Considerations for the application of nematodes on foliage

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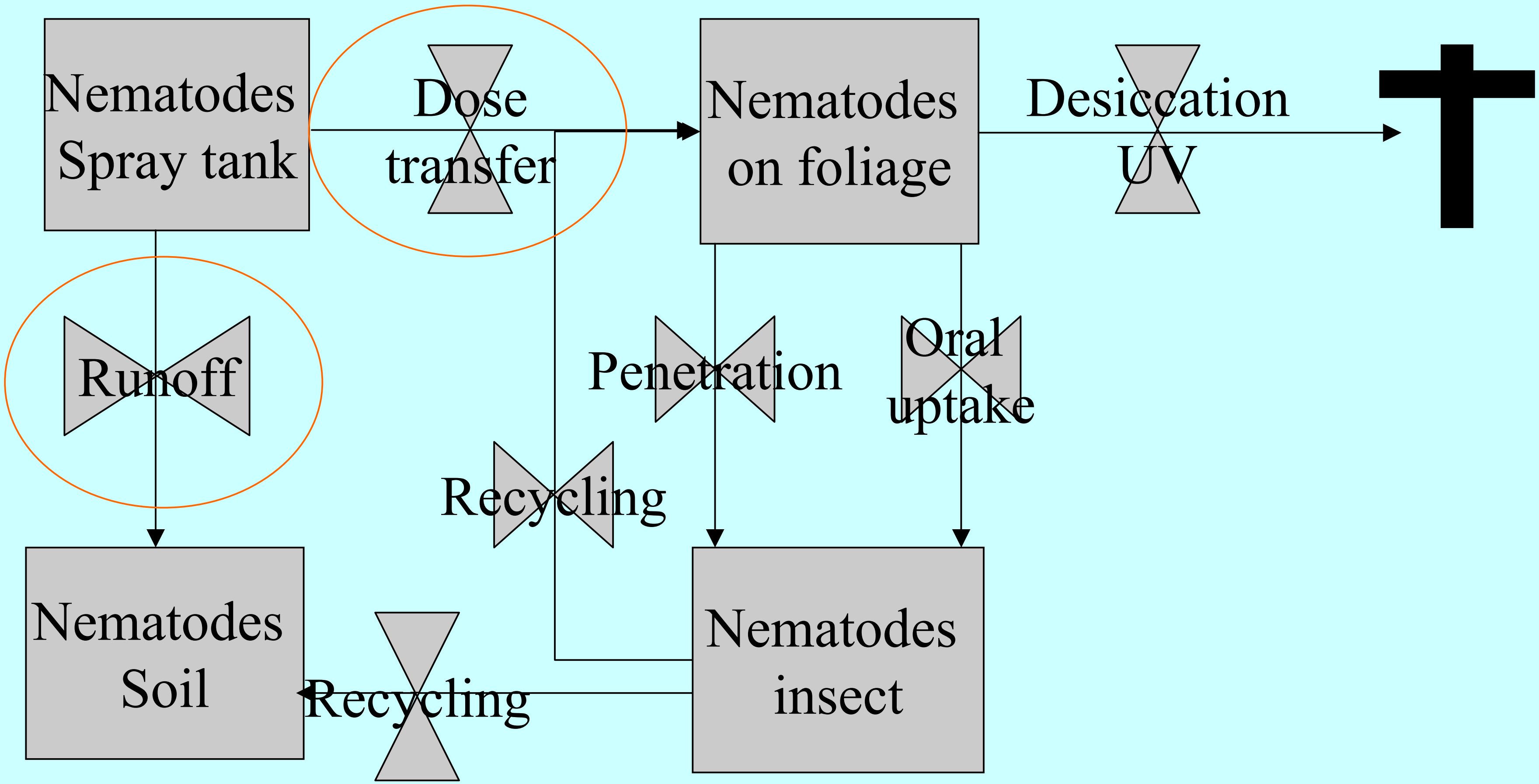
Main processes involved



Run-off and dose-transfer Droplet size approach

- Nematodes do not fit into small droplets
- Hydraulic nozzles produce a wide range of sizes, many droplets do not carry nematodes
- Commercial spinning disk produce too small droplets
- Slow rotation, modified spinning disk produce right droplet size
- Wright et al. 2005: Best results with high througput hydraulic nozzles

Run-off and dose transfer

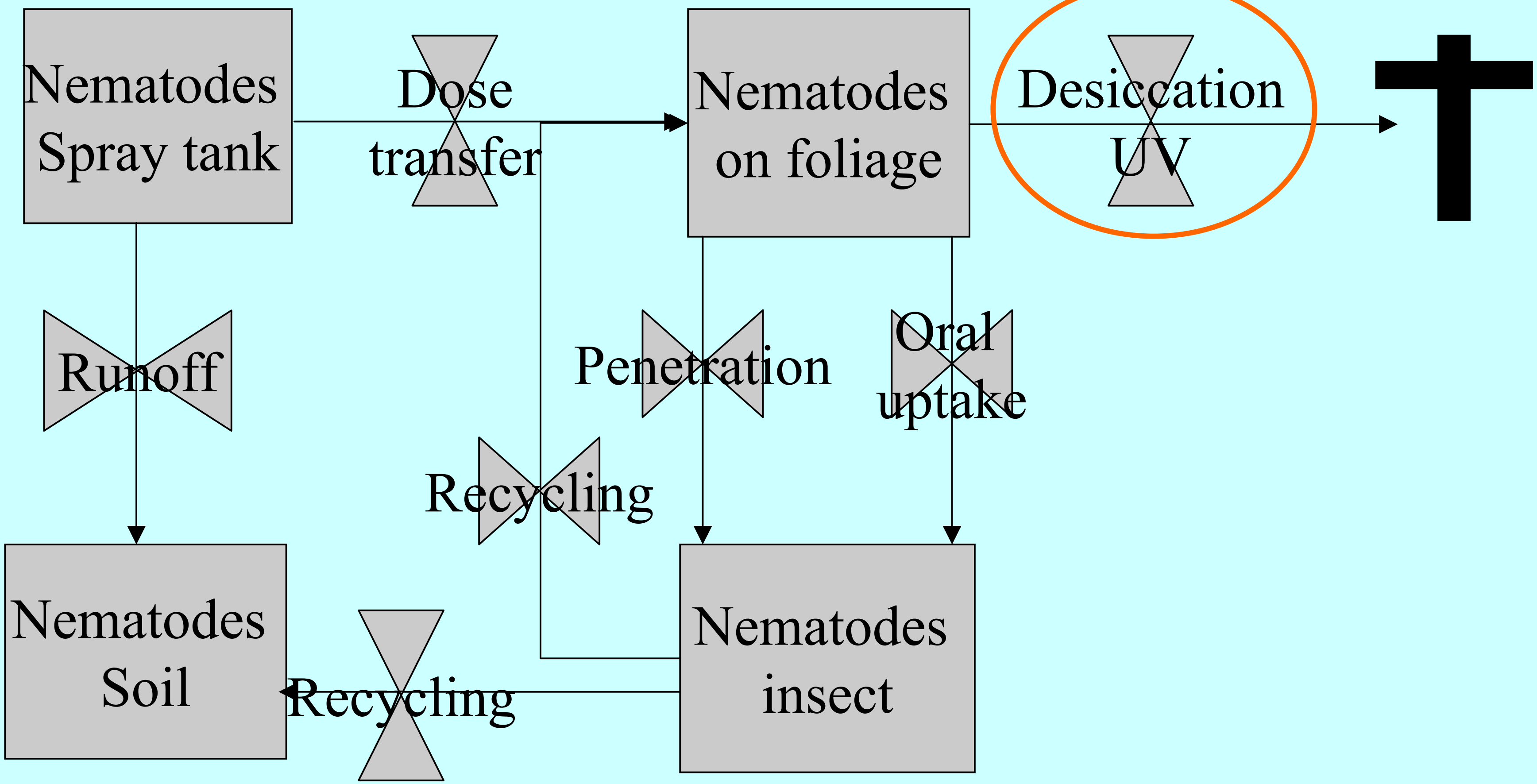
- Large droplets carry nematodes
- Large droplets are more prone to bounce-off or run-off
- Use of wetting agent
  - Decreases surface tension of water
  - Droplet spreads on leaf surface
  - Nematodes are not trapped into droplets
- Applied volume dependant on leaf area

Effect of polymers on run-off: Cabbage leaves, 45° inclination

Polymer	%	% EPN loss (± confidence band)
Water		**70.0 (12.4) a**
Arabic gum	0.1%	51.9 (12.2) ab
	0.2%	52.9 (15.2) ab
	0.3%	39.1 (12.0) bc
Guar gum	0.1%	55.7 (11.9) ab
	0.2%	56.6 (5.3) ab
	0.3%	26.8 (22.8) cd
Xanthan	0.1%	69.2 (2.6) a
	0.2%	**17.1 (16.8) cd**
	0.3%	**22.2 (15.1) cd**
Alginate	0.1%	32.9 (23.8) bcd
	0.2%	**12.6 (5.9) d**
	0.3%	**17.8 (23.1) cd**

Schroer et al. Biocontrol Science & Technology. In press

Main processes involved

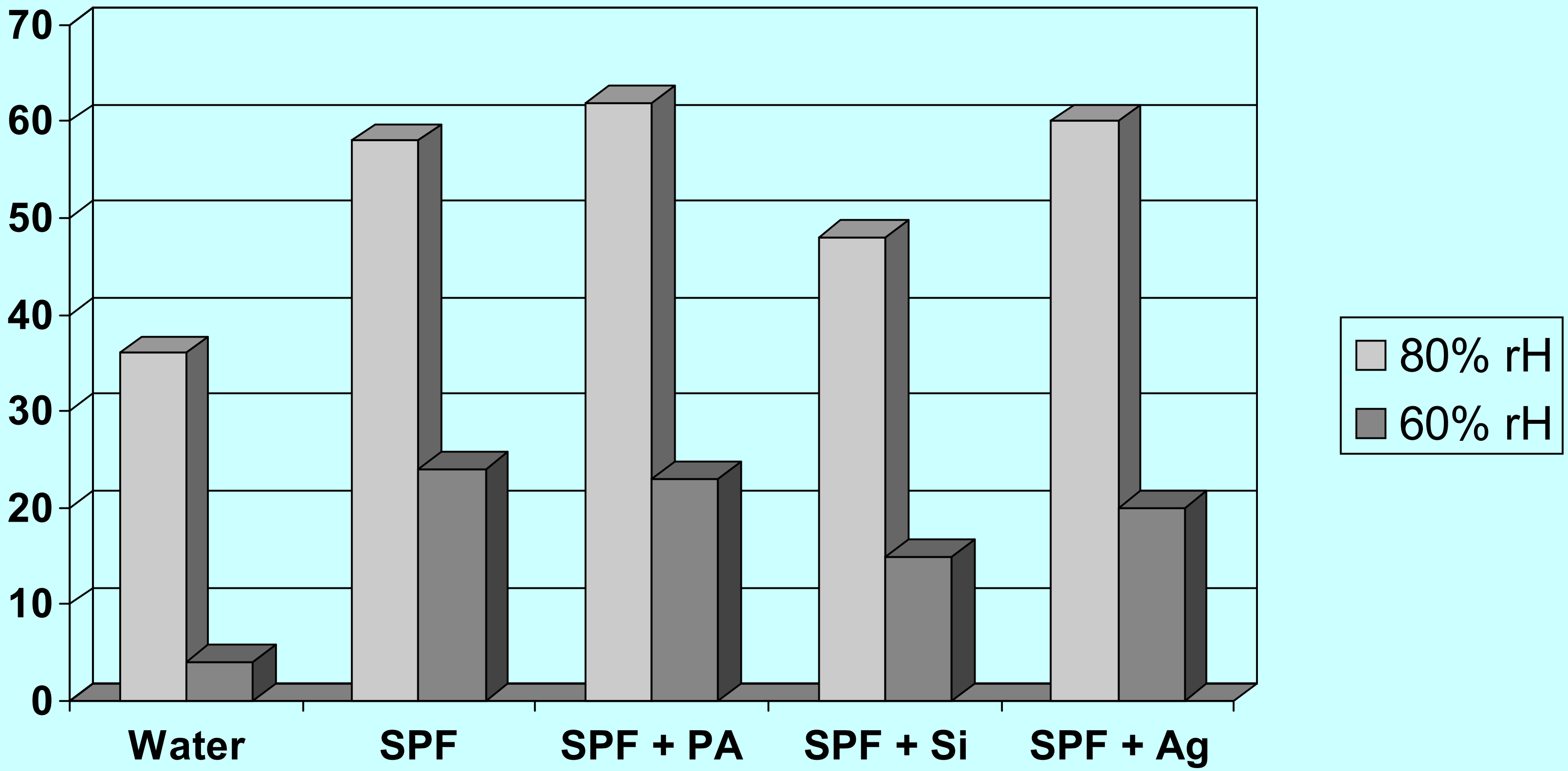


Desiccation and UV-tolerance

- Formulation additives
- Pre-adaptation to desiccation tolerance
- Genetic approach
  - Use of resistant isolates
  - Selective breeding for desiccation tolerance
  - Genetic engineering
- Adapt environment
  - Apply in the evening
  - Use blackouts after spraying in Glasshouse
- Is the *activity* maintained ? Are nematodes trapped ?
- Reduce residence time of nematodes on foliage !!
  - e.g. facilitate penetration into leafminer galleries
  - facilitate penetration into insects

Survival of *S. carpocapsae* on cabbage leaves

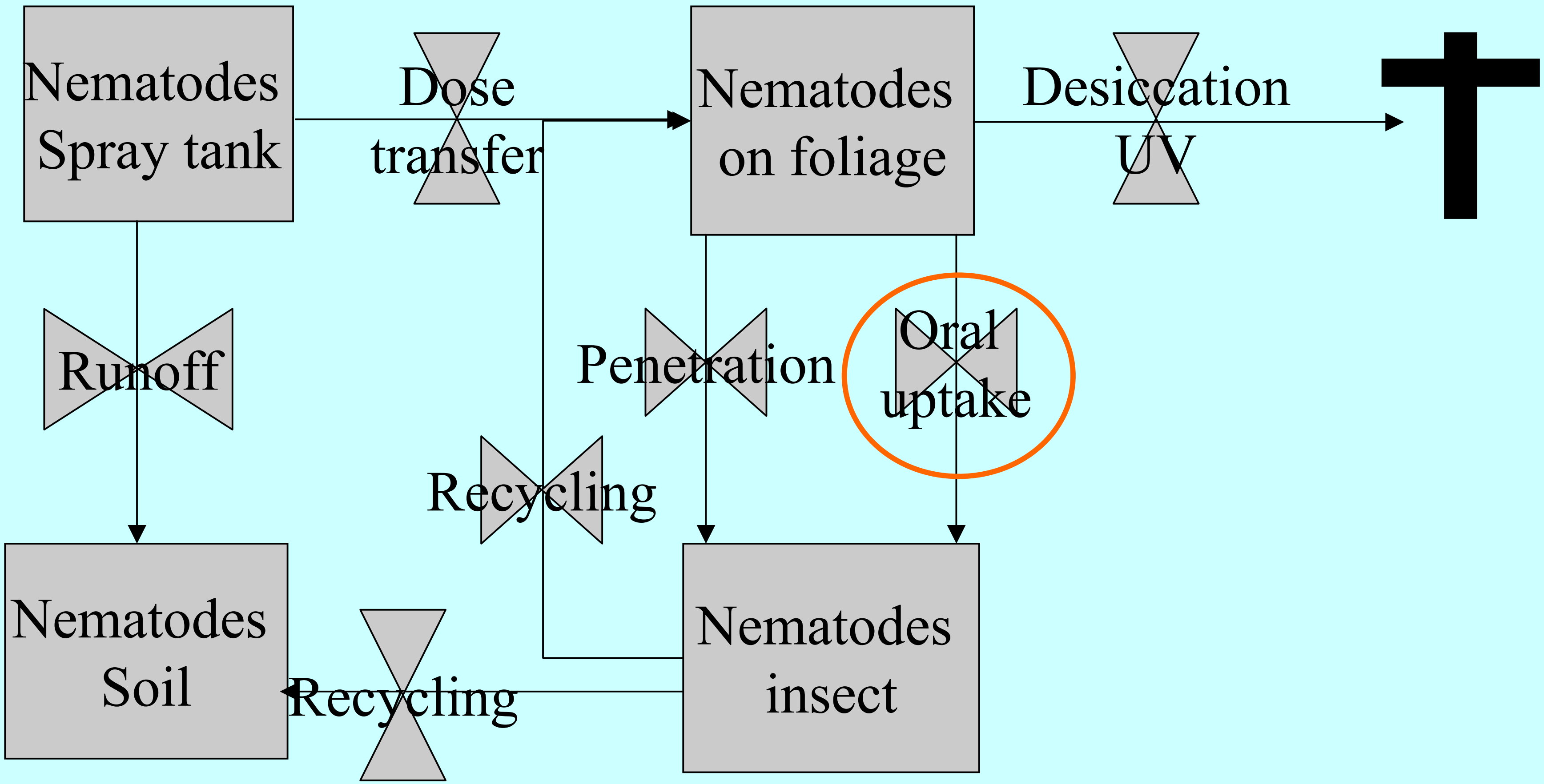
LT50 (h)



SPF = 0.3% Rimulgan , 0.3% Xanthan

PA: Polyacrylat; SI: fumed silica, AG: K-alginat

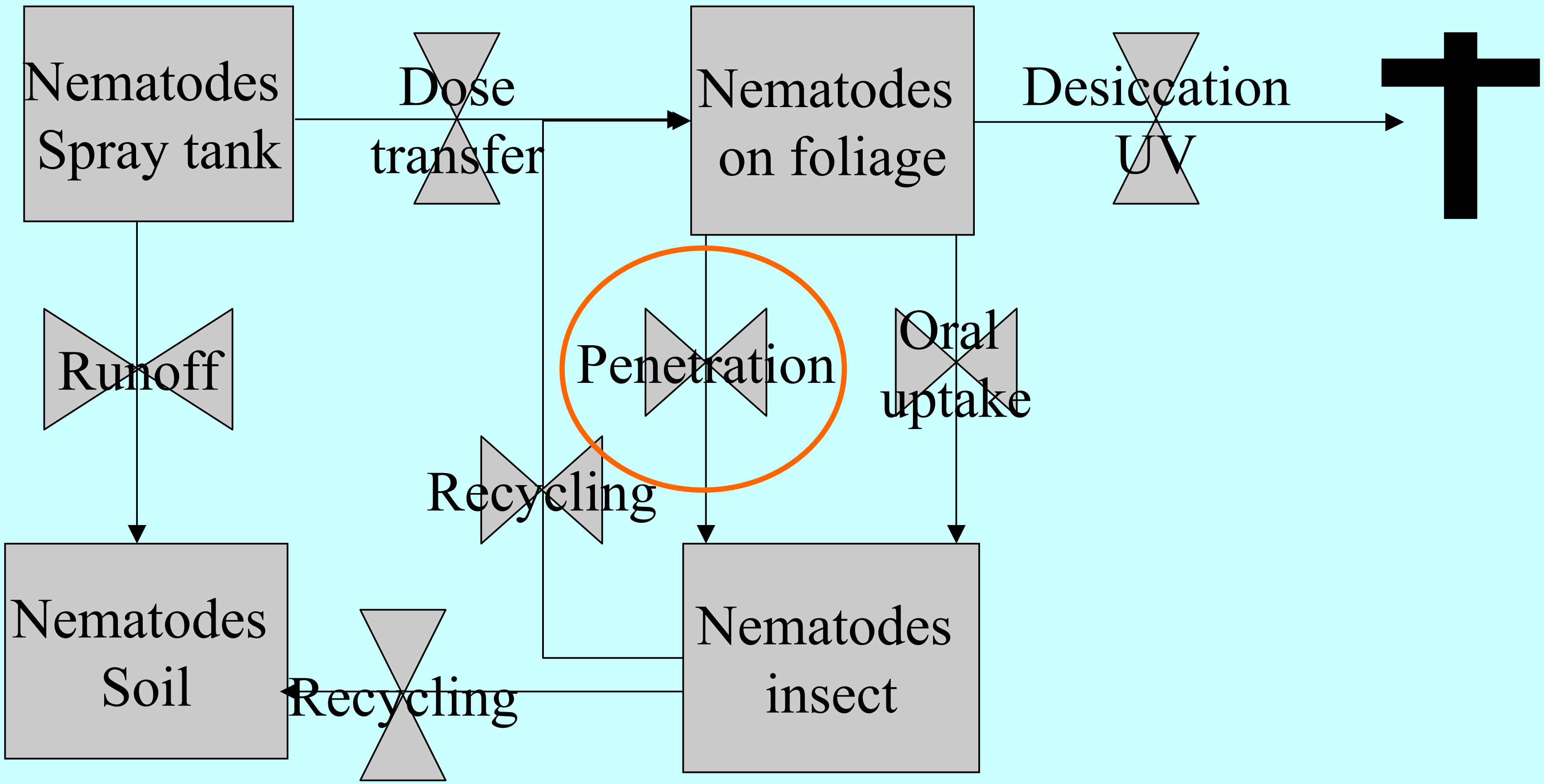
Main processes involved



Increase oral uptake

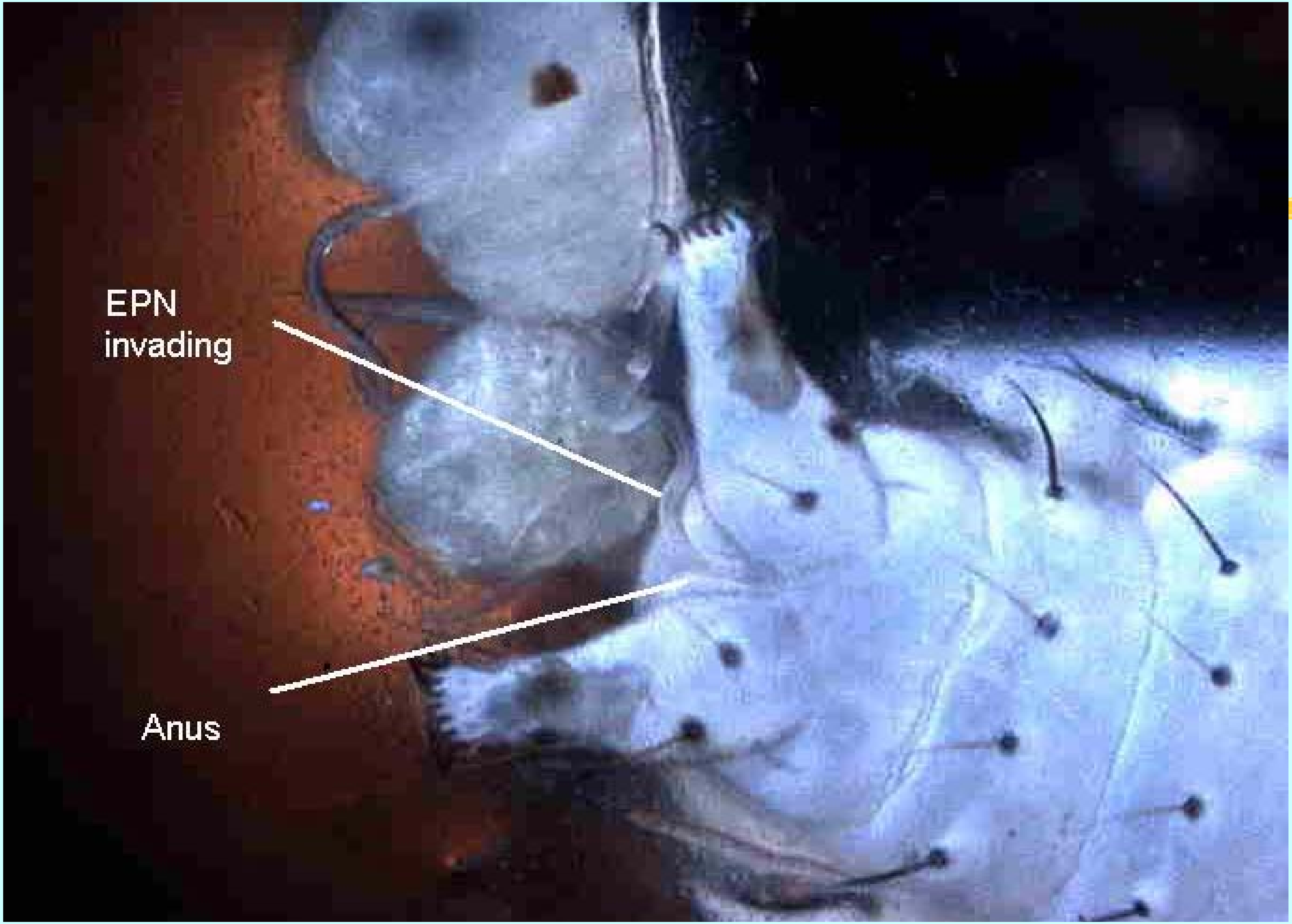
- Alginate deposits (Navon *et al.* 1998, 2002)
  - Incorporation of nematodes into gel-deposits
  - Phagostimulants in deposits
- Works for
  - *Spodoptera littoralis*
  - *Helicoverpa armigera*
- Alginate deposits prone to desiccation
- No effect on *Plutella xylostella*
- No oral activity on Thrips

Main processes involved



Increase nematode penetration

- Insect with natural openenings (Anus, Spiracles)
- Ensure nematode-insect contact
- Provide matrix for nematode movement



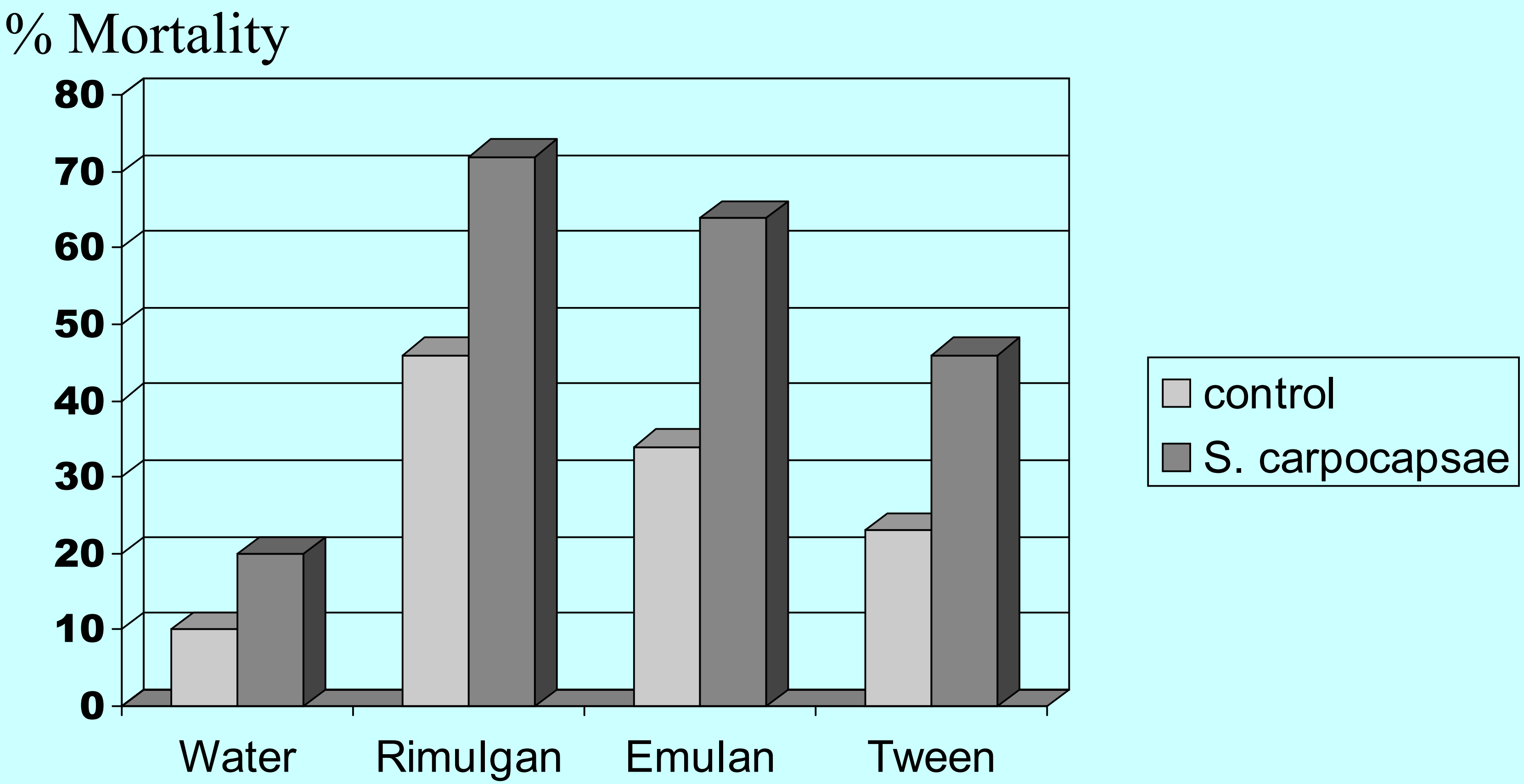
Sibylle Schroer, Kiel

Formulation to control *P. xylostella*

- Surfactant-polymer formulation
- Surfactant:
  - Castor Oil derivates

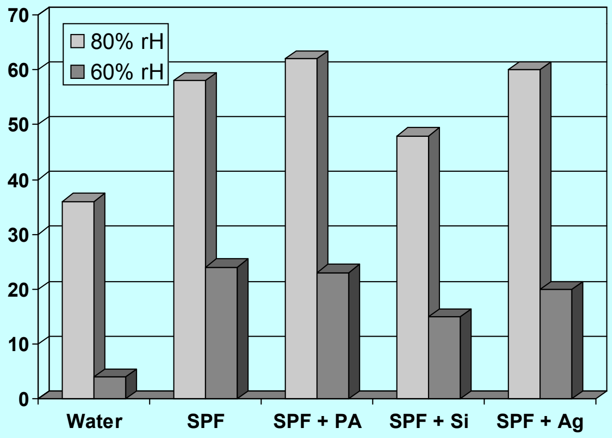
  Rimulgan or Emulan ELP (0.2 to 0.3%)
  - Tween 80
- Polymer:
  - Xanthan (0.2 to 0.3%)
  - Arabic gum
  - Guar gum
  - K-alginate

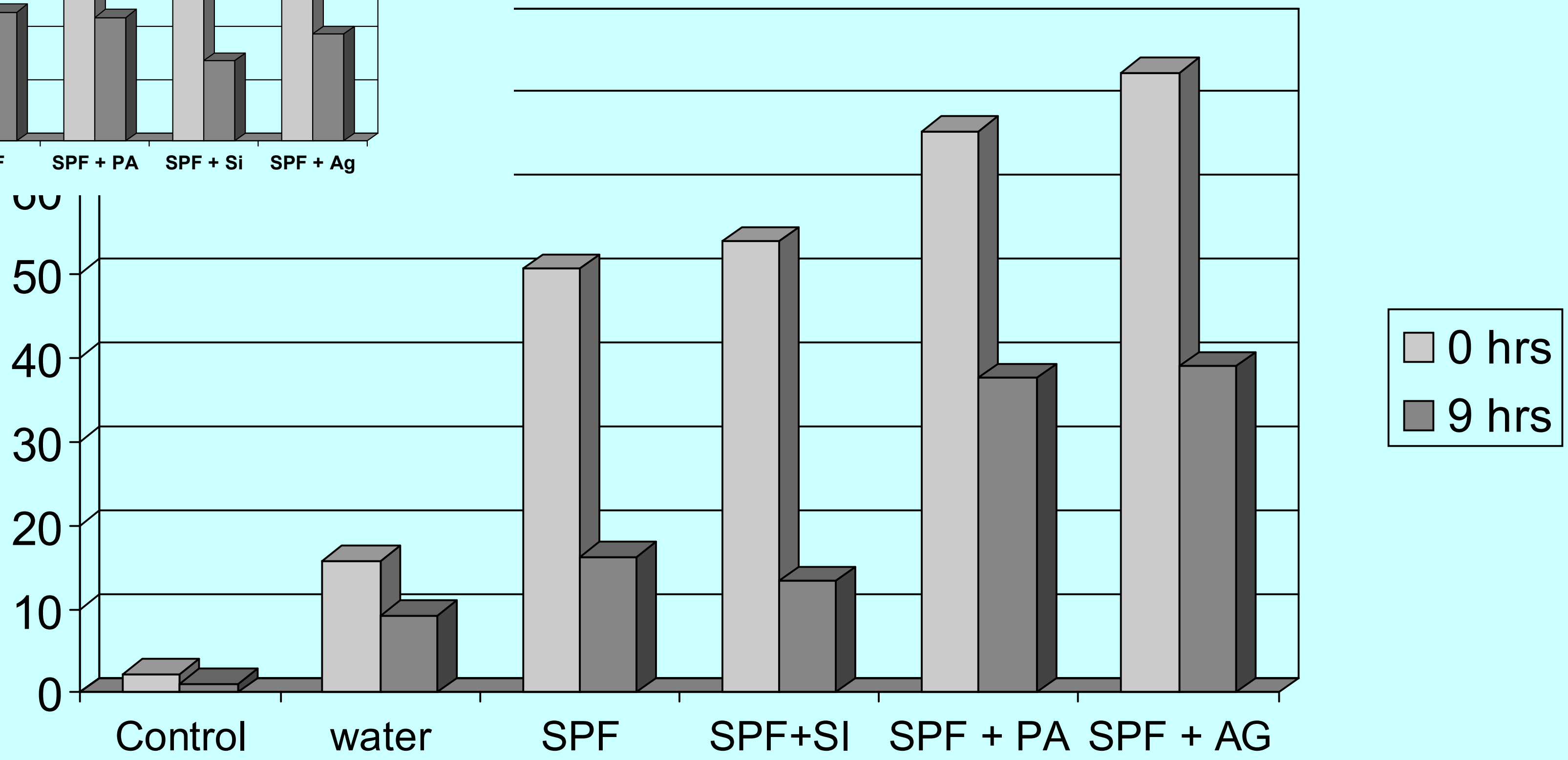
Screening for surfactant 60% rH



Reduction in efficacy with time

LT50

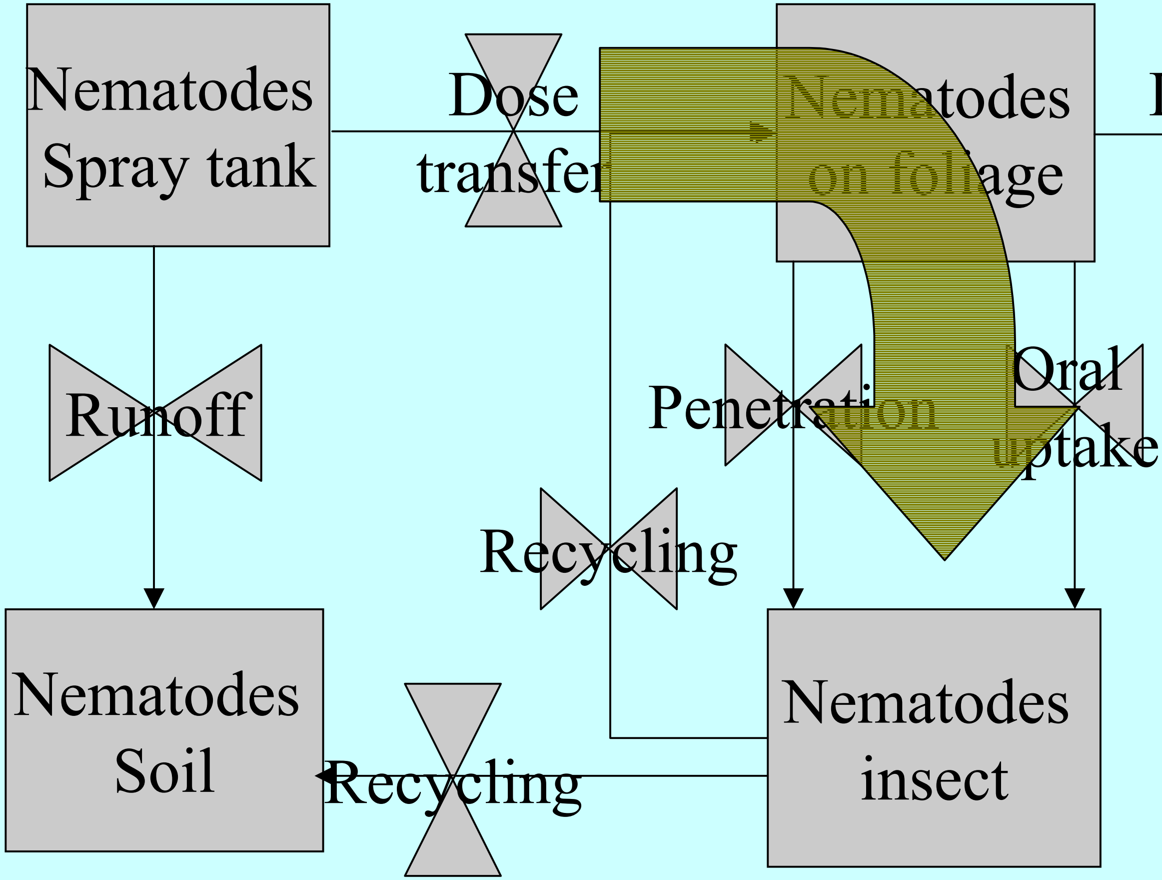




What happened ?

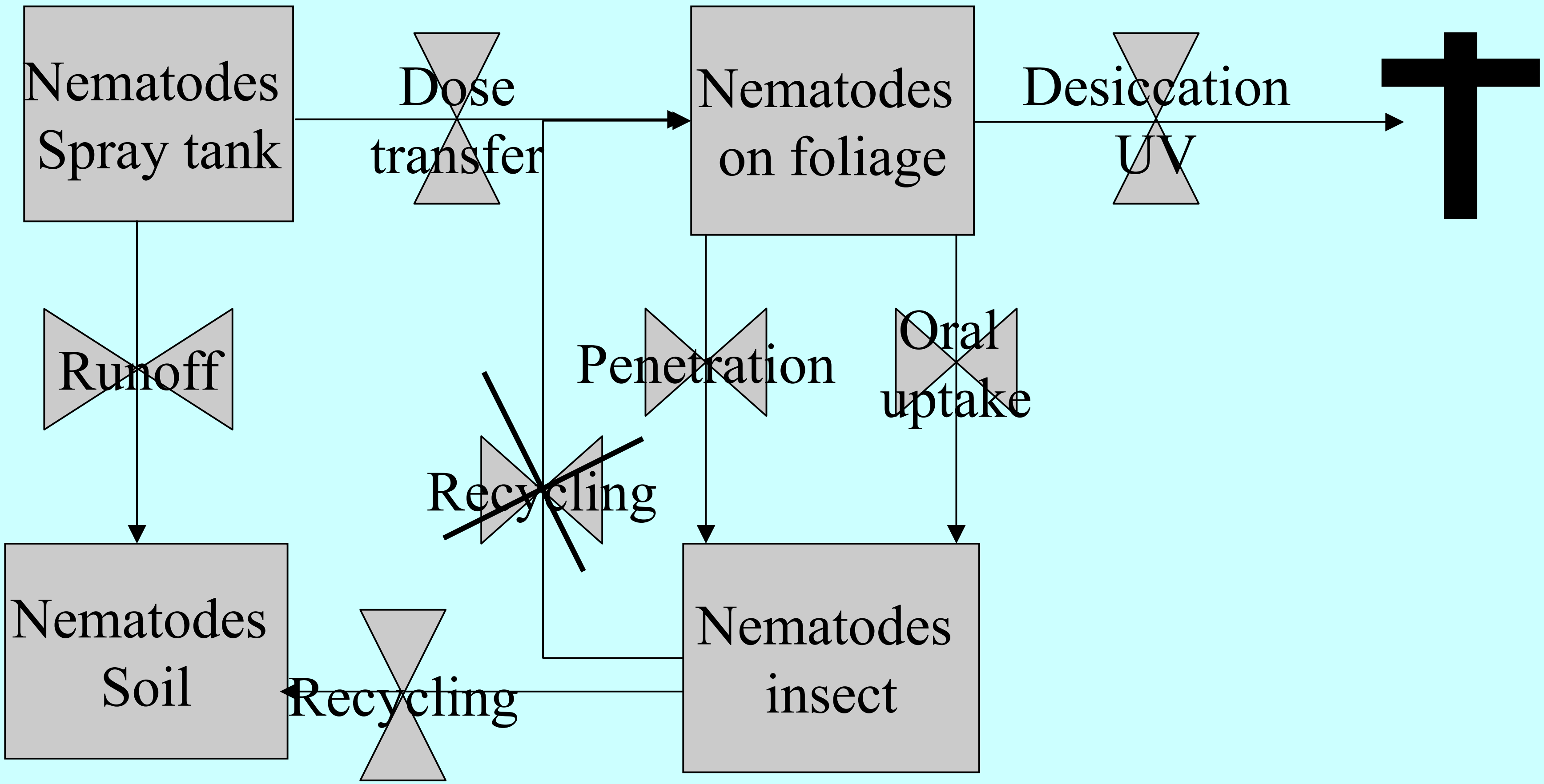
- Nematodes survive on foliage
- Penetration activity decreases rapidly
- Insect movement restricted by formulation
- Nematode movement supported but only in polymer-film
- Properties of polymer-film changes with desiccation

Optimise insect infection rather than nematode survival



Rates of change are not constant !
Influenced by:
Time, rH, T
Spatial distribution of insects

Recycling ?



Nematodes Spray tank
Dose transfer
Nematodes on foliage
Desiccation UV
Runoff
Penetration
Oral uptake
Recycling
Nematodes Soil
Recycling
Nematodes insect

Conclusions

- Consider all processes when designing foliar application
- Get nematodes and insects together quickly
- Rely on split-application rather than nematode survival
- Ensure penetration of nematode into insect host
- Thrips:
  - Flower, open buds or leaf onsets are good arenas for penetration
  - Leaf-thrips are more difficult => try Rimulgan/Xanthane formulation ?