Control of western flower thrips by entomopathogenic nematodes: possibilities and challenges

By
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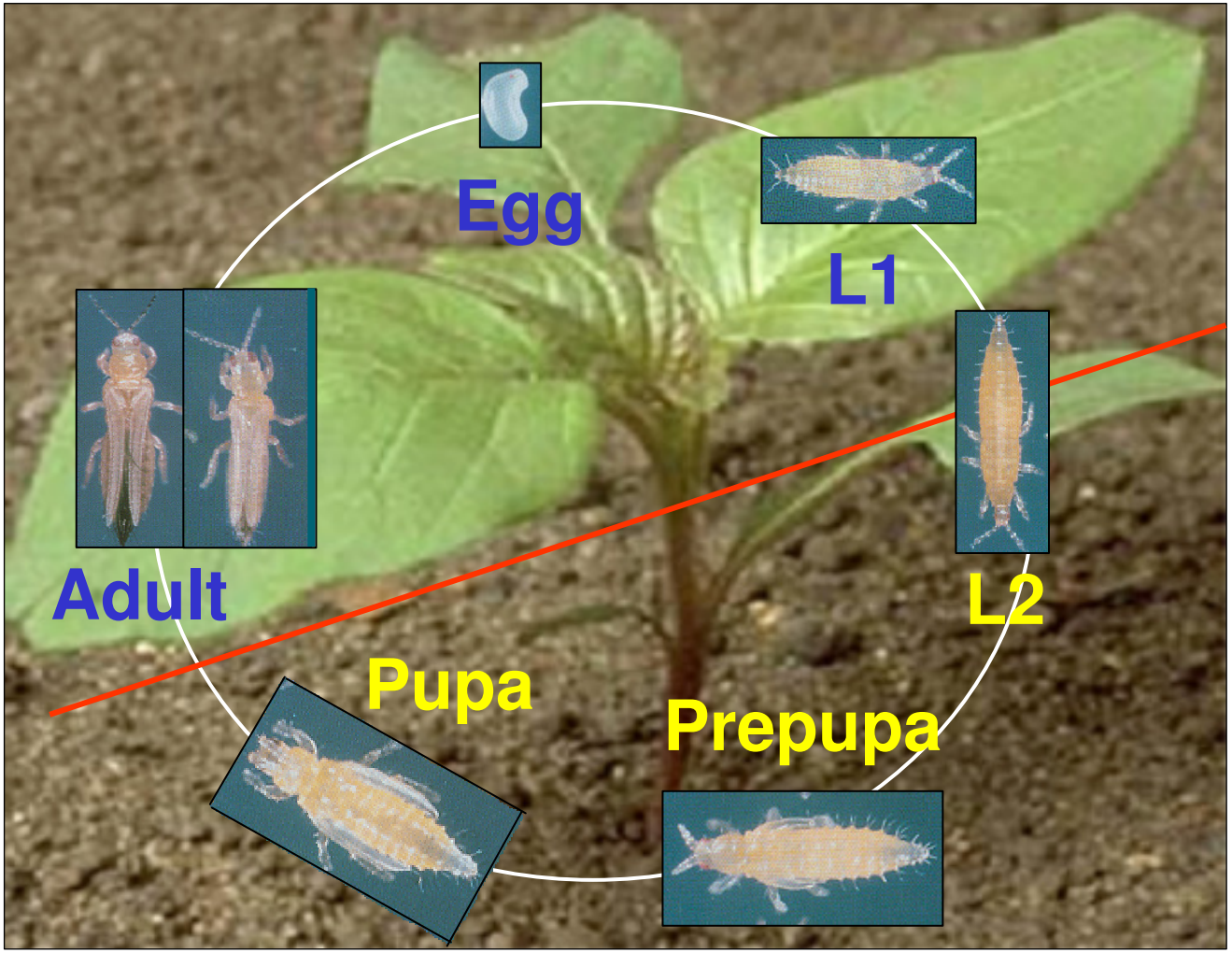
Western Flower Thrips (WFT)



Western Flower Thrips (WFT)

- Damage high value crops through direct feeding and oviposition

- Vectoring plant viruses, e.g., TSWV

Western Flower Thrips (WFT)

Control

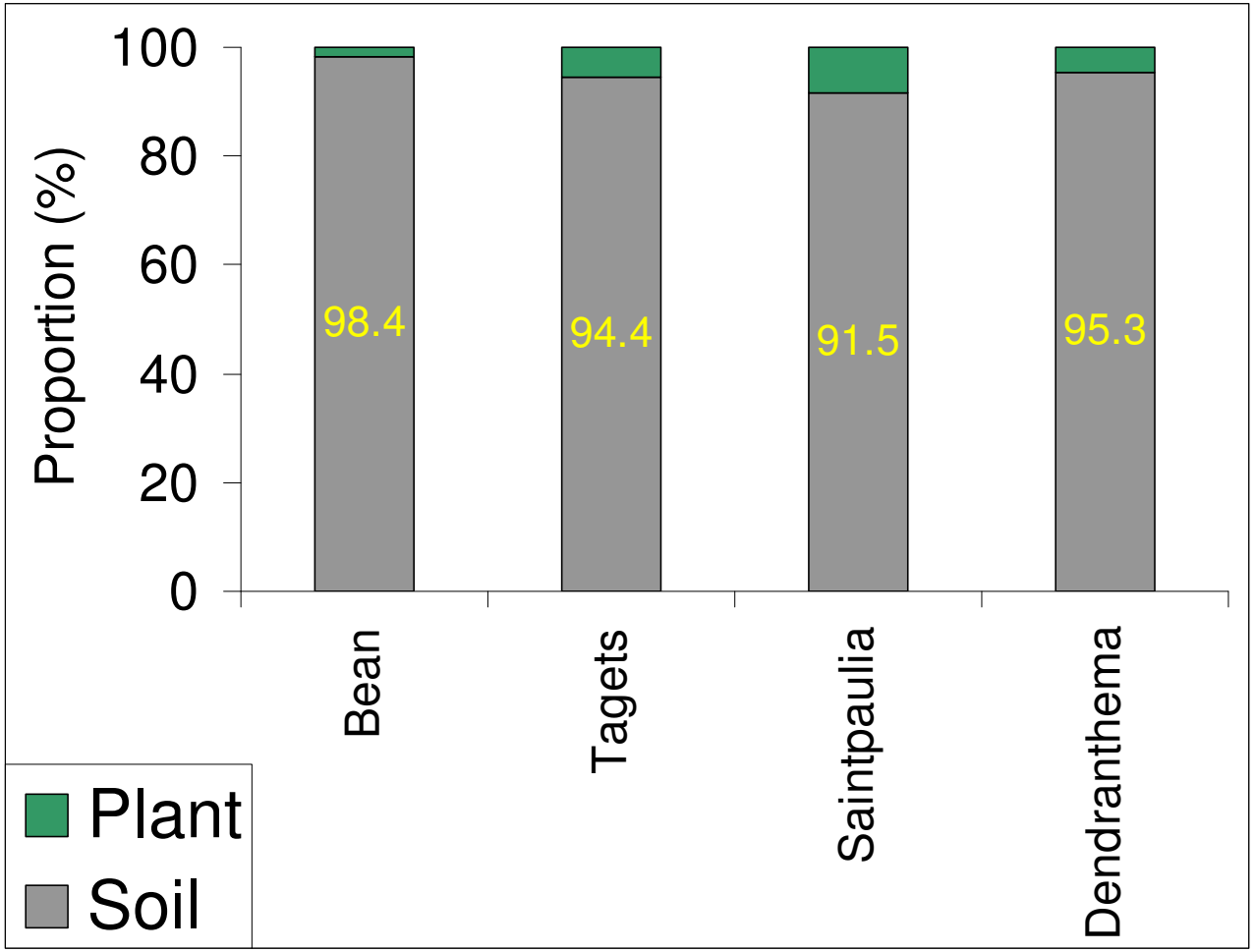
- WFT control is not easy:
  - Cryptic feeding behaviour
  - High reproductive rate
  - Developed resistance to common insecticides

Encouraging to use EPN for WFT control

A. High proportions of WFT pupate in the soil
B. All soil-dwelling developmental stages are susceptible
C. The foliar-feeding stages can also be controlled by EPNs

Encouraging to use EPN for WFT control

A. Up to 98% of WFT populations pass through soil to complete their developmental cycle



Berndt, 2003. PhD Thesis, Hannover University.

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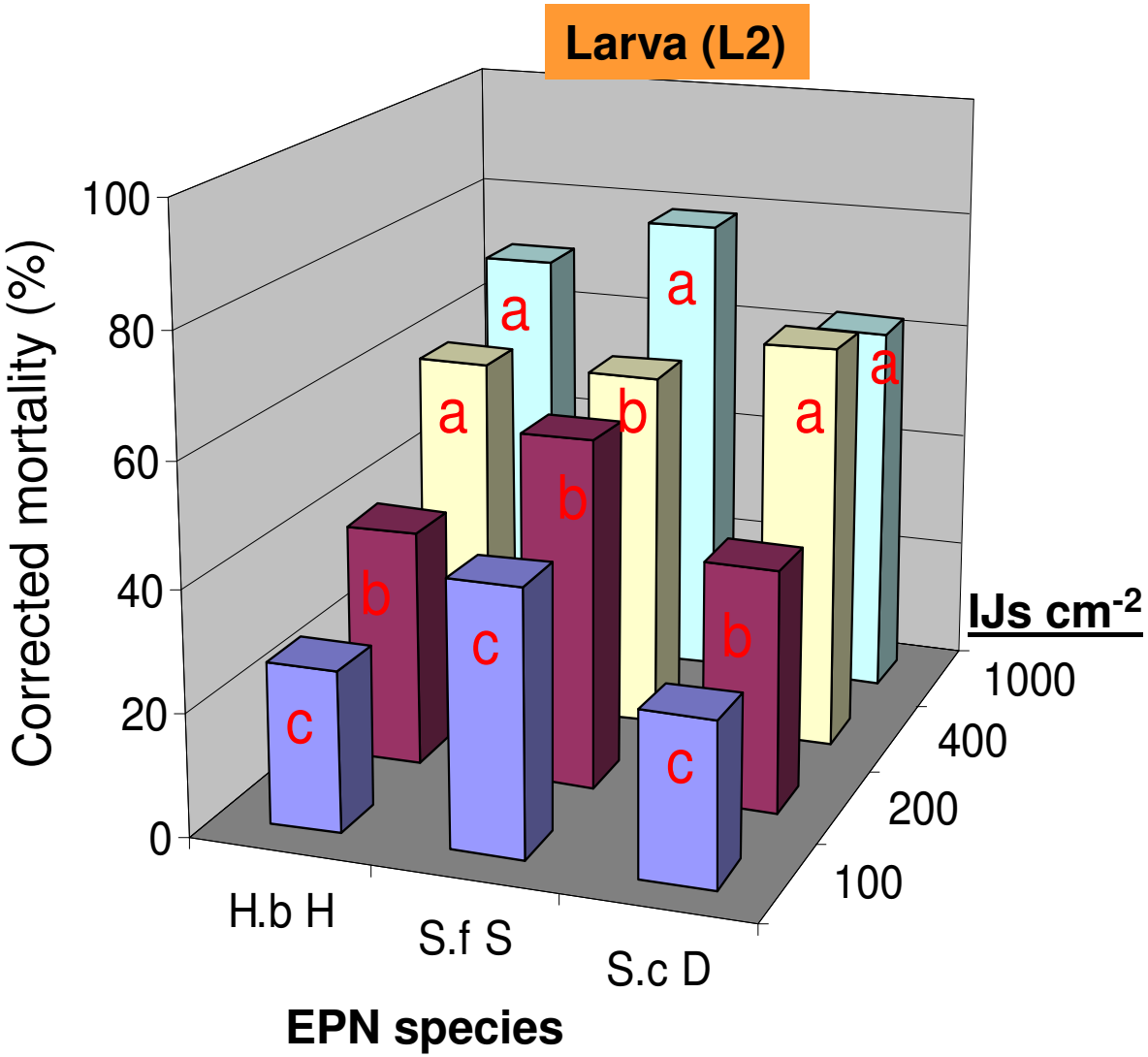
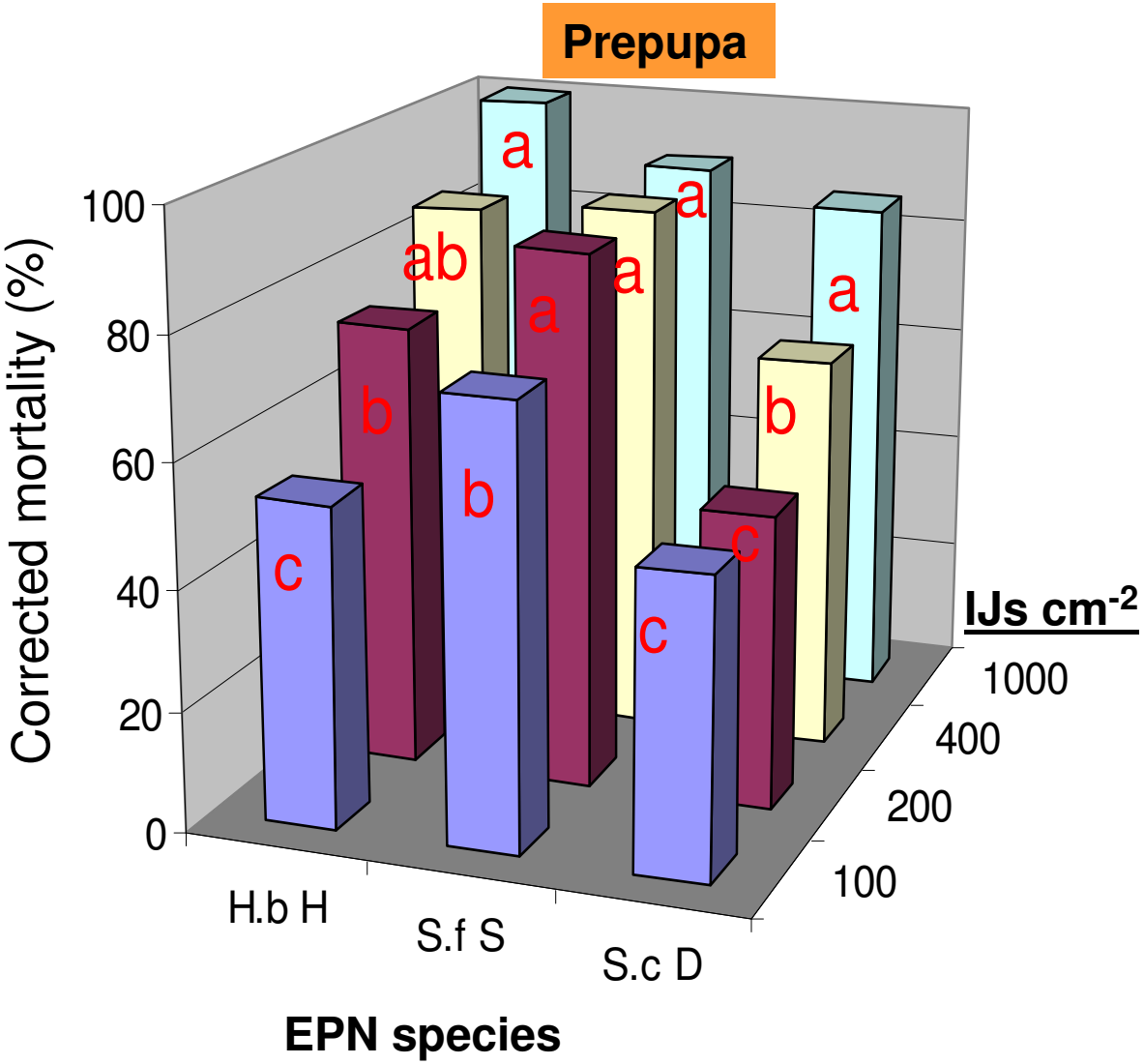
Encouraging to use EPN for WFT control

B. All soil-dwelling life stages are susceptible to selected EPNs



Ebssa et al., 2001. *J. Invert. Pathol.* 78, 119–127.

Encouraging to use EPN for WFT control



Ebssa et al., 2001. *J. Invert. Pathol.* 78, 119–127.

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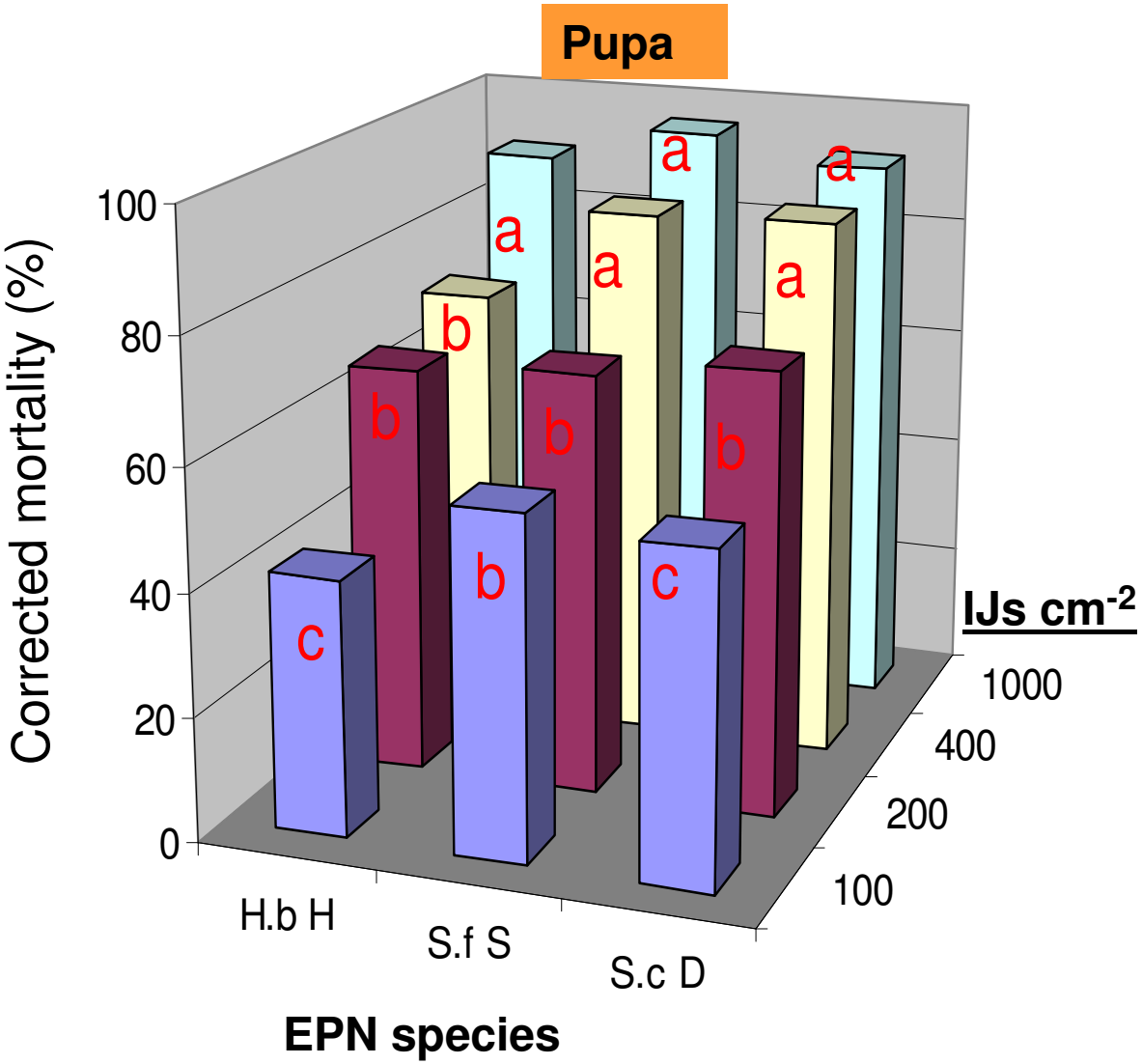
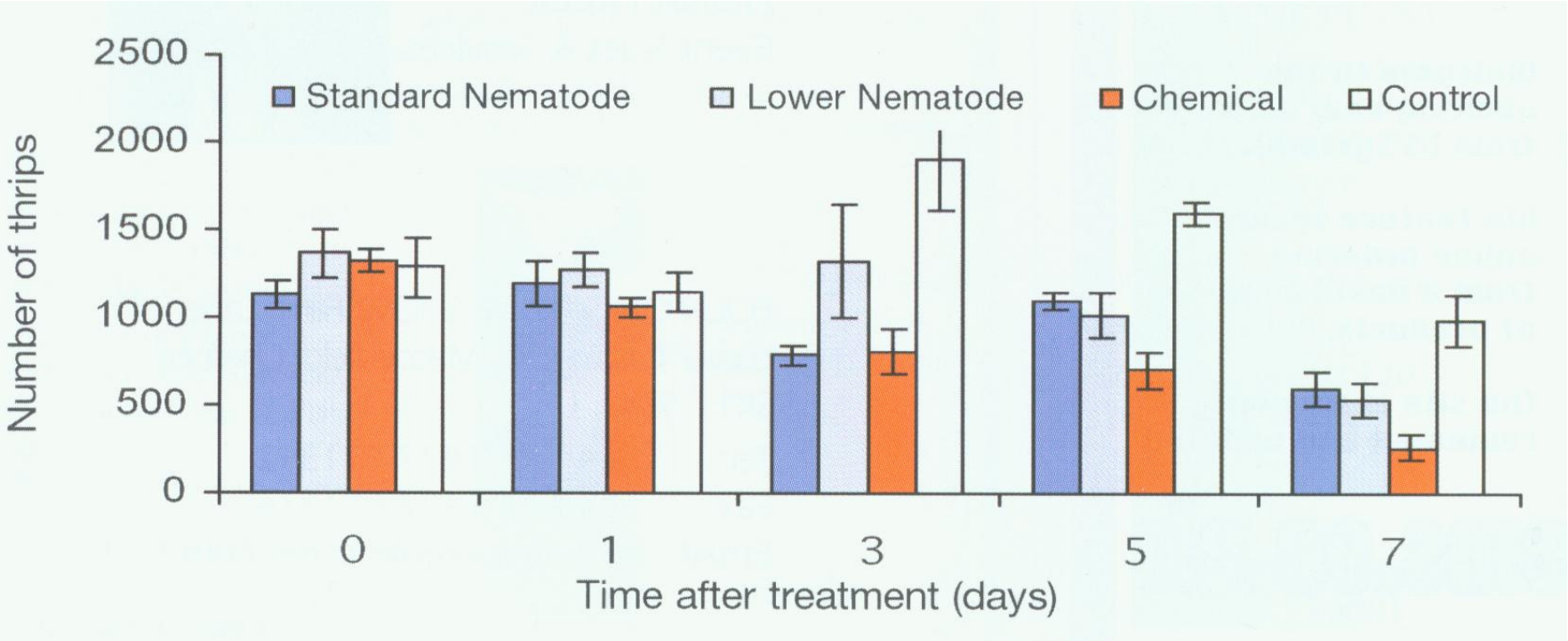


Ebssa et al., 2001. *J. Invert. Pathol.* 78, 119–127.

Encouraging to use EPN for WFT control

C. The foliar feeding stages can also be targeted
(e.g. use of Nemasys F)



Piggot & Wardlow, 2002. The Growers, Feb. 20-23.

Challenges in using EPN for WFT control

A. High temperatures – pest population, soil moisture

B. WFT body size

C. Behaviour of the soil dwelling stages of WFT

D. Foliar applications of EPN could also be challenging

E. Pest of high value crop and vector of Tospoviruses
(very low economic threshold levels is required)

Challenges in using EPN for WFT control

WFT becomes more important under warmer temperatures;
and such high temperatures:

1. favour fast WFT population build up, increasing WFT density per area

Life history and life tables of western flower thrips

Table 2. Summary of life table data for *Frankliniella occidentalis* at different temperatures.

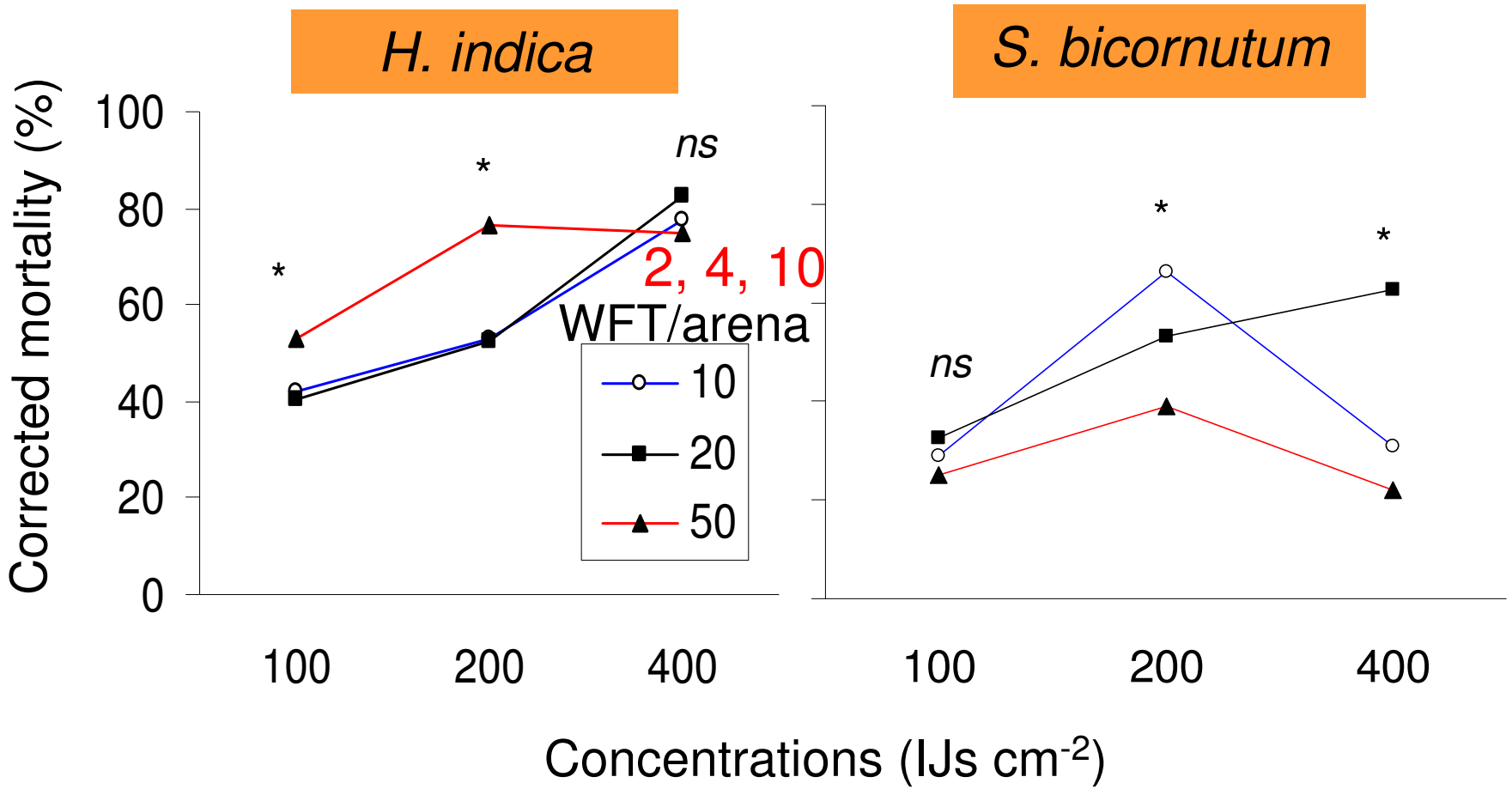
Temperature °C	Σm_x	R_0	r_m	T days	Proportion females	°D for development; egg to adult
15	2.24	1.02	0.002	12.685	0.55	274
18	2.64	2.54	0.11	8.789	0.58	253
20	5.24	5.00	0.21	8.057	0.61	242
23	6.68	5.77	0.30	6.150	0.69	228
25	5.20	6.04	0.30	4.577	0.64	245
30	9.48	8.48	0.51	4.321	0.86	257

R_0 = net replacement rate; r_m = intrinsic rate of natural increase; T = mean generation time; Σm_x = sum of average number of female offspring.

Gaum et al., 1994. *Bulletin of Entomological Research* 89, 219-224.

Challenges in using EPN for WFT control

WFT mortality as caused by EPNs at different host densities



Ebssa et al, 2004. *Biological Control,* 29, 145–154

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Challenges in using EPN for WFT control

WFT becomes more important under warmer temperatures:

and such high temperatures:

1. favour fast WFT population build up, increasing WFT density per area

2. shorten the life period of the soil-dwelling stages
   thus, shorten the contact time of EPN and WFT in the soil

Challenges in using EPN for WFT control

Table 1. Average duration (days) of each developmental stage and the number of eggs laid by *Frankliniella occidentalis* on English cucumbers cv. Pepinex at different temperatures. The percentage of time spent in each life stage is given in brackets.

Stage	15°C	18°C	20°C	23°C	25°C	30°C
Egg	15.53 ± 0.205 (32.4)	9.75 ± 0.167 (34.3)	6.76 ± 0.132 (30.9)	5.11 ± 0.153 (32.4)	4.25 ± 0.960 (28.9)	3.09 ± 0.079 (26.9)
Larva (L_1+L_2)	22.55 ± 0.434 (47.0)	13.31 ± 0.243 (46.8)	9.80 ± 0.174 (44.9)	6.60 ± 0.152 (41.8)	6.46 ± 0.086 (43.9)	5.40 ± 0.079 (47.0)
Prepupa	3.00 ± 0.028 (6.3)	1.63 ± 0.069 (5.7)	1.56 ± 0.071 (7.1)	1.04 ± 0.028 (6.6)	1.04 ± 0.028 (7.1)	1.01 ± 0.020 (8.8)
Pupa	6.88 ± 0.073 (14.3)	3.75 ± 0.083 (13.2)	3.73 ± 0.064 (17.1)	3.02 ± 0.020 (19.2)	2.96 ± 0.028 (20.1)	1.99 ± 0.020 (17.3)
Tot. immature stage	47.96 ± 0.540	28.44 ± 0.293	21.85 ± 0.230	15.77 ± 0.123	14.71 ± 0.136	11.49 ± 0.099
Female	39.70 ± 0.435	30.67 ± 0.218	25.19 ± 0.302	18.92 ± 0.210	12.80 ± 0.270	10.08 ± 0.302
Av. number of eggs/female hatched	2.76	4.62	8.59	9.68	9.65	10.65

[a] ± SEM = Standard error of the mean; percentage of developmental time required for each life stage given in parentheses.

Gaum et al., 1994. *Bulletin of Entomological Research* 89, 219-224.

Challenges in using EPN for WFT control

➔under high temperature, fast rate of development, less contact time and hence a low EPN efficacy against WFT

➔ This could be a combined influence of (1) influence on the rate of development of WFT (2) the direct effects of temperature on EPN survival and efficacy and/or

Challenges in using EPN for WFT control

Ebssa et al, 2004. *Biological Control,* 29, 145–154.

CM(%) of WFT as caused by EPNs at different temperatures

	100 IJs cm^{-2}		**400 IJs cm^{-2}**	
°C	*H. indica*	*S. bicornutum*	*H. indica*	*S. bicornutum*
20	23.6 B a	29.8 A a	54.2 B a	34.1 B b
25	48.9 A a	39.3 A b	84.0 A a	47.0 A b
30	36.4 AB a	3.2 B b	77.7 A a	14.1 C b
35	26.4 AB a	0.0 B b	27.2 C a	0.0 D b

For a given concentration: means **within a column** (row) followed by the same **upper case** (lower case) do not differ significantly

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Challenges in using EPN for WFT control

WFT becomes more important under warmer temperatures:
and such high temperatures:

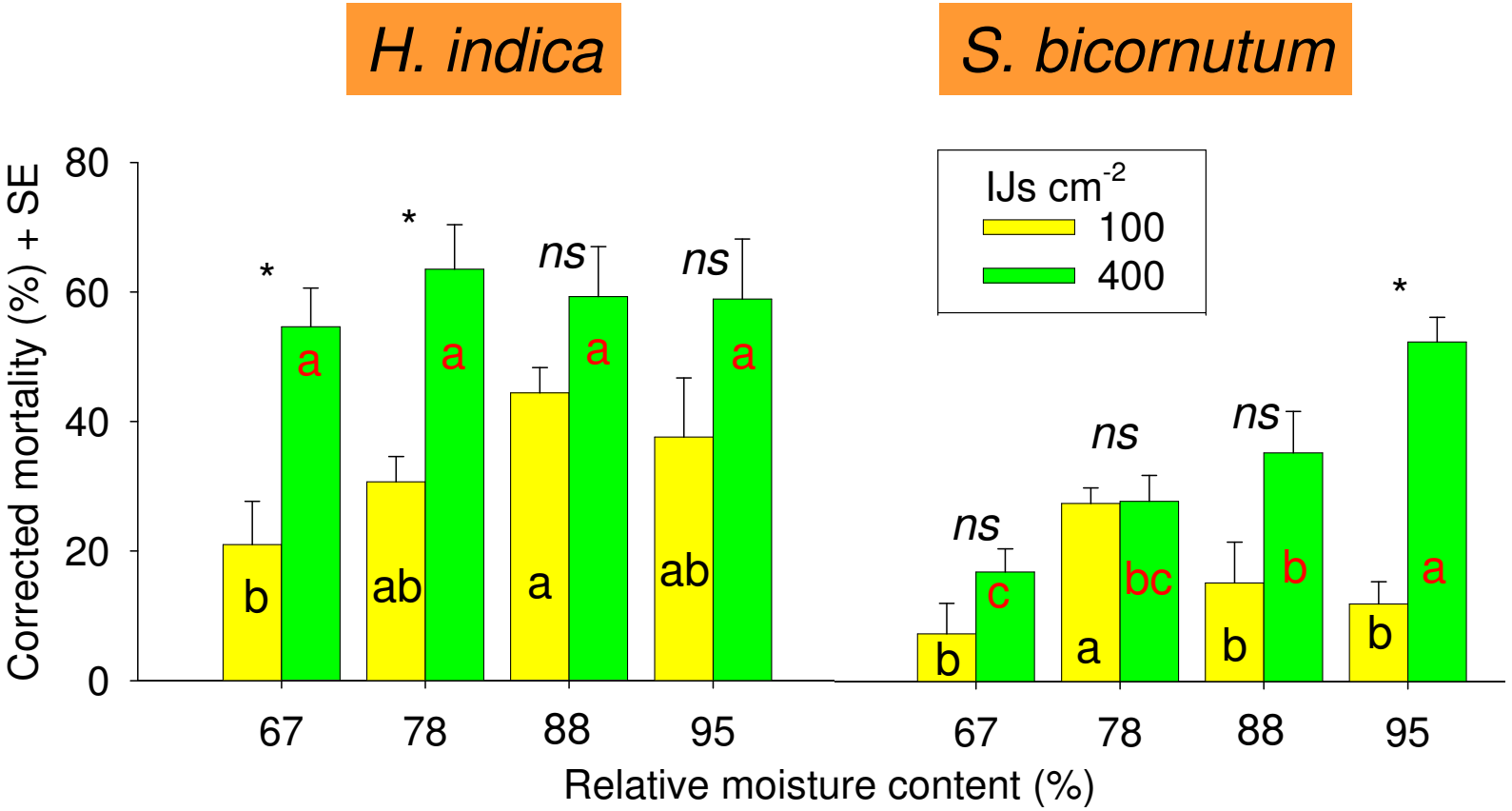
1. favour fast WFT population build up, increasing WFT density per area

2. shorten life period of the soil-dwelling stages thus, shorten contact time of EPN and WFT in the soil

3. increase soil desiccation rate, which has a negative impact on EPN efficacy

Challenges in using EPN for WFT control

WFT mortality by EPNs at different pre-application moisture levels



Ebssa et al. 2004, *Entomol Exper.Appl.* 112, 65–72.

Challenges in using EPN for WFT control

A. Temperatures

B. Body size

- Soil-dwelling stages of WFT are less than a mm in length and IJs of most EPN species are about ½ mm in length

➔ could be difficult for the IJs to locate their host (otherwise, high concentrations are required)

C. Behaviour of the soil dwelling life stages of WFT

Prepupa and pupa **do not feed and hence no cue** sources from plants to attract the IJs

Up on disturbance (maybe including attempts of IJs to colonise the host), both prepupa and pupa **move and may search for a new "IJ-free" space** in the soil;
and remain there until the IJs reach and disturb them again

➔ the speed of the host in changing its position is by far greater than the speed by which IJs follow the position-changing host

➔ before the IJs reach the host at its new position, WFT may finish its soil dwelling developmental stages and leave the soil

➔ These call for application of EPN at higher concentrations.
But production cost maybe reduced significantly in the future.

Challenges in using EPN for WFT control

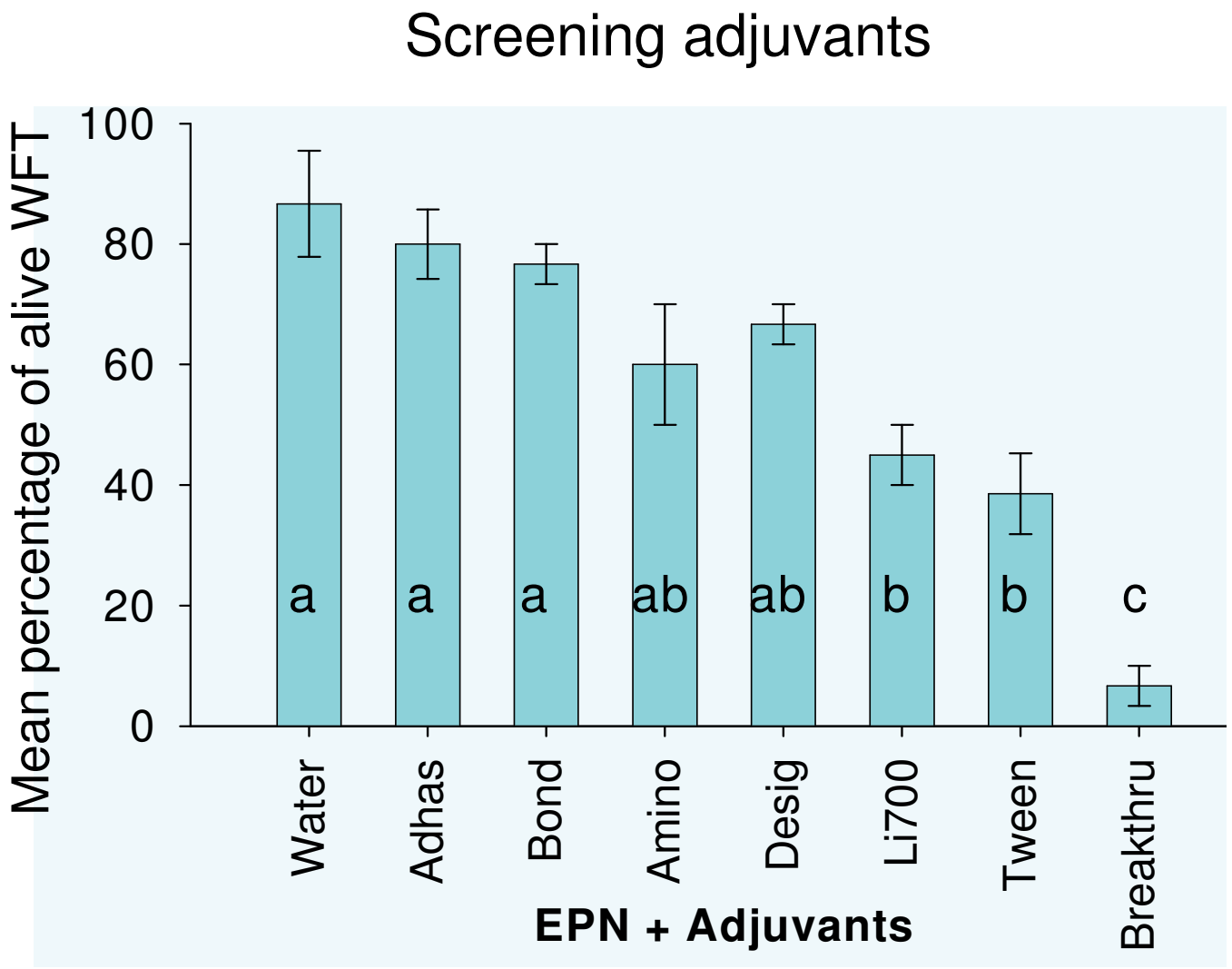
A. Temperatures

B. Body size

C. Behaviour

D. All challenges of using EPNs for foliar applications, such as desiccation and application problems, need to be resolved

Challenges in using EPN for WFT control



Halweh 2004, MSc Thesis, Hannover University.

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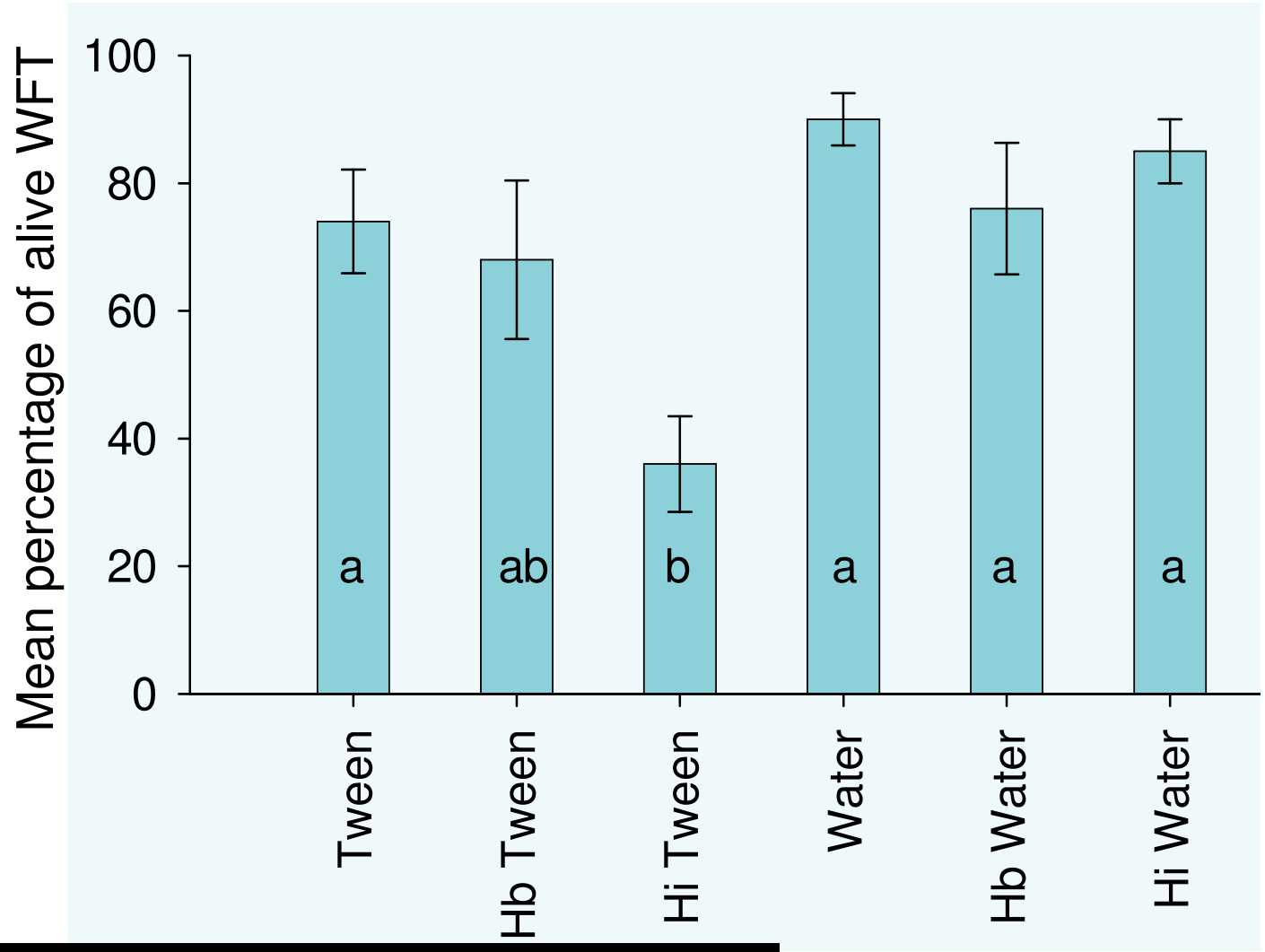
Challenges in using EPN for WFT control

Application of EPN against female WFT-Leaf-disc experiment



Halweh 2004, MSc Thesis, Hannover University.

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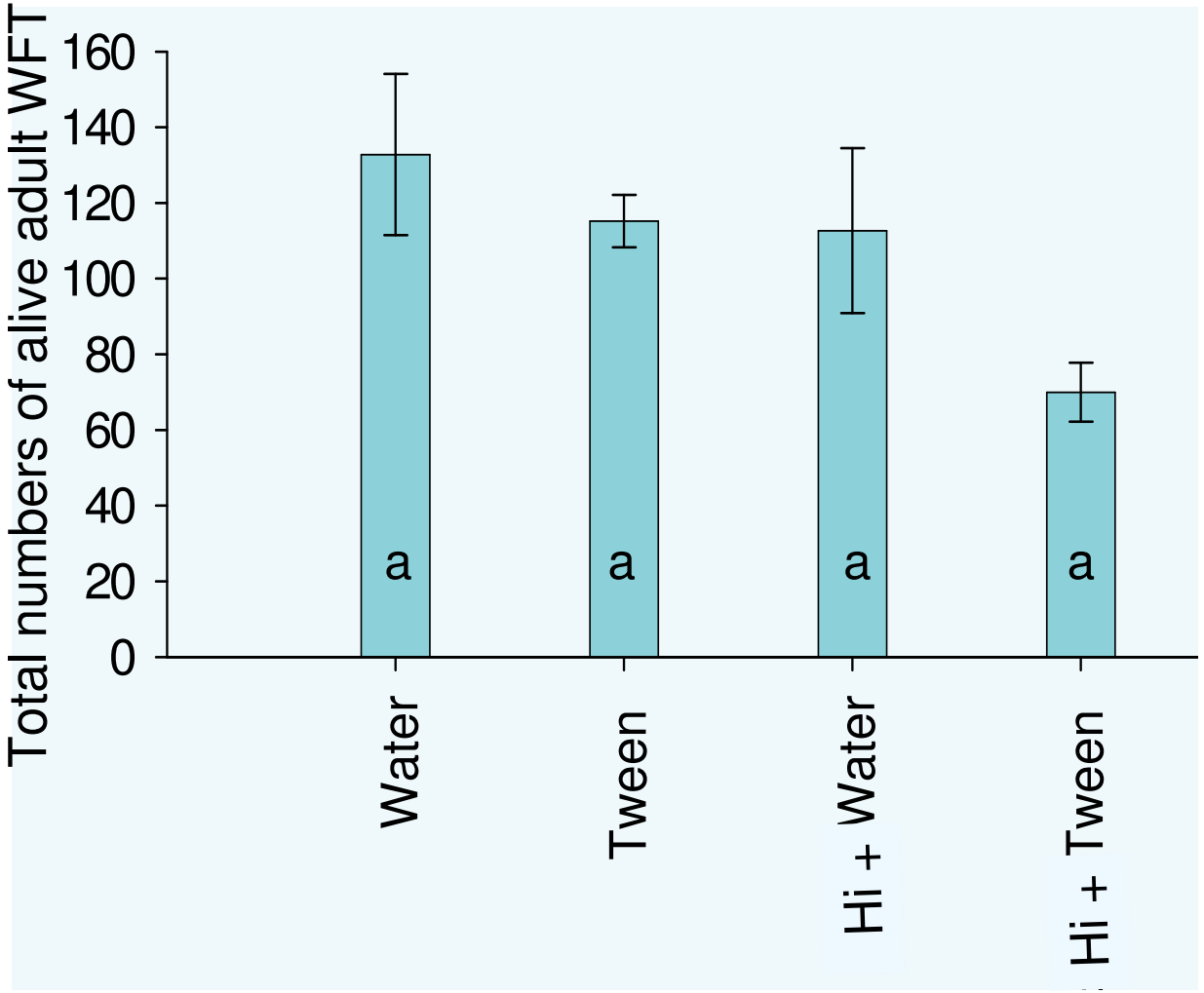
Challenges in using EPN for WFT control

Weekly applications of EPNs on flowering Chrysanthemums



Halweh 2004, MSc Thesis, Hannover University.

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Challenges in using EPN for WFT control

A. Temperatures

B. Body size

C. Behaviour

D. Foliar applications could be also challenging

E. WFT is a high value crop pest and vector of Tospoviruses

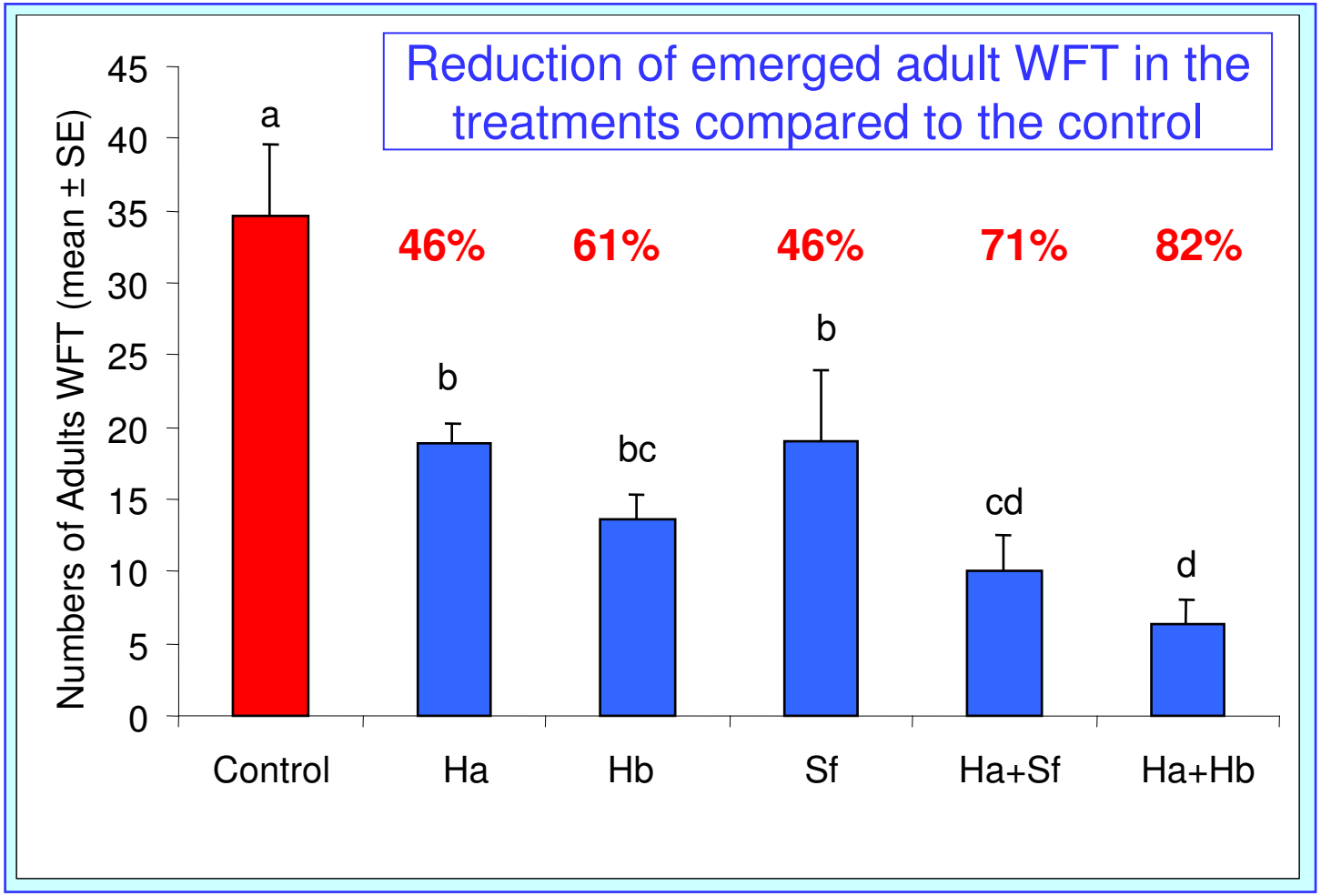
➔ extremely low economic threshold level is required,

The good thing is that:

EPN can successfully be combined with other biocontrol agents of WFT

The good thing in using EPN for WFT control

Combined applications of EPNs and *Hypoaspis aculeifer*



Premachandra, Borgemeister, Ehlers & Poehling, 2003
BioControl 48, 529-541.

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The good thing in using EPN for WFT control

Combined applications of EPNs & *Amblyseius cucumeris* (AC)
WFT Corrected mortality using emerged adult thrips

Ebssa et al. Biological Control, 2006.

EPN	IJs cm^{-2}	Numbers of *Amblyseius cucumeris* per plant			
		C*	3	5	10
C*	0	-	15.5 d	24.6 d	47.1 c
Hb	100	55.8 bc	47.2 c	62.3 bc	68.0 ab
	200	64.6 bc	60.2 bc	68.2 ab	82.9 a
Hi	100	60.1 bc	67.9 bc	57.4 bc	73.2 ab
	200	64.7 bc	64.1 abc	67.9 ab	83.1 a

*C = Control (no EPNs and/or no mites were used); Hb = *H. bacteriophora*; Hi = *H. indica*
Means **within any cell** followed by same letters do not differ significantly.

Conclusion:

Great potential, but great attentions and more jobs are required to improve the efficacy of the nematodes for the control of WFT.