PPP Project Annual Report 2018
The PPP-projects that have been established under the direction of the top sectors must submit an annual report on their technical and financial progress. This format is to be used for reporting the technical progress. A separate format ('PPP final report') is available for PPP-projects that have been completed in 2018.

The annual reports will be published in full on the websites of the TKIs/top sector, excluding the blocks 'Approval coordinator/consortium' and 'Planning and progress'. Please ensure that no confidential matters are left in the remaining blocks.

The PPP Project Annual Reports must be submitted to the TKI's before March 1st 2019. For Wageningen Research this will be coordinated via a central point.

General information	
PPP number	KV 1409-045
Title	Mechanism of thrips resistance in Capsicum
Theme	T&U, Meer met Minder
Executive knowledge institution(s)	Plant Breeding, Wageningen University and Research
Research project leader (name + e-mail address)	Ben Vosman (ben.vosman@wur.nl)
Coordinator (on behalf of private parties)	Alejandro Lucatti (alejandro.lucatti@vegetableseeds.basf.com)
Government contact person	Annet Zweep
Total project size (k€)	800 k€
Address projectwebsite	-
Start date	June 1, 2015
End date	December 31, 2019

Approval coordinator/consortium *The annual report should be discussed with the coordinator/the consortium. The TKIs appreciate being informed of possible feedback on the annual report.*	
The coordinator has assessed the annual report on behalf of the consortium:	x approved □ rejected
Possible feedback on the annual report:	

Planning and progress (if there are changes to the project plan, please explain)	
Is the PPP going according to plan?	Yes, although validation of the candidate gene for resistance will not be possible within the timeframe of the project
Have there been changes in the consortium/project partners?	no
Is there a delay and/or deferred delivery date?	No, but the project has been extended until the end of 2019
Are there any substantive bottlenecks? Provide a brief description	Fine mapping of the resistance gene proved to be more difficult than anticipated.
Are there any deviations from the projected budget?	no

Short content description/aim PPS
What is going on and how is this project involved?
What will be delivered by the project and what is the effect of this?

Thrips are among the major pests worldwide. They are difficult to control because of their cryptic habit, the larvae hide in closed buds and pupate in soil. This makes them difficult to reach by pesticide sprays, which limits their effectiveness. Recently we have discovered an effective source of thrips resistance in pepper and shown that the resistance was based on inhibition of larval development. The goal of the current project is to elucidate the mechanism and identify the gene(s) involved. This information is essential for the development of thrips resistant pepper varieties and may also results in leads that will help breeders to develop thrips resistant varieties in other crops as well.

Results in 2018/ so far
Give a short description of the high-lights and project deliverable in 2018 / so far

Thrips are among the major pests worldwide. They puncture plant cells and feed on the content, causing silvering of the leaves. More importantly, they can transmit viruses that can destroy a complete crop in a matter of weeks. Thrips are invasive species with a high reproduction rate that can spread rapidly over a large area. Several thrips species have a worldwide distribution. Thrips are also difficult to control because of their cryptic habit, the larvae hide in closed buds and pupate in soil. This makes them difficult to reach by pesticide sprays, which limits their effectiveness. Recently we have discovered an effective source of resistance against thrips in pepper and shown that the resistance was based on inhibition of larval development. A single QTL for larval development and thrips damage was found in an F2 population. The goal of this project is to elucidate the mechanism of thrips resistance and identify the gene(s) involved.

The project has started with screening F3 plants for recombination in the QTL region to fine map the resistance gene. Building on the results obtained in 2017 the region was narrowed down to 15 putative/predicted genes based on the Zunla assembly. There are still a few recombinants that may further reduce the number of candidate genes, but for this additional markers are needed. To obtain them the resistant parent has been resequenced (5x coverage).
In addition to the fine mapping an RNAseq analysis has been carried out on F4-plants with and without the resistance QTL. Results from this analysis may further reduce the number of candidate genes for resistance.

Metabolites are likely to be involved in thrips resistance (Maharijaya et al., 2018). For this reason the materials used for RNAseq, and materials from the resistant and susceptible parent of the population, were also subjected to metabolomics analysis to contribute to the elucidation of the resistance mechanism.

Companies involved in the project transferred the QTL on chr. 6 into different backgrounds. The first materials (2 different backgrounds, made by Nunhems) produced were handed over to WUR and tested for thrips resistance. Materials containing the resistance allele were shown to be more resistant than materials without the allele, thus validating the importance of the QTL. Plants that contained the QTL on chromosome 5 mentioned in the PCT/EP2008/055374 patent application did not show a significant difference in thrips resistance with plants that did not contain the QTL. Further tests, including more thrips resistance tests on material with and without QTL on chr 6 in different backgrounds (produced by Bejo) and greenhouse tests will be carried out in 2019.

Number of delivered products in 2018 *(in an appendix, please provide the titles and/or description of the products or a link to the products on public websites)*

Academic articles	Reports	Articles in journals	Introductions/workshops
		2	5

Titles/ description of the most important products in 2018 (5 at max) and their target group

See appendix

Appendix: Names of the products or a link to the products on a public website including the link to the project summary on Kennisonline

Lectures:
Vosman, B. (2018) Breeding for thrips resistance in vegetables. TKI-TU netwerkevent 2018, April 3, Nieuwegein, NL.

Vosman, B. (2018) Enrichment of Crop Genepools with Wild Relative and Landrace Diversity. 4th International Conference "Plant Genetics & Breeding Technologies" July 12-13, 2018, Vienna.

Vosman, B. (2018) Different Mechanisms of Insect Resistance in tomato and pepper. 15th Solanaceae Conference, Sept 30th - Oct 4th 2018, Chiang Mai, Thailand.

Peer reviewed publications:
Maharijaya, A., B. Vosman, K. Pelgrom, Y. Wahyuni, R.C.H. de Vos & R.E Voorrips (2018) Genetic variation in phytochemicals in leaves of pepper (*Capsicum*) in relation to thrips resistance. Arthropod-Plant Interactions https://doi.org/10.1007/s11829-018-9628-7

Van Haperen, P., R.E. Voorrips, J.J.A. van Loon & Ben Vosman (2018) The effect of plant development on thrips resistance in *Capsicum*. Arthropod-Plant Interactions https://doi.org/10.1007/s11829-018-9645-6

Posters:
Van Haperen, P., Voorrips, R.E., Van Loon, J.J.A., Vosman, B. (2018) The effect of plant development on thrips resistance in *Capsicum*. 2nd International CRC 973 Symposium, April 9 – April 11 2018, Berlin, Germany.

Van Haperen, P., Voorrips, R.E., Van Loon, J.J.A., Vosman, B. (2018) The effect of plant development on thrips resistance in *Capsicum*. TKI Horticulture and Propagation material Network Event 2018, April 3, Nieuwegein, NL.