



AgriSun Solutions pty ltd

APPLE APPLICATION & TIMING GUIDE

Reflective Orchard Ground Film

Research-informed guidance
for Gala, Fuji, Cripps Pink,
Braeburn, Honeycrisp,
Granny Smith and Golden
Delicious

1. PURPOSE OF THIS GUIDE

Reflective orchard ground cover is used to alter the light environment within an apple orchard by redirecting a portion of available solar radiation from the orchard floor upward toward the canopy.

Apple research has investigated reflective ground materials in relation to:

- red skin coloration,
- canopy light distribution,
- fruit maturity,
- protective netting,
- training systems,
- fruit quality,
- return bloom,
- and yield.

The response is not identical across cultivars or orchard systems.

For this reason, this guide distinguishes between:

PUBLISHED STUDY TIMING

A timing that was actually used in a published experiment.

and

SOUTH AFRICAN TRIAL PRIORITY

A cultivar or application where local conditions should be evaluated before AgriSun develops a specific commercial recommendation.

2. BEFORE USING THE CULTIVAR GUIDE

For every apple block, first record:

- cultivar,
- expected first harvest date,
- current colour,
- maturity,

- canopy density,
- row orientation,
- training system,
- protective netting,
- sunburn history,
- irrigation status,
- and the part of the canopy where the grower wants to alter the light environment.

Reflective-film results should be interpreted together with these orchard factors.

3. GALA

WHAT RESEARCH TELLS US

Gala has one of the clearest published reflective-film timing references.

Layne, Jiang and Rushing evaluated metallised high-density polyethylene reflective film in commercial Gala apple orchards.

The film was installed **four weeks before the anticipated start of harvest**.

Under the conditions of the experiment, reflective film increased the proportion of red coloration on the fruit.

Research on Mondial Gala in Spain also found that reflective-film treatment improved red skin coloration, although responses in other quality variables were not identical across seasons and treatments.

WHERE REFLECTIVE FILM MAY BE RELEVANT

A Gala grower may consider reflective ground film where:

- fruit within the inner or lower canopy is under-coloured,
- exposed fruit colours better than shaded fruit,
- netting reduces available canopy light,
- or final red colour is affecting commercial grading.

The strongest research case is therefore **final-stage light management for red skin coloration**.

PUBLISHED TIMING

4 WEEKS BEFORE ANTICIPATED HARVEST

This is a directly published timing from the Layne et al. Gala study.

Important

It should be treated as a **research reference**, not a guarantee that exactly four weeks is optimal for every South African Gala orchard.

WHAT TO MEASURE

At installation:

- existing red colour,
- background colour,
- maturity,
- canopy position,
- sunburn,
- expected harvest date.

At harvest:

- percentage red colour,
- treated vs untreated canopy positions,
- soluble solids,
- firmness,
- starch index,
- fruit weight,
- sunburn,
- external defects,
- pack-out category.

SOUTH AFRICAN TRIAL PRIORITY

HIGH PRIORITY — YES

South African Gala trials should establish:

- whether four weeks remains appropriate under local radiation and temperature conditions,
- response beneath local net systems,
- optimum film placement,
- colour response by canopy position,
- and any interaction with sunburn.

The international evidence is strong enough to provide a starting point, but local optimisation is still valuable.

4. FUJI

WHAT RESEARCH TELLS US

Fuji has direct published research on reflective orchard-floor films.

A 1999 Scientia Horticulturae study specifically investigated covering the orchard floor with reflective film in Fuji apples.

The researchers reported increased anthocyanin accumulation and improved fruit coloration in treated Fuji fruit.

Fuji research has also investigated the interaction between reflective materials, orchard light and hail/protective netting.

Fuji is therefore **not an unresearched application**.

What is less clear is one universal pre-harvest timing that can responsibly be applied to every Fuji strain and growing region.

WHERE REFLECTIVE FILM MAY BE RELEVANT

Potentially where:

- shaded Fuji fruit colours poorly,
- interior fruit differs from exterior fruit,
- netting reduces red colour development,
- or a grower has difficulty reaching desired red coverage before harvest.

Fuji strain also matters.

Published work shows considerable differences in colour behaviour between Fuji strains even without reflective-film treatment.

PUBLISHED TIMING

No single universal Fuji timing should be published by AgriSun yet.

The literature supports pre-harvest use, but different Fuji experiments have used different systems and treatment schedules.

AgriSun should therefore **not simply transfer the Gala four-week timing to Fuji.**

WHAT TO MEASURE

- Fuji strain,
- existing red coverage,
- canopy position,
- anthocyanin / objective colour measurement where available,
- maturity,
- soluble solids,
- firmness,
- starch degradation,
- fruit temperature,
- sunburn,
- pack-out.

SOUTH AFRICAN TRIAL PRIORITY

HIGH PRIORITY — YES

South African trials should establish:

- timing by Fuji strain,
 - response under local netting,
 - colour response in shaded fruit,
 - optimum film placement,
 - interaction with hot pre-harvest conditions,
 - and whether improved colour occurs without undesirable maturity or quality changes.
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5. CRIPPS PINK / PINK LADY®

WHAT RESEARCH TELLS US

Cripps Pink is a late-season, bi-coloured apple for which red colour is commercially important.

There is horticultural evidence and commercial experience supporting the use of reflective mulch as a colour-management technique in Cripps Pink, including Australian industry guidance describing the cultivar as responsive to reflective mulch.

South African work has also investigated red-colour improvement strategies in Cripps Pink, including reflective mulching in local research work.

However, the evidence available to us does **not** justify publishing one universal AgriSun timing for Cripps Pink.

WHERE REFLECTIVE FILM MAY BE RELEVANT

Particularly where:

- final red coverage determines market class,
- fruit inside the canopy remains under-coloured,
- vigorous canopies reduce fruit exposure,
- or protective netting reduces available light.

Because Cripps Pink is harvested late, temperature and maturity at the time of treatment should also be considered.

PUBLISHED TIMING

No single cultivar-wide timing established for AgriSun.

AgriSun should not claim:

“Install Cripps Pink film X weeks before harvest”

until local or directly applicable cultivar-specific timing evidence supports that statement.

WHAT TO MEASURE

- red skin coverage,
- colour intensity,
- fruit position,
- background colour,
- firmness,
- starch index,

- soluble solids,
- fruit-surface temperature,
- sunburn,
- commercial grade,
- pack-out.

SOUTH AFRICAN TRIAL PRIORITY

VERY HIGH PRIORITY

This is one of the cultivars I would actively prioritise for AgriSun trials.

South African trials should determine:

- most useful pre-harvest deployment period,
- colour response by canopy position,
- interaction with protective netting,
- maturity at installation,
- sunburn response,
- and commercial pack-out.

This is particularly relevant because Cripps Pink is already an important South African commercial cultivar and local colour-management research exists.

6. BRAEBURN

WHAT RESEARCH TELLS US

Braeburn has direct published research involving reflective ground covers.

A European study on Braeburn Hillwell evaluated reflective ground covers applied at different pre-harvest timings, including treatments several weeks before harvest.

Other research on Braeburn Mariri Red under pearl hail netting has also evaluated reflective ground material before harvest.

This establishes Braeburn as a **directly researched reflective-ground-cover cultivar**.

WHERE REFLECTIVE FILM MAY BE RELEVANT

Potentially where:

- fruit struggles to develop adequate red colour,
- interior fruit remains green,
- netting reduces available canopy light,
- or growers want to improve the light environment during final colour development.

PUBLISHED TIMING

The Braeburn literature includes reflective-ground-cover treatments deployed during the **final several weeks before harvest**, but treatment schedules differ between experiments.

For this reason, I would **not reduce the Braeburn evidence to one universal number** in the AgriSun guide.

WHAT TO MEASURE

- red coverage,
- background colour,
- canopy position,
- soluble solids,
- firmness,
- starch index,
- maturity,
- sunburn,
- external defects,
- pack-out.

SOUTH AFRICAN TRIAL PRIORITY

HIGH PRIORITY

Local trials should establish:

- whether earlier or later deployment performs best,
- response beneath South African netting systems,
- colour response in shaded positions,
- and interaction with high solar radiation.

7. HONEYCRISP

WHAT RESEARCH TELLS US

Honeycrisp has strong recent research under protective netting.

Mupambi and colleagues evaluated reflective groundcover in Honeycrisp apples grown under protective netting.

The study reported improved fruit skin colour with reflective groundcover.

Importantly, the study reported **no effect of the reflective groundcover treatments on yield, fruit weight, firmness or soluble solids** under those experimental conditions.

This is an excellent example of why AgriSun should describe outcomes individually:

Colour improved.

That does not mean every fruit-quality variable improved.

WHERE REFLECTIVE FILM MAY BE RELEVANT

Especially:

- beneath protective netting,
- where red skin coverage is reduced,
- in the lower canopy,
- or where netting creates a colour-management trade-off.

PUBLISHED TIMING

The Honeycrisp research supports **late-season/pre-harvest deployment**, but AgriSun should not publish one universal number of days without tying it to the exact experimental protocol.

WHAT TO MEASURE

- red skin coverage,
- colour category,
- upper vs lower canopy,
- fruit weight,
- firmness,
- soluble solids,
- maturity,
- sunburn,
- pack-out.

SOUTH AFRICAN TRIAL PRIORITY

MEDIUM PRIORITY

Honeycrisp is scientifically useful for AgriSun because it gives us very good evidence about reflective groundcover under netting.

A South African trial is valuable if the cultivar is commercially relevant to the target grower, but it is less strategically urgent than Gala, Cripps Pink, Fuji or Golden Delicious.

8. GRANNY SMITH

WHAT RESEARCH TELLS US

Granny Smith is a very different application because it is a green-skinned cultivar.

Reflective groundcover has nevertheless been researched directly in Granny Smith.

Work under protective netting investigated reflective groundcover as a way of improving orchard light conditions and reported effects on return bloom and yield.

This is important:

Reflective groundcover is not only a red-colour technology.

In green cultivars, the research question can instead involve:

- canopy light,
- flowering,
- return bloom,
- or broader orchard physiology.

At the same time, Granny Smith is recognised as particularly vulnerable to sunburn under South African conditions.

WHERE REFLECTIVE FILM MAY BE RELEVANT

Potentially:

- under protective netting where canopy light is reduced,
- where growers want to investigate return bloom or canopy light,
- or as part of a longer-term orchard-light-management programme.

It should **not** be promoted as a pre-harvest red-colour application.

PUBLISHED TIMING

No universal short pre-harvest timing.

The Granny Smith research question is different from Gala.

AgriSun should therefore avoid assigning Granny Smith the Gala or Braeburn colour-development programme.

WHAT TO MEASURE

Depending on the trial objective:

- canopy PAR,
- return bloom,
- flower-bud development,
- yield,
- fruit weight,
- maturity,
- fruit-surface temperature,
- sunburn incidence,
- canopy condition.

SOUTH AFRICAN TRIAL PRIORITY

VERY HIGH PRIORITY

Because of South Africa's sunburn conditions, Granny Smith deserves careful local evaluation.

The key question is not:

“Can we make Granny Smith redder?”

It is:

Can reflective groundcover improve the orchard light environment without creating an unacceptable increase in fruit exposure or heat-related injury?

This should be studied under local protective-net systems.

9. GOLDEN DELICIOUS

WHAT RESEARCH TELLS US

Golden Delicious should not be treated as though it were simply another red-colour cultivar.

Research has examined the effects of light environment and reflective ground surfaces in Golden Delicious and related apple orchard systems, but the production objective differs from Gala, Fuji or Braeburn.

Golden Delicious fruit is also relevant to sun-exposure and fruit-surface-temperature research.

The appropriate question is therefore broader than colour alone.

WHERE REFLECTIVE FILM MAY BE RELEVANT

Possible research objectives include:

- canopy light distribution,
- shaded-vs-exposed fruit development,
- maturity,
- soluble solids,

- fruit-surface temperature,
- and orchard-light management beneath netting.

It should not be promoted as a standard red-colour application.

PUBLISHED TIMING

No universal AgriSun pre-harvest timing established.

The available evidence does not justify saying:

“Golden Delicious should receive reflective film X weeks before harvest.”

WHAT TO MEASURE

This is one of the most important cultivars to measure comprehensively.

Record:

- fruit-surface temperature,
- canopy position,
- sun exposure,
- sunburn incidence,
- sunburn severity,
- background colour,
- maturity,
- soluble solids,
- firmness,
- external peel condition,
- pack-out.

SOUTH AFRICAN TRIAL PRIORITY

HIGHEST PRIORITY

Golden Delicious should have a dedicated South African AgriSun research programme.

The commercial question is:

Can reflective-film placement and timing modify the canopy light environment while maintaining acceptable fruit temperature and external quality as fruit approaches required harvest maturity?

The trial should compare:

AGRISUN-TREATED AREA

against

UNTREATED CONTROL

and, where relevant, record conditions under protective netting separately.

Until those trials are completed:

AgriSun does not claim that reflective ground film prevents Golden Delicious sunburn.

AgriSun does not claim that reflective ground film increases Golden Delicious sunburn.

The result must be measured.

10. QUICK APPLE TIMING SUMMARY

Cultivar	What the evidence currently allows AgriSun to say
Gala	4 weeks before anticipated harvest directly studied
Fuji	Reflective ground film directly researched; no single universal AgriSun timing yet
Cripps Pink / Pink Lady®	Reflective mulch relevant to colour management; South African timing trial needed
Braeburn	Direct reflective-ground-cover research exists; final-

Cultivar	What the evidence currently allows AgriSun to say
	weeks pre-harvest treatments studied, but no single universal timing
Honeycrisp	Pre-harvest groundcover research under protective netting; colour response documented
	Reflective groundcover directly researched for
Granny Smith	objectives beyond red colour; no universal short pre-harvest timing
Golden Delicious	Different objective; no universal AgriSun timing; high-priority South African trial

11. SOUTH AFRICAN APPLE TRIAL PRIORITIES

PRIORITY 1 — GOLDEN DELICIOUS

Study:

- fruit-surface temperature,
 - sunburn,
 - maturity,
 - Brix,
 - canopy light,
 - film position,
 - timing,
 - pack-out.
-

PRIORITY 2 — CRIPPS PINK / PINK LADY®

Study:

- timing,
- red colour coverage,
- maturity,
- netting,

- film placement,
 - pack-out.
-

PRIORITY 3 — FUJI

Study:

- strain-specific response,
 - timing,
 - red colour,
 - under-net performance,
 - sunburn,
 - pack-out.
-

PRIORITY 4 — GALA

Use the published four-week timing as the initial benchmark and determine whether South African conditions require adjustment.

Study:

- 4-week reference treatment,
 - colour response,
 - film position,
 - netting,
 - maturity,
 - sunburn.
-

PRIORITY 5 — GRANNY SMITH

Focus on:

- canopy light,
 - protective netting,
 - return bloom,
 - fruit temperature,
 - sunburn,
 - yield.
-

PRIORITY 6 — BRAEBURN

Determine:

- best local pre-harvest window,
 - colour response,
 - under-net performance,
 - maturity.
-

HONEYCRISP

Trial where commercially relevant.

Its greatest value to AgriSun currently is the strong published evidence showing reflective groundcover can improve colour beneath protective netting **without automatically altering Brix, fruit weight, firmness or yield.**

12. WHAT EVERY AGRISUN APPLE TRIAL SHOULD RECORD BEFORE INSTALLATION

- ☐ Cultivar and strain
 - ☐ Block
 - ☐ Tree age
 - ☐ Rootstock
 - ☐ Expected first harvest
 - ☐ Current fruit colour
 - ☐ Current maturity
 - ☐ Canopy density
 - ☐ Training system
 - ☐ Row orientation
 - ☐ Netting
 - ☐ Sunburn history
 - ☐ Film position
-

DURING THE TRIAL

- ☐ Installation date
 - ☐ Weather
 - ☐ Fruit colour
 - ☐ Fruit-surface temperature
 - ☐ Sunburn
 - ☐ Canopy condition
 - ☐ Reflected light/PAR where equipment is available
 - ☐ Film condition
-

AT HARVEST

- ☐ Colour coverage
- ☐ Fruit weight
- ☐ Soluble solids
- ☐ Firmness
- ☐ Starch index
- ☐ Background colour
- ☐ Sunburn incidence
- ☐ External defects
- ☐ Commercial pack-out

Use the same assessment method in treated and untreated areas wherever practical.

13. IMPORTANT INTERPRETATION RULE

**A RESPONSE IN ONE CULTIVAR DOES NOT
AUTOMATICALLY APPLY TO ANOTHER.**

For example:

Gala has a directly published four-week treatment.

That does **not** mean Fuji, Cripps Pink, Golden Delicious or Granny Smith should automatically receive the same programme.

Likewise, a research result showing improved red colour does not automatically mean:

- higher Brix,
- larger fruit,
- greater yield,
- earlier harvest,
- lower sunburn,
- or better profitability.

Each response should be measured separately.

14. SELECTED APPLE RESEARCH

Gala

Layne, D.R., Jiang, Z. & Rushing, J.W. (2002).

The Influence of Reflective Film and ReTain on Red Skin Coloration and Maturity of ‘Gala’ Apples.

HortTechnology, 12(4), 640–645.

Fuji

Ju, Z., Duan, Y. & Ju, Z. (1999).

Effects of Covering the Orchard Floor with Reflecting Films on Pigment Accumulation and Fruit Coloration in ‘Fuji’ Apples.

Scientia Horticulturae, 82, 47–56.

DOI: [10.1016/S0304-4238\(99\)00038-2](https://doi.org/10.1016/S0304-4238(99)00038-2).

Honeycrisp

Mupambi, G. et al. (2021).

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

HortTechnology, 31(5), 607–614.

DOI: [10.21273/HORTTECH04776-20](https://doi.org/10.21273/HORTTECH04776-20).

Braeburn

Published Acta Horticulturae work has evaluated reflective ground covers in Braeburn during final pre-harvest colour development.

Granny Smith

Published Acta Horticulturae research has investigated reflective groundcover beneath protective netting in Granny Smith, including effects on return bloom and yield.

Apple Ground-Cover Placement

Gonzalez, L. & Robinson, T.L.

Effect of Different Reflective Ground Covers on Light Reflection and on the Coloring of Apples at Harvest.

Acta Horticulturae 1366.

Research included EverCrisp, Honeycrisp, NY1 and NY2 and demonstrated the importance of material, deployment configuration and training system.

AGRISUN REFLECTIVE SOLUTIONS

Better Light. Applied With Evidence.

Published research gives us the starting point.

South African trials allow us to determine what works under our cultivars, climate, netting systems and orchard conditions.