



Pioneering the Future

Controlled Release Fertilizers (CRF)

Vertical Integration of Plant Nutrients in an Urban Environment

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4 R Nutrient Stewardship principles

🌱 What are the 4 R's



RIGHT SOURCE

Matches fertilizer type to crop needs.



RIGHT RATE

Matches amount of fertilizer type crop needs.



RIGHT TIME

Makes nutrients available when crops need them.



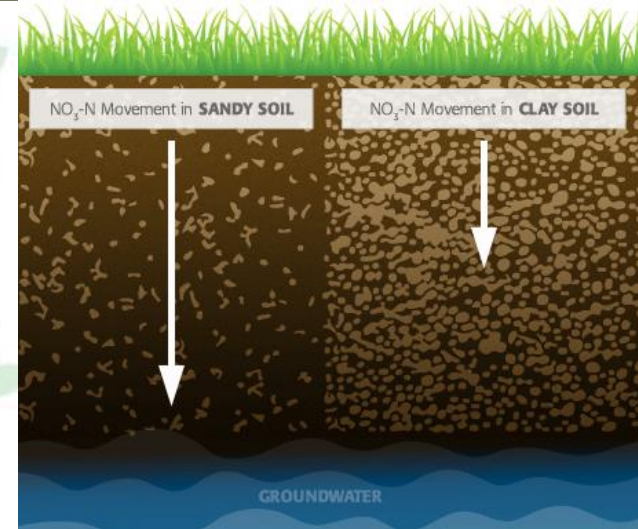
RIGHT PLACE

Keep nutrients where crops can use them.

Source: <http://www.nutrientstewardship.com/4rs/>

Conventional challenges of achieving the 4R's

- ❖ Intricate computerized irrigation systems and fertilizer controllers.
- ❖ Exceptional management skills to master computer and the relationships of different fertilizers
- ❖ In a closed system nutrient recycling is essential yet has its own challenges.
- ❖ High rate of leaching required to remove excess salts from root zone. (~30%)
- ❖ Excesses cause Contamination of soil and groundwater



Urban challenges of achieving the 4R's

- ❖ For continuous cropping the crops will be in different growth stages, requiring very different nutrient ratios
- ❖ Urban gardens tend to consist of many different crops requiring different nutrient ratios, but utilizing the same irrigation system.
- ❖ In periods of low water demand over-irrigating in order to get nutrients applied.



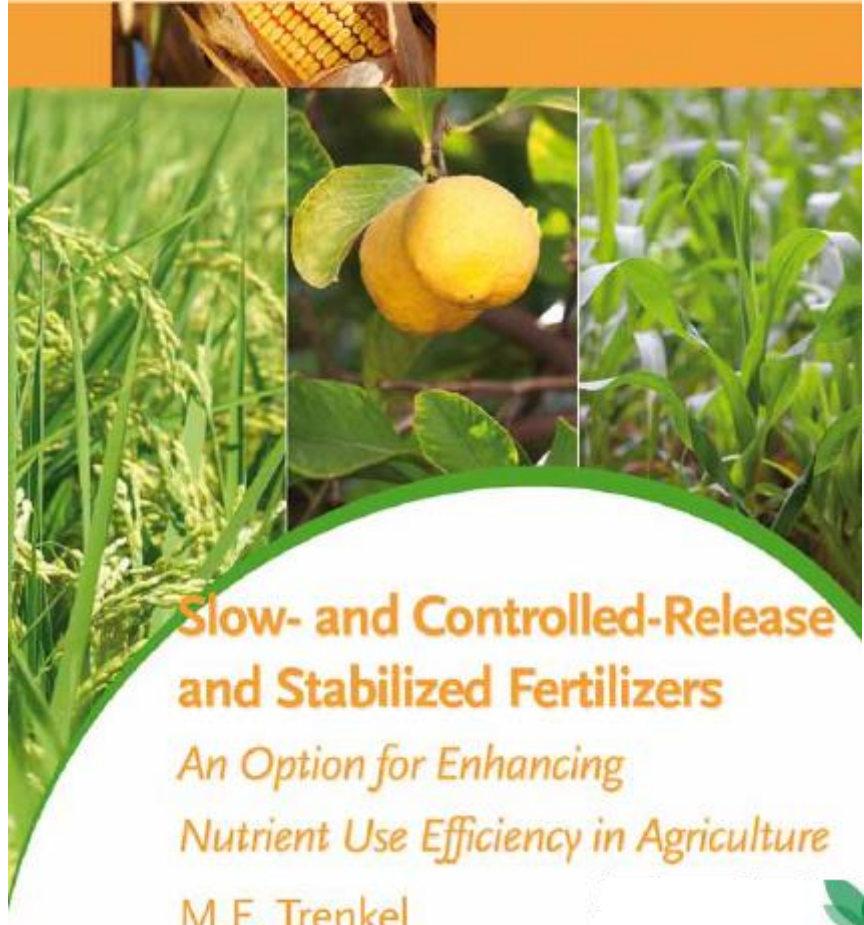
Vertical challenges of achieving the 4R's

- ✦ When fertigating Vertical walls, nutrient rich water is percolated through the wall panels, losing concentration on the way. Upper plants over fertilized and lower plants under fertilized.
- ✦ Salinity build-up can be a problem.
- ✦ Difficulty monitoring and adjusting nutrient ratios in closed irrigation system.



Controlled Release Fertilizers (CRF) – the New?

- ❖ CRF been around for 20 years.
- ❖ IFA have defined the difference between CRF, SRF and Stabilized Fertilizers
- ❖ All enhance the efficiency of fertilizers, but have very different applications and uses. M.E. Trenkel published work explaining the differences.
- ❖ See IFA website for pdf or hardcopy version:
<http://www.fertilizer.org/ItemDetail?iProductCode=9137Hardcopy&Category=AGRI&WebsiteKey=411e9724-4bda-422f-abfc-8152ed74f306>



Slow- and Controlled-Release and Stabilized Fertilizers

*An Option for Enhancing
Nutrient Use Efficiency in Agriculture*

M.E. Trenkel

Enhancing the Efficiency of Fertilizers

Slow or controlled release fertilizers?

- ✦ Both delay the availability of a nutrient for plant uptake or extends its availability to the plant longer than 'rapidly available nutrient fertilizers'
- ✦ Slow release (SRF) – nutrient release pattern is fully dependant on soil and climatic conditions and **cannot be predicted**
- ✦ Controlled release (CRF) – release pattern, **quantity and time can be predicted** within certain limits, soil temperature the main driver.

Source: afbi, Catherine Watson, 2013

Enhancing the Efficiency of Fertilizers

Definition of Slow Release fertilizers (SRF)

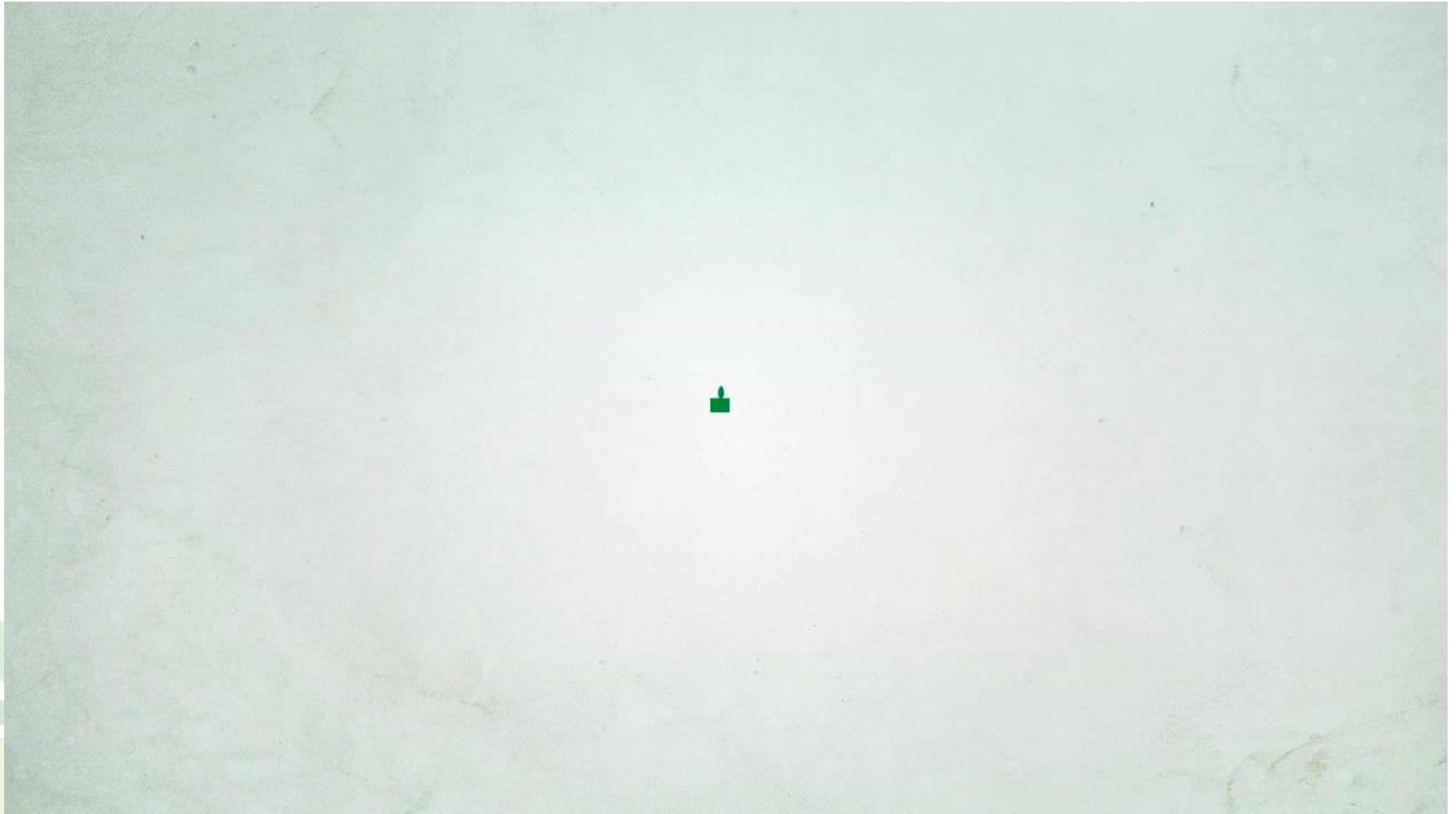
- ✦ Slow release fertilizers: Fertilizer, of which, by chemical compound action or physical action of the nutrients, the nutrient availability to plants is spread over a period of time
- ✦ nutrient release pattern is fully dependant on product characteristics, soil and climatic conditions and **cannot be predicted.**
- ✦ From a technology point of view: Generally products based on reduced solubility and/or (microbiological) degradation
- ✦ Products can be either solid or liquid N, some NPK, or stabilized N

Enhancing the Efficiency of Fertilizers

Definition of Controlled Release Fertilizer (CRF)

- ✿ Fertilizer in which nutrient release is controlled, meeting the stated release rate of nutrient and the stated release time.
- ✿ release pattern, **quantity and time can be predicted** within certain limits, soil temperature the main influence.
- ✿ From a technology point of view: Coated, water-soluble, solid fertilizers.
- ✿ Products are mostly Polymer coated Urea, MAP, KNO₃, NPK compounds

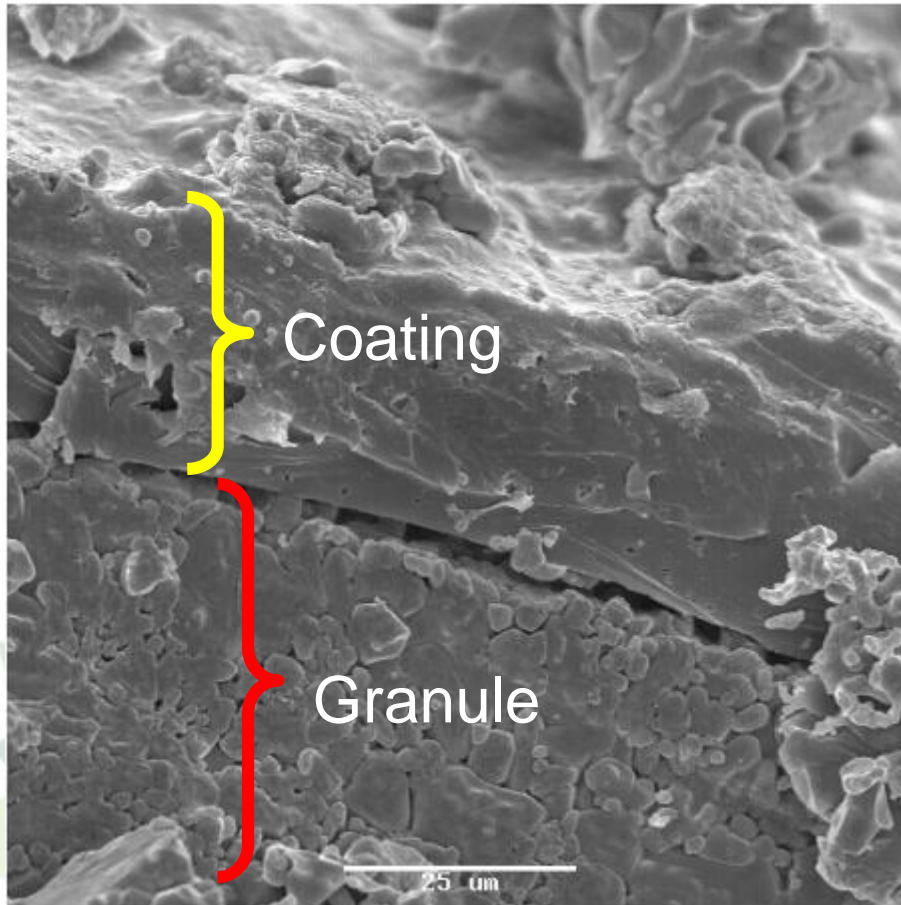
How CRF Works?



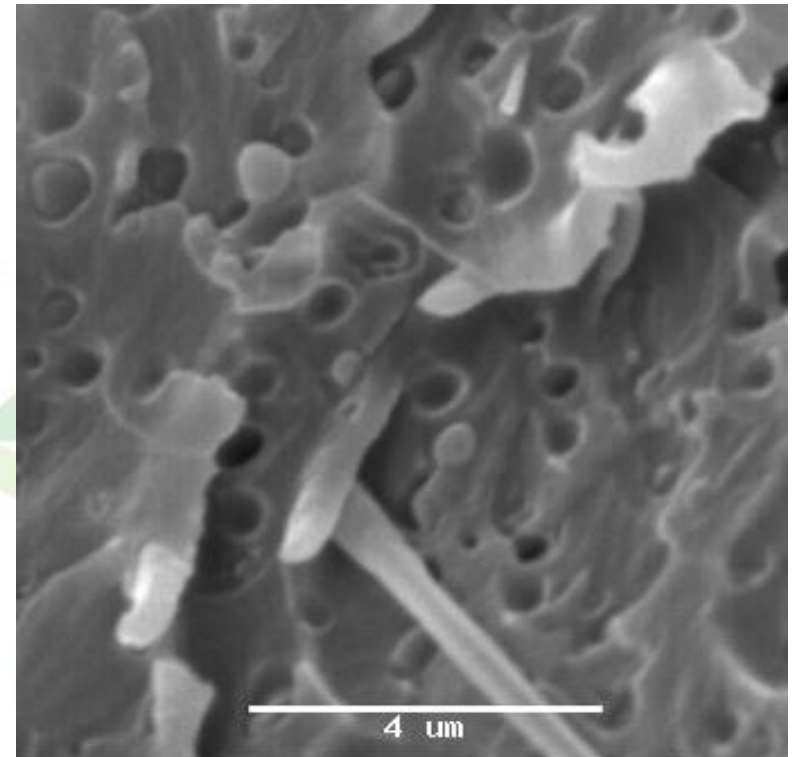
 CRF = Fertigation in a Granule

CRF Polymer Coating Technology - Diffusion

🌿 Electron Scanning Microscope view of NPK granule

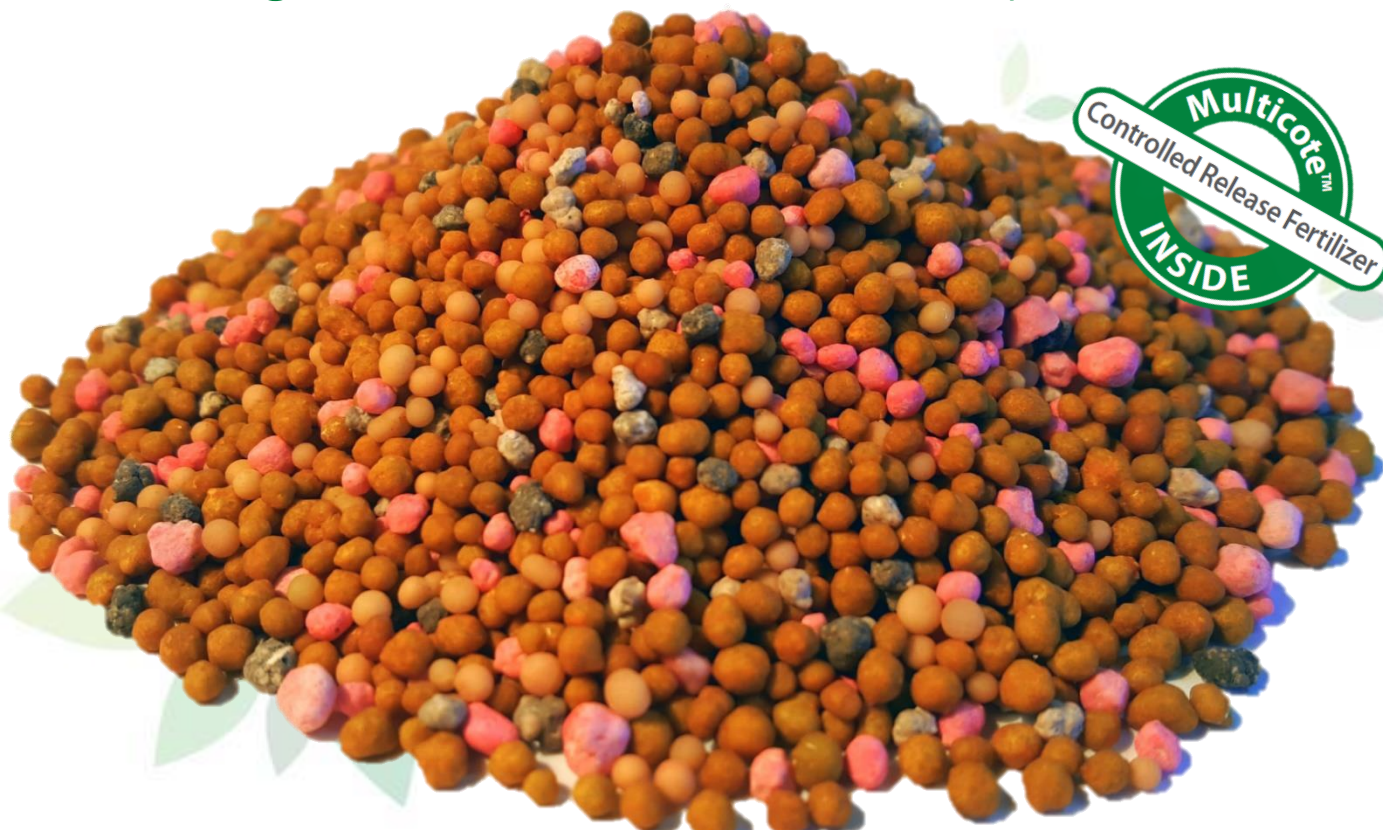


Coating 6X



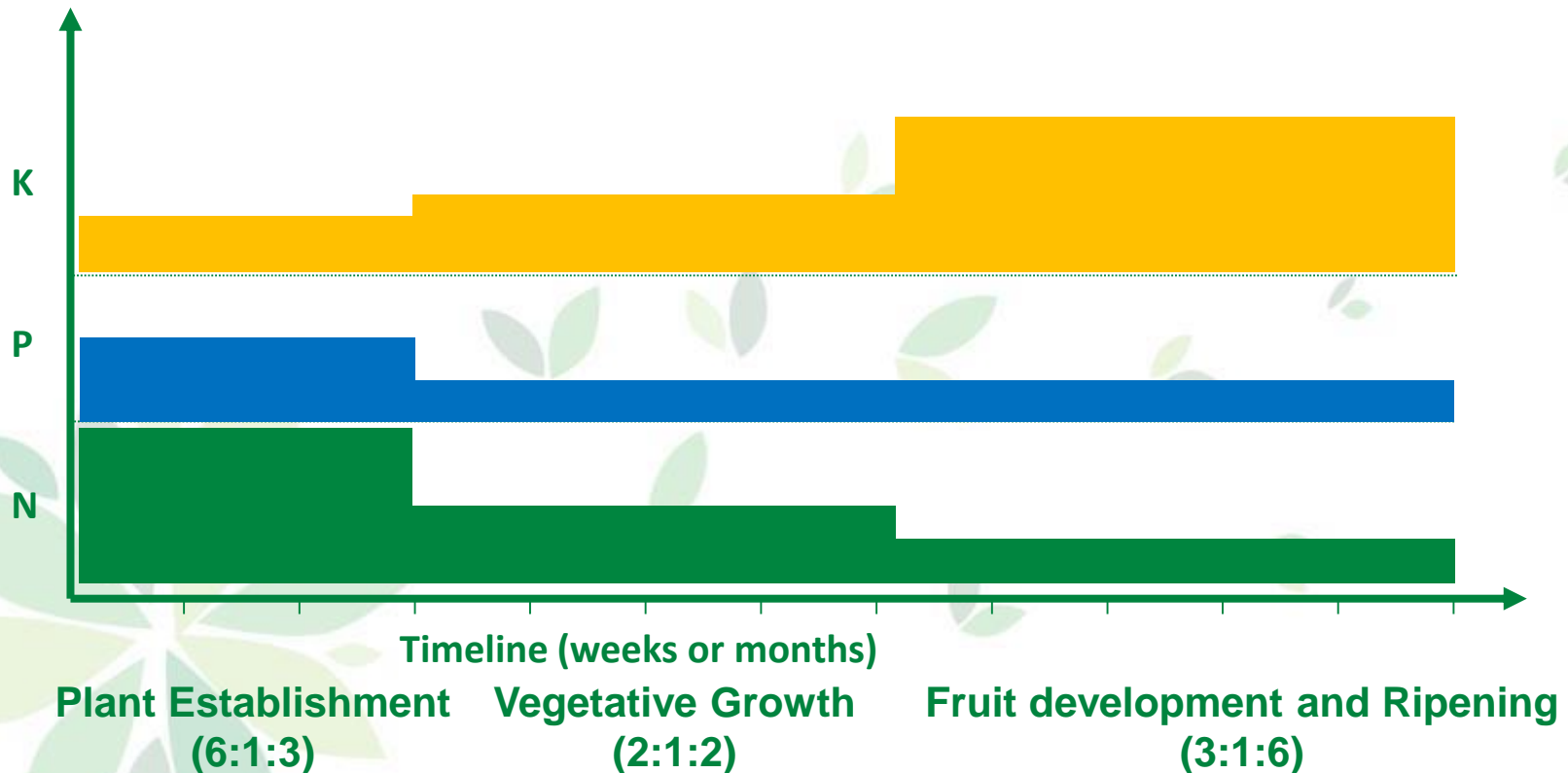
CRF is the Right Source

- CRF is combined with regular granular fertilizers (starter) to form prescription NPK formulas for a wide range of crops and applications.
- CRF comes in different Forms and Longevities: All Polymer Coated Urea, MAP, KNO₃ or NPK compounds, and others.
- Longevities from 2 to 16 months)



CRF in the Right Rates – releasing in Stages

- Balanced Formulas with N-P-K ratios and longevities that are adapted to exactly match the needs of the crop in its various growth stages, over the whole season (2 to 16 months).



CRF in the Right Time

- 🌱 **Optimal Plant Development** - Nutrients are precisely supplied in accordance with specific plant needs



Controlled release:
optimal nutrition
throughout the growth
season

Granular soluble fertilizer:
hazardous excess at the beginning
followed by deficiency towards the end
of the growth season

CRF in the Right Place – the Root Zone

- ✿ A single application of CRF is placed directly in the root zone at planting.
- ✿ Release programmed to follow growth cycle and nutrient demand.



CRF applied with success

- Vertical Veg – a company specializing in producing material wall panels with pouches in which to grow flowers, vegetables and herbs.
- 10 to 15 g of suitable CRF formula is added to each pouch during planting.



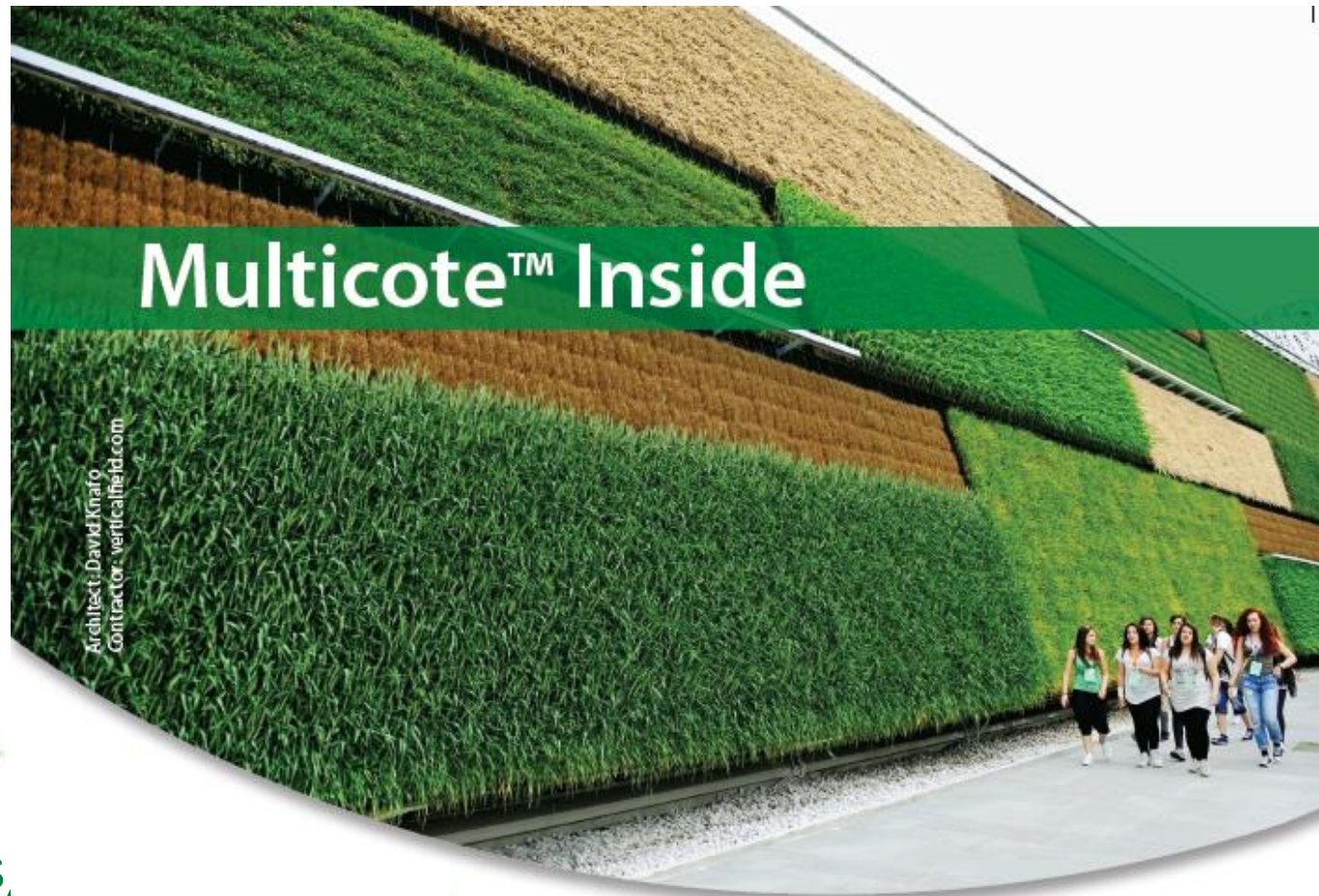
CRF applied with success

🌿 Israeli Pavilion – Vertical Field– Expo Milan 2015

🌿 Wall 70 meters long by 12 meters high, (840m²)

🌿 fully decorated with living crops, (wheat, rice, maize)

🌿 the Vertical Field at Expo Milano 2015 was nourished continuously over six months, thanks to just a single application of Haifa's Multicote™.



CRF applied with success

- 🌿 Israeli Pavilion – Vertical Field – Expo Milan 2015
- 🌿 Each panel individually watered with state of the art water conservation system



- 🌿 Source: <http://verticalfield.com/it/blog/israeli-pavilion-by-cnbc/>

CRF applied with success

- ✻ Living wall – Hotel Verde Reception area, Cape Town International Airport
- ✻ Panels planted with a variety of different plants
- ✻ Each needing its own nutrient ratio and amount.



CRF applied with success

🌱 Multicote™ in Soil - Strawberry



CRF applied with success

🌿 Multicote™ in Soil – Cucumber and Tomato



CRF applied with success

- 🌿 Soil – 1st year Blueberry.
- 🌿 Multicote applied at planting.
- 🌿 Soil preparation done correctly & proper irrigation.
- 🌿 Even & uniform growth



CRF applied with success

🌱 Multicote™ in Coir - Raspberries



CRF applied with success

🌱 Multicote™ in Coir – Turmeric



CRF applied with success

- 🌱 Multicote™ in Coir – Peppadew
- 🌱 Extremely hot climate: Include CRF with 12 month longevity



CRF applied with success

- ✦ Multicote™ in Water – Tomato
- ✦ Tomato grown in soilless gutter system.
- ✦ Simple, single mesh bag of MC placed in reservoir.
- ✦ Water EC. Monitored and bag removed / replaced accordingly.
- ✦ Good vegetative growth – careful temperature control



Summary – Benefits of using CRF

- 🌿 Fertigation in a Granule
- 🌿 Aim: Single application = supplying 75 – 100% crop nutrient demand
- 🌿 Better NUE = ~30% less nutrient applied.
- 🌿 Continuous supply of nutrients, = no saw-tooth effect.
- 🌿 Favourable EC: Ability to monitor and adjust throughout season (bag flush) = good root and microbe development
- 🌿 Nutrient delivery independent from irrigation scheduling
- 🌿 Better uptake = less leachate (drain-to-waste).
- 🌿 Less wastage = less waterway pollution.



Challenges Ahead for the CRF

- ✦ **CRF N, P, K** has the potential to **mimic the soil buffer capacity** to control N, P, K ions in the soil solution to **improve NUE** or uptake efficiency (longevity, pattern of release, stability?)
- ✦ **Blends of CRF (N, P, K) with CONV (N, P, K) are more desirable** or appropriate than CRF only. (Depending on crops and conditions?)
- ✦ Introducing CRF (N, P, K) technology into open field agriculture will **save non-renewable natural resources**, and **reduce impact to the environment**
- ✦ **The Key to CRF?** Find the **right value equations** and **change grower culture?**

Thank you for your attention.



 **Any Questions?**

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