

**Austro2011/FORMEC'11:**

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# **MONITORING THE DRYING OF RESIDUE BUNDLES DURING STORAGE IN THE FOREST AND AT A TERMINAL IN IRELAND**

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# Objectives of the Trial

Pre-commercial determination of:

- Rate of MC% change storing at a terminal and in the forest;
- Variation in drying between green & brown bundles;
- Effect of covering bundles in stack;
- Effect of stacking in double width rows compared to single width rows;
- Effect on drying of exposure on an open clearfell site compared to storage under trees at a sheltered site.



# Trial Overview

- 1100 bundles made from Sitka spruce (*Picea sitchensis*) residues of shortwood clearfell operations.
- Roundwood cut to 7cm top diameter.
- All bundles were 70cm in diameter and 2.5m length.
- Brown residues: site clearfelled in May 2009; harvester and forwarder drove on residues; left loose over winter & bundled in February 2010.
- Green residues: Clearfell in February 2010, bundled within 4 weeks.
- Storage trials from March to August 2010.



# Methods: Forest Storage Treatments

Storage Treatments		Green	Brown
Cover:	Top Cover	Yes	Yes
	No Cover	Yes	Yes
Stacking:	Single Row	Yes	Yes
	Double Row	No	Yes
Site:	Exposed	Yes	Yes
	Sheltered	No	Yes



# Green bundles, exposed site, single row, covered and no cover



# Brown bundles, exposed site, single row, covered and no cover



# Brown bundles, double row, exposed site, cover and no cover



# Brown bundles, single row, in sheltered site with no cover and cover





# Methods: Storage at Terminal

- 125 green and 125 brown bundles placed in six storage bins on load cells
- Monitored weight change continuously over time

## Treatments trialed:

- Green bundles with a top cover, replicated in two bins
- Green bundles with no top cover, no replication
- Brown bundles with a top cover, replicated in two bins
- Brown bundles with no top cover, no replication



# Top covered & uncovered bundles in storage bins on load cells at terminal



# Moisture content sampling

## **Pre-storage :**

- Total weight of each stack
- 90 green & 63 brown bundles sampled

## **Post-storage :**

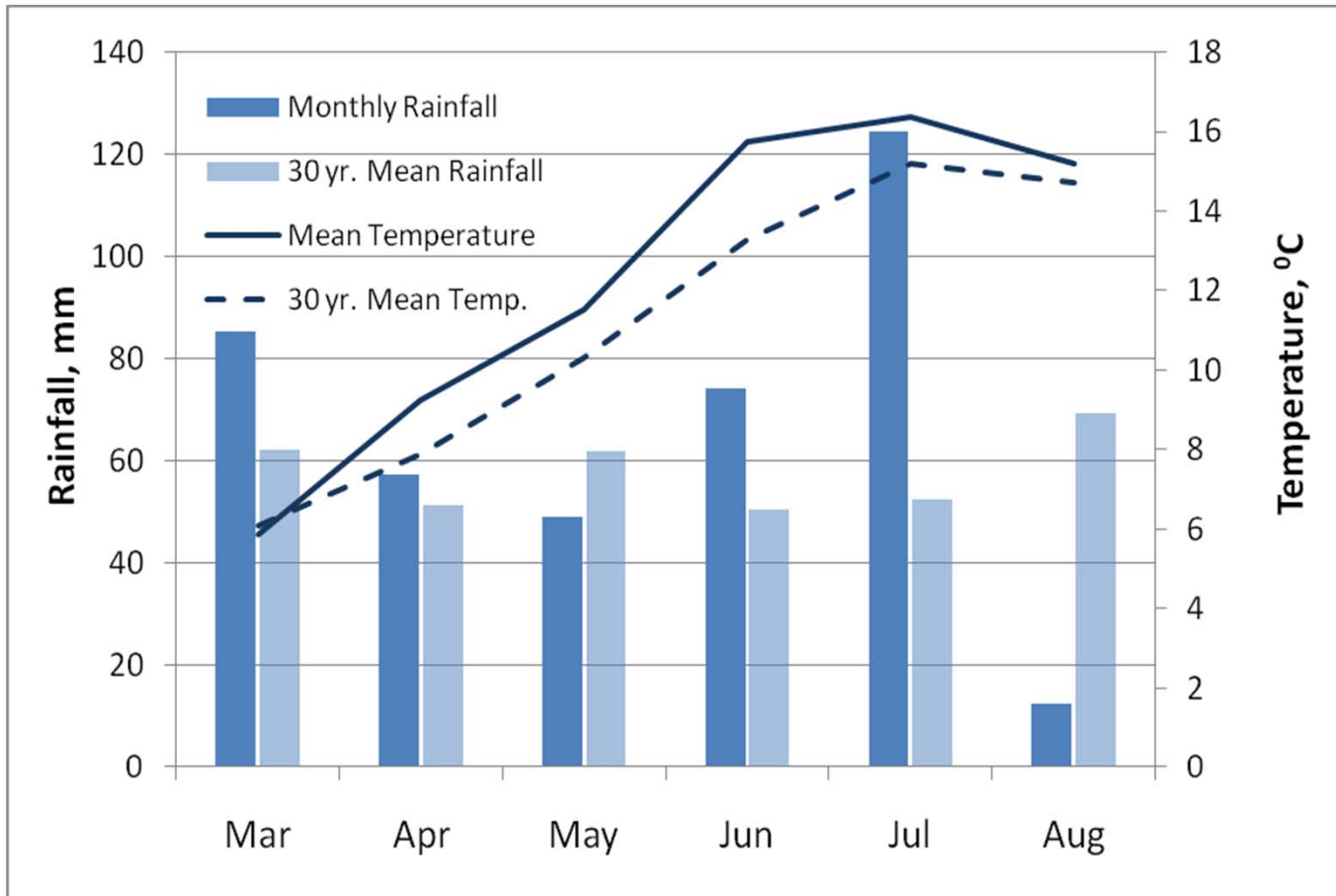
- Total weight of each stack
- Forest storage trial: 20 bundles per stack, 160 bundles in total
- Terminal storage: 50 point samples per storage bin, 300 samples in total
- Moisture content determined by oven drying to 105°C
- All bundles comminuted with Jenz 660AZ chipper/shredder



# Sampling bundles for moisture at the terminal



# Weather Conditions



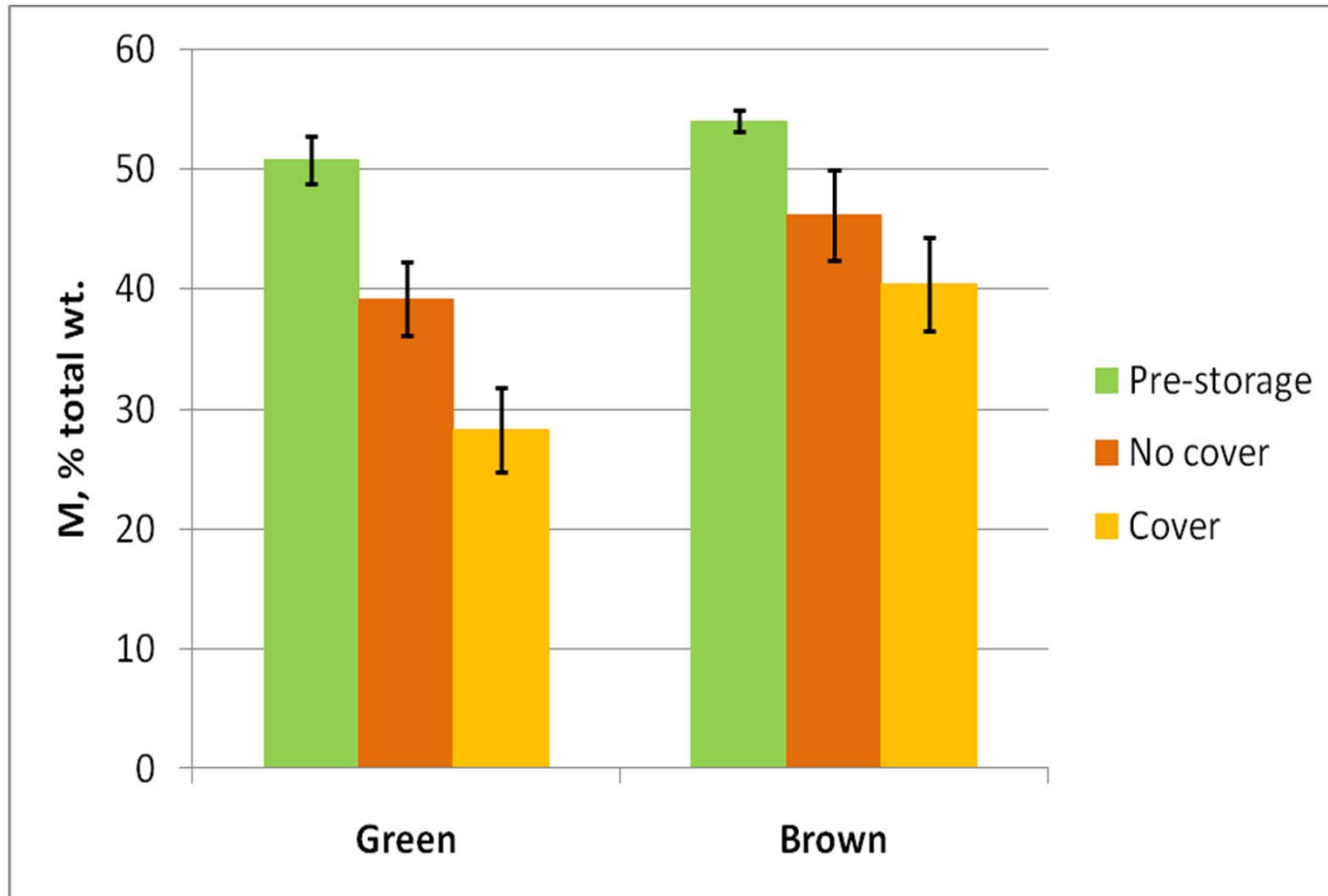
# Results: Forest Storage Trial

Stack ID					No. Bundle	Storage Period	Pre Storage Total Wt.	Post Storage Total Wt	Pre-storage Moisture	Post-storage Moisture
						weeks	[kg]	[kg]	[% , total wt.]	[% , total wt.]
1	G	N	S	EX	120	18	36297	28940	50.8 (9.3)	39.2 (5.7)
2	G	C	S	EX	119	18	36456	25900	50.8	28.3 (7.1)
3	B	N	S	EX	49	21	19688	17780	54.0 (3.5)	46.2 (7.4)
4	B	C	S	EX	140	21	51444	36232	54.0	39.5 (10.7)
5	B	N	S	SH	71	21	25428	23048	54.0	47.5 (7.4)
6	B	C	S	SH	184	21	69587	54100	54.0	45.2 (10.2)
7	B	N	D	EX	104	21	37755	32635	54.0	41.9 (7.3)
8	B	C	D	EX	70	21	26224	21485	54.0	40.4 (7.6)

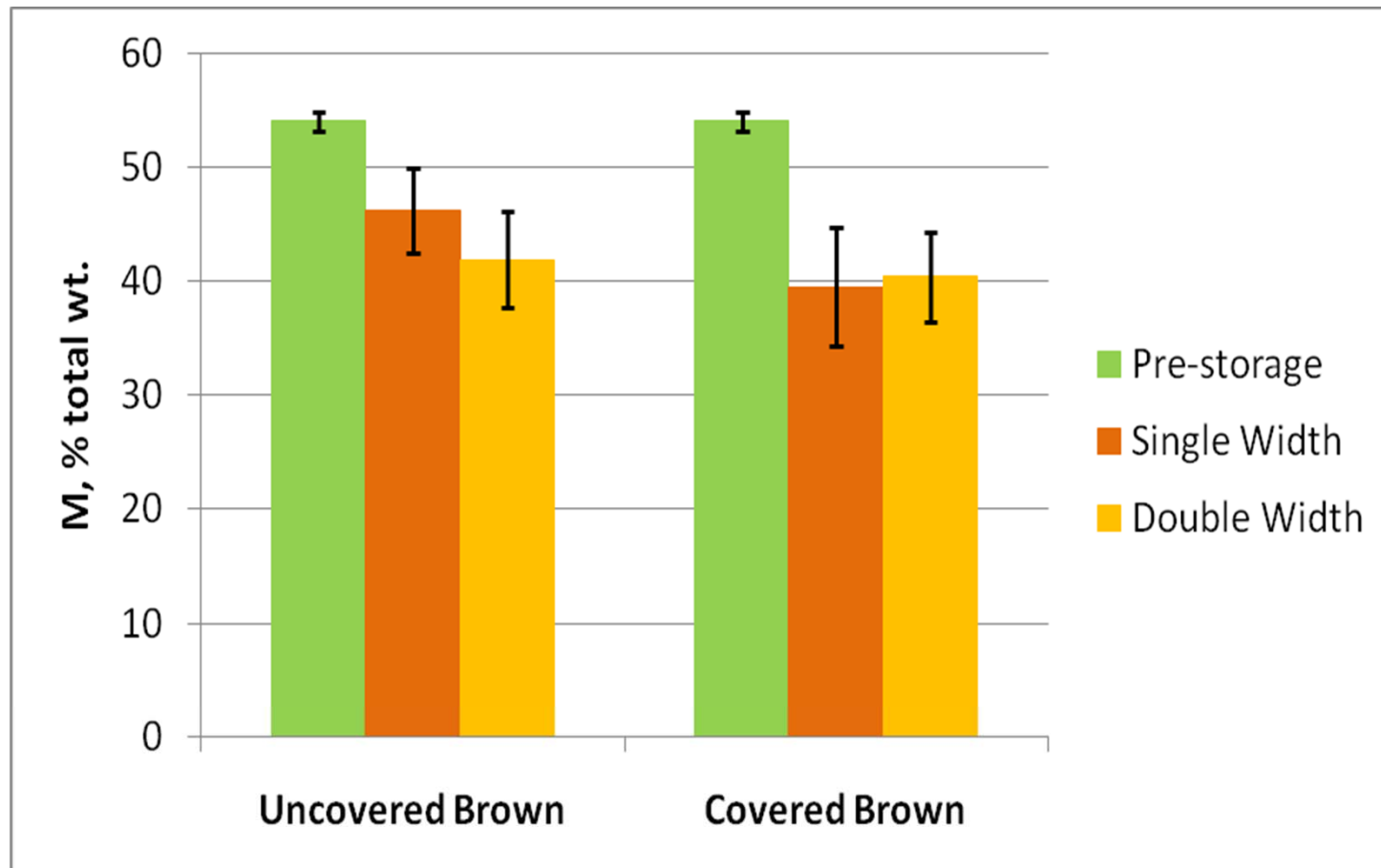
( ) standard deviation



# Forest Storage Results: Effect Of Top Cover On Drying In Green And Brown Bundles

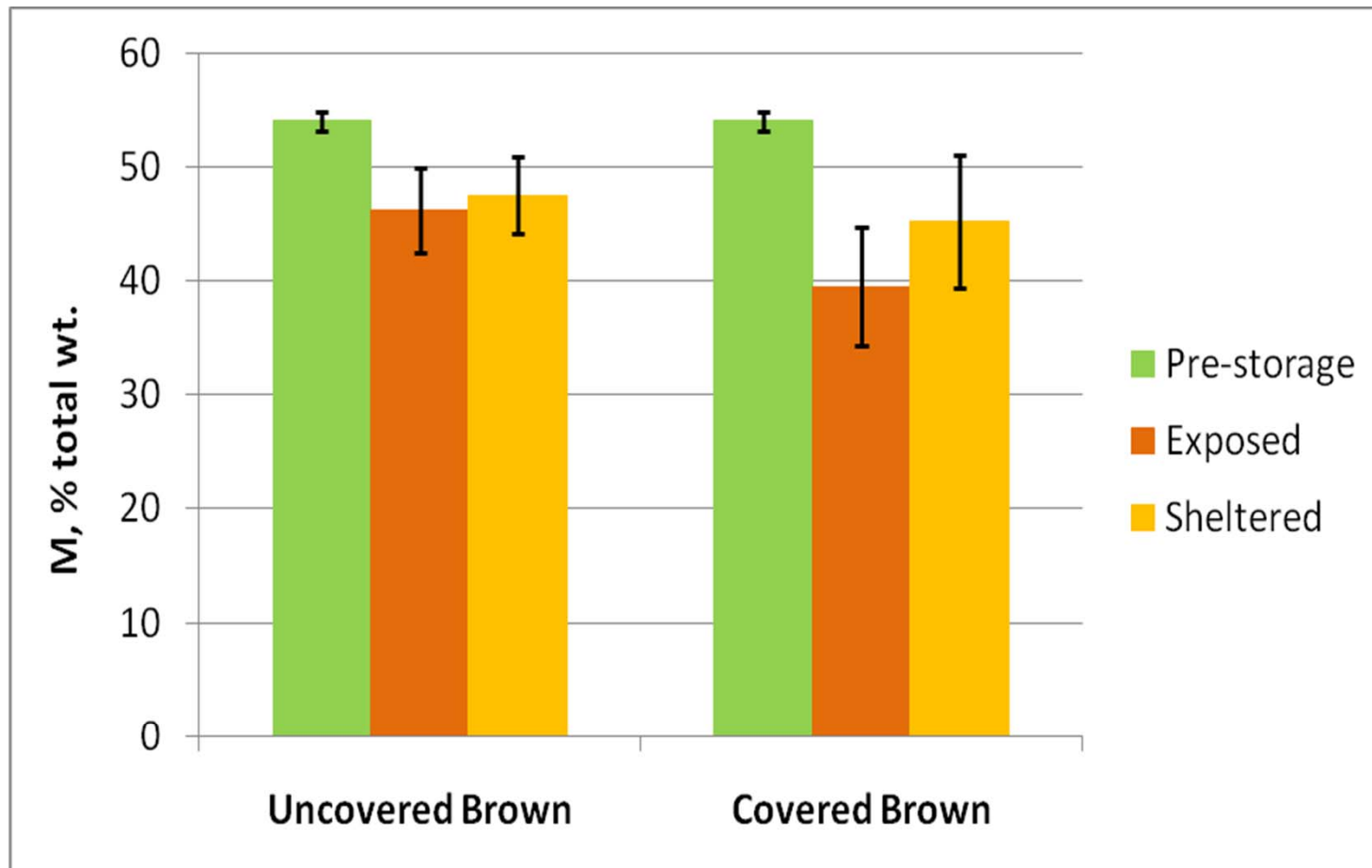


# Forest Storage Results: Effect Of Stacking Bundles In Single Or Double Rows





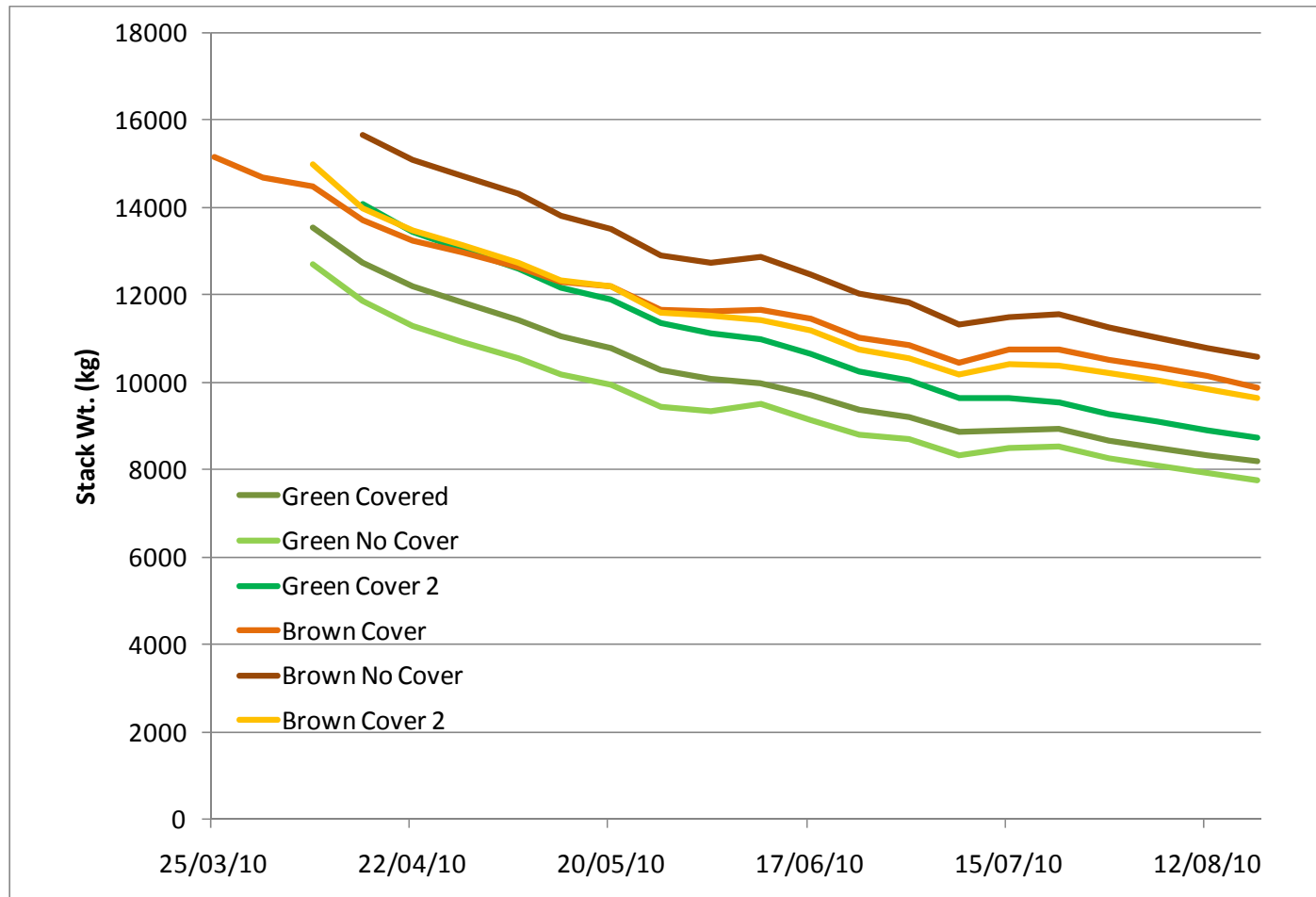
# Forest Storage Results: Effect Of Stacking in Exposed or Sheltered location



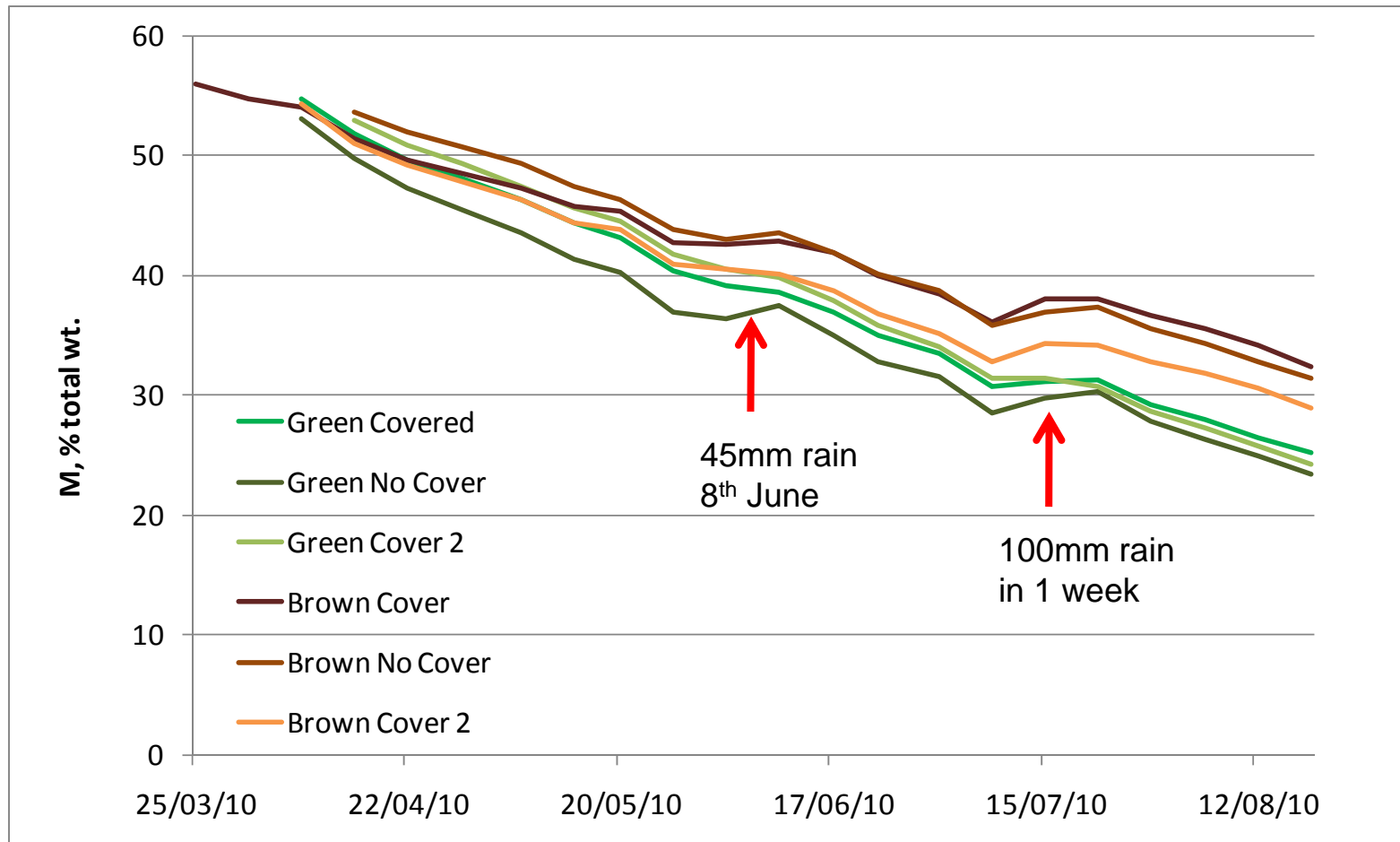
# Results: Terminal Storage

Stack ID			Storage Period [weeks]	Start Weight [kg]	End Weight [kg]	End Moisture Content [% , total wt.]	End Dry Matter Wt. [kg]	Start Moisture Content [% , total wt.]
1	G	C	19	13688	8196	25.1 (3.6)	6139	55
2	G	N	19	12815	7782	23.3 (2.9)	5969	53
3	G	C	19	14858	8729	24.2 (2.3)	6617	55
4	B	C	21	15146	9864	32.4 (5.6)	6668	56
5	B	N	19	16513	10545	31.2 (6.1)	7255	56
6	B	C	19	14978	9625	28.8 (4.7)	6853	54

# Terminal Storage Results: Stack Weight Change Over Storage Period At Terminal



# Terminal Storage Results: Moisture Content Change Over Storage Period At Terminal

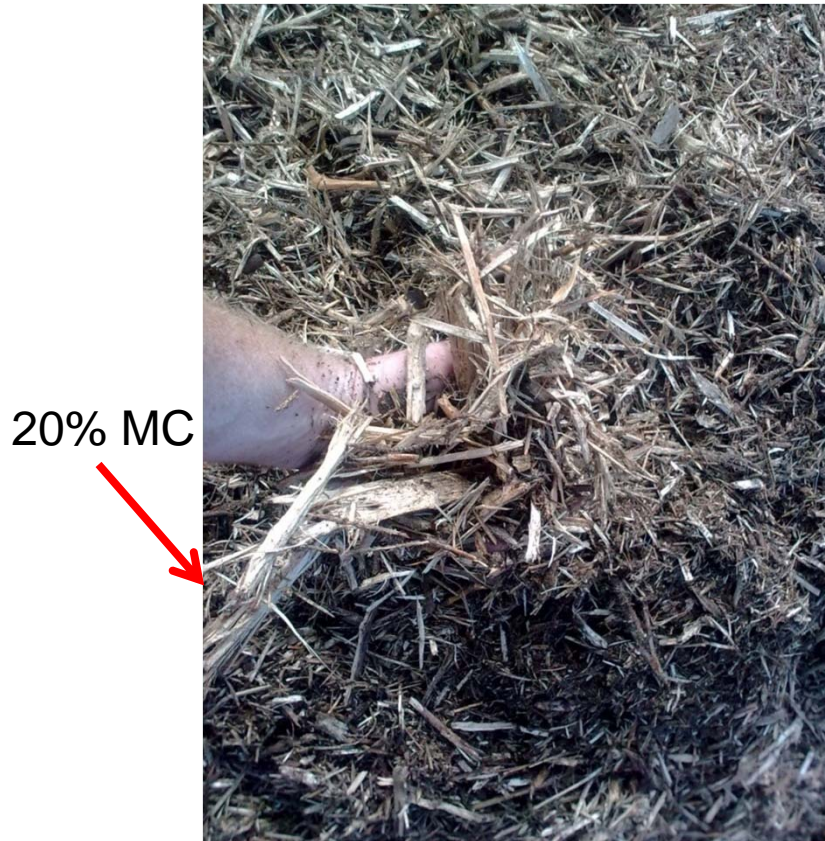


# Conclusions: forest storage of residue bundles

- Green & brown bundles dried significantly over storage period – benefit for transport & energy content
- Using a top cover improved drying in green bundles but not (statistically significantly) in brown bundles
- Stacking in a double row did not significantly affect drying – benefit for extraction and storage space
- No (statistically significant) difference between exposed and sheltered locations
- Variation in bundles within stack was a confounding effect.



# Variation in bundle composition



woody bundles dried better than bundles with high fine branch/needle content



# Conclusions: Storage at Terminal

- Better and more uniform drying compared to forest storage -  
No ground contact
- Top cover had no significant effect, contrary to forest storage
- Moisture content may increase during heavy rainfall, but effect is temporary.
- Recommendation: Delay removal/chipping for two weeks after heavy rain
- Overall recommendation: Preparation for bundling during harvesting necessary to increase quality uniformity



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Thank you.

