Performance of *Derris microphylla* as a High-Shade Tree

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Introduction

- Tea is a shade-loving plant that thrives in partial shade
- *Albizia spp.* is recommended as high-shade
  - low- and mid-elevation
- Farmers have issues with *Albizia*:
  - Excessive trunk girth and height make it difficult to manage
  - Requires frequent replanting, typically every 12 years
- Growers often leave *Albizia* unattended
  - Sell them for timber when they become unmanageable
- Damage to tea bushes both physically by falling trees and physiologically with the sudden exposure to direct sunlight
  - Need for an alternative high-shade tree / smaller and more manageable than *Albizia*

Objective

To test the growth performances of potential high-shade tree species and to study their effect on the growth and yield of tea

Methodology

- **Location**
  - Houpe estate, Kahawatta (6.56 N, 80.52 E / 30 m AMSL / WL2a / > 2400 mm yr^{-1})
- **Treatments**

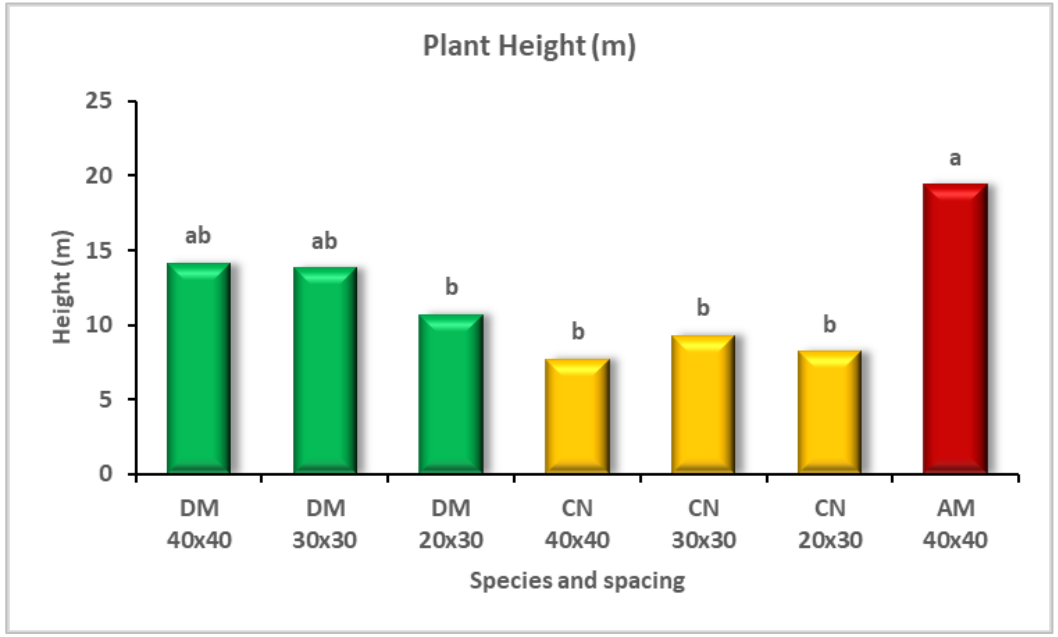
Derris microphylla	40x40 ft	(DM-40x40)
Derris microphylla	30x30 ft	(DM-30x30)
Derris microphylla	20x30 ft	(DM-20x30)
Cassia nodosa	40x40 ft	(CN-40x40)
Cassia nodosa	30x30 ft	(CN-30x30)
Cassia nodosa	20x30 ft	(CN-20x30)
Albizia moluccana	40x40 ft	(AM-40x40) (Control)

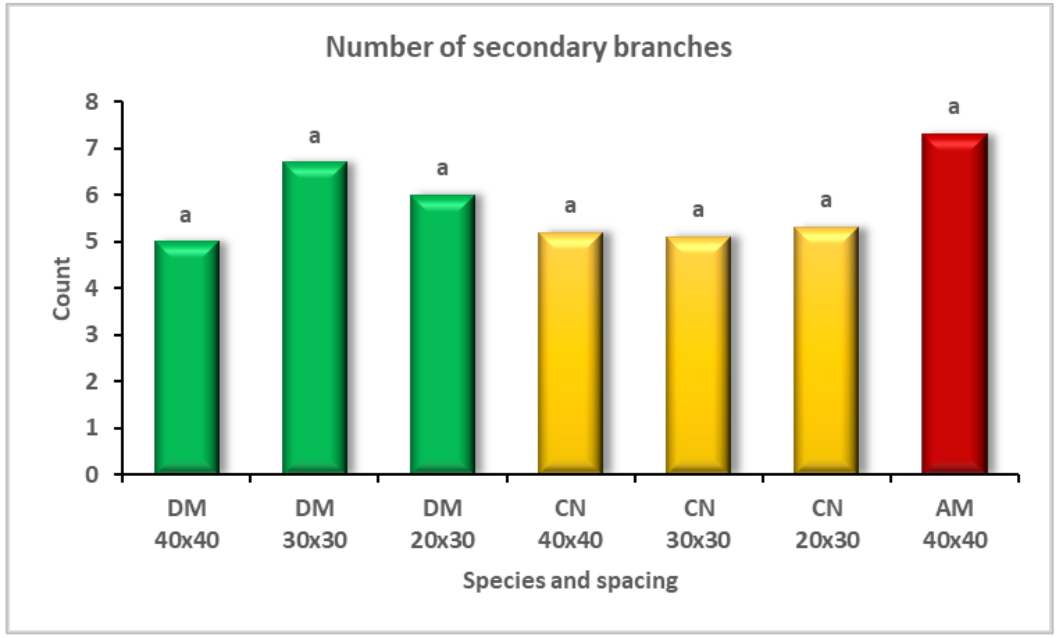
RCBD with 3 Replicates

Result and Discussion

Growth of shade trees

Plant height and branch development



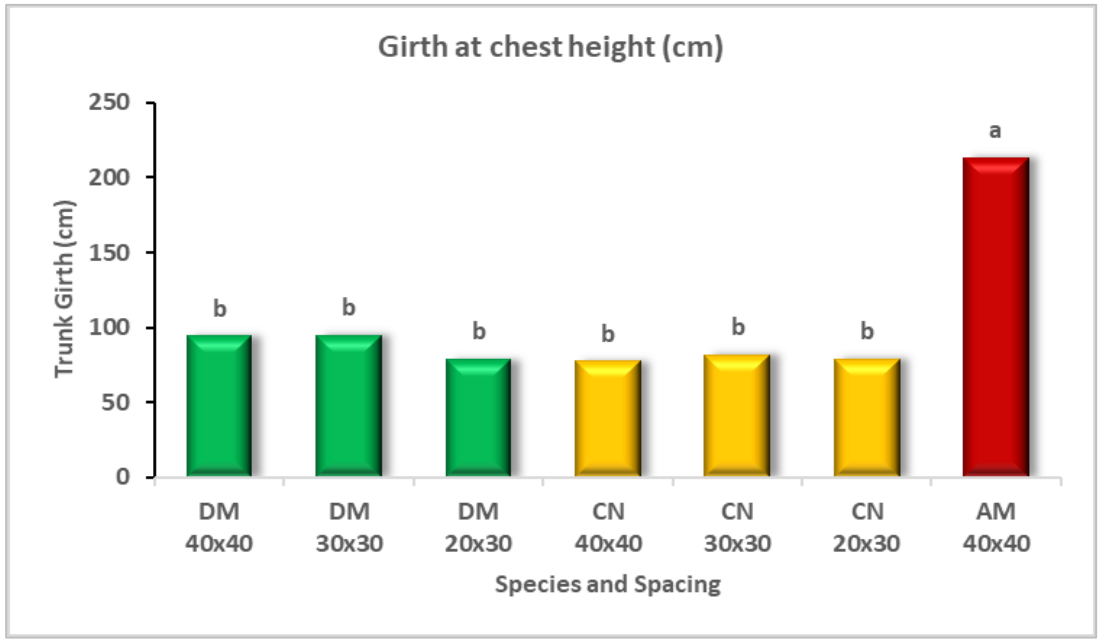


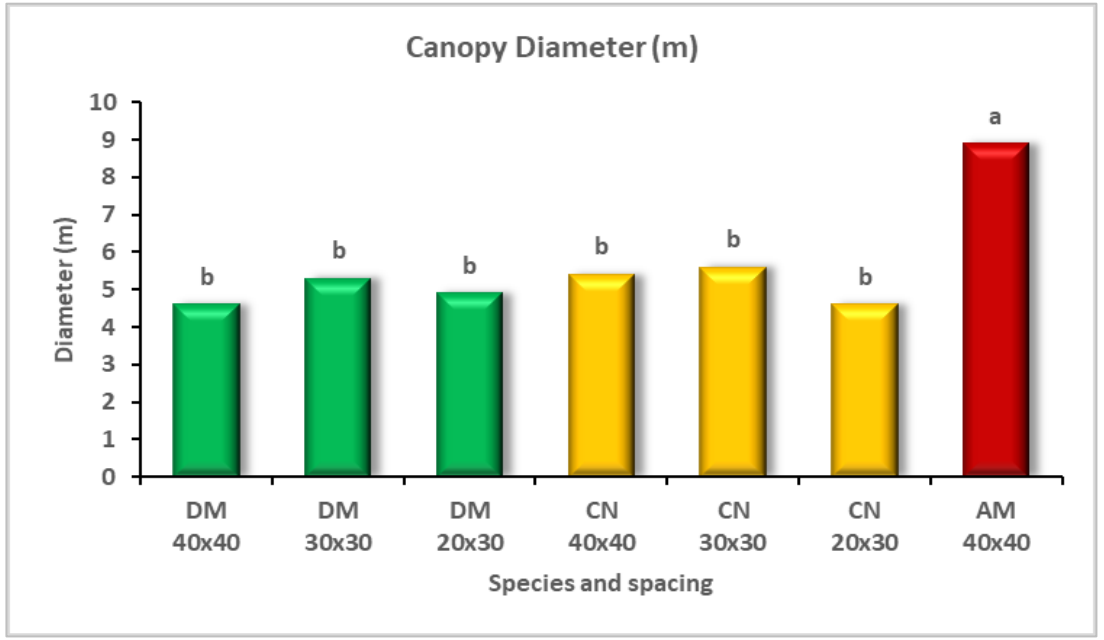
- *Derris microphylla* showed comparable to low plant height to *Albizia moluccana*
  - Shorter plants make shade management easier
  - *C. nodosa* was shorter than both *D. microphylla* and *A. moluccana*

- No significant difference in the count of secondary branches
- *C. nodosa* produced extremely thick dense canopy
  - Needed higher number of lopping

- *D. microphylla* found to be easier in shade management than *A. moluccana*

Trunk girth and canopy development

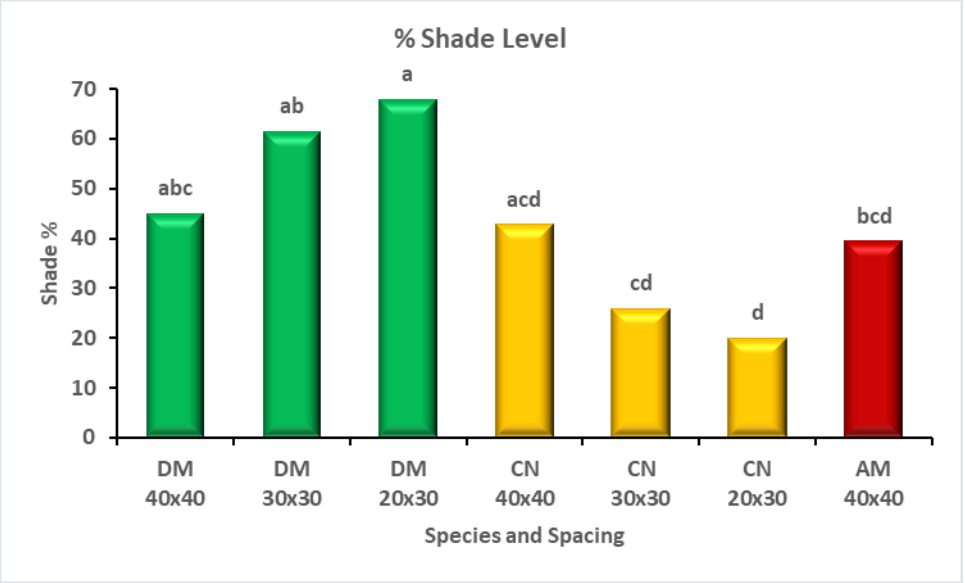




- *D. microphylla and C. nodosa* recorded smaller trunk girths which was easier for the management of shade compared to *A. moluccana*
- Both new shade tree species showed narrower canopy diameters (spread) than *A. moluccana*
- Tested new shade trees are smaller plants easier for management of shade

Level of shade provided under each shade regime

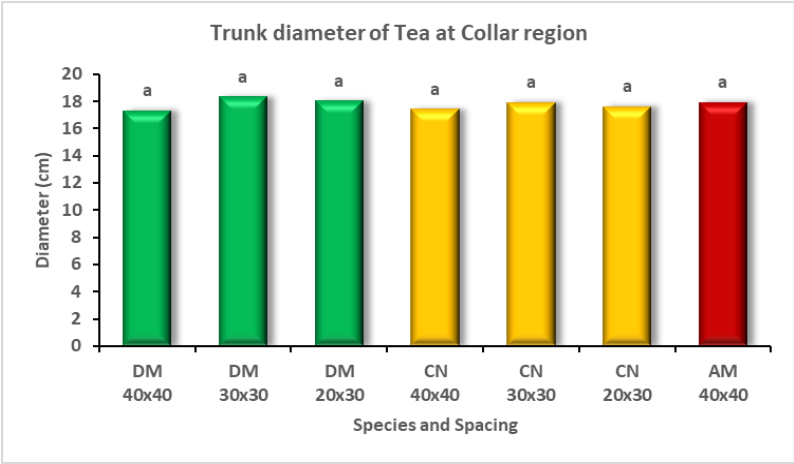
- Shade condition under *A. moluccana* showed comparable values to those under *D. microphylla* (40x40) and *C. nodosa* (40x40)
  - *C. nodosa* showed many casualties
  - Canopy height was also lower than others
- *D. microphylla* (40x40 ft) provided adequate shade level to tea compared to *A. moluccana*

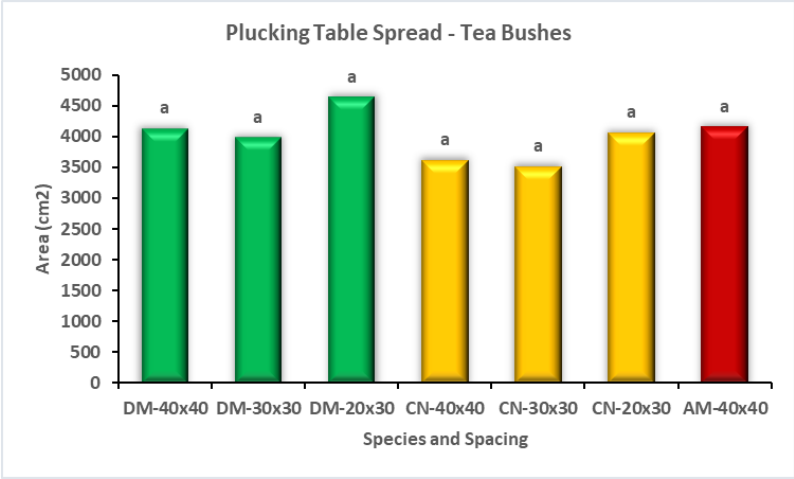


Growth and yield of tea bushes

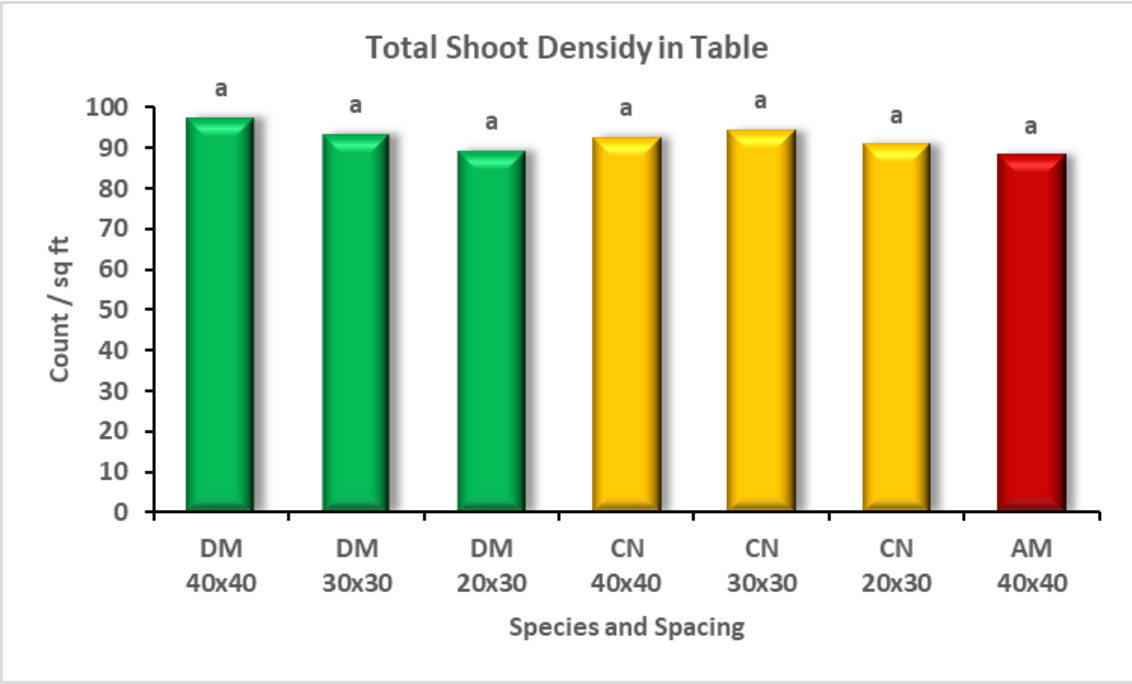
Girth of main stem and spread of plucking table

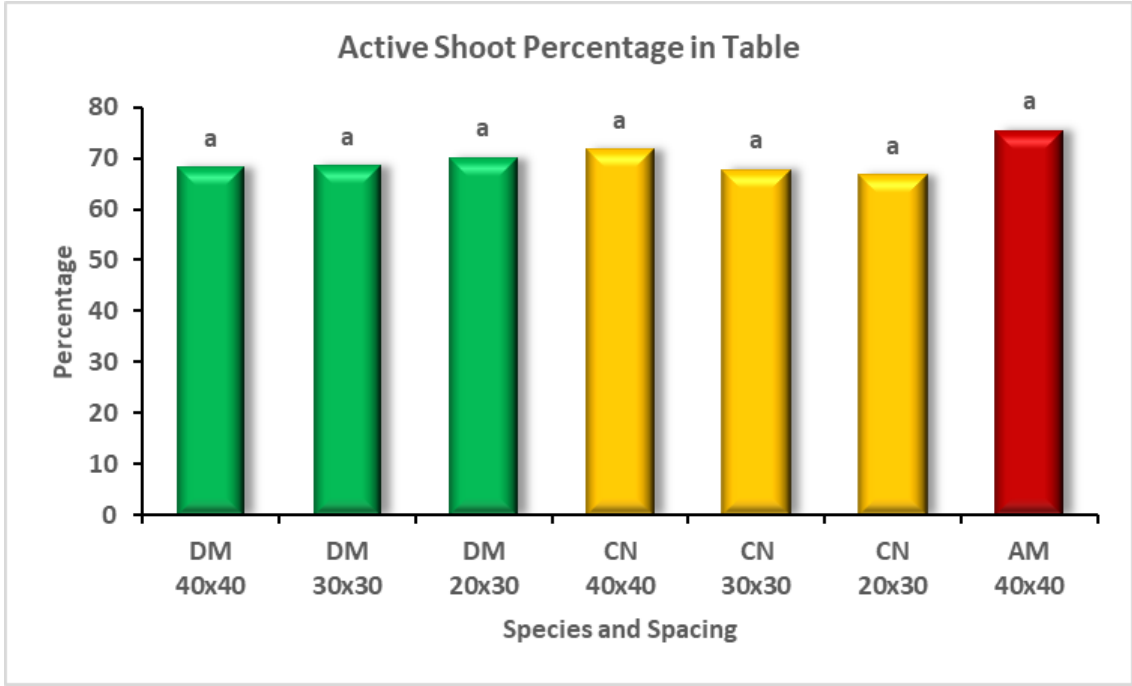
- Trunk girth of tea was comparable under all shade systems
- Spread of the table was not significantly varied
  - All shade systems equally supported the frame development in tea
  - Vascular system development → nutrient and water supply
- New shade TRTs have supported the growth of tea bushes similar to that of *A. moluccana*



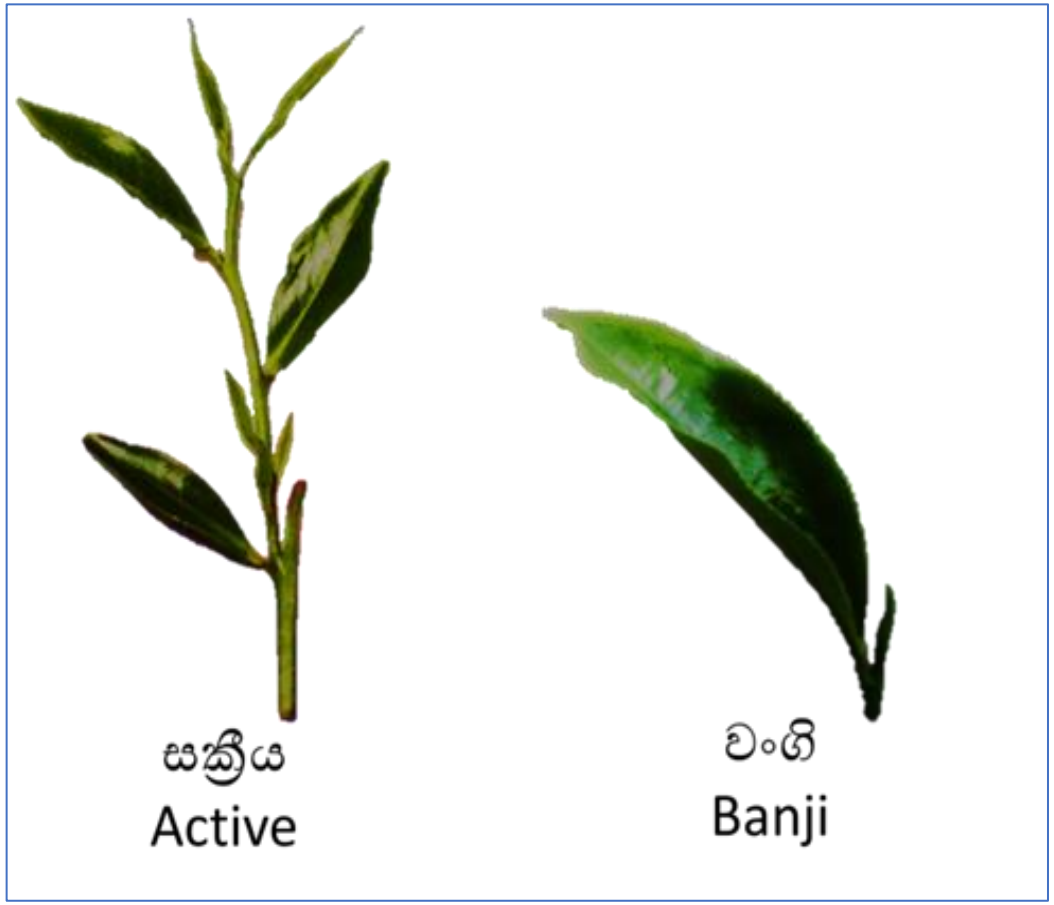


Shoot density and *Active growth* - plucking table



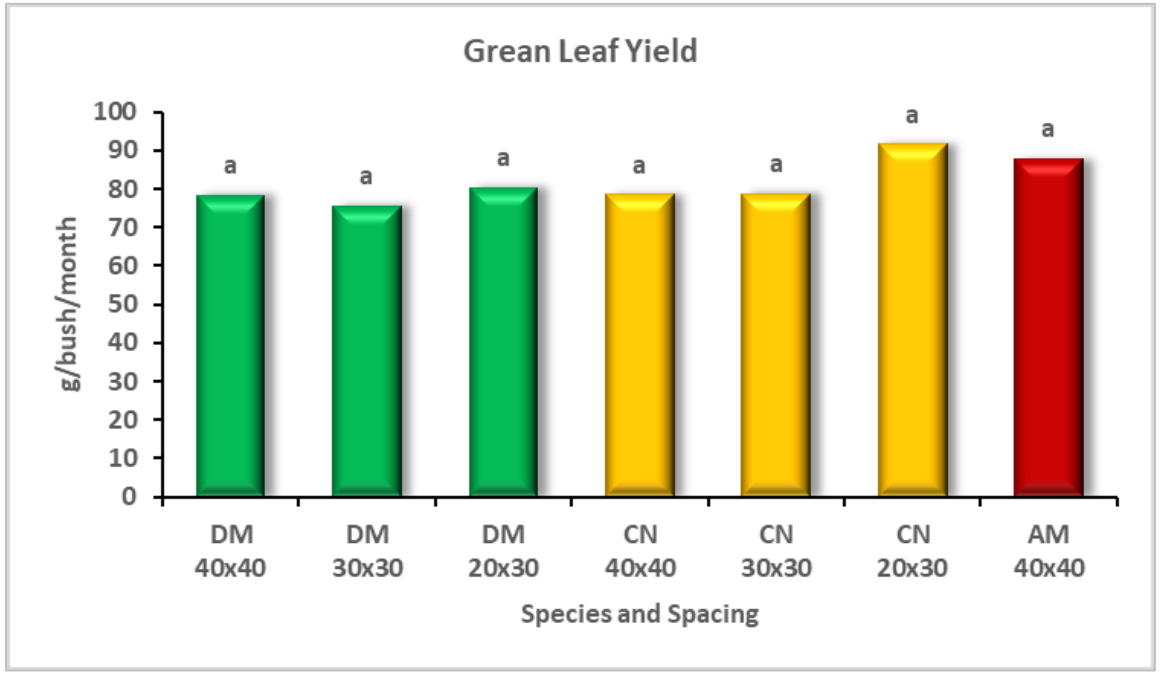


- Shoot counts using a 1 ft^2 quadrat at the center of the plucking table
- Total shoot density did not vary with the shade systems tested
- Active shoot growth was not affected by different shades provided
  - Banji shoots → less weight / takes longer to grow actively
- Hence, tested new shade trees have supported the active growth of tea shoots comparable to tea under *A. moluccana*



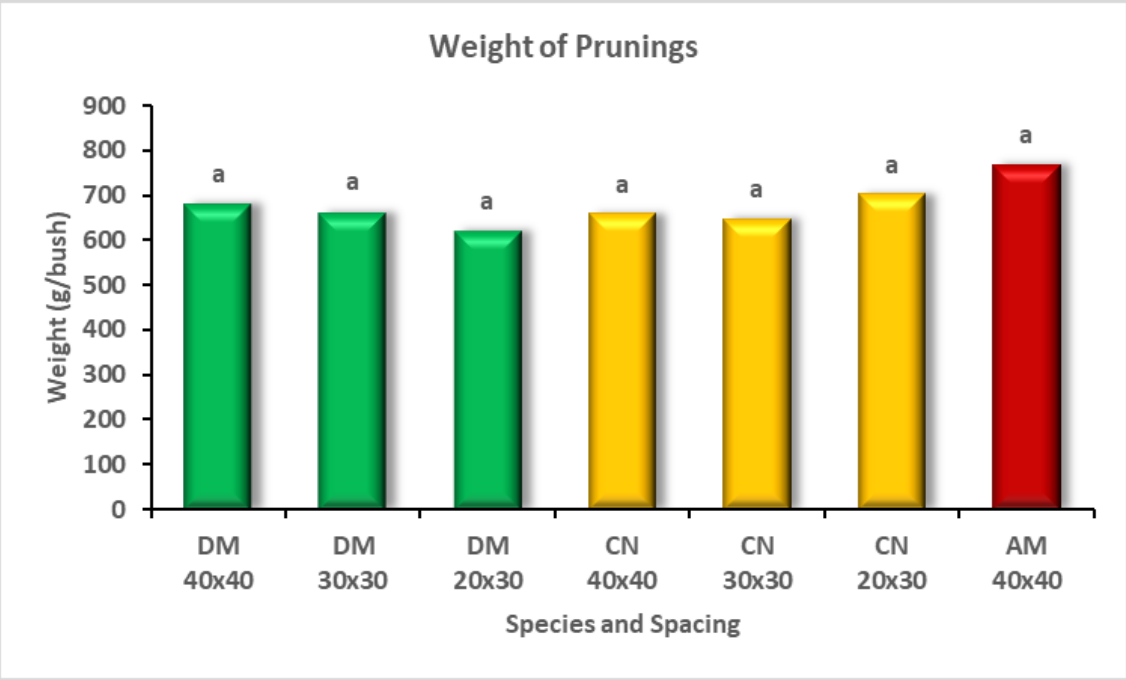
Green Leaf Yield

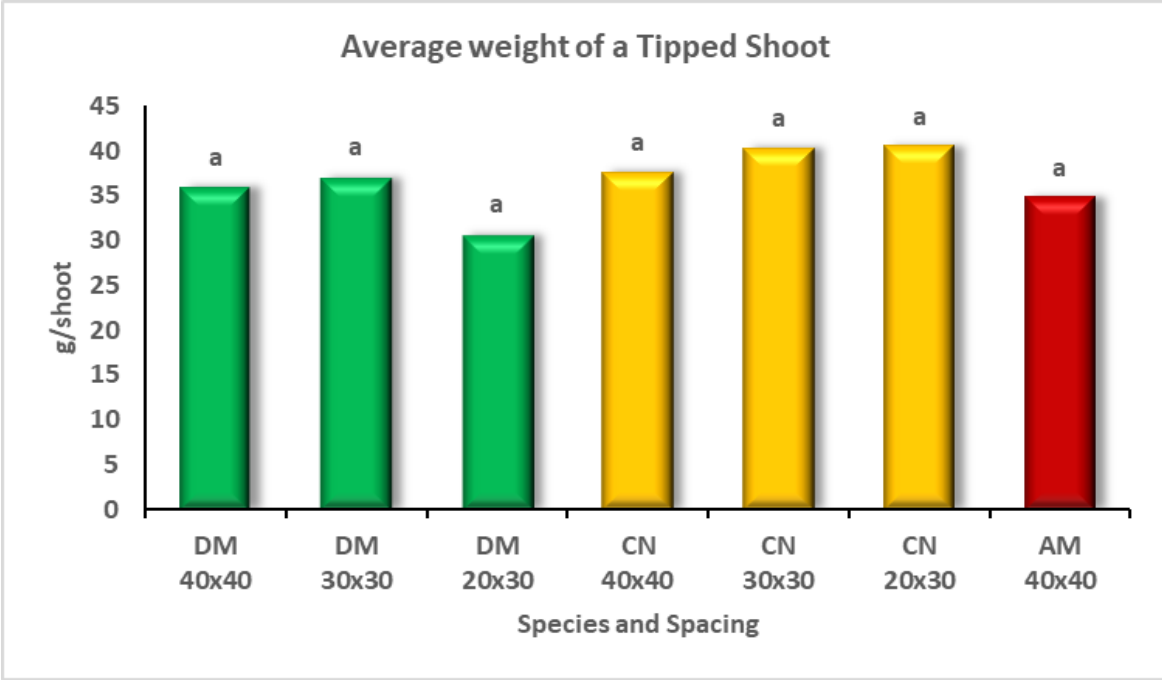
- No significant variation could be observed in tea shoot yield in different shade treatments
- Tea shoot yield of all shade treatments were comparable to that of *A. moluccana* (control)
- Tested new shade systems have supported growth and yield of tea similar to tea grown under *A. moluccana*



Recovery after pruning

Pruning and tipping weights

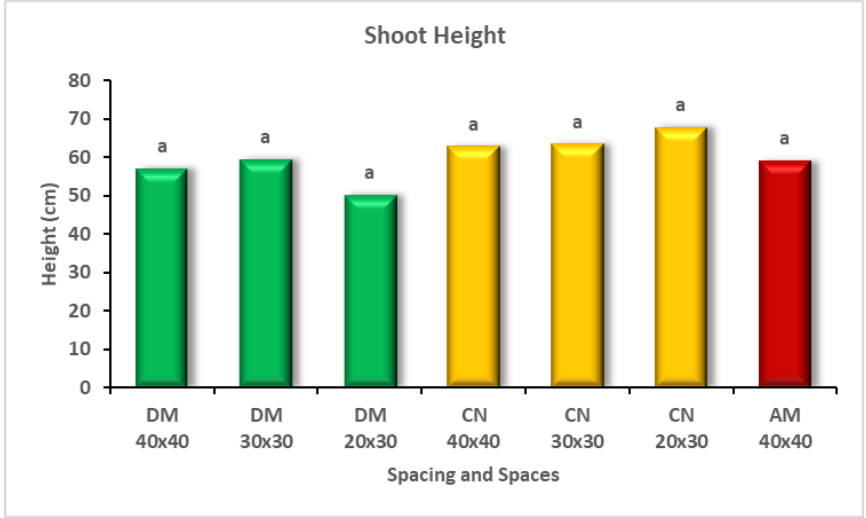


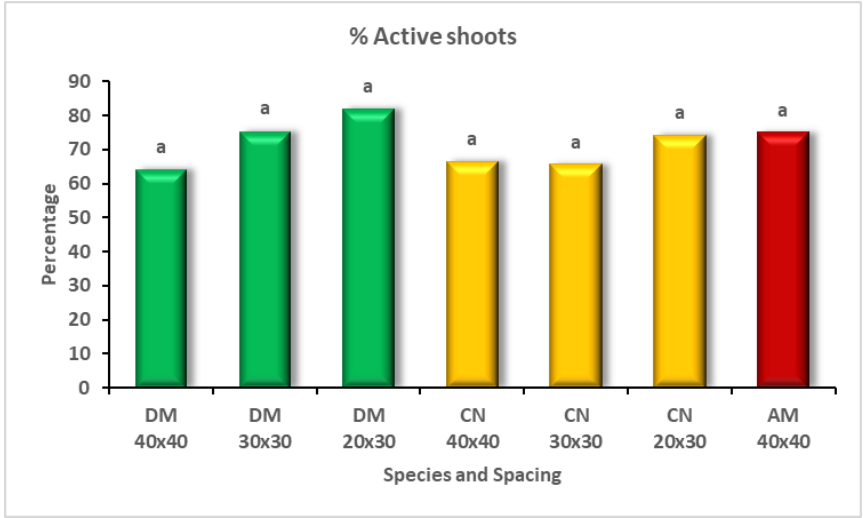


- Weight of pruned branches showed no significant variation among the shade treatments
- Average weights of a tipped branch became comparable across all TRTs
- This indicates that shade provided by new tree species have comparable effects on the recovery after pruning of tea similar to that of *A. moluccana*

Tipped shoot height and percentage active shoot growth

- Tipped shoot height was not affected by the shade TRTs
  - At 8-12 leaves stage, leaving 4-6 leaves
- 60-70% of tipped shoots were actively growing irrespective of the shade TRT
  - Active shoots grow fast and adds more weight
- New shade treatments have comparable effect with *A. moluccana* in the active shoot development after pruning





Soil related parameters

Soil properties measured in 0-6 inch depth

TRT	pH	C (%)	N (%)	K (ppm)	P (ppm)
DM-40x40	5.07[a]	1.37[a]	0.208[a]	134.5[a]	18.63[a]
DM-30x30	5.05[a]	1.41[a]	0.210[a]	139.1[a]	20.27[a]
DM-20x30	4.84[a]	1.82[a]	0.208[a]	120.6[a]	21.40[a]
CN-40x40	5.02[a]	1.39[a]	0.221[a]	143.2[a]	22.53[a]
CN-30x30	4.94[a]	1.55[a]	0.191[a]	134.5[a]	21.17[a]
CN-20x30	4.89[a]	1.59[a]	0.219[a]	144.6[a]	22.70[a]
AM-40x40	4.94[a]	1.66[a]	0.201[a]	135.8[a]	22.40[a]
CV	3.05	13.39	4.91	10.95	16.4

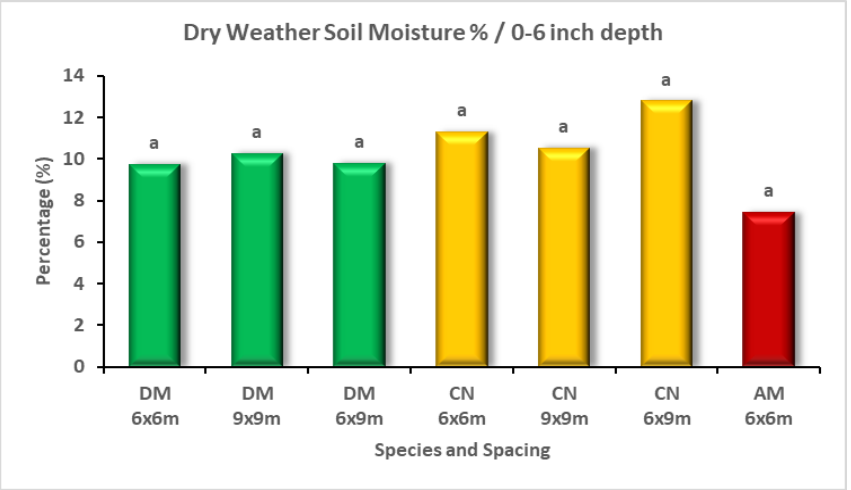
Soil properties measured in 6-12 inch depth

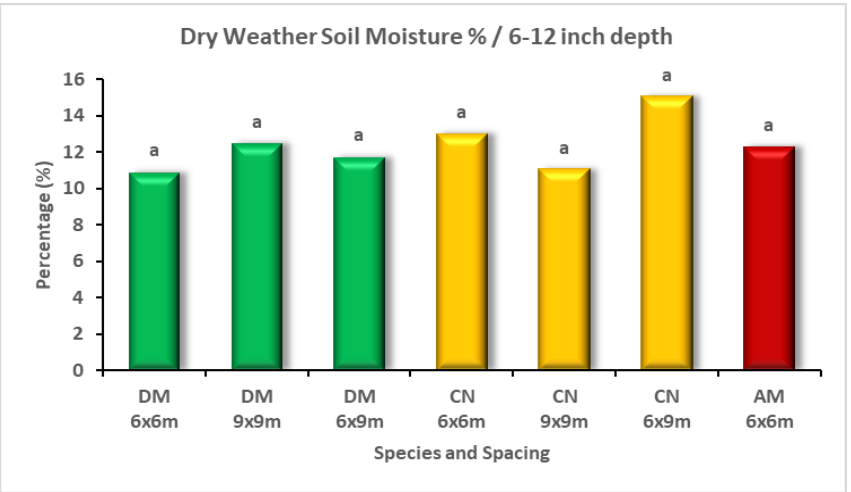
TRT	pH	C (%)	N (%)	K (ppm)	P (ppm)
DM-40x40	4.88[a]	1.34[a]	0.200[a]	141.0[a]	21.13[a]
DM-30x30	4.92[a]	1.44[a]	0.210[a]	125.3[a]	20.60[a]
DM-20x30	4.68[a]	1.36[a]	0.200[a]	131.2[a]	22.33[a]
CN-40x40	4.94[a]	1.38[a]	0.198[a]	137.5[a]	21.07[a]
CN-30x30	4.71[a]	1.43[a]	0.210[a]	134.4[a]	21.02[a]
CN-20x30	4.86[a]	1.38[a]	0.198[a]	143.8[a]	18.33[a]
AM-40x40	4.95[a]	1.47[a]	0.205[a]	130.7[a]	21.07[a]
CV	4.87	9.47	7.04	11.37	11.20

- All soil parameters in both the soil depths recorded no variation among treatments
- Further, N, P, K, C percentage and pH were fall within the normal range of low-country tea soils (Anon, 2000; Liyanage *et al.*, 2014)
- Therefore, effect of new shade systems on soil related parameters were comparable to that of *A. moluccana*

Dry weather soil moisture contents

- Soil moisture records under *D. microphylla* and *C. nodosa* high-shade systems were comparable with *A. moluccana* in both the soil depths
  - Low-country → more frequent droughts / Climate change
  - Therefore, the effect of new shade systems on dry season soil moisture conditions is important
- New shade tree species resulted comparable effect on dry season soil moisture content to that of *A. moluccana*





Pest and Disease

	Dead SHB (%) after 14 days
Derris	95±0.54
TRI 2025	23±0.6

- Laboratory Bio-Assay using *D. microphylla* and TRI 2025 stems
  - Introduced SHB (10) to the stem parts (CRD with 6 reps)
- 14 days after introduction of beetles
  - 95% of SHBs dead in *D. microphylla* stems
  - No brood development observed
  - Dead as introduced adults themselves
- *D. microphylla* is a NON-HOST plant for SHB / No other P&D observed

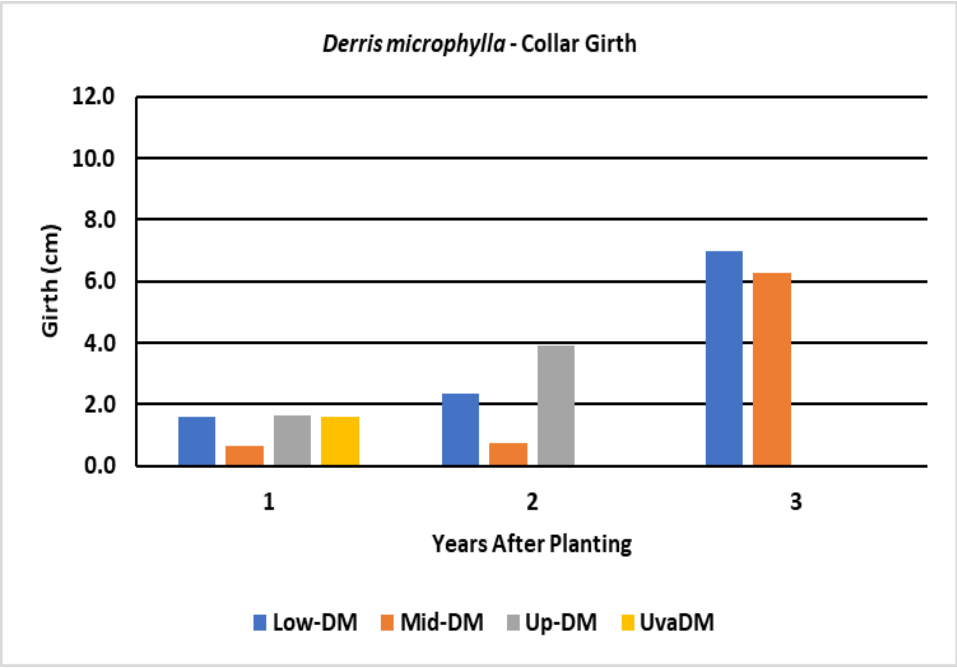
Root system of *Derris microphylla*

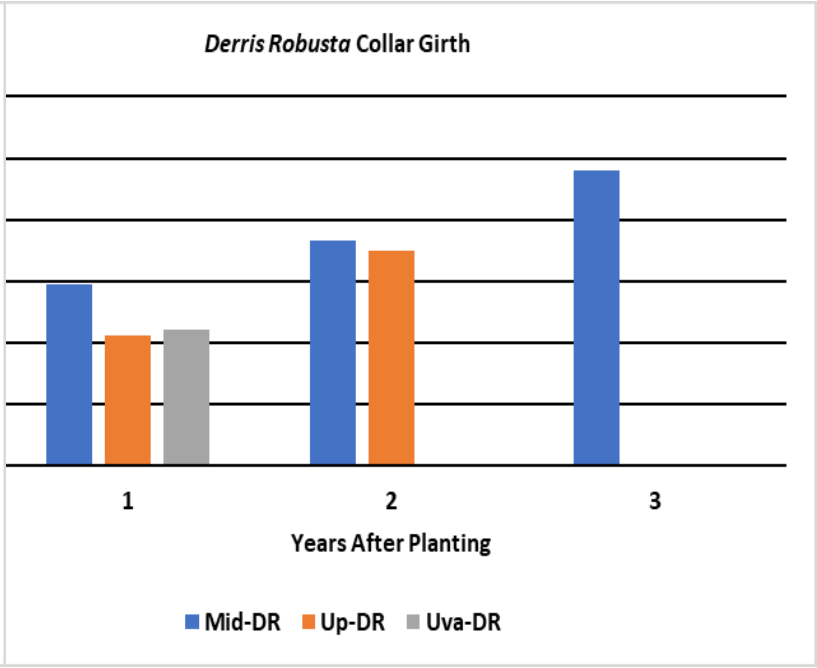


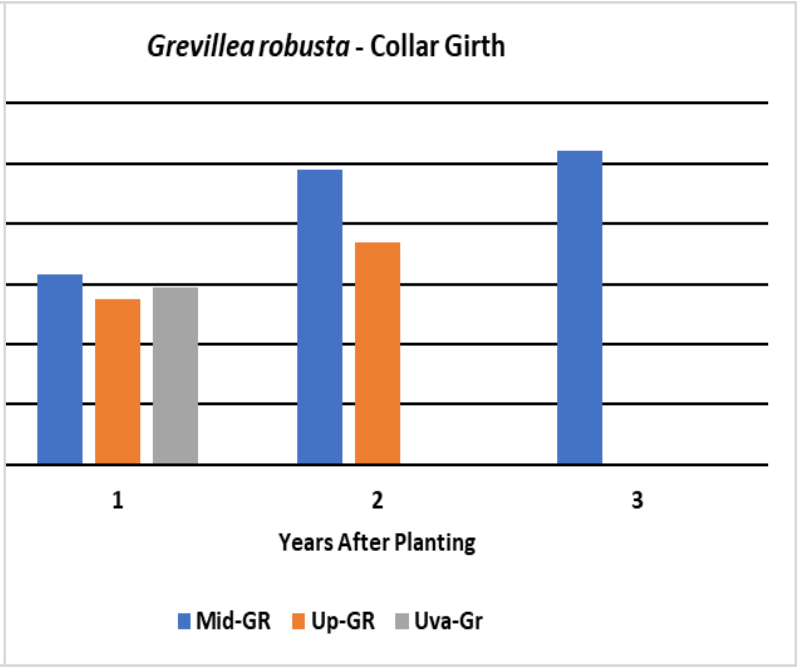
Anchorage / Nutrient Cycling

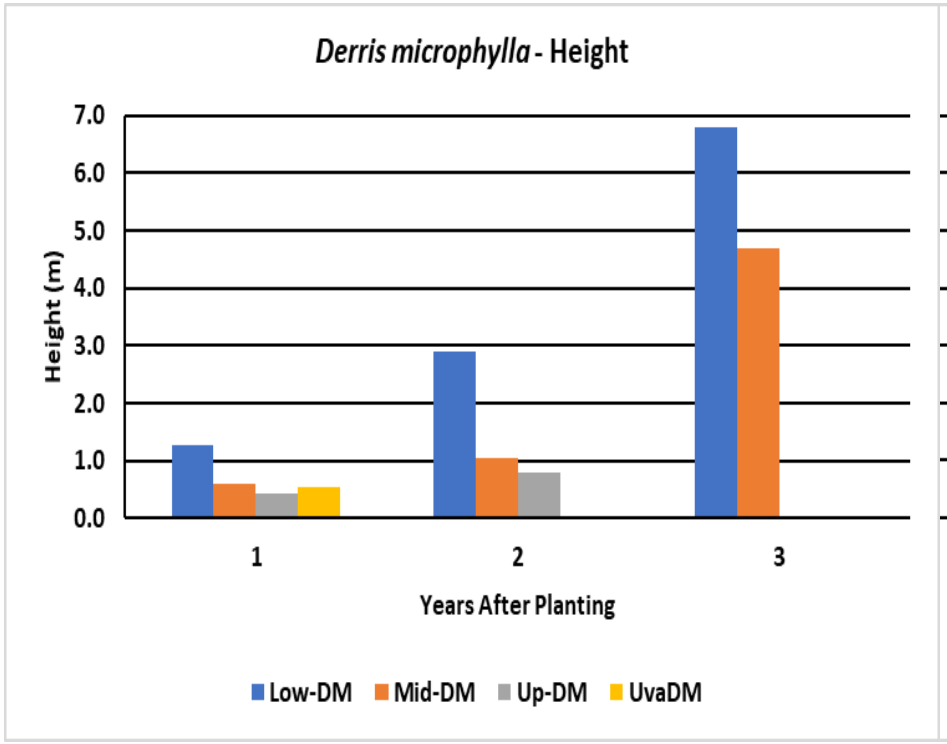
- Plant height 10 m
- Tap root depth 2 m (1/5th the height)
- Canopy diameter 5 m
- Roots has grown even beyond drip line

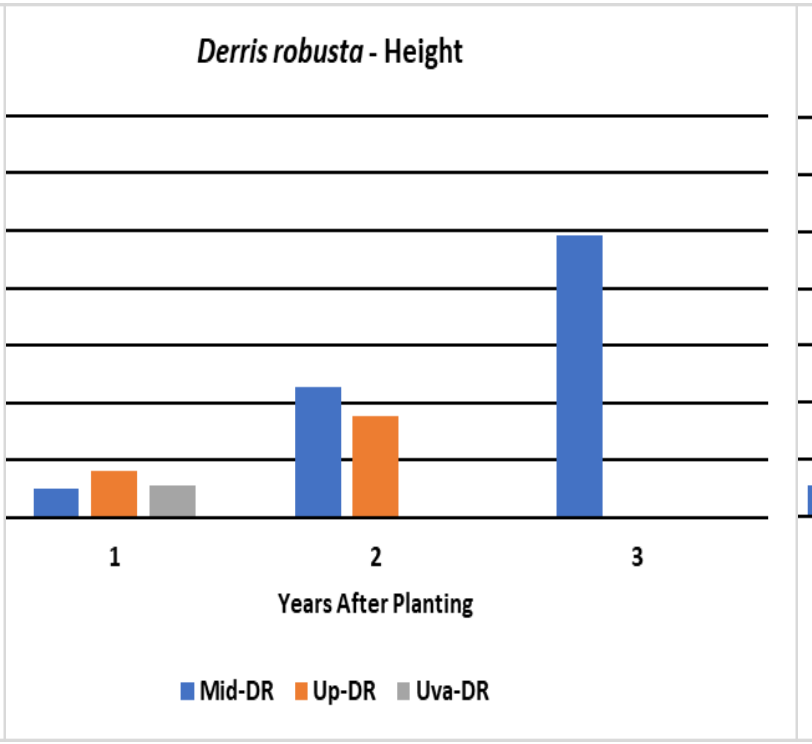
Experiments in other Elevations

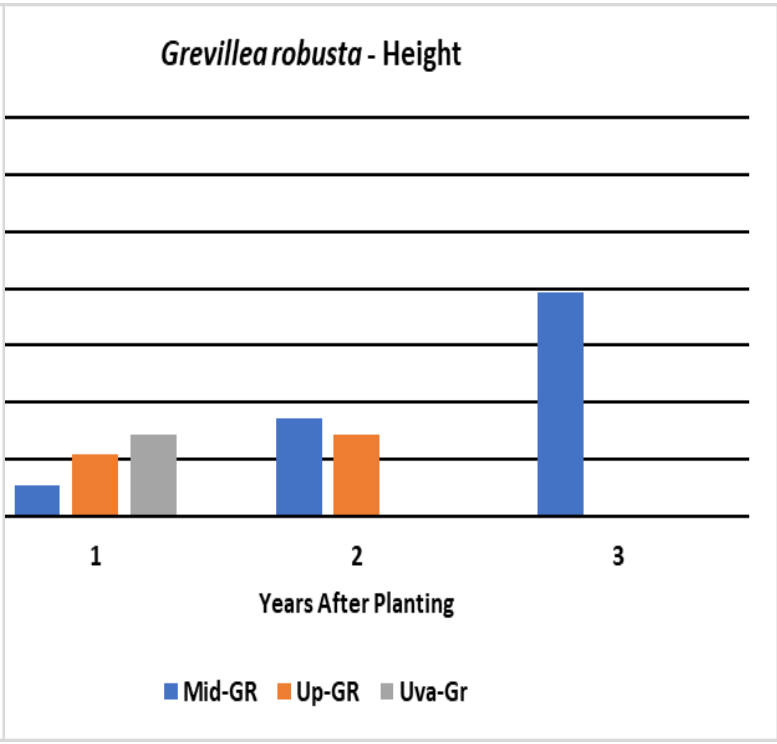







Derris microphylla - Height
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Height (m)
1
2
3
Years After Planting
Low-DM
Mid-DM
Up-DM
UvaDM


Derris robusta - Height
1
2
3
Years After Planting
Mid-DR
Up-DR
Uva-DR


Grevillea robusta - Height
1
2
3
Years After Planting
Mid-GR
Up-GR
Uva-Gr

Other field observations

- *Cassia nodosa*
  - Heavily attacked by porcupines
  - Collar region canker and heavy casualties
  - Spikey stem with maturity
  - Dry weather leaf fall (deciduous) during February

- *Derris microphylla*
  - No P&D observed in the field
  - *D. microphylla* plant spaces gave comparable results
  - Lowest density can be used
  - Manageable plant size even after 20-25 years

    (in a separate observation site)

Conclusions

- *Derris microphylla* grows smaller than *Albizia moluccana* that it is easier for shade management
- *Derris microphylla* has longer replacement duration than *Albizia moluccana*
- *Derris microphylla* (40x40 ft) can be recommended as an alternative high shade tree species for *Albizia moluccana* in low-grown tea plantations
- *Cassia nodosa* is not a suitable alternative candidate for *Albizia moluccana* as a high shade tree in low-grown tea plantations
  - Thick and fast growth of secondary branches, dry period leaf fall and heavy casualties

Acknowledgement

Management and the field staff of Houpe estate, Kahawatta.

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Thank you!