Progress of crop impacts studies performed in Malé Declaration countries during current RAPIDC funding phase

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Second crop impact workshop of the Malé Declaration

Pathumthani, Thailand

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Outline

- Overview and aims of RAPIDC crop activities
- Status quo of experimental campaigns in Malé Declaration countries
- Problems
- Changes in experimental protocols
- Outlook
- Questions

Overview and aims of RAPIDC crop activities

- Assessment of impacts of air pollutants (e.g. ozone) on crop growth and crop production in South Asia (Malé Declaration countries) and southern Africa (APINA) using
  - bio-monitoring and
  - chemical protectant methods

This scientific evidence will be used to

- Inform policy makers and the public
- Perform socio-economic risk assessments

Overview and aims of RAPIDC crop activities

Clover biomonitoring experiment

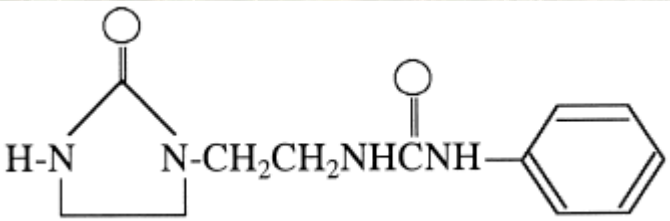
- Highly standardised biomonitoring technique using two genotypes of the white clover (*Trifolium repens* L.) cultivar Regal with differing sensitivity to ozone:
  - Ozone-sensitive genotype NC-S (left)
  - Ozone-resistant genotype NC-R (right)

- Response parameter: Visible leaf injury and NC-S/NC-R biomass ratio
- Developed in subtropical climate of North Carolina
- Extensively used as bio-indicator in ICP Vegetation (Europe)

Overview and aims of RAPIDC crop activities

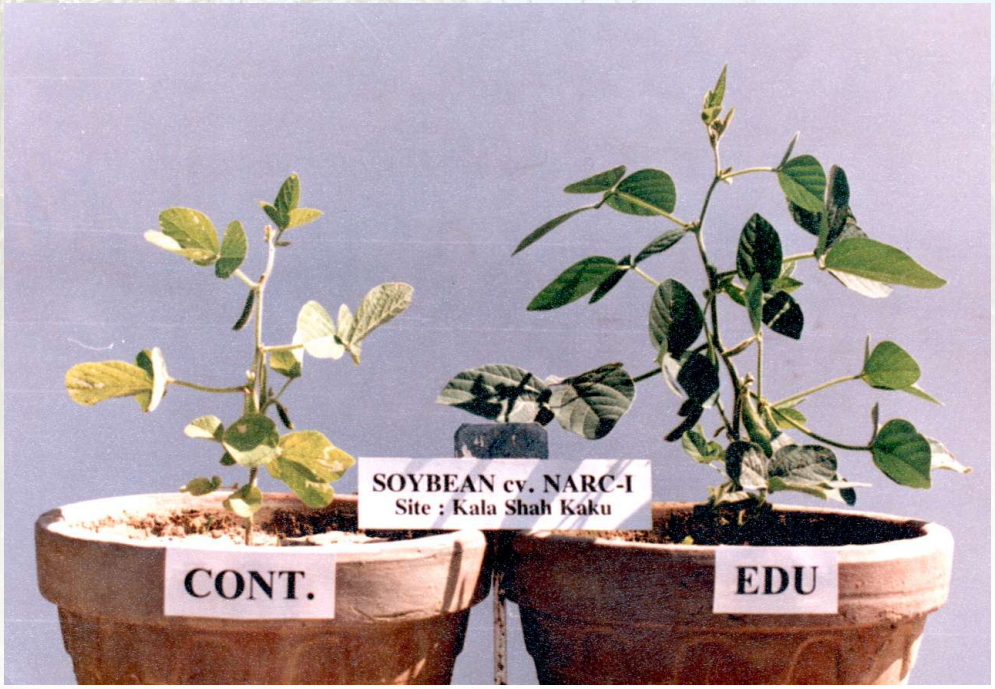
Chemical protectant study using EDU

EDU suppresses acute and chronic ozone injury on a variety of crop plants (e.g. Mung bean, wheat, potato, spinach, tobacco) under ambient O_3 conditions (Godzik & Manning, 1998)



Structural formula for N-(2-(2-oxo-1-imadazolidinyl)ethyl)-N'-phenylurea

abbreviated as EDU for ethylenediurea



Pakistan soybean cv. NARC-1 showing protective effect of EDU at a roadside rural site in Lahore, Pakistan (photo courtesy of A. Wahid)

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Status quo of experimental campaigns in Malé Declaration countries

map

Status quo of experimental campaigns in Malé Declaration countries

- Bangladesh
  - Clover biomonitoring and EDU experiment (mung bean) terminated
- India
  - EDU experiment using mung bean, spinach and potato terminated
- Nepal
  - EDU experiment (mung bean) currently running
- Pakistan
  - Clover biomonitoring currently running, EDU experiment (mung bean) terminated, but second experiment started last week
- Sri Lanka
  - EDU experiment (mung bean) terminated recently

Problems

- Plant import
  - No import permit for clover cuttings to India yet
- Transport/transfer
  - Plants died several times during transport or shortly after arrival at their final destination

    → possible reasons: long duration of flight, low temperature during flight, communication problems
- Acclimatisation
  - Plants struggled to adapt to local climate after arrival
- Pests
  - Infested soils (with pathogens), mildew and mite attacks

Problems (cont.)

- EDU supply
  - EDU production very costly (production either in Potchefstroom (South Africa) or York (U.K.)): one growing season experiment approx. $ 2000
  - Shipment difficulties
- Passive sampling
  - Samplers got lost during transport
  - Delayed return
  - Delayed analysis
- Data transfer
  - Please send data to Patrick for final report!!!

Changes in experimental protocols as agreed at Dhaka training workshop

Establishment of clones

Specify by some physical characteristic (rather than time) when the clover plants are well enough established and ready for exposure

Soil for exposure experiment

Allow the use of a local soil mixture for establishment of cuttings: local sandy loam soil + peat (humus)

If possible “sterilize” the soil e.g. by spreading on a clean surface and exposing to high temperatures / direct sunlight

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Slow Release Fertilizer

N13: P13: K13 ratio suggested, but if not available at least make sure all major nutrients are included

May also be beneficial to add minor nutrients (e.g. Fe, Mg, S)

Should last for a minimum of 4 months (clover bio-monitoring) otherwise will have to be re-applied during experiment

Growing season (exposure period) for clover

Identify appropriate local growing season for clover based on min & max T°C

The growth period should be extended (i.e. past 4 harvests, max of 6 harvests) wherever possible to give greatest chance of "capturing" high ozone periods during the year

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Wicks

Tie 2 up round pot until needed (i.e. when soil is drying out too quickly) – this should avoid over-watering when plants are still rather immature

Amount of water provided to pot can be controlled to some extent by level of water in reservoir pot - this can help to reduce over-watering

Passive Samplers

Send to IVL at least every 8 weeks (2 batches). **Inform Patrick when experiment will finish!**

Where possible use continuous electrical ozone monitoring in combination with passive samplers (e.g. in India) to provide information on diurnal profiles and ozone peak concentrations

Visible injury assessments

Add additional injury class as “jump” from 5 to 25% injury is too big:

Class	Definition
0	no injury
1	< 5 % of fully expanded leaves with injury
2	5 to 15% of fully expanded leaves with injury
3	15 to 30 % of fully expanded leaves with injury
4	30 to 50 % of fully expanded leaves with injury
5	> 50 % of fully expanded leaves with injury

Valid for clover bio-monitoring and EDU experiment using e.g. mung bean

EDU timing of application

Start application of EDU once the cotyledon leaves are fully mature which will coincide with emergence of the first new leaves

Suggested extension of EDU protocol

Guide for additional physiological measurements (e.g. stomatal conductance) and additional phenological assessments of crops used in EDU experiment, to

- parameterise stomatal ozone flux models
- assess the influence of temperature - a main driver of climate change influencing species-specific onset of growth stages - on phenology

  → relate crop growth stage lengths to effective temperature sums (ETS) to identify temperature and growth stage interactions

protocol extension focused on potato, but applicable with slight alterations to other crops used in EDU experiment

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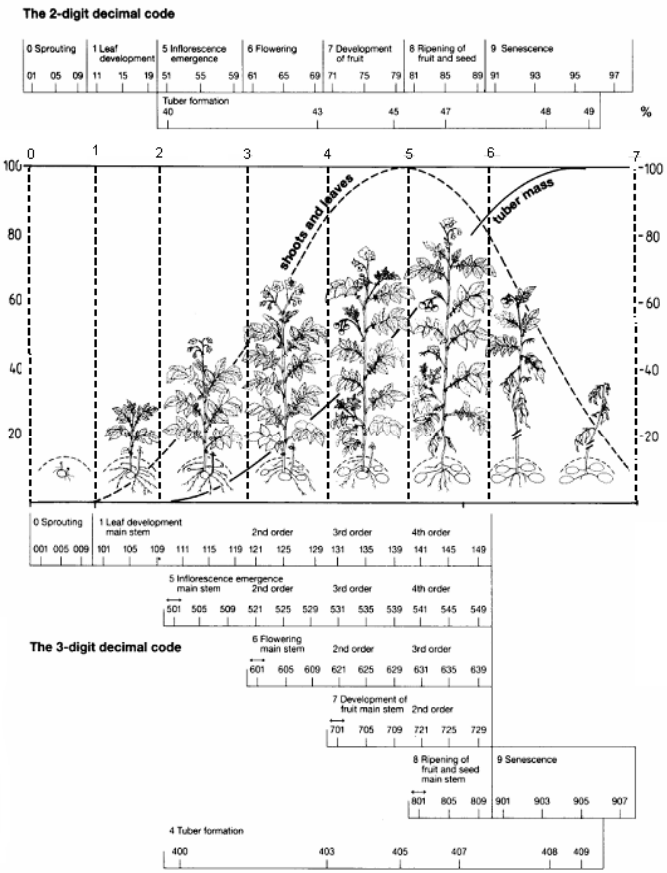
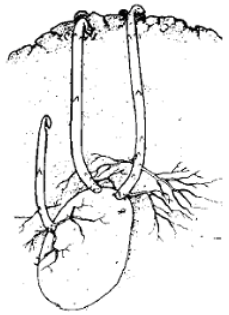
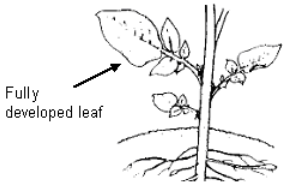
Potato



Potato

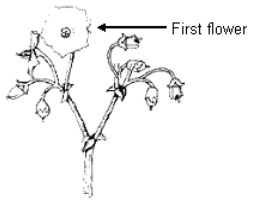


Sprouting/germination



Full development of first leaf

Emergence of first inflorescence



Emergence of the first flower

Development of first fruit

(modified from Hack *et al.*, 1993)

Detailed assessment of growth stages (here: potato) crucial

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Outlook

- Are people still interested in clover bio-monitoring?
- New bio-monitoring system using bush bean (*Phaseolus vulgaris* L.) might be available soon
- Extension of EDU experiment using additional species and cultivars? Screening experiment?
- Pan-Asian open top chamber (OTCs) experiment desirable?
- **BUT**: RAPIDC funding coming to an end

→We need to submit a very good final report describing the so far proved evidence of impacts of ozone on crops to secure future funding!

Outstanding questions?