) The instruments and methods that are being used