Unlocking year-round production of high-quality PRACs

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Introduction

Potato Rooted Apical Cuttings (**PRACs**) are one of the most exciting opportunities to enhance availability of high-quality starter material for multiplication of seed potato and could revolutionize the potato sector in Africa. PRACs are produced from Mother Plants (**MPs**) in a screenhouse, which in turn come from disease-free Tissue Culture (**TC**) plants. However, PRAC nurseries struggle to produce PRACs of consistent quality and MPs often age and must be discarded and replaced after only 3 months.

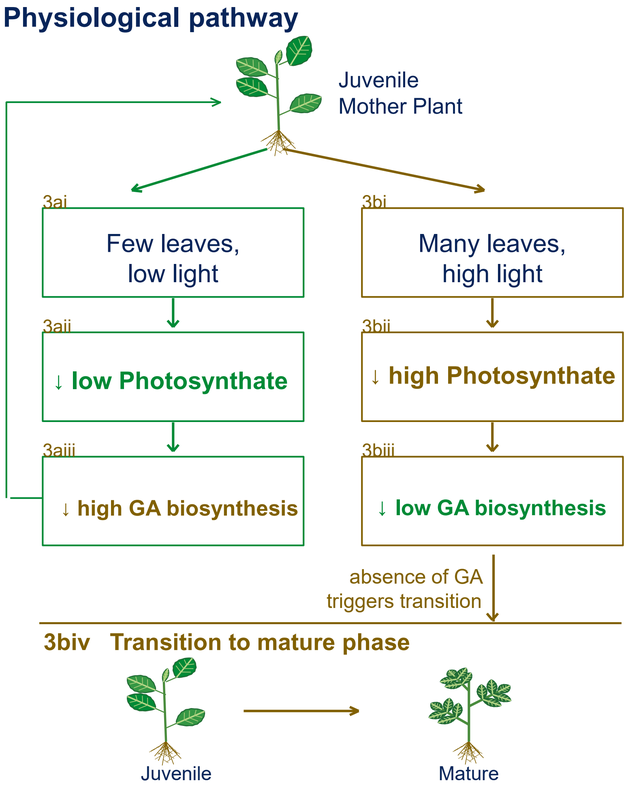
The reason is not simple ageing: as Mother Plants grow, their leaves progressively compound, entering a mature phase. And once a plant reaches this compounded state, a "cutting" taken from it is no longer a true apical cutting (of undifferentiated cells) but a stem cutting bearing an already-differentiated shoot tip, which is why productivity falls.

Plant biology explains this: leaf form changes as a shoot ages, moving from simple juvenile leaves toward more complex, adult forms (Njoku, 1956a). In compound-leaved plants this is driven by how long leaf morphogenesis (leaflet initiation) is sustained before differentiation fixes the final form (Bar and Ori, 2015). Compounding therefore marks how far along the juvenile-to-mature trajectory a shoot has moved — and makes a potato mother plant apex too mature to serve as a good PRAC source.

Quality PRACs must therefore be taken from Mother Plants in juvenile form, that have simple round leaves. We describe a theoretical background for understanding the transition from juvenile to mature phase and show evidence supporting our hypotheses that simple management techniques of shade, disciplined cutting and plant hormones can be used to maintain juvenile mother plants in commercial cutting nurseries.

Scan for full theory

Physiological pathway



Theoretical framework

Three factors govern this transition from juvenile to mature phase in plants generally. Gibberellin enables the maintenance of juvenile phase (3aiii) and absence of Gibberellin mediates the transition to mature phase (3biii).

Photosynthate ("sucrose") output is the trigger that drives the transition (3bii), and photosynthate rises with either high light intensity or a greater leaf area or both (3bi)(Njoku, 1956a, 1956b; Xu, Hu and Poethig, 2021). Adding sucrose experimentally accelerates the transition from juvenile to mature phase (Xu, Hu and Poethig, 2021).

The photosynthate sucrose trigger downregulates Gibberellin biosynthesis (3biii)), leading to absence of GA, and enabling the transition to take place (3biv).

We hypothesize that in potato, shade and disciplined cutting of excess shoots and leaves delay compounding by limiting photosynthate supply from light capture and leaf area, respectively, while exogenous GA helps maintain a more juvenile, productive mother-plant state. The proposed sucrose–miR156–GA interactions in potato remain to be tested.

Managed vs unmanaged mother plant lifecycle

Juvenile phase mother plant (MP)
Simple round leaves



Actively managed: shading, regular cutting, GA spray

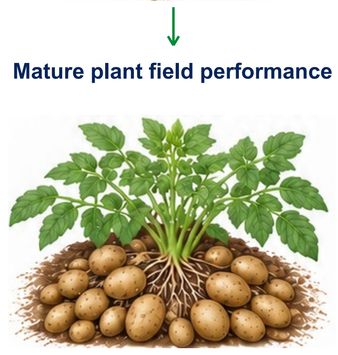
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Rooted apical cutting



↓

Mature plant field performance

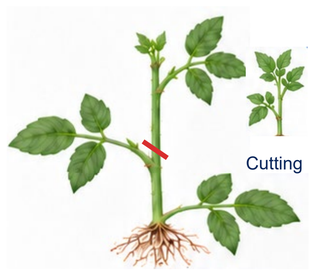


22 to 25 tubers/PRAC

Cut above node 2



Mature phase mother plant (MP)
Compounded divided leaves



Unmanaged: high light, irregular cutting, no GA

↓

Rooted stem cutting



↓

Mature plant field performance



7–12 tubers per PRAC

Managed lifecycle

MP produces for over 12 months
up to 77 PRACs per MP*
≤35 G1 tubers per PRAC
≤2,695 G1 tubers per MP

Unmanaged lifecycle

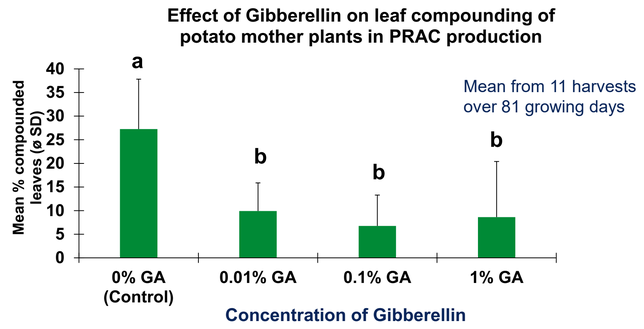
MP ages and discarded
after 3 months
15–20 PRACs per MP
≤12 G1 tubers per PRAC

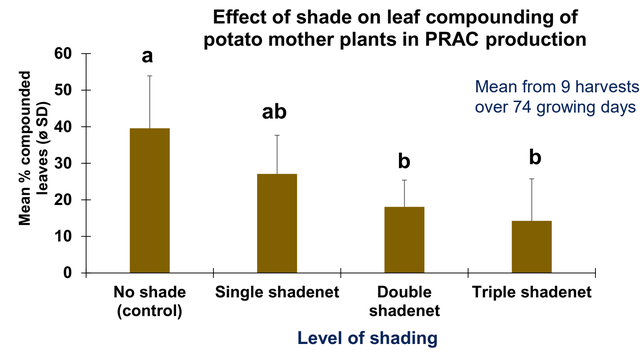
**data for most productive variety, Wanjiku. Most popular variety, Shangi, gave 65 PRACs per MP with 21 G1 tubers per PRAC*

Conclusion: Mother plants treated with light, GA and regular cutting give quality productive PRACs

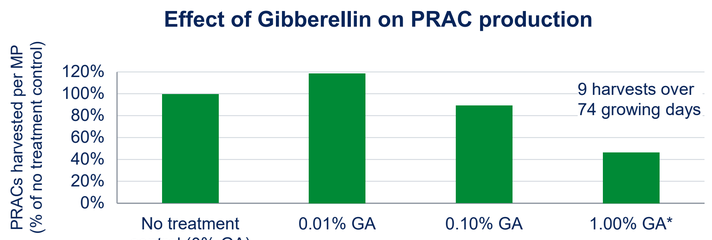
Insight: Mother plants maintained in juvenile form remain productive for over 12 months.

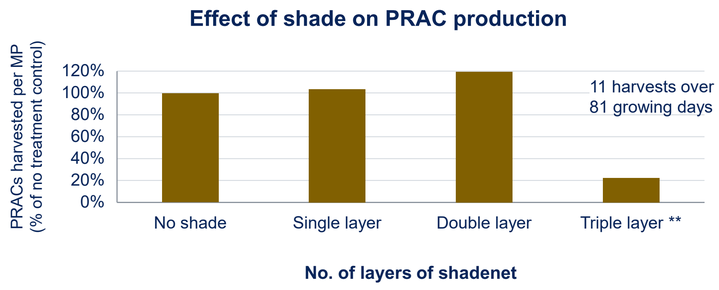
Evidence · trial results





Insight: GA and shading both sharply cut leaf compounding versus untreated controls — most effectively at 0.1% GA and double-layer shade net. P ≤ 0.001





Insight: 0.01% GA and double-layer shade each raised cutting output ~20% per mother plant over controls — but 1% GA or triple-layer shade sharply cut yield (P ≤ 0.001) because of excessive lengthening of mother plant stems, that made PRACs difficult to handle.

Scan for full time-course data





Agronomy for full yield potential



FIPS Africa's companion poster by Mulupi *et al.* (see QR code) shows quality PRACs of the **Wanjiku variety reliably produce 30–35 G1 tubers each** *(tuber numbers per PRAC vary by variety).*

These yields are only realised when PRACs are well managed in the field and require: planting with WonderGro soil conditioner and fertiliser; deep planting so the first collar leaf is covered; wide spacing (75 cm × 30 cm) for proper hilling; hilling three times; good crop protection and reliable rain.

FIPS' PRACS agronomy poster

Conclusion and real-world implementation & consequences



Building on this learning through ongoing adapting, PRAC production units now routinely **apply double shadenet (50%) and 0.005% GA** to mother plants alongside a strict regular-cutting discipline. **Managed this way, compounding has been eliminated and mother plants remained productive for up to 12 months** and produced up to 77 quality PRACs each.

FIPS Africa and partner Paul Munene have developed PRAC nurseries producing 2 million quality PRACs per year, enabling 600 Village Based Advisors to act as Decentralised Seed Multipliers supplying quality G2 seed potato to farmers. FIPS is teaching partners in Kenya, Tanzania, Burundi, Madagascar and elsewhere how to produce and use good-quality PRACs.

The impact of this work on the seed potato sector is shown in FIPS companion poster by Jennifer Wanjiku *et al*. (see QR code)

FIPS impact poster

Acknowledgements

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