Resultaten multifactorieel onderzoek: effect multi-stressoren op bijenvolken

Coby van Dooremalen

23 februari 2019
Bijscholingsdag leraren bijenteelt



Sommige links naar artikelen is alleen de samenvatting gratis toegankelijk, een aantal zijn vrij toegankelijk in het geheel (voor eigen gebruik of onderwijsdoeleinden)

Zomer	Winter
Veel contact met 'buitenwereld' -> **blootstelling aan <u>stress</u>** **-> verlaagde <u>prestatie</u>?**	**-> Verlaagde overleving?**





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Prestatie



- Overleving
- Optimaal gezond
- Maximale honingoogst/ bestuivingscapaciteit?
- (niet)vermeerderen?
- Raatvast?
- Zachtaardig?
- …



- Overleving
-
-
- Voortplanting (max groei)
-
-
-

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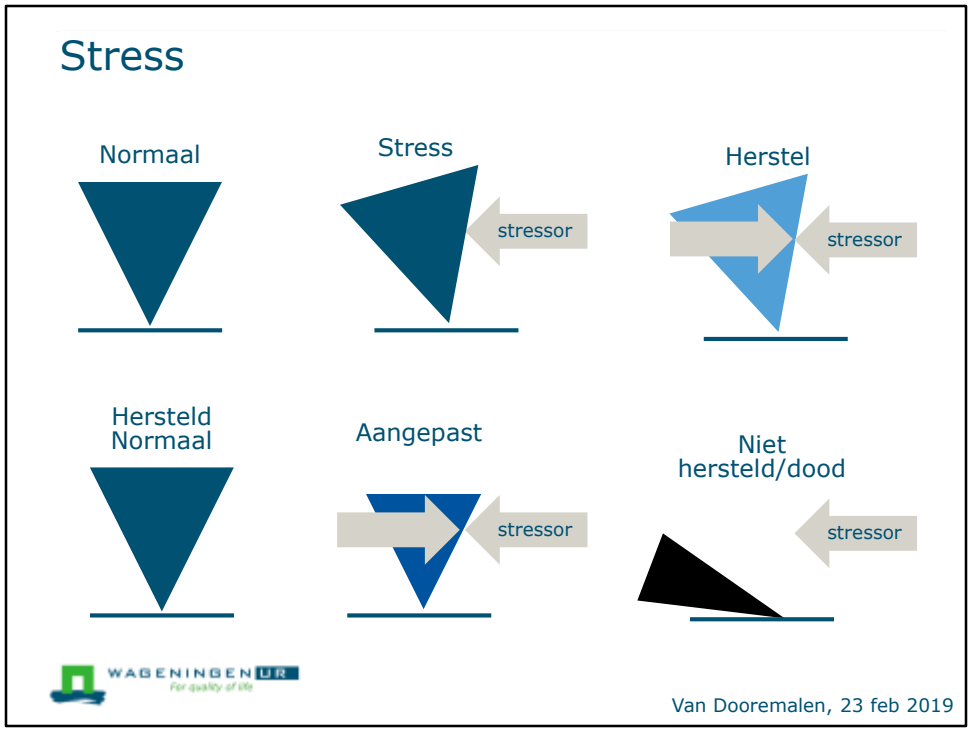
Een prestatie als ‘goed’ beoordeeld, hoeft vanuit het perspectief van bij helemaal niet perse ‘goed’ te zijn. Een bijenvolk is primair gericht op overleving en voortplanting.

Stress

- Een vorm van spanning/druk in het lichaam (mens/plant/dier) als reactie op externe prikkels, gevolgd door fysiologische reacties
- Stressor: de conditie die stress veroorzaakt
- Probleem ontstaat indien ‘draaglast’ > ‘draagkracht’





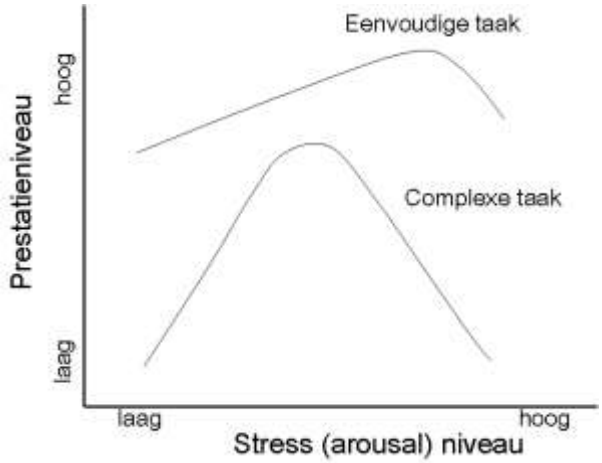


Een organisme (mens/dier/plant) zonder stress is in balans (in homeostase). Wanneer een stressor vanuit de omgeving tegen het organisme aandrukt zodat het uit balans raakt (bijv een varroamijtbesmetting in het volk) dat ontstaat stress, welke het lichaam probeert te compenseren door een tegenreactie (bijv. verhoogd aandeel bijen dat hygiënisch gedrag uitvoert). Dan zijn er verschillende optie als eindresultaat, afhankelijk van of de stressor chronisch aanhoudt of kortdurend was:

- Het organisme hersteld volledig
- Het organisme hersteld, maar er ontstaat een nieuwe balans met een andere resultaat
- De tegen reactie was niet voldoende en het organisme gaat dood

Stress, niet altijd negatief

- Wet van Yerkes-Dodson



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https://nl.wikipedia.org/wiki/Wet_van_Yerkes-Dodson

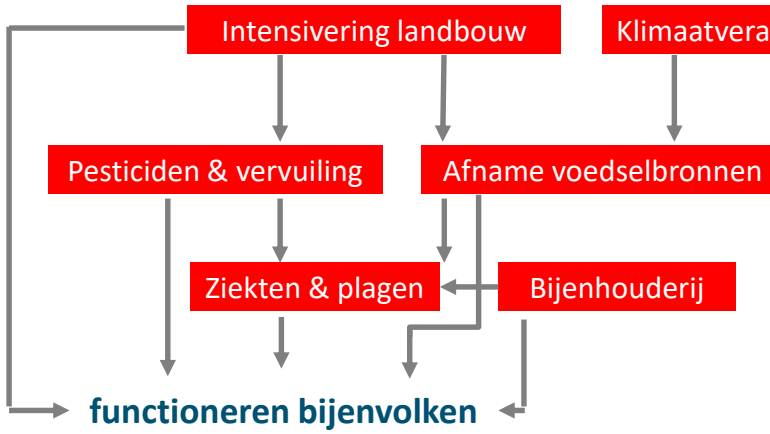
Stress

- Stress over meerdere generaties => evolutie
- Stress tijdens leven van 1 generatie => tijdelijk aanpassen (vluchten of vechten) of tolereren

Welke stressoren ervaren bijenvolken?

Alomtegenwoordige stress bijenvolken, nu & toekomst





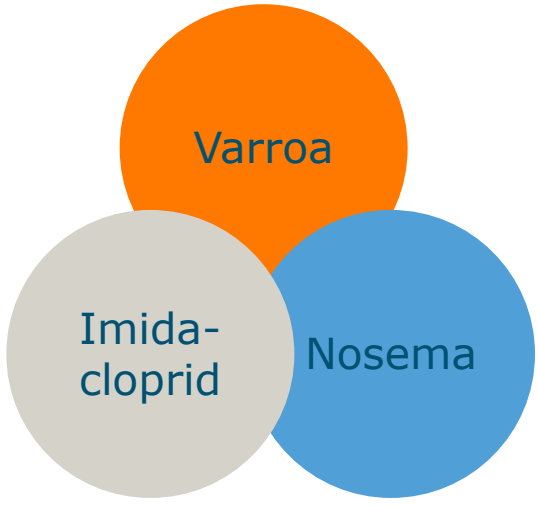
Van Dooremalen & van Langevelde, 23 feb 2019



Effect **veld-realistische blootstelling** aan multi-stressoren op prestaties HB **volk**

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Stressor -> ~~fysiologische aanpassing~~ -> prestatie

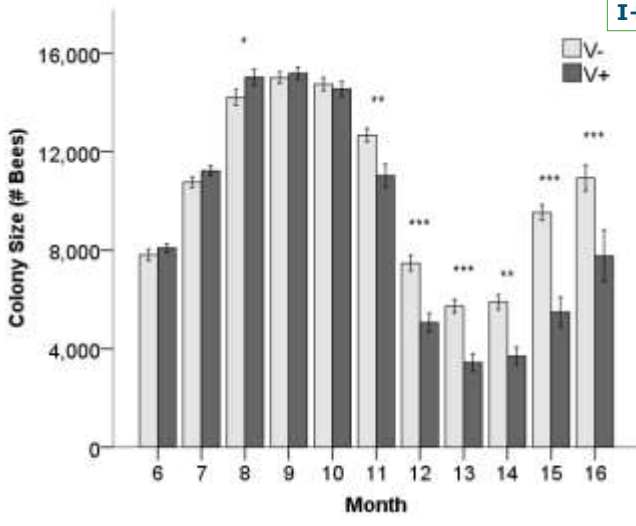


Van Dooremalen et al 2018

Volksgrootte (geschatte aantal bijen) per maand

Overlevende volken (dood 'missing value')

V+ 11% kleiner dan V-
N+ 2.5% kleinder dan N-
I+ geen verschil met I-

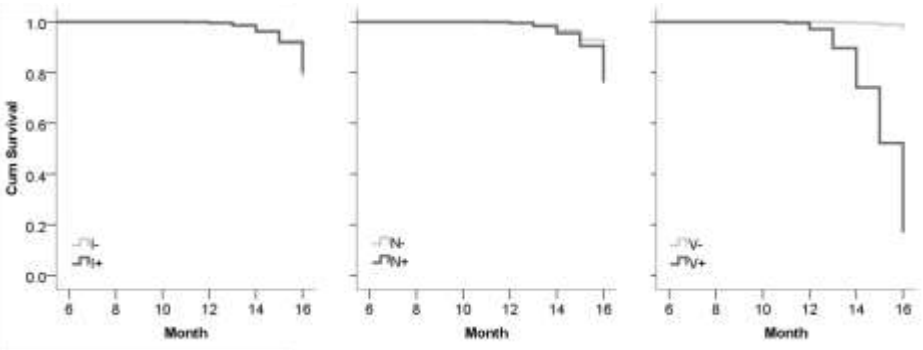


Geen synergie of interactie tussen stressoren gevonden

Van Dooremalen et al 2018

https://esajournals.onlinelibrary.wiley.com/doi/10.1002/ecs2.2378

Kans op overleven (of om dood te gaan) voor volk



Kans op doodgaan
V+ > V- 59.1x
N+ > N- 1.4x (NB. dit waren geen zieke volken!)
I+ = I-

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Van Dooremalen et al 2018

Dively et al 2015

Imida-cloprid

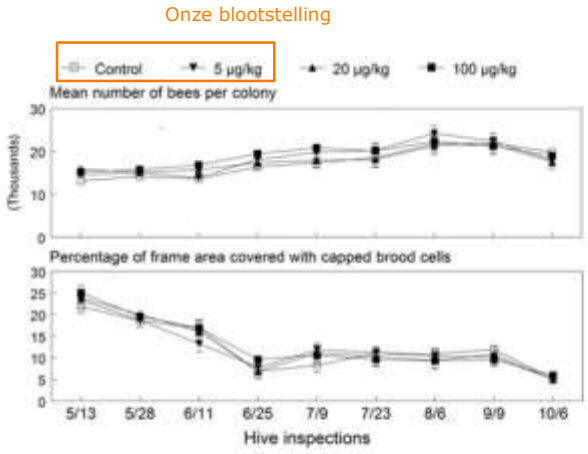


Fig 2. Mean (±SE) colony size and percentage of capped brood cells in the 2009 colonies exposed to untreated or imidacloprid-spiked diet patties for 12 weeks (May 15 to August 8). ANOVA results for bees (dose: $F_{(3, 26.7)} = 0.99$, $p = 0.414$; date: $F_{(8, 281)} = 75.25$, $p < 0.001$; interaction: $F_{(24, 281)} = 1.13$, $p = 0.311$) and brood (dose: $F_{(3, 25.9)} = 0.06$, $p = 0.980$; date: $F_{(8, 279)} = 68.27$, $p < 0.001$; interaction: $F_{(24, 279)} = 0.69$, $p = 0.859$).

https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0118748

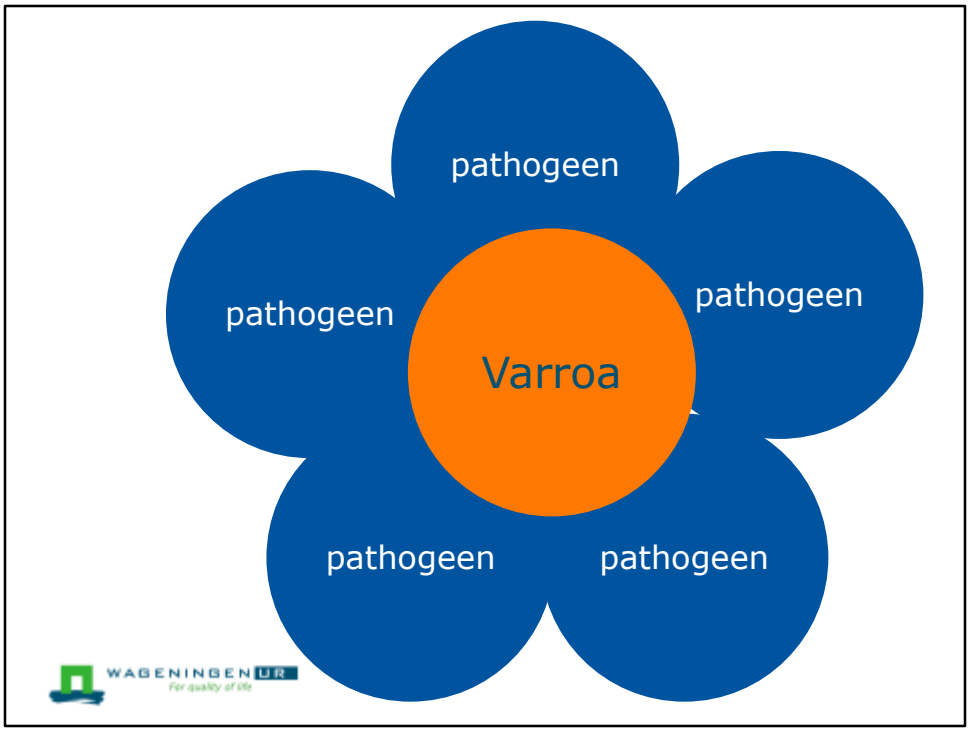
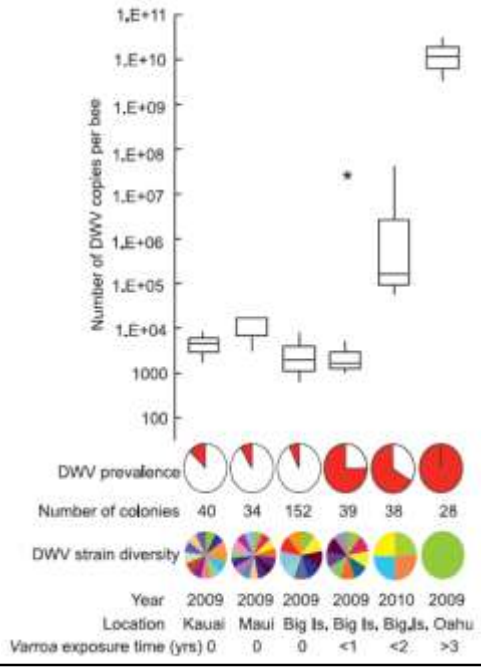

pathogeen
pathogeen
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Varroa
pathogeen
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Table 1. Virus infections of honey bees (*Apis mellifera* unless otherwise noted). Those listed in Bold are recorded as having been transmitted by *Varroa destructor*.

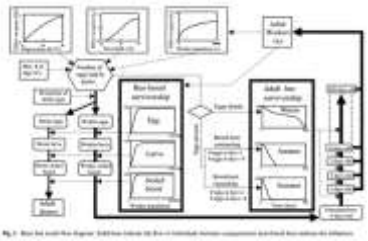
VIRUS	SYMPTOMS	REFERENCE
ABPV = Acute Bee Paralysis Virus	Kills larvae, pupae, and adults only in association with Varroa, otherwise bees seem healthy.	Anderson 1995; Bailey et al. 1979
BQCV = Black Queen Cell Virus	Affects queen prepupae and pupae sealed in cells. They become pale, then darken, staining the cell. Mostly in association with *Nosema apis*.	Anderson 1995
BXV = Bee Virus X	Reduces life span of adult bees	Bailey 1981
BYV= Bee Virus Y	Associated with *Nosema apis*	Anderson 1995
CBPV = Chronic Bee Paralysis Virus	Infected bees become listless crawlers with trembling to dislocated wings, and are often hairless and greasy in appearance.	Anderson 1995
CWV = Cloudy Wing Virus	Wings sometimes somewhat opaque	Hornitzky 1987
DWV = Deformed Wing Virus	Deformed wings and short survival time (<48 hrs) when infection is high.	Yang & Cox-Foster 2005
Verkreukelde vleugeltjes virus		
KBV = Kashmir Bee Virus	Apparently more or less harmless unless associated with other pathogens such as *Nosema apis* and *Melissococcus pluton*. Infects both *A. cerana* and *A. mellifera*.	Anderson 1995
KV = Kakugo Virus	Aggression (virus is found in the brain).	Fujiyuki et al. 2004
SBV = Sac Brood Virus	Sac brood.	
SBPV = Slow Bee Paralysis Virus	Kills bees after about 12 days, Paralysis of fore legs.	Anderson 1995
TSBV = Thai Sac Brood Virus	Sac brood of *A. cerana*.	

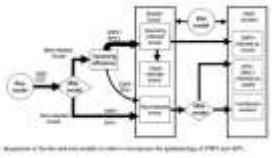
Global Honey Bee Viral Landscape Altered by a Parasitic Mite
Stephen J. Martin *et al.*
Science **336**, 1304 (2012);
DOI: 10.1126/science.1220941



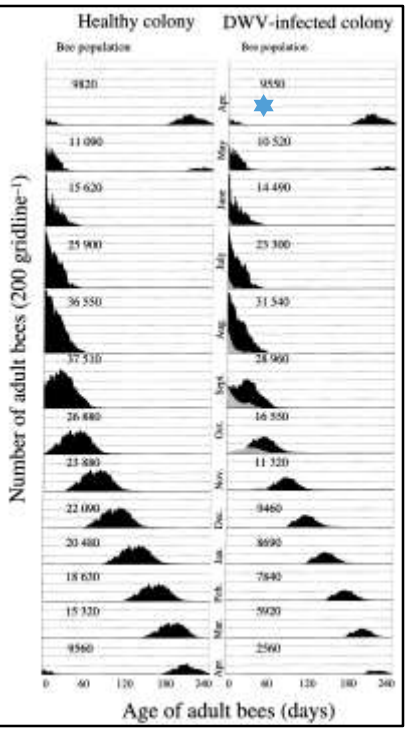
http://science.sciencemag.org/content/336/6086/1304.abstract

Martin et al 2001



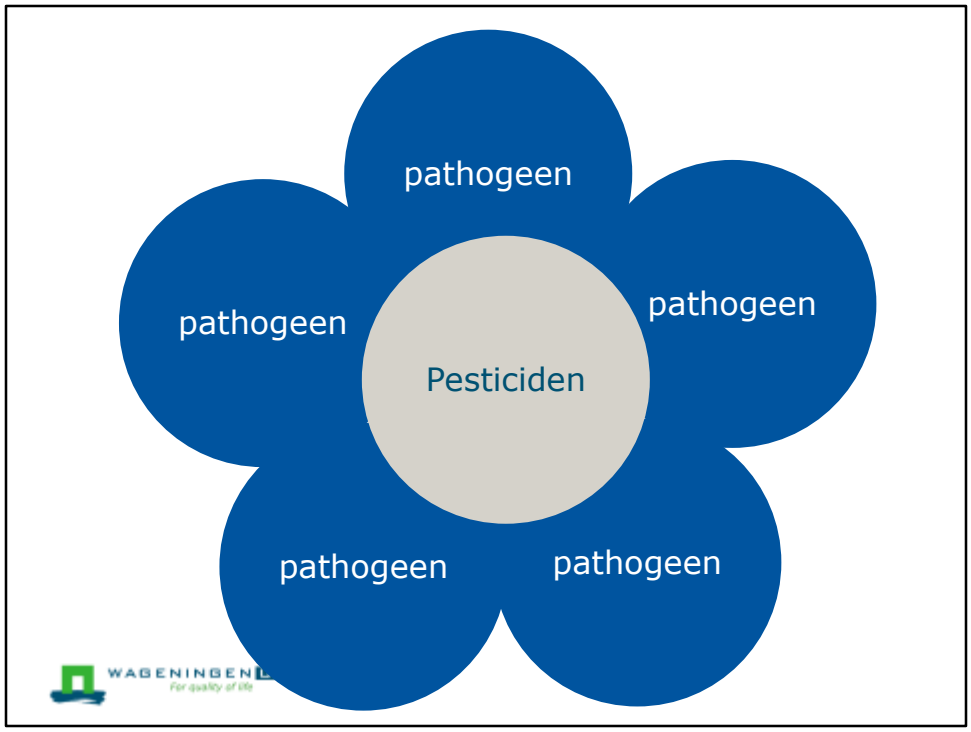


DWV besmetting: 5 mijten+DWV in volk jaar ervoor



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https://besjournals.onlinelibrary.wiley.com/doi/full/10.1046/j.1365-2664.2001.00662.x


pathogeen
pathogeen
pathogeen
Pesticiden
pathogeen
pathogeen

Osterman et al 2019 (clothianidin zaadcouting in koolzaad)

Table 1 Clothianidin residues in honeybees, pollen and nectar during 2013–2014

	Control fields[a]		Treated fields[b]	
	Range[c]	Mean ± s.e.m.[c]	Range[c]	Mean ± s.e.m.[c]
2013				
Honeybees	<LOD–0.89	0.13 ± 0.11	0.35–4.90	2.4 ± 0.50
Pollen	<LOD	<LOD	6.60–23.00	13.9 ± 1.80
Nectar	<LOD–0.61	0.11 ± 0.08	6.70–16.00	10.30 ± 1.30
2014				
Honeybees	<LOD	<LOD	0.15–1.50	1.10 ± 0.20
Pollen	<LOD	<LOD	2.40–16.00	6.10 ± 2.00
Nectar	<LOD	<LOD	2.60–9.80	4.90 ± 1.10

[a]Sample size: 2013, $n = 8$; 2014, $n = 4$. No honeybees with pollen could be found at two of the control fields
[b]Sample size: 2013, $n = 8$; 2014, $n = 6$
[c]Concentrations of clothianidin in honeybees ($ng\,g^{-1}$) and in pollen ($ng\,g^{-1}$) and nectar ($ng\,ml^{-1}$) sampled from foraging honeybees in cl during 2013–2014
[d]Wilcoxon test for differences between treatments. P values < 0.05 are highlighted in bold
[e]Sample size, T clothianidin-treated oilseed rape fields, C control fields, LOD limit of detection

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https://www.nature.com/articles/s41467-019-08523-4

Osterman et al 2019

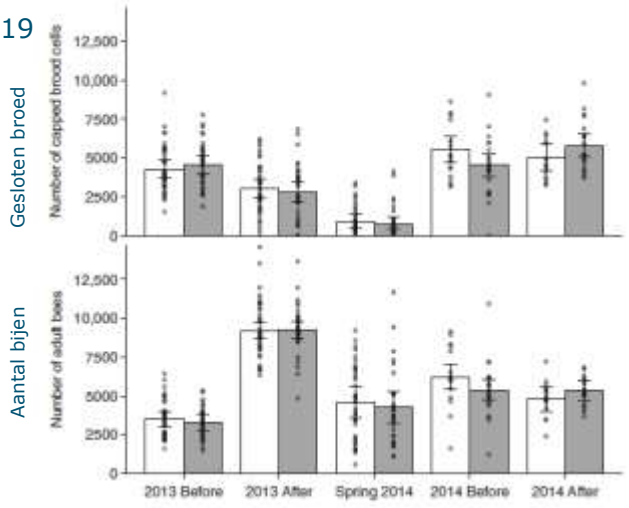


Fig. 2 Honeybee colony development. The mean (±95% confidence limits) number of adult bees and the number of capped brood cells per colony in relation to seed treatment (control = white bars; clothianidin-treated = grey bars) in oilseed rape fields before and after the oilseed rape bloom in two years (2013 and 2014) and at the 2014 spring inspection; $n = 8$ fields per treatment in 2013 and $n = 4$ control fields and 6 clothianidin-treated fields in 2014. Circles indicate measured values per colony

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Osterman et al 2019

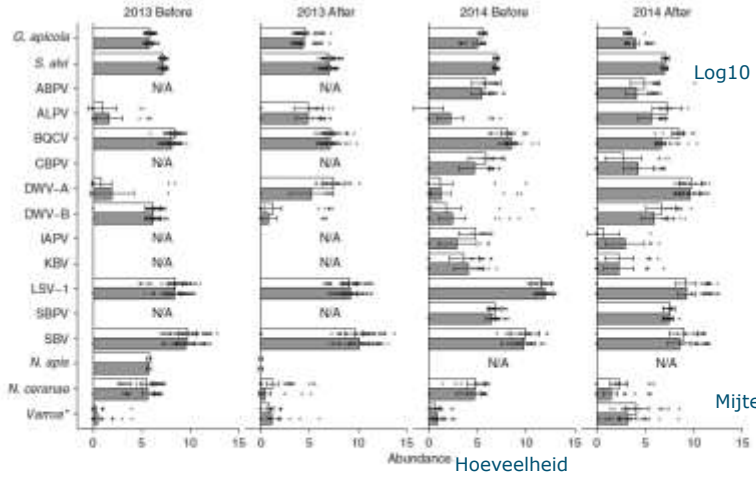


Fig. 5 Microorganism/parasite abundance. The abundance (+95% confidence intervals) of frequently detected target organisms (*Gilliamella apicola*, *Snodgrassella alvi*, acute bee paralysis virus (ABPV), black queen cell virus (BQCV), deformed wing virus type-A (DWV-A), deformed wing virus type-B (DWV-B), Israeli acute paralysis virus (IAPV), Kashmir bee virus (KBV), Lake Sinai virus 1 (LSV-1), slow bee paralysis virus (SBPV), Sacbrood virus (SBV), *Nosema ceranae* and *Varroa destructor*) in honeybee colonies in relation to the treatment (control = white bars; clothianidin-treated = grey bars) in oilseed rape fields ($n = 8$ fields per treatment in 2013; $n = 4$ control and $n = 6$ treated fields in 2014) before and after the oilseed rape bloom in two years (2013 and 2014). *The abundance of *V. destructor* was represented by the number of mites per 100 bees, while the microorganisms were expressed as $\log_{10}$ [units] per bee[70]. Microorganism abundance was not analysed (N/A) if it was detected in less than 11 samples per year. Circles indicate measured values per colony

Thompson 2012 (ESFA rapport 204pag)



fera

Supporting Publications 2012:EN-340

EXTERNAL SCIENTIFIC REPORT

Interaction between pesticides and other factors in effects on bees[1]

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Food and Environment Research Agency, Sand Hutton, York YO41 1LZ

ABSTRACT

Bees are important pollinators of both managed crops and wild flora. An overview of the interactions between pesticides and other factors in effects on bees considered: 1) The importance of the different exposure routes in relation to the overall exposure of bees to pesticides; 2) Multiple exposure to pesticides (including substances used in bee medication) and potential additive and cumulative effects; and 3) Interactions between diseases and susceptibility of bees to pesticides. Nectar foraging bees are likely to experienced highest exposure to both sprayed and systemic seed and soil treatments compounds followed by nurse and brood-attending bees. In both cases the major contribution to exposure was contaminated nectar with direct overspray playing a significant role in exposure. However, there are a variety of other routes (and other bee species) where there is currently insufficient data to fully total exposure. There are a large number of studies that have investigated the interactions between pesticides in bees. By far the majority have related to the interactions involving EBI fungicides and can be related to their inhibition of P450. The scale of the synergy is shown to be dose and season-dependent in acute exposures but there are few data relating to the effect of time between exposures, the effect of route of exposure or on chronic exposure effects at realistic exposure levels. There are a wide range of factors which affect the immunocompetence of bees including diet quality, pest and diseases. Although there are a limited number of laboratory based studies which suggest effects of a pesticide on disease susceptibility there is no clear evidence from field-based studies that exposure of colonies to pesticides results in increased susceptibility to disease or that there is a link between colony loss due to disease and pesticide residues in monitoring studies.

- Een groot aantal factoren hebben effect op de afweer van bijen (dieet kwaliteit, plagen en ziekten)
- Uit labstudies blijkt in een aantal gevallen dat gevoeligheid voor ziekten toeneemt met blootstelling aan pesticide
- Zulke relaties zijn nooit duidelijk aangetoond onder omstandigheden met veldblootstelling

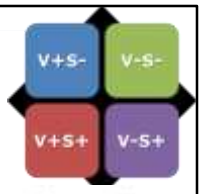
https://efsa.onlinelibrary.wiley.com/doi/abs/10.2903/sp.efsa.2012.EN-340

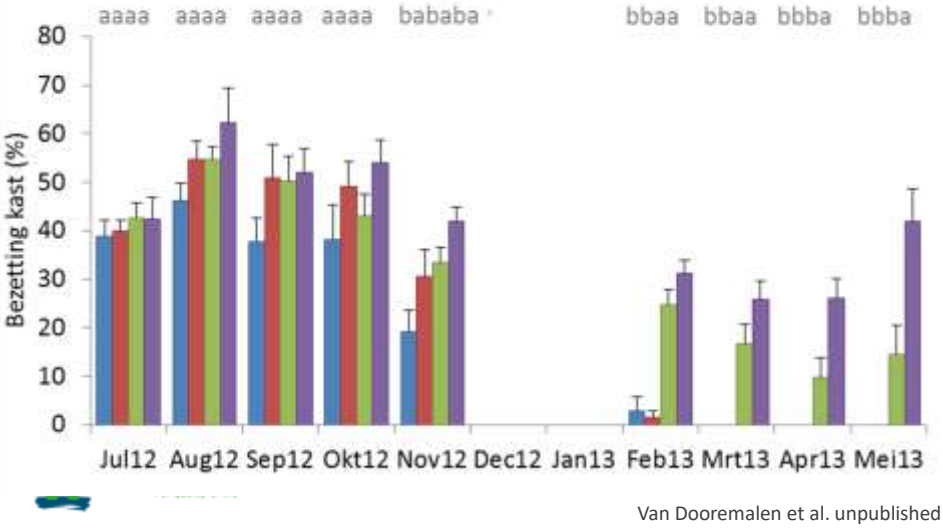


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Van Dooremalen et al. unpublished

Effect op volken: **grootte & overleving**

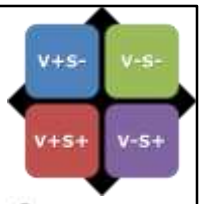


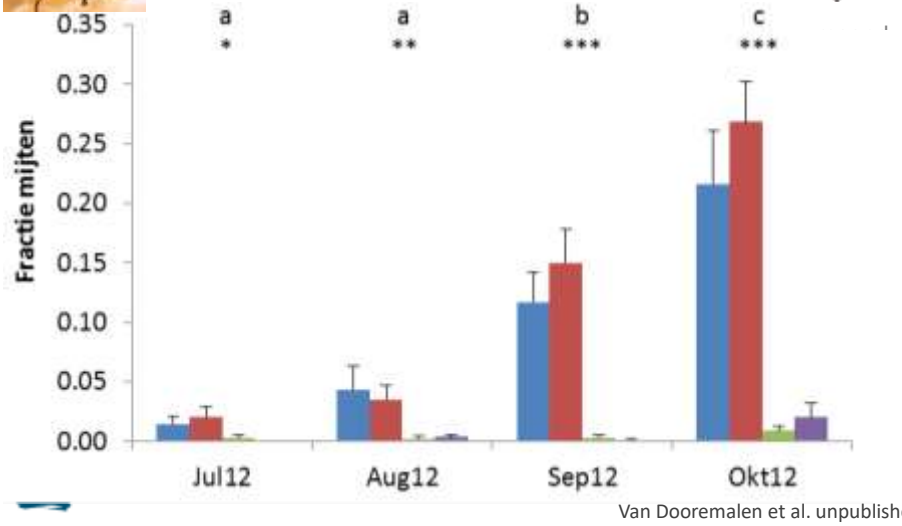


Van Dooremalen et al. unpublished

Effect behandeling: **Varroa** & stuifmeel



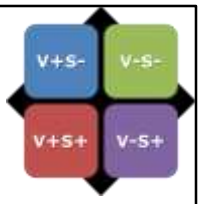


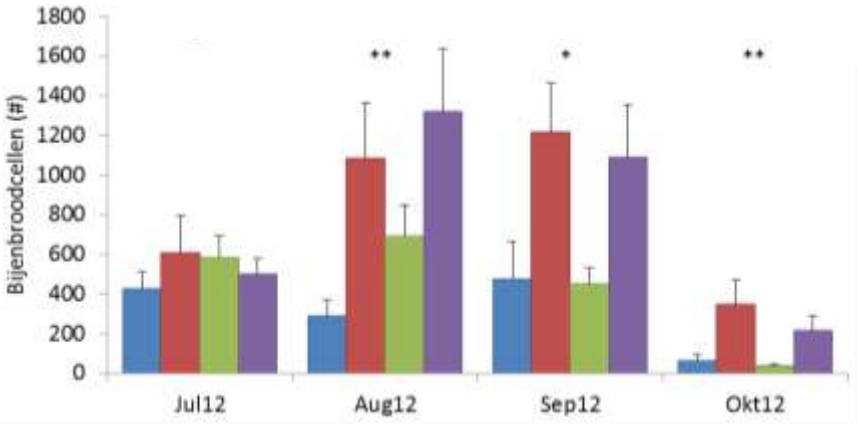


Van Dooremalen et al. unpublished

Effect behandeling: Varroa & **stuifmeel**







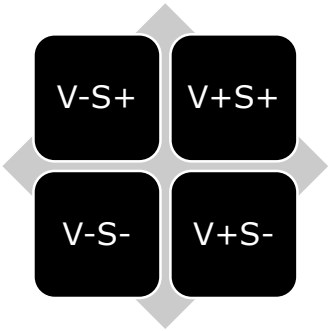
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Van Dooremalen et al. unpublished

Effect stuifmeel en *Varroa destructor* op groei individuen

- Laboratorium
- 50 bijen per groep

- Popstadium: wel of geen varroa
- 1ste week na uitlopen: veel of weinig stuifmeel

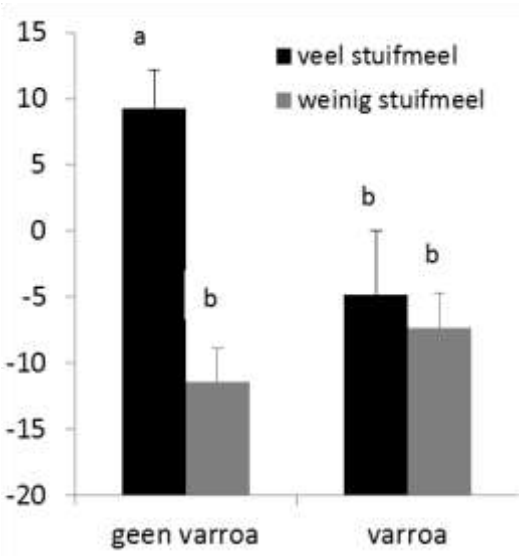


Van Dooremalen et al (2013) Journal Insect Physiology

https://www.sciencedirect.com/science/article/pii/S0022191013000449?via%3Dihub

Groei (mg) in bijen tussen dag 0 en 7





Van Dooremalen et al (2013) Journal Insect Physiology

Varroa x stuifmeel aanbod, veld-lab

- In veldproef, natuurlijke varroabesmetting groter effect dan (40%) stuifmeel reductie
- Stuifmeeltoevoer zomer ervoor, beïnvloed volksgrootte uitgewinterde volken
- In labstudie gaf gebrek aan stuifmeel zelfde patroon in combinatie met varroa.
- Stuifmeel werkt in volk waarschijnlijk via broed. Is afweging minder aanwas+goede conditie vs. veel aanwas+slechte conditie

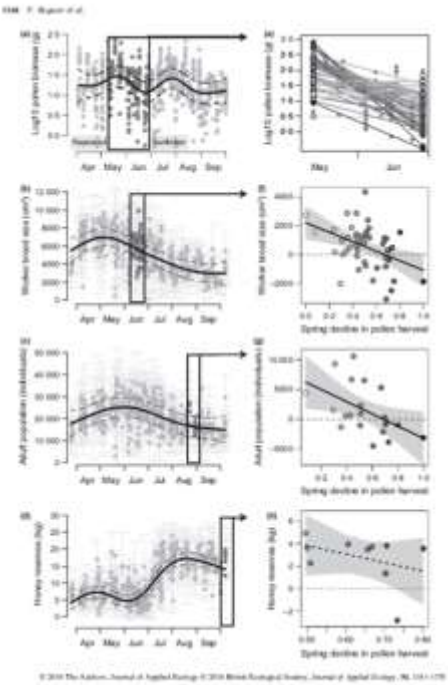
Requier et al 2017

Hoe sterker de afname in stuifmeel in het voorjaar (in agrarisch gebied):

Hoe minder broed in juni

Hoe kleiner het volk in augustus

Hoe minder honing in het najaar



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https://besjournals.onlinelibrary.wiley.com/doi/abs/10.1111/1365-2664.12836

Requier et al 2017

Hoe sterker de afname in stuifmeel in voorjaar:

Hoe meer varroa in September

Hoe lager de seizoensoverleving

Hoe lager de winteroverleving

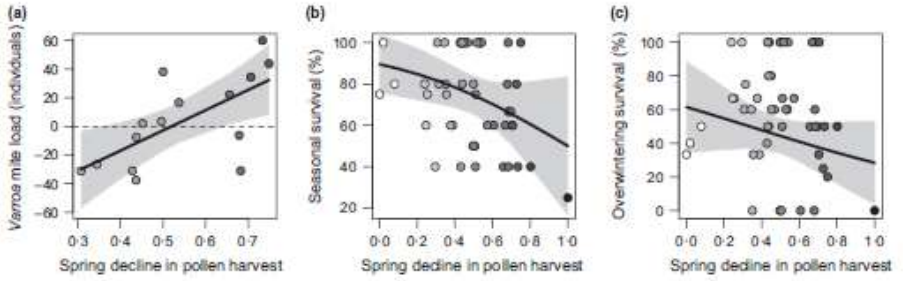


Fig. 2. State of health of the colony with (a) the *Varroa* mite load in September, (b) colony seasonal survival (March–November) and (c) overwintering survival (November to March of the next year). Each dot represents the measurement for one apiary ($n = 15$, $n = 50$ and $n = 50$, respectively) and colour gradient shows the decline in pollen harvest (see Fig. 1). The horizontal dashed line indicates zero effect on *Varroa* mite load, and the thick lines show the binomial generalized linear models (GLM) predictions with shaded areas indicating the 95% CI.

Multi-stressoren bijenvolken samenvatting

- Stressoren komen naast elkaar voor in de omgeving rondom het volk
- Minder interacties (1+1=3) dan misschien vaak genoemd wordt in literatuur+media als oorzaak bijensterfte
- Oorzaken sterfte: enkele stressor of eenvoudige optelling van stressoren
- Waar wel interactie, dan in combinatie met varroa (als vector!)

-> oplossing voor varroa-interacties = onderdruk varroa (door resistentie vanuit bijenvolk of door mijtbestrijding door bijenhouder)

Dank aan NBV en Imkers NL voor organiseren van deze dag

Rijksdienst voor Ondernemend Nederland

Ministerie van Landbouw, Natuur en Voedselkwaliteit

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