



# Mulching of harvest residue after clearfelling in Eucalyptus and Pine stands; a comparison of productivity, CO<sub>2</sub> emissions, costs and its influence on downstream operations.

by

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Evolving with technology  
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# Presentation overview

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# Introduction

“*Mulching* is the application of an organic layer over the soil surface”  
(Bautista et al., 2009)

Mulching offers a solution for the comminution of residues almost immediately after harvesting.

## Benefits

1. Reducing period between successive rotations
2. Reduced fire risk
3. Improve long term soil health



# Study aim

The aim of this study was to quantify the **productivity rates, CO<sub>2</sub> emissions, and costs** between eucalyptus and pine plantations.

In addition, analyzing the **influence** that **residue management** has on **pitting** and **planting productivities**.

1. Time studies
2. Biomass assessments
3. Monitoring fuel consumption



# Research site

**Pine site  
Bulwer**



**Eucalyptus site  
Zululand**

# Sites description

Site	Stand size (ha)	Previous species	Machine
<b>Eucalyptus</b>			
S1	19.18	E. GxU	CAT
S2	18.45	E. GxU	CAT
<b>Pine</b>			
S3	26.11	P. pat	Tigercat
S4	16.07	P. pat	Tigercat

# Mulcher specification

	CAT 586c	Tigercat M726G
Engine Power (kW)	261	275
Revolutions per min (rpm)	1880	1800
Fuel capacity (L)	494	570
Weight (Kg)	17 214	13 560
Attachment	FAE 300U	TC 4061
Working width (mm)	2544	2440
Weight (kg)	4 010	3 970
No. teeth	58	50



# Biomass assessment

Site	Stump volume (m <sup>3</sup> ·ha <sup>-1</sup> )	Residue volume (m <sup>3</sup> ·ha <sup>-1</sup> )	Mean residue diameter (cm)	Stump + residue volume (m <sup>3</sup> ·ha <sup>-1</sup> )
<b>Eucalyptus</b>				
S1	24.7	35.9	7.9 ±2.3	60.6
S2	20.3	16.1	5.7 ±2.1	36.4
<b>Mean</b>	<b>22.5</b>	<b>26.0</b>		<b>48.5</b>
<b>Pine</b>				
S3	22.6	78.1	7.0 ±4.3	100.7
S4	22.3	103.8	8.5 ±4.5	125.1
<b>Mean</b>	<b>44.9</b>	<b>90.6</b>		<b>112.9</b>

# Before



# After



# Mulcher productivity

Site	ha·hr <sup>-1</sup>	hr·ha <sup>-1</sup>	Min·100m <sup>-1</sup>
<b>Eucalyptus</b>			
S1	0.40	2.62	3.89
S2	0.35	2.91	4.39
<b>Mean</b>	<b>0.38</b>	<b>2.78</b>	<b>4.13</b>
<b>Pine</b>			
S3	0.31	3.19	4.49
S4	0.39	2.60	3.63
<b>Mean</b>	<b>0.35</b>	<b>2.90</b>	<b>4.06</b>

# Comments on productivities

- The mulcher achieved similar productivities (0.35 and 0.38 ha hr<sup>-1</sup>) in both treatments – even though the initial biomass volumes were lower in Eucalyptus (48.5 m<sup>3</sup>·ha<sup>-1</sup>) compared to Pine (112.9 m<sup>3</sup>·ha<sup>-1</sup>)
- This indicates that the mulchers are not hindered by the biomass volumes and has adequate mechanical capacity for the task.

# CO<sub>2</sub> Emissions

	Eucalyptus (CAT)	Pine (Tigercat)
Engine power (Kw)	261	275
Fuel consumption (l/hr)	32	34
Fuel consumption (l/ha)	89.0	98.6
CO <sub>2</sub> emissions (KgCO <sub>2</sub> /diesel liter)	2.7	2.7
<b>CO<sub>2</sub> emissions (KgCO<sub>2</sub>/ha)</b>	<b>240.2</b>	<b>266.2</b>

# Costs in ZAR

	<b>Eucalyptus (CAT)</b>	<b>Pine (Tigercat)</b>
Machine Cost	R 6 000 000	R 6 450 000
Machine cost (R/hr)	R 2 050	R 2 144
<b>Machine cost (R/ha)</b>	<b>R 5 393</b>	<b>R 6 126</b>

(Ackerman et al., 2014)

# Summary

	Eucalyptus	Pine
Productivity (ha/hr)	0.38	0.35
Productivity (hr/ha)	2.78	2.90
CO <sub>2</sub> emissions (KgCO <sub>2</sub> /ha)	240.20	266.20
Machine cost (R/ha)	R 5 393.00	R 6 126.00

# Discussion

- Mulching productivities between eucalyptus and pine stand did not differ significantly.
- A 26 Kg CO<sub>2</sub>/ha difference in emission between eucalyptus and pine stand
- The mulching cost on both eucalyptus and pine stand are comparable.
- Even though Pine mulching cost R 733.00 more per a hectare compared to eucalyptus mulching, this difference in cost is directedly related to
  - Machine Fuel consumption
  - Machine purchase price
  - And not species difference

# Productivity results of downstream operations



05 Dec 2019



01 July 2020

# Pitting productivity

Site	ha·hr <sup>-1</sup>	hr·ha <sup>-1</sup>	Percentage difference
<b>Eucalyptus (mechanised)</b>			
Mulched	0.27	3.85	15%
Burnt	0.25	4.44	
<b>Pine (manual per person hour)</b>			
Mulched	0.05	17.54	
Burnt	0.06	15.87	10%



# Planting productivity

Site	ha·hr <sup>-1</sup>	hr·ha <sup>-1</sup>	Percentage difference
<b>Eucalyptus (semi-mechanised)</b>			
Mulched	1.66	0.63	50%
Burnt	1.15	4.44	
<b>Pine (manual per person hour)</b>			
Mulched	0.08	12.29	40%
Burnt	0.06	17.19	



# Results

- A higher productivity rate was observed for pitting after mulching, than for pitting after burning on the Eucalyptus site (mechanised pitting)
- A higher productivity rate was observed for pitting after burning, than pitting after mulching on the Pine site (manual pitting)
- As expected, both semi-mechanised and manual planting productivity **after mulching** was higher than on burnt sites (fewer impediments)

# Discussion and Conclusion

- Manual pitting is slightly quicker on burnt sites than on mulched sites
- Both semi-mechanised and manual planting were quicker on mulched sites
- Incomplete combustion of larger material negatively impacts movement (machine and person) - windrowing might help
- Overall, mulching combined with mechanised pitting and semi-mechanised planting yields the highest productivity.

The logo for Sappi, featuring the word "sappi" in a bold, blue, lowercase sans-serif font.

# Thank you | Dankie | Enkosi

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