# Computer model for simulating the long-term dynamics of annual weeds under different cultivation practices

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# Development of the weed infestation in the course of time is influenced by:

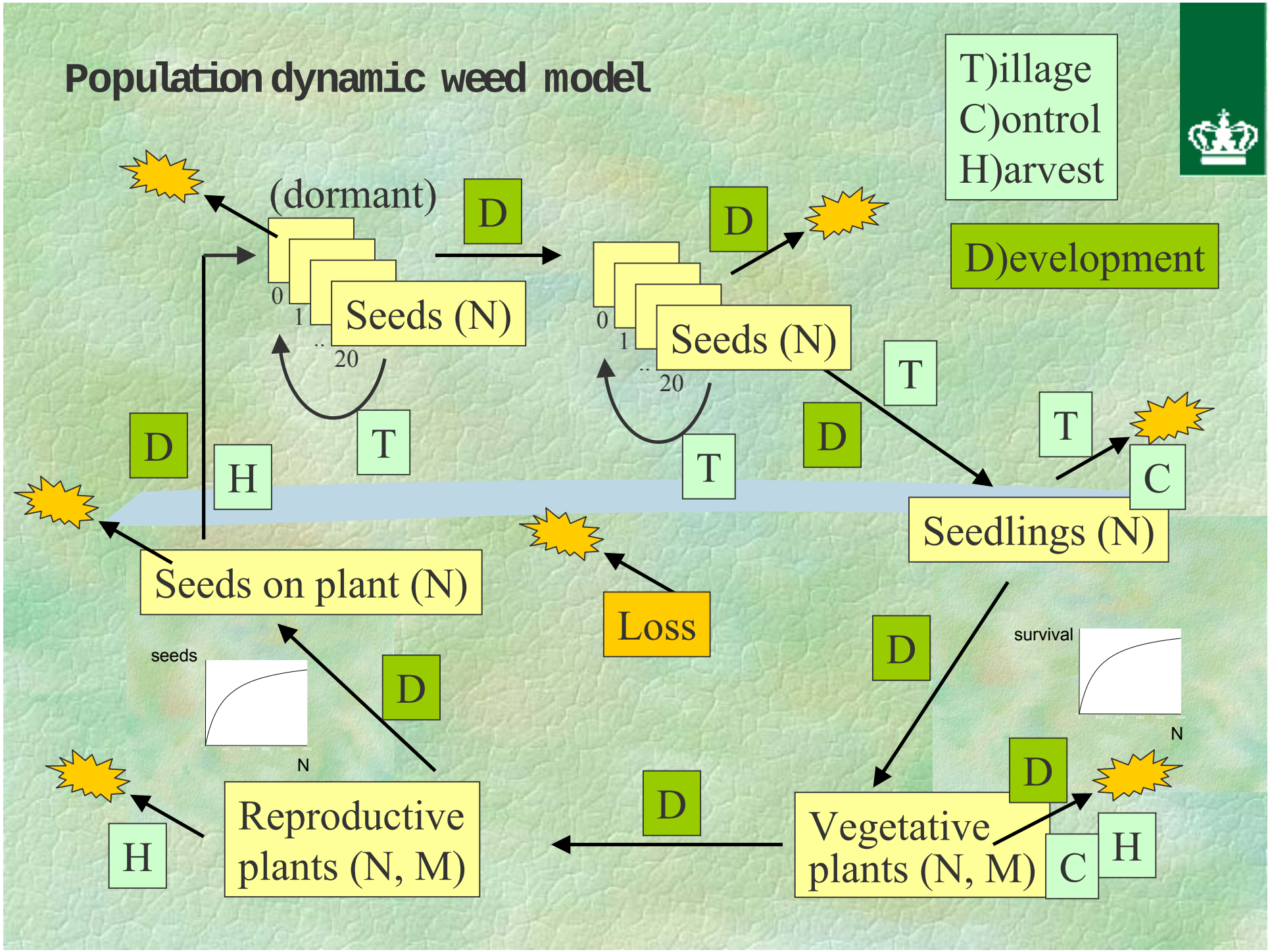
- Crop rotation
- Preventive measures:
  - Cultivation practices
  - Competitiveness
- Direct weed control

# Management

- Plan crop rotation
- Plan strategy for prevention in each crop
- Plan direct control in each crop – apply if needed

# How does it all influence weed development?

- Computer system to predict development
- General trend – not exact numbers
- Used to plan
  - Crop rotation
  - Preventive measures
  - Level of efficacy needed of weed control
- **Tells what experts know already!**


Population dynamic weed model
T)illage
C)ontrol
H)arvest
D)evelopment
(dormant)
D
Seeds (N)
0
1
..
20
T
H
Seeds on plant (N)
Loss
Seedlings (N)
C
seeds
N
survival
N
Reproductive plants (N, M)
Vegetative plants (N, M)

# Model stages

- Seedlings (number)
- Vegetative plants (number & mass)
- Reproductive plants – carrying seeds (number & mass)
- Seeds (number)
  - On the plant
  - On the ground
  - In the soil

# Tillage – effects on seed distribution in soil

- Models by Cousens & Moss (1990)
  - Plouging
  - Harrowing
- Simple models:
  - No pertubation
  - Surface – seeds on surface worked into top soil layer
  - Random – all seeds in layer mixed randomly
- All models fit to the depth of each tillage
- Vertical distribution of seeds in the soil: 20 1-cm layers

# Mortality of seeds

- In undisturbed soil
  - Data from Chancellor (1986)
    - For each species
  - Exponential decrease
  - Equal at all layers in the soil
- On soil surface
  - Fixed rate per day
    - Common to all species (predation)

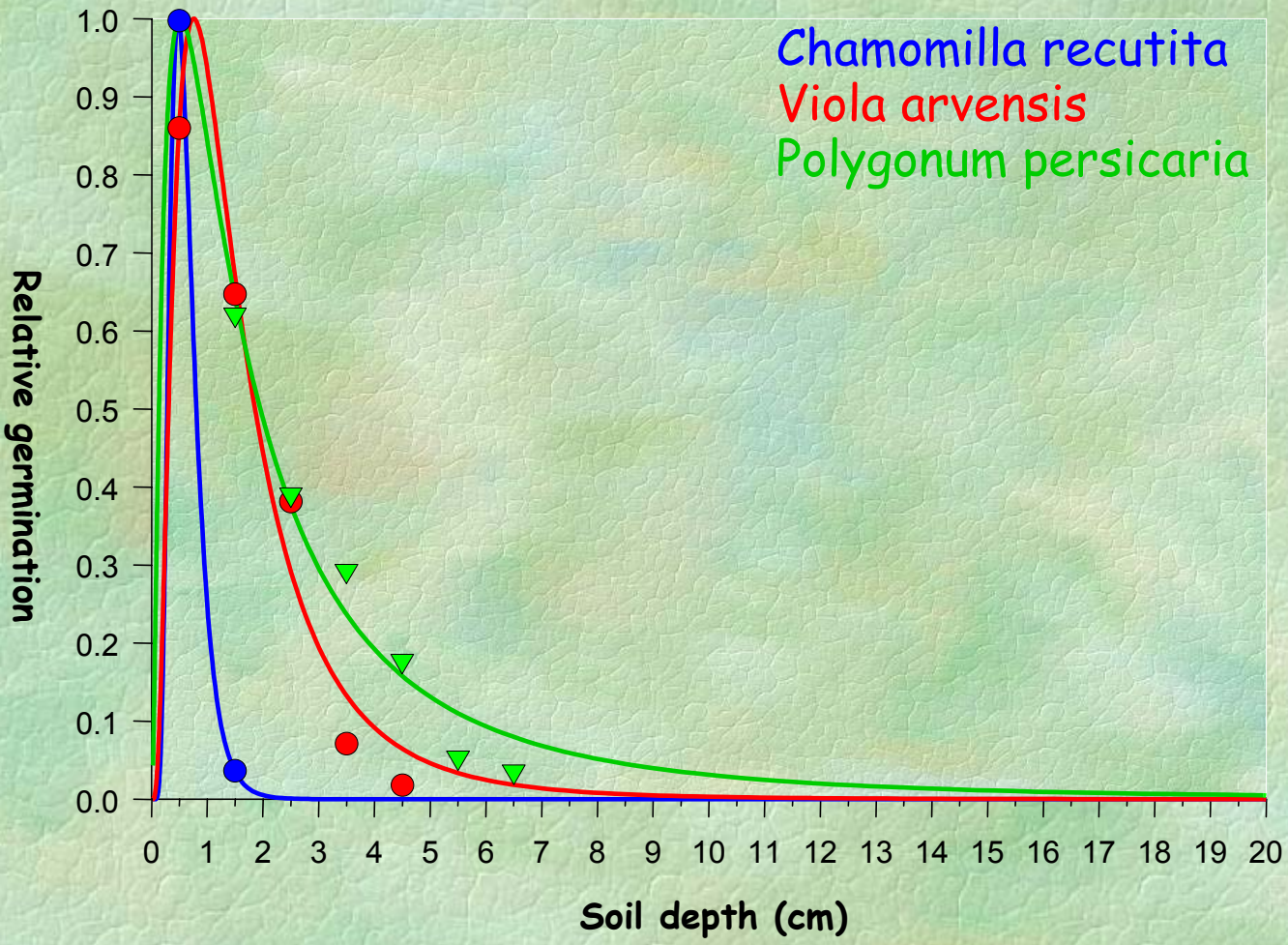
# Natural seed mortality without soil disturbance (Chancellor 1986)

| Weed species | Percent decrease (yearly) | Half life (years) |
|---|---|---|
| Aethusa cynapium | 0.7 | 103.4 |
| Fumaria officinalis | 0.9 | 79.7 |
| Lamium amplexicaule | 4.3 | 15.7 |
| Solanum nigrum | 5.2 | 13.0 |
| Viola arvensis | 5.8 | 11.6 |
| Papaver rhoeas | 6.0 | 11.2 |
| Polygonum convolvolus | 7.1 | 9.4 |
| Arenaria serpyllifolia | 7.7 | 8.6 |
| Capsella bursa-pastoris | 8.2 | 8.1 |
| Polygonum aviculare | 8.9 | 7.4 |
| Tripleurospermum inodorum | 10.1 | 6.5 |
| Stellaria media | 11.7 | 5.6 |
| Veronica hederifolia | 13.0 | 5.0 |
| Veronica arvensis + V. persica | 16.1 | 3.9 |
| Raphanus raphanistrum | 22.2 | 2.8 |
| Chrysanthemum segetum | 23.6 | 2.6 |

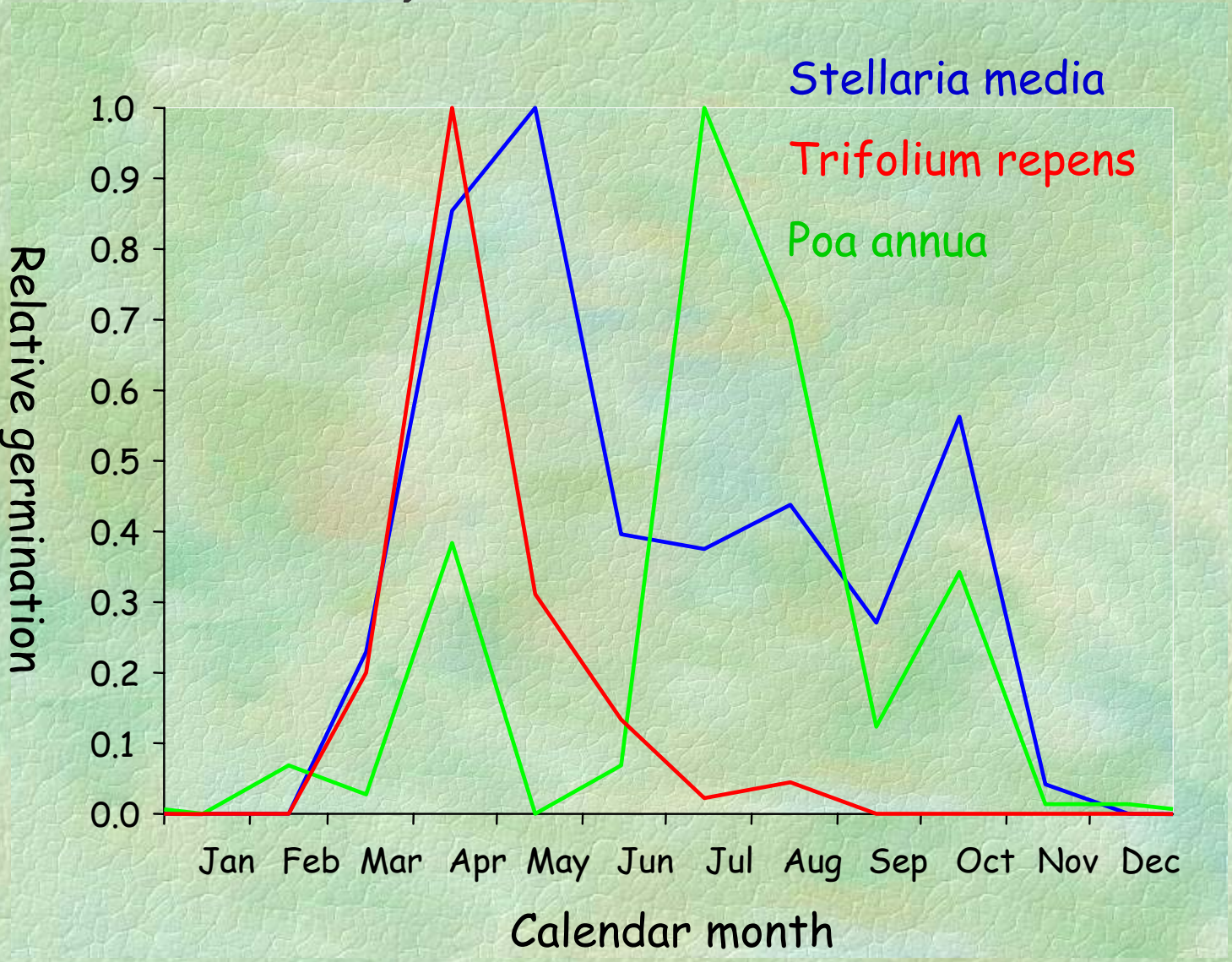
# Germination

- Rate depends on
  - Vertical position in the soil
  - Season (dormancy)
  - Tillage

# Log-normal model for germination depth (Chancellor 1964)



# Seasonal variation in germination (Chancellor 1986)



# Seed production

- Proportional to weed mass
- Fixed daily rate
  - Specific to each species

# Weed mortality

- Competition
- Cultural practices
  - Mode of intervention
  - Life stage of weeds
    - Seeds are unaffected
      - Other than vertical movement
      - except for removal with harvest material
    - Seedlings most sensitive
    - Vegetative plants less sensitive
    - Reproductive plants least sensitive

# Other model attributes

- Time-step: one day
  - Modelled on day-degree scale

# Model limitations (at present)

- Only one weed (at a time)
  - Only interspecific competition with crop and intraspecific competition
- Dormancy included only as
  - Primary dormancy
  - Willingness to germinate during the year

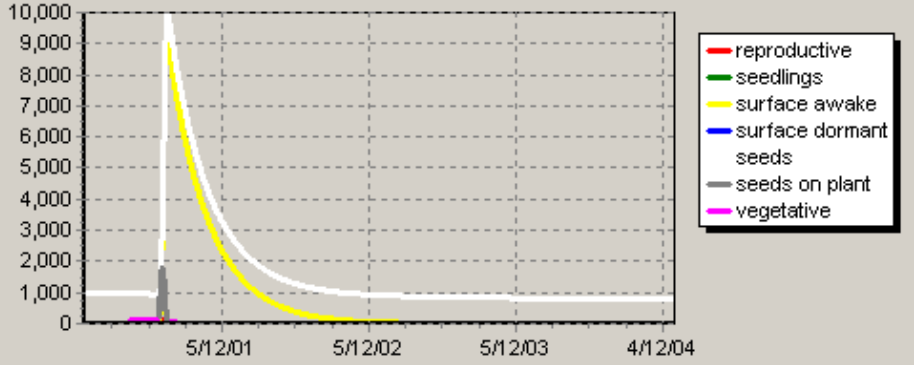
Field Weed Population Dynamics Model - sinar1.txt

Model Advanced Window Help

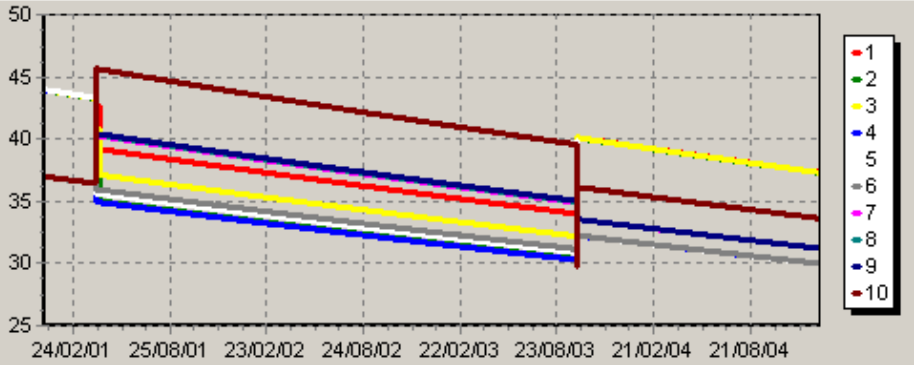
## Interventions

01/01/01 ploughing
08/04/01 harrowing
15/04/01 sowing
15/08/01 harvest
15/09/01 crop closses
01/05/02 grazing, intensive
01/07/02 mowing
01/10/02 grazing, light
01/05/03 grazing, intensive
01/07/03 mowing
15/09/03 mowing
30/09/03 ploughing
01/10/03 harrowing
07/10/03 sowing
15/08/04 harvest

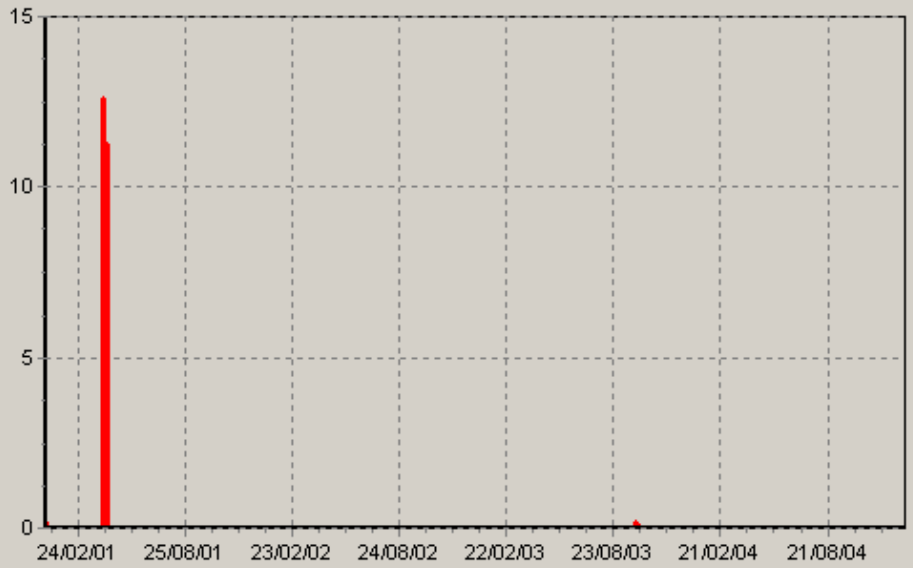
## Charlock- individuals per m2



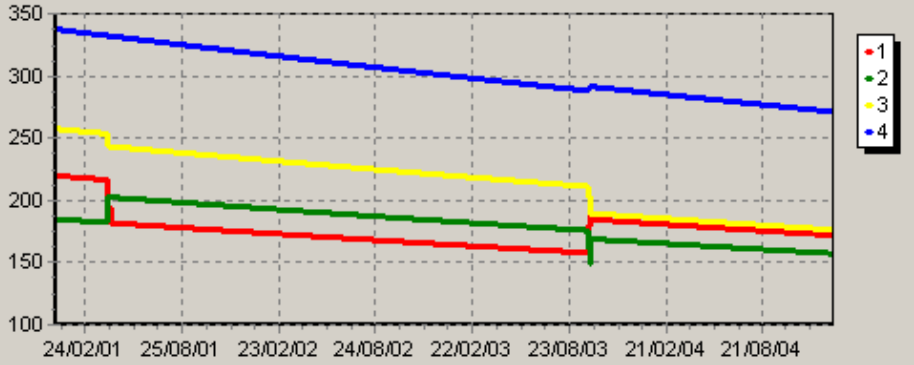

## Charlock- top 10 1-cm soil layers




## Charlock- germination per day

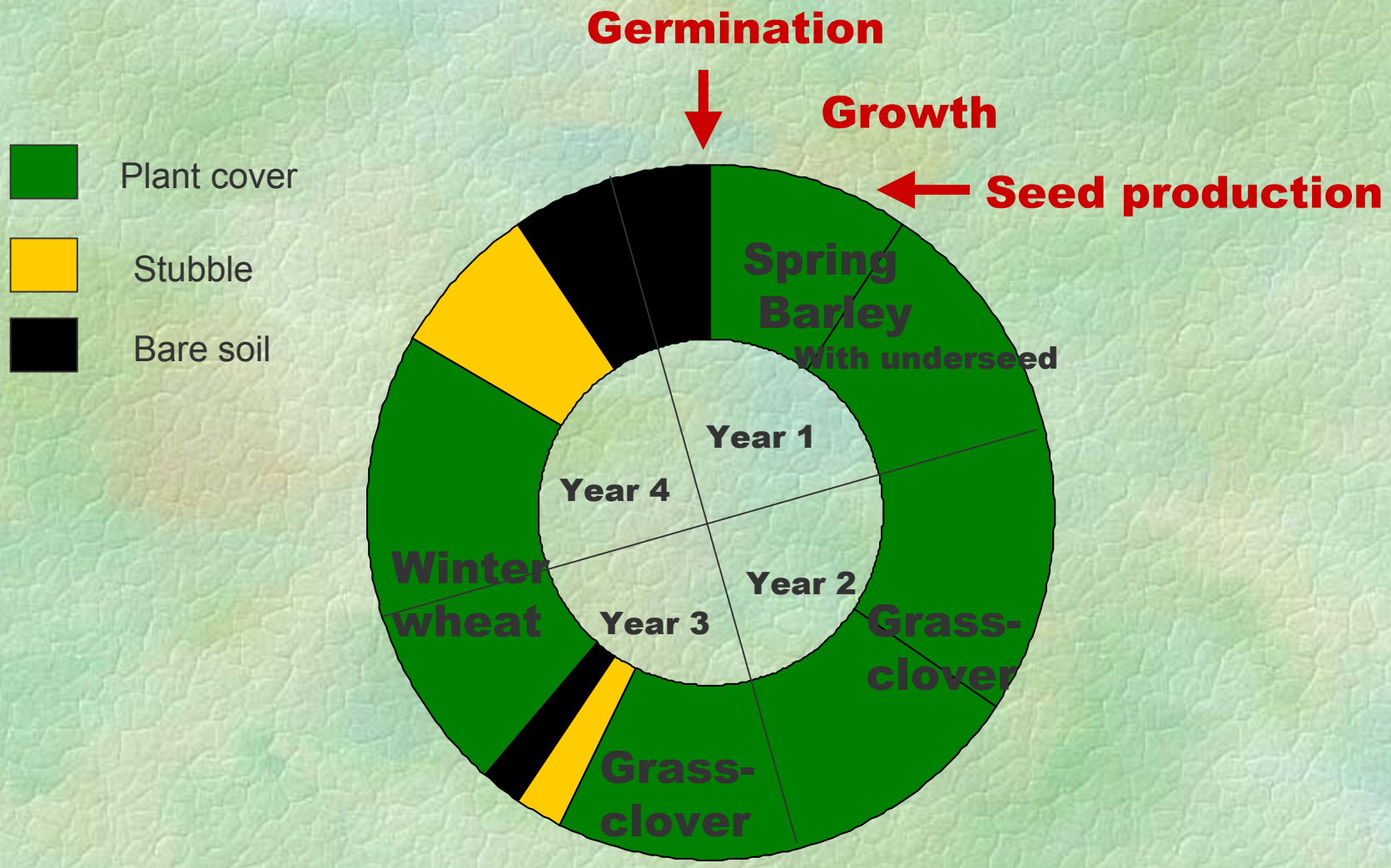



## Charlock - 5-cm soil layers

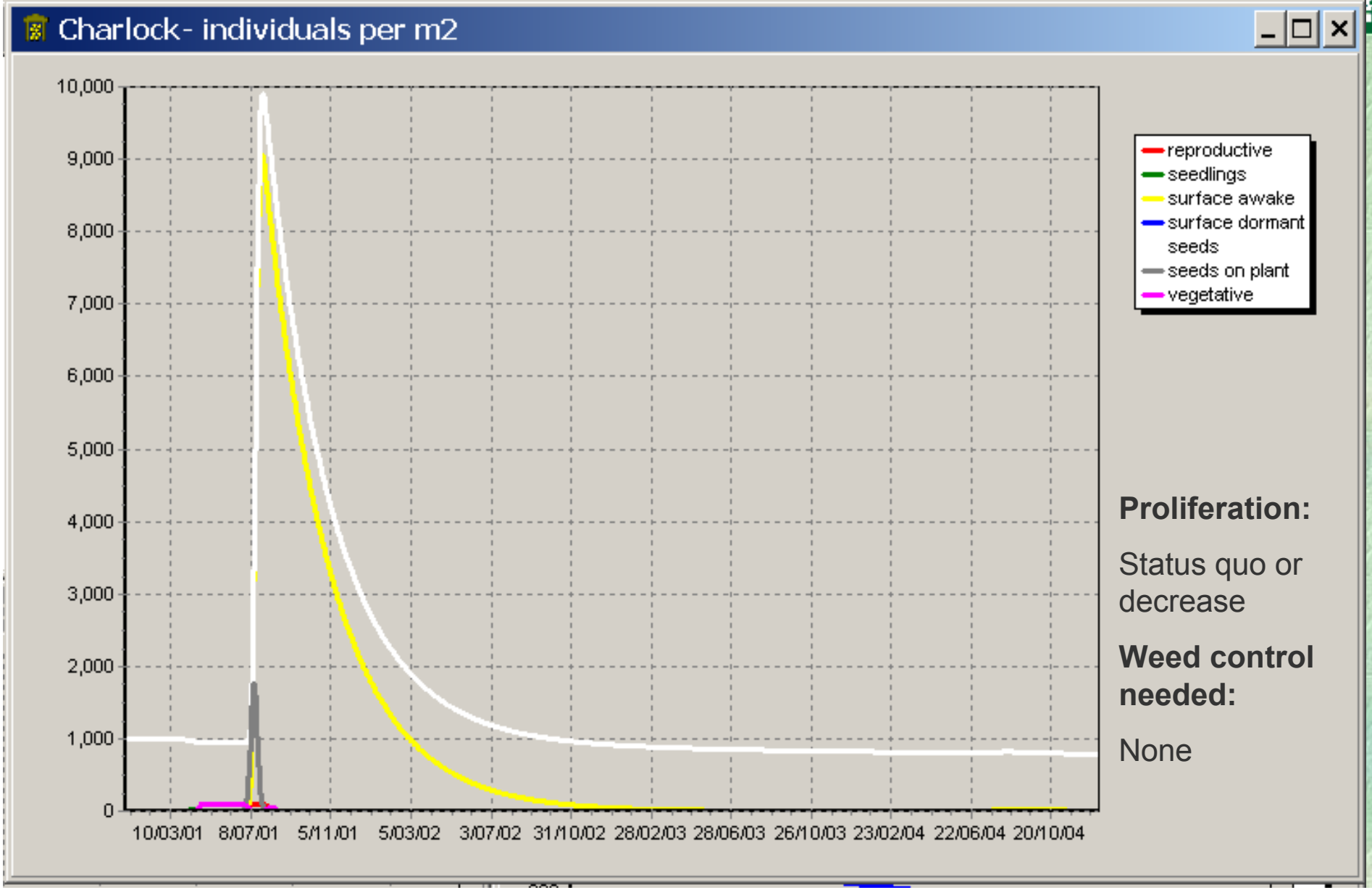



Start

# Rotation I - Sinapis arvensis



# Rotation I – Sinapis arvensis



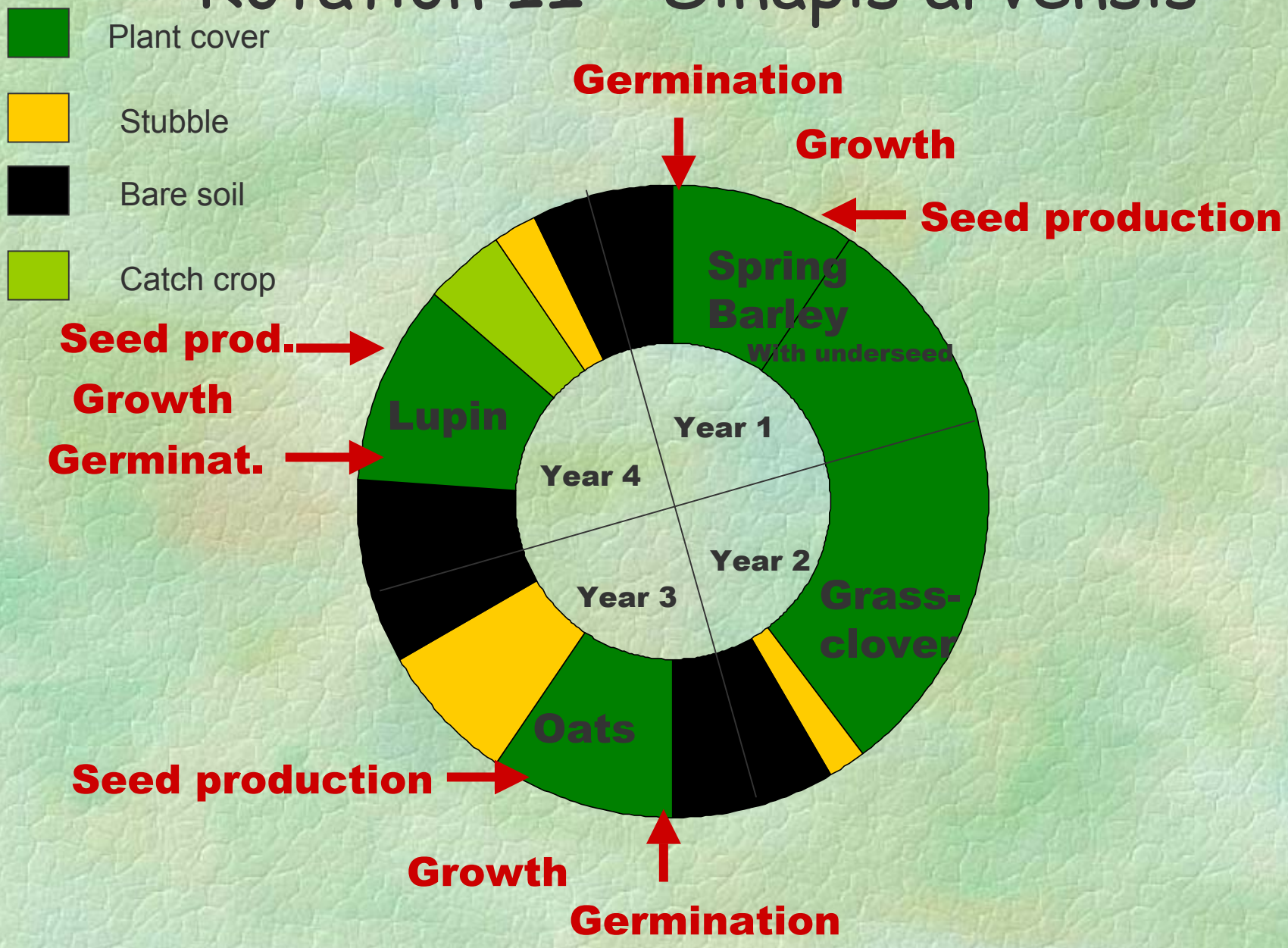

**Proliferation:**

Status quo or decrease

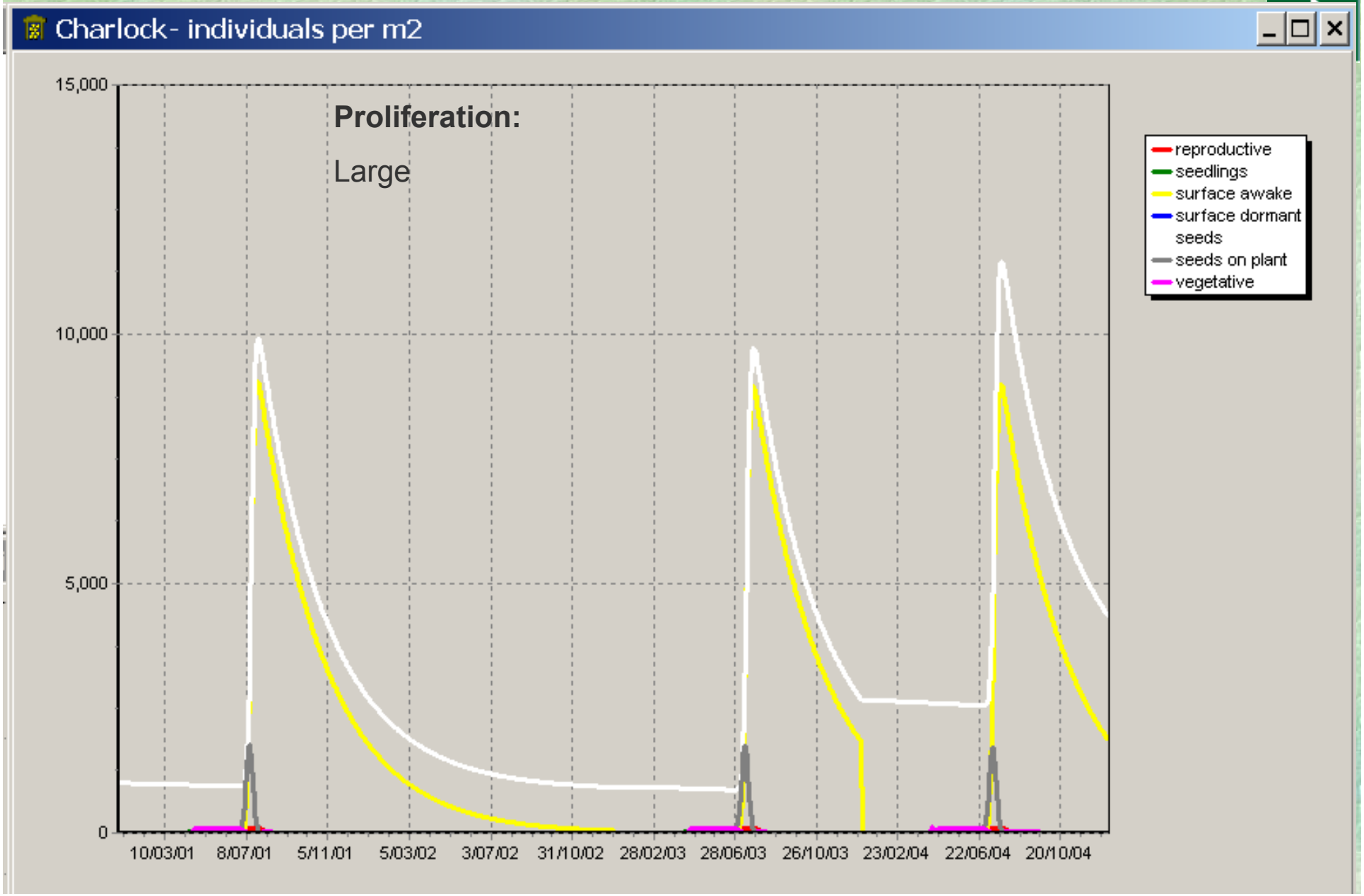
**Weed control needed:**

None

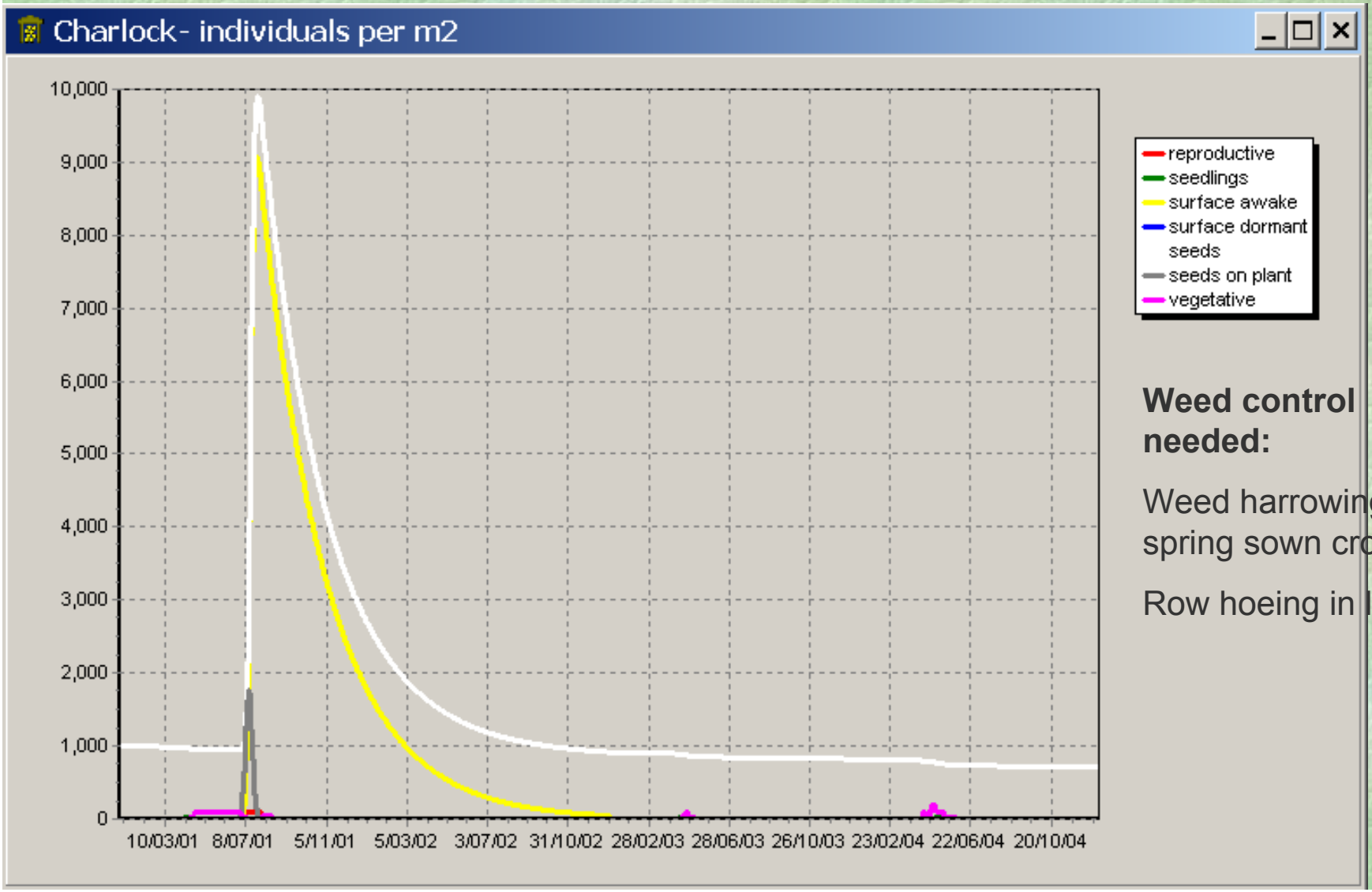
# Rotation II - Sinapis arvensis



# Rotation II - Sinapis arvensis



# Rotation II - Sinapis arvesis with effective weed control




**Weed control needed:**

Weed harrowing in spring sown crops

Row hoeing in lupins

# Is it any good?

- When finished – we hope so!
- Can predict the trend in weed development
- Can pinpoint where prevention is important
- Can focus on the need for control and the efficacy needed

# Problems

- Data for input
- Parameterizing
- Validation
  - But we have data to do so:
    - Several fields with known treatments and weed flora over some years
    - Experiments with different crop rotations with seed reserve counts