AgriSun Solutions pty ltd

APPLE SUNBURN & HIGH-TEMPERATURE MANAGEMENT

Reflective Orchard Ground Film

Research-informed guidance for high-radiation apple orchards

1. PURPOSE OF THIS GUIDE

Apple sunburn is a major production risk in warm, high-radiation growing regions.

The risk is particularly relevant where fruit is:

- highly exposed,
- subjected to intense solar radiation,
- exposed to elevated fruit-surface temperatures,
- or grown in orchards where canopy or netting management changes the light environment.

Reflective orchard ground film also changes the orchard radiation environment by redirecting a portion of incoming solar radiation upward from the orchard floor.

For that reason, reflective ground film should be managed as a **light-management technology**, not as a sunburn-control treatment.

This guide explains:

- what South African research tells us about apple sunburn,
- why kaolin particle film is not the same as reflective ground film,
- why fruit-surface temperature matters,
- why cultivar matters,
- how protective netting changes the picture,
- what growers should monitor,
- and why Golden Delicious deserves dedicated South African trials.

Your existing technical resource correctly makes the distinction that the Western Cape research used kaolin applied to trees and fruit, whereas AgriSun is an orchard-floor film.

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2. WHAT IS APPLE SUNBURN?

Apple sunburn is a physiological injury associated with excessive heat, solar exposure or a combination of the two.

Published work by Schrader, Zhang and Duplaga distinguished different types of sunburn injury in apples, including:

SUNBURN BROWNING

and

SUNBURN NECROSIS.

The important practical message is that sunburn cannot be understood from air temperature alone.

Fruit itself absorbs solar radiation.

As a result, the surface of an exposed apple can become substantially hotter than the surrounding air.

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3. FRUIT-SURFACE TEMPERATURE MATTERS

Fruit-surface temperature is one of the most important variables when assessing apple sunburn risk.

In the work by Schrader and colleagues, sunburn browning was associated with elevated fruit-surface temperatures in the presence of sunlight, whereas still higher temperatures resulted in sunburn necrosis.

Published literature has often cited approximately:

46–49°C FRUIT-SURFACE TEMPERATURE

in association with sunburn browning under direct solar exposure,

and approximately:

$52 \pm 1°C$

for thermal injury associated with sunburn necrosis under the experimental conditions investigated.

IMPORTANT

These numbers are **research observations**.

They are not universal orchard thresholds.

They should **not** be converted into an AgriSun instruction such as:

> “Remove reflective film when the temperature reaches 46°C.”

That would be inappropriate.

Actual sunburn risk depends on multiple interacting variables, including cultivar, fruit exposure, acclimation, solar intensity, canopy architecture and orchard conditions.

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4. AIR TEMPERATURE IS NOT ENOUGH

An orchard may experience an ambient air temperature that appears manageable while exposed fruit surfaces become much hotter.

For this reason:

AIR TEMPERATURE ≠ FRUIT-SURFACE TEMPERATURE.

A grower evaluating reflective ground film in a high-risk block should therefore not rely only on the weather-station temperature.

Where practical, fruit-surface temperature should form part of the trial-monitoring programme.

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5. SOUTH AFRICAN SUNBURN RESEARCH

South African research is especially relevant to AgriSun because apple sunburn has been studied directly under Western Cape commercial conditions.

Wand, Theron, Ackerman and Marais investigated apple fruit quality following applications of kaolin-based particle film in South African orchards.

The cultivars studied included:

GRANNY SMITH

BRAEBURN

FUJI

ROYAL GALA

CRIPPS PINK.

The research is valuable because it demonstrates the commercial importance of sunburn under local production conditions and shows that cultivar response matters.

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6. VERY IMPORTANT: WHAT THE SOUTH AFRICAN STUDY ACTUALLY USED

The South African research used:

KAOLIN-BASED PARTICLE FILM

applied to:

THE TREE AND FRUIT SURFACES.

This is fundamentally different from AgriSun Reflective Orchard Film.

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7. KAOLIN VS REFLECTIVE GROUND FILM

KAOLIN PARTICLE FILM

Kaolin-based particle film is sprayed onto plant and fruit surfaces.

The coating increases the reflectivity of those surfaces and can reduce heat load.

AGRISUN REFLECTIVE ORCHARD FILM

AgriSun is placed on the orchard floor.

Its physical function is to redirect a portion of radiation reaching the ground upward toward the canopy.

The technologies therefore work in different locations and by different mechanisms.

KAOLIN

acts on:

THE FRUIT / LEAF SURFACE

REFLECTIVE GROUND FILM

acts on:

THE ORCHARD-FLOOR LIGHT ENVIRONMENT

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8. WHAT THIS MEANS FOR AGRISUN

The South African kaolin study is useful evidence about:

- sunburn risk,
- cultivar sensitivity,
- fruit exposure,
- and South African growing conditions.

It is **not** evidence that AgriSun Reflective Orchard Film prevents sunburn.

AgriSun should therefore never state:

> **“South African research proves our reflective ground film reduces apple sunburn.”**

That would be incorrect.

Your existing technical material already makes precisely this distinction.

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9. WHY CULTIVAR MATTERS

The South African research involved several cultivars because apple response to heat and solar exposure is not identical across all apples.

The study included:

- Granny Smith,
- Braeburn,
- Fuji,
- Royal Gala,
- Cripps Pink.

Cultivar differences may involve:

- peel characteristics,
- fruit colour,

- solar absorption,
- natural exposure within the canopy,
- harvest timing,
- acclimation,
- and orchard management.

Therefore:

ONE APPLE CULTIVAR ≠ ALL APPLE CULTIVARS.

AgriSun should not develop a single universal sunburn-management statement for every apple.

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10. CULTIVARS REQUIRING PARTICULAR ATTENTION

Reflective film should be evaluated particularly carefully where an orchard already has a significant sunburn history.

Cultivars deserving close monitoring include:

GOLDEN DELICIOUS

GRANNY SMITH

FUJI

CRIPPS PINK / PINK LADY®

GALA AND GALA STRAINS

BRAEBURN

This does not mean these cultivars have identical sunburn susceptibility.

It means sunburn, fruit exposure and fruit-surface temperature should form part of the trial assessment.

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11. WHAT REFLECTIVE GROUND FILM CHANGES

AgriSun changes the orchard radiation environment.

The film redirects a portion of available solar radiation from below toward the canopy.

Depending on:

- film position,
- film width,
- canopy architecture,
- row orientation,
- sun angle,
- fruit exposure,
- netting,
- and environmental conditions,

the amount of radiation interacting with individual fruit may change.

Therefore:

MORE REFLECTED LIGHT IS NOT AUTOMATICALLY BETTER.

The objective is to use reflected light appropriately for the cultivar and orchard.

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12. WHERE SUNBURN RISK MAY BE HIGHER

Extra caution is appropriate where several risk factors occur together.

These may include:

HIGH SOLAR RADIATION

Especially during periods of clear, intense summer weather.

HIGH FRUIT-SURFACE TEMPERATURE

Particularly on exposed fruit.

OPEN CANOPY

Fruit suddenly receiving more direct radiation may be more vulnerable.

RECENT PRUNING OR CANOPY CHANGE

Removing protective foliage can abruptly increase fruit exposure.

WESTERN OR SUN-EXPOSED FRUIT POSITIONS

Depending on orchard orientation and local conditions.

WATER STRESS OR IRRIGATION PROBLEMS

Poor tree water status can compound heat stress.

HIGH-SUNBURN-HISTORY BLOCKS

Past damage indicates that the orchard environment can already reach risky conditions.

NEW REFLECTIVE-FILM APPLICATION

Any treatment altering the radiation environment deserves monitoring until its local effect is understood.

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13. AVOID “SET AND FORGET”

Reflective ground film should not be treated as an orchard input that is installed and ignored until harvest.

During the application period, growers should monitor:

- weather,
- fruit condition,
- film condition,
- fruit exposure,
- irrigation,
- and heat events.

This is particularly important during unusual high-radiation periods.

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14. GOLDEN DELICIOUS

A DIFFERENT PRODUCTION QUESTION

Golden Delicious is particularly important because the commercial objective differs from that of Gala, Fuji or Cripps Pink.

In red or bi-coloured cultivars, reflective-film research often focuses on red skin coloration.

Golden Delicious is a green-to-yellow apple.

Increasing red pigmentation is not the objective.

Instead, growers may need to balance:

- maturity,
- soluble-solids development,
- background colour,
- fruit exposure,
- fruit-surface temperature,
- sunburn,
- external fruit quality,

- and commercial harvest requirements.

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15. WHY GOLDEN DELICIOUS IS STRATEGICALLY IMPORTANT

Golden Delicious can remain on the tree while commercial maturity and soluble-solids targets develop.

During this period, exposed fruit may continue to experience substantial solar radiation.

That creates an important research question for AgriSun:

CAN REFLECTIVE GROUND FILM ALTER CANOPY LIGHT IN A USEFUL WAY WITHOUT CREATING AN UNACCEPTABLE INCREASE IN SOLAR INJURY?

At present, AgriSun does **not** have sufficient evidence to answer that question universally.

That is why Golden Delicious should become a South African research priority.

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16. GOLDEN DELICIOUS — SOUTH AFRICAN TRIAL PRIORITY

HIGHEST PRIORITY

A dedicated Golden Delicious programme could become one of AgriSun's most strategically valuable local trials.

The trial should not begin with the assumption that reflective film reduces sunburn.

Nor should it begin with the assumption that reflective film increases sunburn.

The purpose is to **measure the interaction**.

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17. CORE GOLDEN DELICIOUS RESEARCH QUESTIONS

A South African trial should ask:

1. Does reflective ground film change fruit-surface temperature?

2. Does film position change that response?

3. Does canopy position matter?

4. Does reflective film change sunburn incidence?

5. Does it change sunburn severity?

6. Does it alter maturity progression?

7. Does it alter soluble solids?

8. Does it change external peel quality?

9. Does it affect commercial pack-out?

10. Does protective netting alter the response?

These are much more useful questions than simply asking:

“Does the film work on Golden Delicious?”

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18. GOLDEN DELICIOUS TRIAL DESIGN

Where practical, use:

TREATMENT 1

AGRISUN REFLECTIVE GROUND FILM

TREATMENT 2

UNTREATED CONTROL

Where a protected block allows further comparison:

TREATMENT 3

NET + AGRISUN

and compare with:

NET ONLY.

The specific design should suit the commercial orchard and available trial area.

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19. WHAT TO RECORD BEFORE INSTALLATION

For Golden Delicious:

☐ Block
☐ Rootstock
☐ Tree age
☐ Expected harvest period
☐ Current fruit maturity
☐ Current soluble solids
☐ Background colour
☐ Existing sunburn
☐ Fruit exposure
☐ Canopy density
☐ Row orientation
☐ Training system
☐ Netting, if present
☐ Irrigation status
☐ Film position

Photograph comparable treated and control areas before installation.

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20. WHAT TO MONITOR DURING THE GOLDEN DELICIOUS TRIAL

FRUIT-SURFACE TEMPERATURE

Where appropriate equipment is available.

Measure comparable fruit:

- in treated and control areas,
- in similar canopy positions,
- and at consistent times.

AMBIENT CONDITIONS

Record:

- air temperature,
- solar conditions,
- major heat events.

SUNBURN

Record:

- existing damage,
- new damage,
- incidence,
- severity,
- canopy position.

MATURITY

Monitor according to the grower's normal programme.

SOLUBLE SOLIDS

Record °Brix using consistent sampling.

EXTERNAL FRUIT CONDITION

Photograph and grade peel condition.

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21. AT HARVEST — GOLDEN DELICIOUS

Compare treated and control fruit for:

☐ Soluble solids
☐ Firmness
☐ Maturity
☐ Background colour
☐ Fruit weight
☐ Fruit size
☐ Sunburn incidence
☐ Sunburn severity
☐ Peel discoloration
☐ Other external defects
☐ Commercial grade
☐ Export pack-out where applicable

Record both favourable and unfavourable results.

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22. WHY PACK-OUT MATTERS

A treatment could alter one biological variable without improving the commercial result.

For example:

fruit might reach a desired maturity,

but additional external damage could negate the benefit.

Conversely, improved light distribution could potentially have value even if Brix does not change.

The final question therefore needs to be:

DID THE TREATMENT CHANGE THE PROPORTION OF COMMERCIALLY ACCEPTABLE FRUIT?

That is why pack-out should form part of the Golden Delicious trial.

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23. REFLECTIVE FILM UNDER PROTECTIVE NETTING

Protective netting changes incoming orchard radiation.

Reflective ground film changes the direction of some radiation that reaches the ground.

The technologies therefore act at different stages of the orchard light environment.

Research in apples has shown that netting can reduce PAR, while reflective mulch beneath the net can increase reflected PAR and improve fruit coloration under some conditions.

Honeycrisp research has also directly evaluated reflective groundcover beneath protective netting and reported improved fruit skin colour under the study conditions.

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24. CAN NETTING REDUCE SUNBURN?

Yes, protective netting can reduce excessive fruit exposure under appropriate systems.

For example, the Chilean Gala Baigent/Fuji Raku Raku study reported substantial reductions in sunburn under shade netting.

However, netting also changed fruit coloration, demonstrating the trade-off between reducing excessive radiation and maintaining sufficient light for colour development.

That is why reflective film beneath netting is scientifically interesting.

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25. DOES REFLECTIVE FILM REPLACE NETTING?

NO.

Reflective ground film is not:

- hail protection,
- shade protection,
- or physical canopy protection.

It does not replace protective netting.

Netting can reduce incoming radiation.

Reflective film redirects part of the radiation already reaching the orchard floor.

The two technologies have different functions.

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26. HIGH-RISK ORCHARDS — PRACTICAL APPROACH

Where a block has a known history of significant sunburn:

DO NOT START WITH THE ENTIRE BLOCK.

Begin with a defined treatment area.

Retain a comparable untreated control.

Monitor both areas.

This gives the grower a practical basis for determining whether the new light environment is appropriate.

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27. WHAT EVERY HIGH-RISK TRIAL SHOULD MONITOR

CORE MEASUREMENTS

FRUIT-SURFACE TEMPERATURE

Where practical.

AIR TEMPERATURE

Useful context, but not a substitute for fruit temperature.

SOLAR CONDITIONS

Particularly clear high-radiation periods.

SUNBURN INCIDENCE

Percentage of affected fruit.

SUNBURN SEVERITY

Not all injury is equally commercially damaging.

FRUIT POSITION

Upper/lower, inner/outer, shaded/exposed.

CANOPY CONDITION

Especially after pruning or foliage loss.

IRRIGATION STATUS

Record abnormal water stress or irrigation failure.

MATURITY

Using normal cultivar-specific methods.

SOLUBLE SOLIDS

Where relevant.

COLOUR

For cultivars where colour is commercially important.

EXTERNAL DEFECTS

Including peel damage.

PACK-OUT

Where possible.

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28. DURING HIGH-TEMPERATURE EVENTS

When unusually high temperatures or solar-radiation conditions are forecast:

1. Inspect treated and control blocks.
2. Examine exposed fruit.
3. Check irrigation.
4. Record fruit-surface temperature where possible.
5. Record new sunburn symptoms.
6. Check film position.
7. Consider local horticultural risk-management practices.

IMPORTANT

AgriSun does not prescribe one universal air-temperature point at which film must automatically be removed.

Fruit-surface temperature and risk vary according to orchard conditions.

Your existing AgriSun material already makes this point explicitly.

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29. IF SUNBURN APPEARS AFTER FILM INSTALLATION

Do not immediately assume causation.

Compare:

AGRISUN TREATED AREA

with

UNTREATED CONTROL.

Record:

- location,
- fruit exposure,
- severity,
- fruit-surface temperature if available,
- weather,
- irrigation,
- canopy position,
- timing relative to installation.

The reflective film may be relevant to the changed radiation environment, but an appropriate comparison is necessary before drawing a conclusion.

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30. WHAT AGRISUN CAN RESPONSIBLY SAY

AgriSun can state:

Apple sunburn is associated with solar exposure and fruit-surface temperature.

Fruit-surface temperature can differ substantially from ambient air temperature.

Cultivar affects sunburn response.

South African apple research confirms that sunburn is commercially important under Western Cape conditions.

Reflective ground film changes orchard light distribution.

High-risk orchards should therefore be evaluated and monitored carefully.

These statements are consistent with the South African kaolin study and the apple sunburn physiology literature.

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31. WHAT AGRISUN DOES NOT CLAIM

AgriSun does **not** claim that reflective orchard ground film:

PREVENTS SUNBURN.

TREATS SUNBURN.

REDUCES SUNBURN BY A SPECIFIC PERCENTAGE.

REDUCES GOLDEN DELICIOUS SUNBURN.

INCREASES GOLDEN DELICIOUS SUNBURN.

MAKES NETTING UNNECESSARY.

CAN BE SAFELY USED AT EVERY TEMPERATURE WITHOUT MONITORING.

MUST ALWAYS BE REMOVED ABOVE A PARTICULAR AIR TEMPERATURE.

GUARANTEES BETTER PACK-OUT IN HIGH-SUNBURN ORCHARDS.

These questions depend on the orchard, cultivar, application and environmental conditions.

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32. IMPORTANT KAOLIN CLAIMS RULE

AgriSun should **never** take a result from the South African kaolin study and present it as though it were an AgriSun ground-film result.

For example:

If kaolin reduced a particular type of injury in an experiment, AgriSun cannot say:

“Reflective film reduces sunburn because South African research proved it.”

The materials and mechanisms are different.

The correct statement is:

South African research demonstrates the importance of apple sunburn and cultivar response under local growing conditions.

That research informs **risk management**, not an AgriSun performance claim.

33. QUICK HIGH-RISK CHECKLIST

BEFORE INSTALLATION

☐ Cultivar identified
☐ Sunburn history recorded
☐ Expected harvest recorded
☐ Existing sunburn photographed
☐ Fruit exposure assessed
☐ Canopy structure recorded
☐ Irrigation checked
☐ Netting recorded
☐ Treated and control areas established

DURING USE

☐ Fruit temperature monitored where possible
☐ Air temperature recorded
☐ Heat events recorded
☐ Fruit exposure checked
☐ Sunburn recorded
☐ Irrigation operating
☐ Canopy condition monitored
☐ Film position checked

AT HARVEST

☐ Sunburn incidence compared
☐ Severity compared
☐ Fruit colour compared where relevant
☐ Brix compared
☐ Maturity compared
☐ External quality compared
☐ Pack-out compared

34. SOUTH AFRICAN APPLE SUNBURN RESEARCH PRIORITIES

PRIORITY 1 — GOLDEN DELICIOUS

Highest priority.

Evaluate:

- film position,
- treatment timing,
- fruit temperature,
- sunburn,
- maturity,
- Brix,
- external quality,
- pack-out.

PRIORITY 2 — GRANNY SMITH

Particularly important because it is a green cultivar and sunburn is commercially relevant.

Evaluate:

- fruit temperature,
- canopy light,
- netting,
- sunburn,
- yield and maturity where relevant.

PRIORITY 3 — CRIPPS PINK

Balance:

- required red colour,

- heat,
- sunburn,
- maturity,
- pack-out.

PRIORITY 4 — FUJI

Evaluate:

- colour response,
- sunburn,
- netting,
- fruit temperature.

PRIORITY 5 — GALA

Use existing colour research as a strong reference but validate heat and sunburn response under South African conditions.

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35. SCIENTIFIC REFERENCES

SOUTH AFRICAN APPLE SUNBURN / KAOLIN

Wand, S.J.E., Theron, K.I., Ackerman, J. & Marais, S.J.S. (2006).

Harvest and Post-Harvest Apple Fruit Quality Following Applications of Kaolin Particle Film in South African Orchards.

Scientia Horticulturae, 107(3), 271–276.

DOI: **10.1016/j.scienta.2005.11.002**.

Important

This study evaluated **kaolin particle film applied to the tree and fruit surfaces**.

It did not evaluate reflective orchard ground film.

APPLE SUNBURN PHYSIOLOGY

Schrader, L.E., Zhang, J. & Duplaga, W.K. (2001).

Two Types of Sunburn in Apple Caused by High Fruit Surface (Peel) Temperature.

Plant Health Progress.

DOI: **10.1094/PHP-2001-1004-01-RS**.

REFLECTIVE GROUNDCOVER UNDER PROTECTIVE NETTING

Mupambi, G. et al. (2021).

Reflective Groundcover Improves Fruit Skin Color in 'Honeycrisp' Apples Grown under Protective Netting.

HortTechnology, 31(5), 607–614.

SHADE NETTING + REFLECTIVE MULCH

Yuri, J.A., Sepúlveda, A., Moya, M., Simeone, D. & Fuentes, M.

Shade Netting and Reflective Mulches Effect on Yield and Quality Variables of 'Gala Baigent' and 'Fuji Raku Raku' Apples.

New Zealand Journal of Crop and Horticultural Science.

DOI: **10.1080/01140671.2022.2098347**.

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36. IMPORTANT USE NOTICE

The information in this guide summarises published apple sunburn research and provides a framework for evaluating reflective orchard ground film responsibly.

Results obtained using:

- kaolin particle films,
- protective netting,
- reflective ground covers,
- particular cultivars,
- or particular climates

should not automatically be transferred from one technology or orchard system to another.

AgriSun Reflective Orchard Film changes the orchard light environment.

Its interaction with fruit temperature and sunburn risk should therefore be evaluated under the conditions of the individual orchard.

AGRISUN REFLECTIVE SOLUTIONS

Better Light. Applied With Evidence.

Manage the light.

Measure the fruit temperature.

Compare the result.

Build the recommendation from evidence.