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How food produced using organic methods may affect consumer health

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Overview

- Product-oriented versus function-oriented research
- To improve value for health of organic crops, we need to understand:
  - How the production methods affect crop composition.
  - How crop composition affects human health.
- This knowledge can be used to provide healthier foods: now and in the future.

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Product-oriented comparison of different production systems

Organic	Conventional
Plant foods have more:	
➢ Dry weight %, minerals	➢ Nitrate
➢ Vitamin C	➢ Protein
➢ % essential amino acids	➢ Synthetic pesticides*
➢ Natural pesticides	

(* = fundamental difference)

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Problems with product-oriented comparison of production systems

- It is not efficient for detection of small but systematic differences between complex and variable systems.
- The few compounds that are fundamentally different (*) tend to receive most of the attention.
- Such studies only give useful information if the measured compounds are important for health.

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Problems with product-oriented comparison of production systems

- We know very little about which food compounds are in fact important for the health of generally well-fed humans!
  - "Important for health" = a realistic change in intake will make a real difference for health
- Nutrients are not important for health if there is no deficiency.
- Toxins are not important for health if the amounts are not harmful.

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Function-oriented comparison of different production systems

Organic	Conventional
Plants have more:	
➢ Intrinsic resistance to diseases and pests	➢ Easily available nutrients
➢ Resilience to stress	➢ Susceptibility to post-harvest infections

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Advantages of function-oriented comparison of production systems

- Function-oriented comparisons focus on those aspects where the production method makes some kind of consistent difference.
- So if any of these functional aspects turn out to be important for human health, there will be difference between the systems.

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Advantages of function-oriented comparison of production systems

- Each of the functional aspects are important in themselves, so if it turns out to not be important for health, it is still of value to understand how it works.
- Once we understand both function and effect, we can improve the methods for better health.

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How the production methods affect crop composition

- Organic crops are more resistant than conventional crops, simply because organic farmers must select the methods (fertilisation, varieties etc.) that best prevent diseases and pests.
- One of the resistance mechanisms in plants is formation of “natural pesticides”, defence related secondary metabolites.
- In nature, plants make a “trade-off” between growth and defence.

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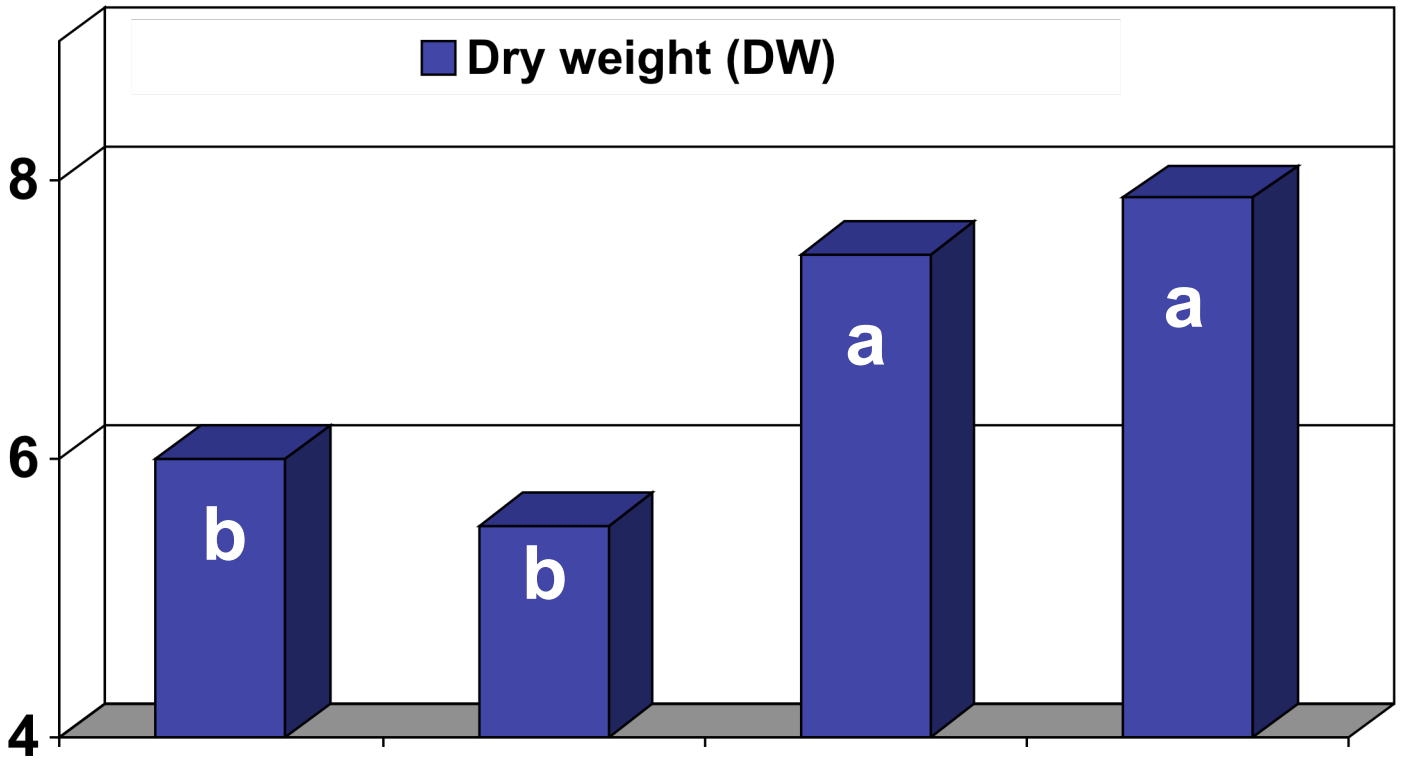
Winter Wheat Yield 2004

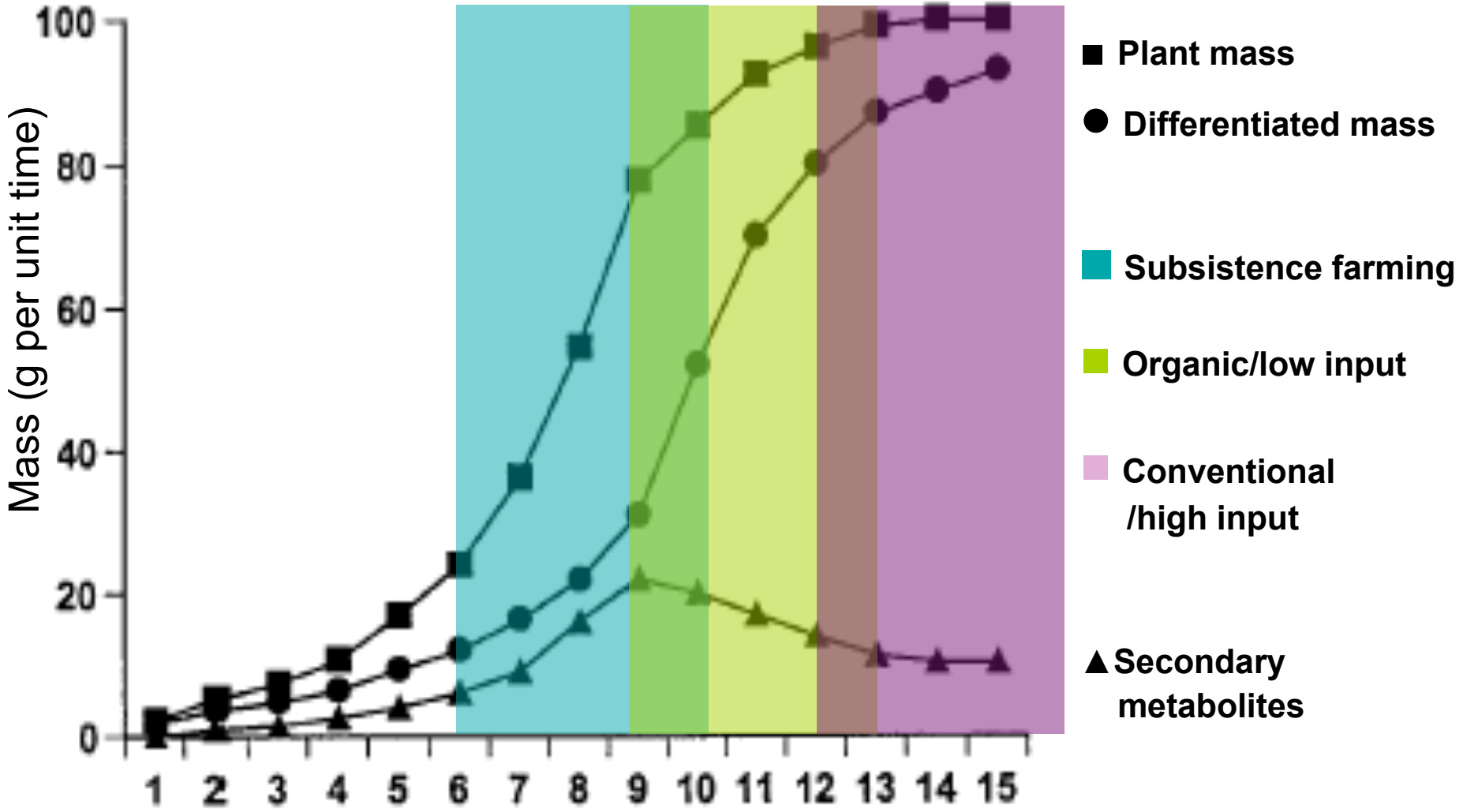
Adding mineral fertilisers to crops treated with pesticides increases yield, while adding mineral fertilisers to non-pesticide treated crops decreases yield; Interaction P < 0.05

P= pesticide and growth regulator
MF= Mineral NPK Fertiliser

(Schmidt et al. 2006)



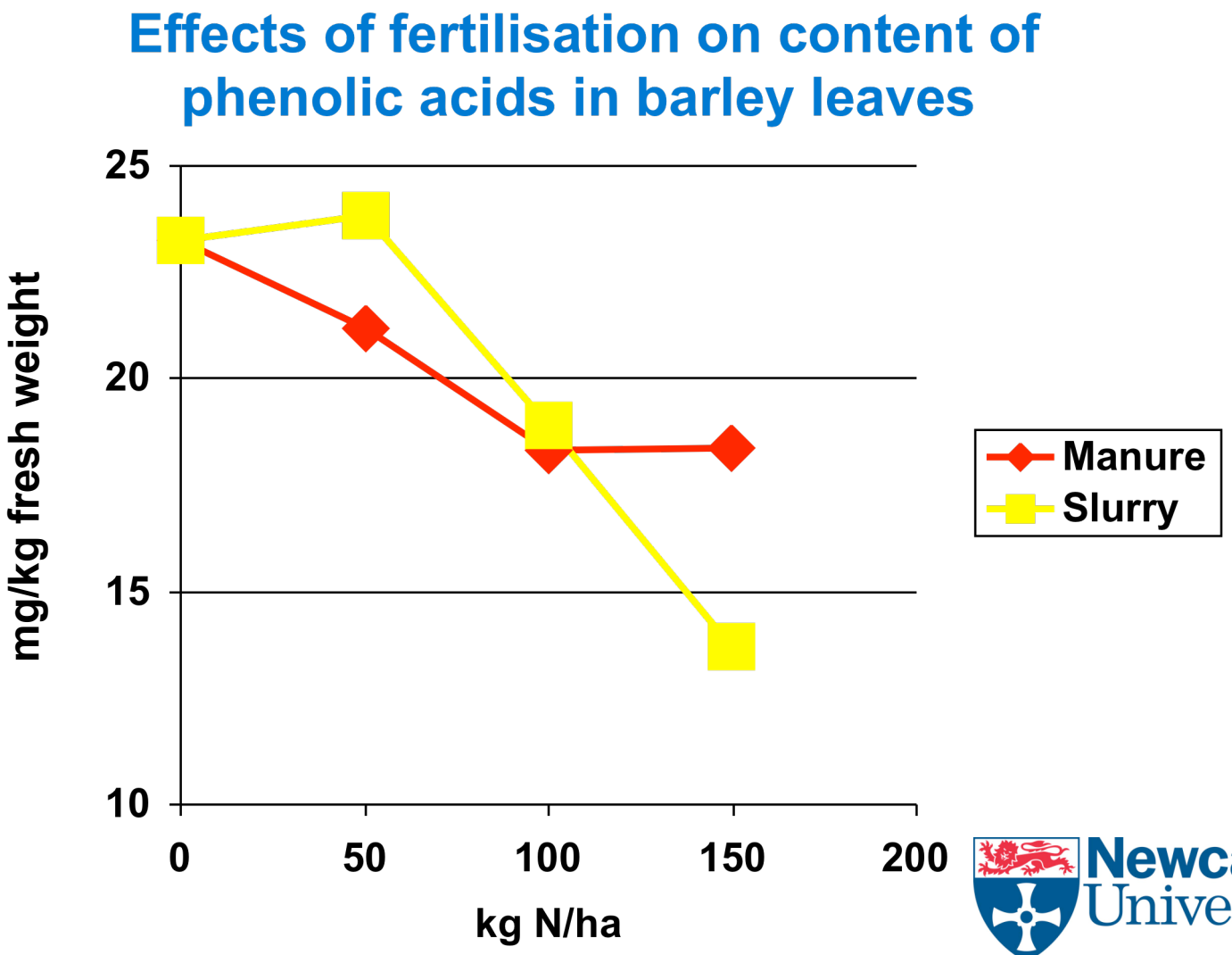
Growth conditions, growth rate and defence compounds



Resource availability, e.g. soluble N

(graph from Stamp 2003)

Difference in composition of low-input and high-input crops



(Nørbæk et al. 2003)

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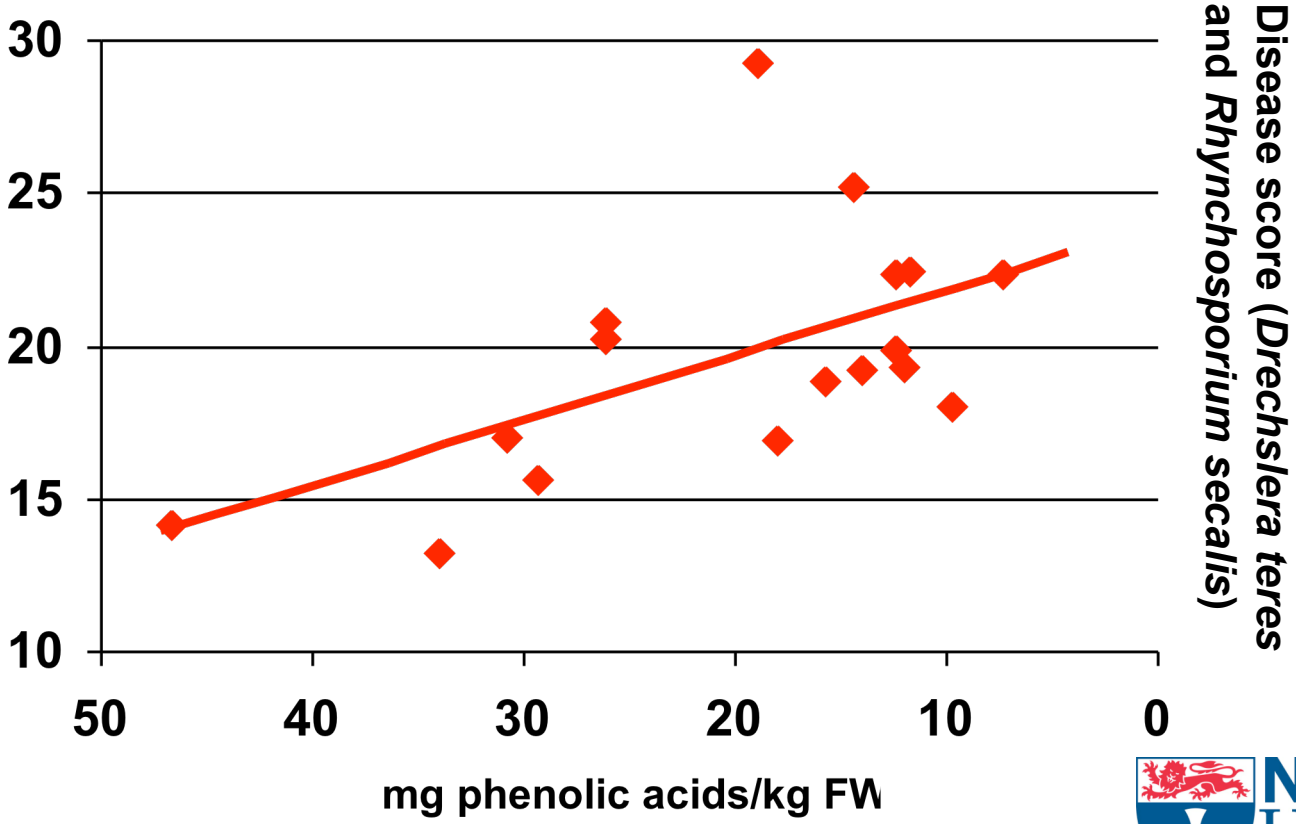
Resistance to diseases of low-input compared with high-input crops

Correlation of disease severity and content of phenolic acids in barley leaves



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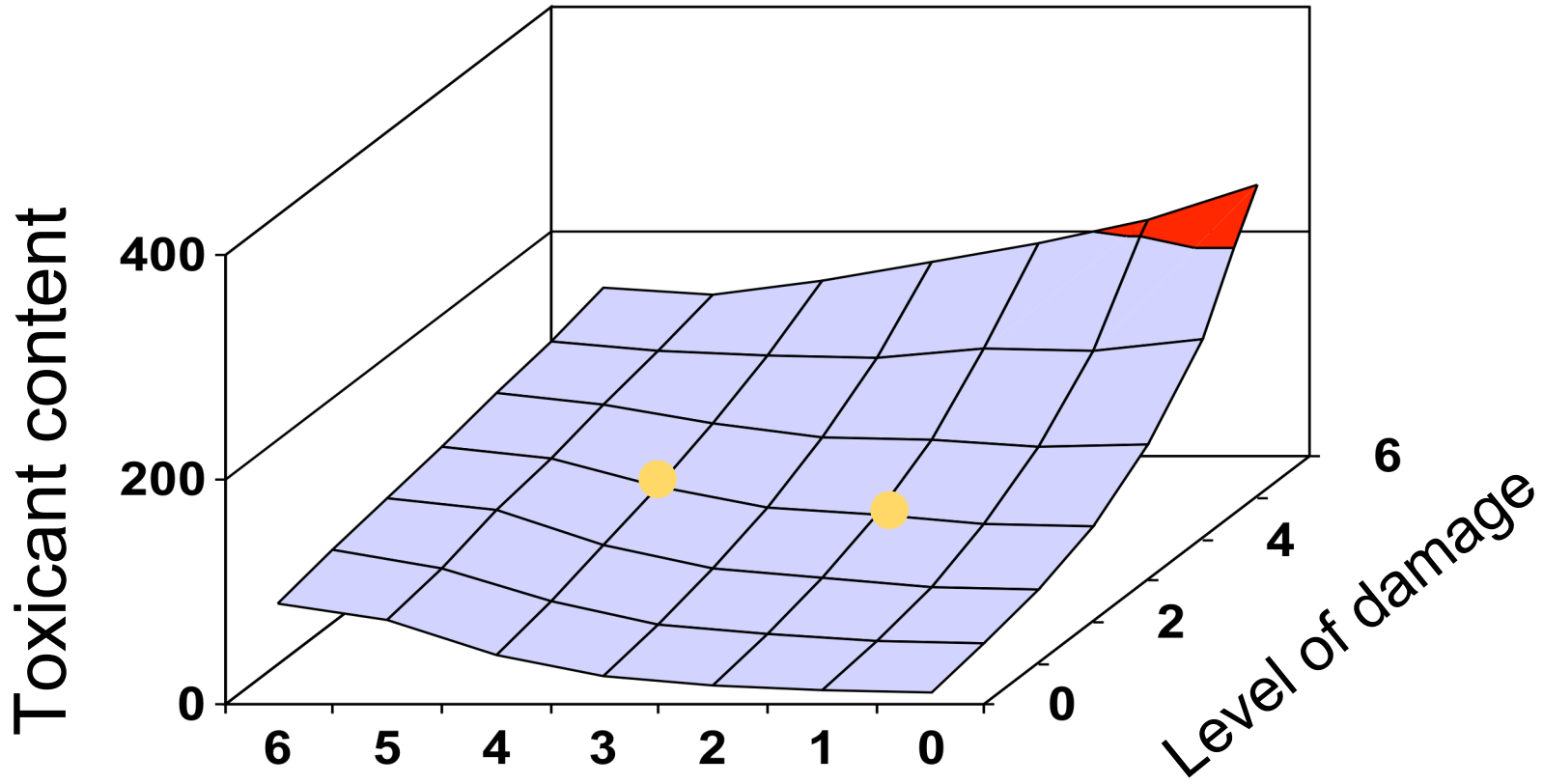
(Aaboer et al. 2003)

Model for toxicant accumulation



Level of resistance (e.g. inverse of resource availability)

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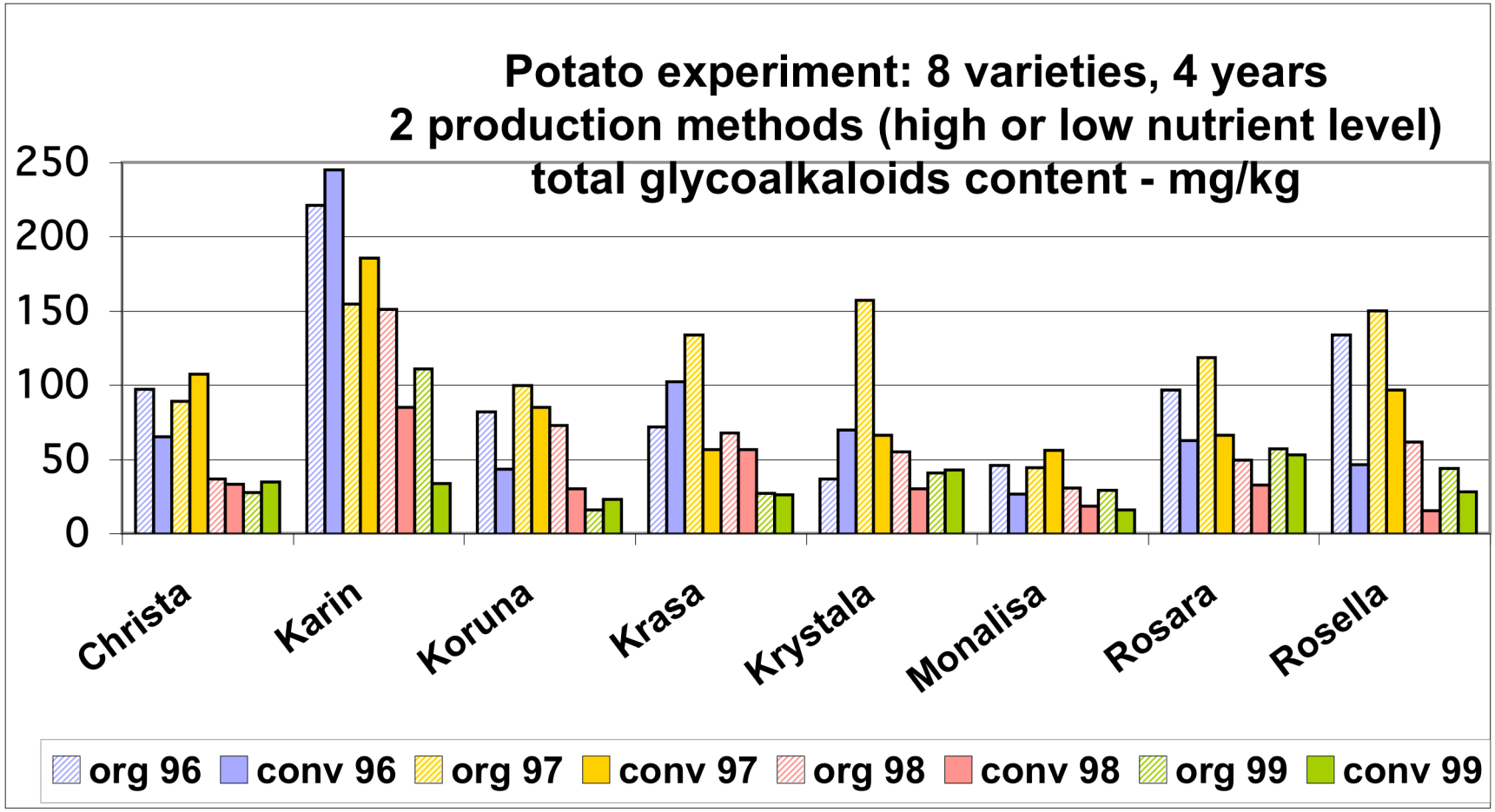
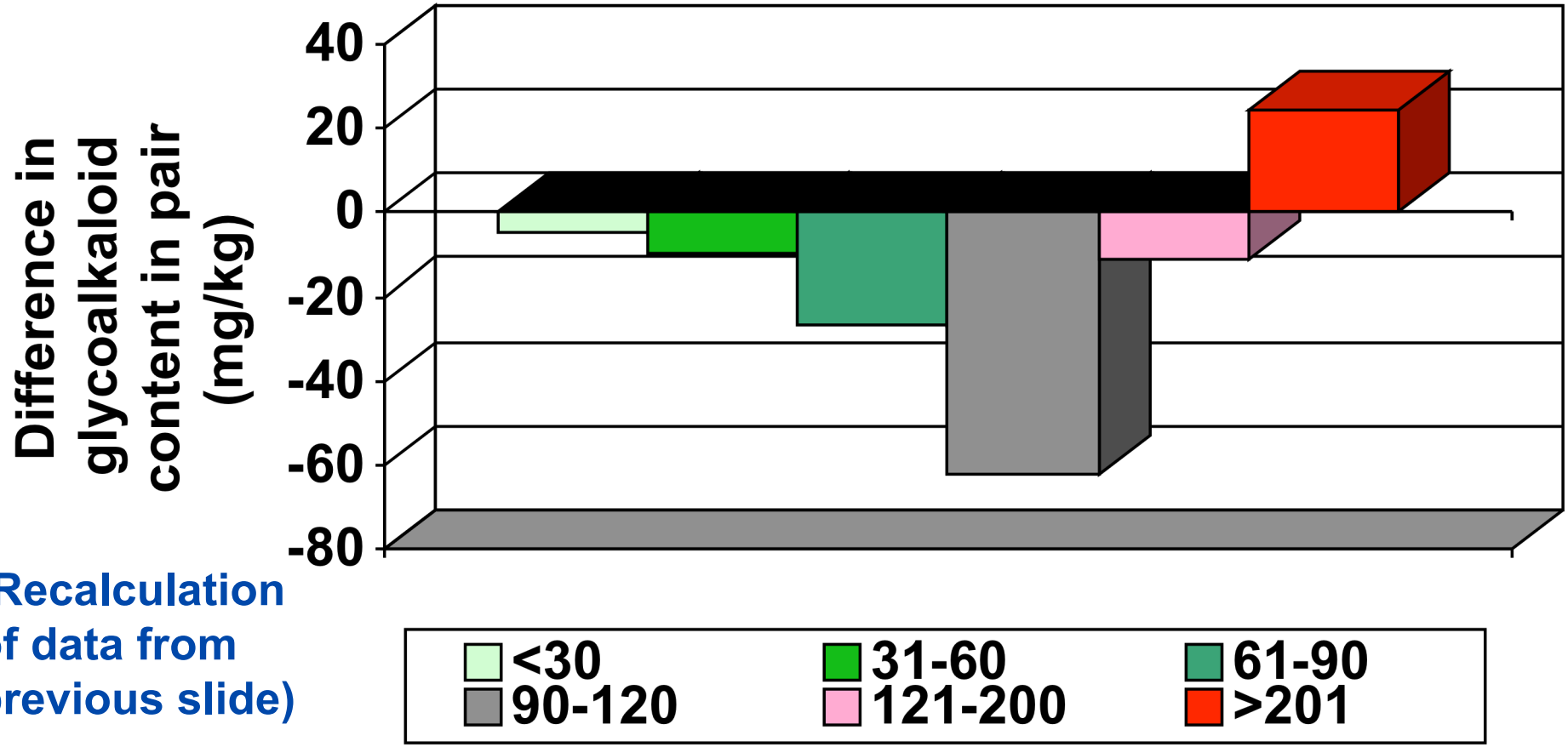
Variability in composition of low-input and high-input crops



(Hajslova et al. 2005)

Effect of growth conditions on response to stress in potato



(Recalculation of data from previous slide)

Pair = same variety and year,
Difference = conventional value minus organic value.

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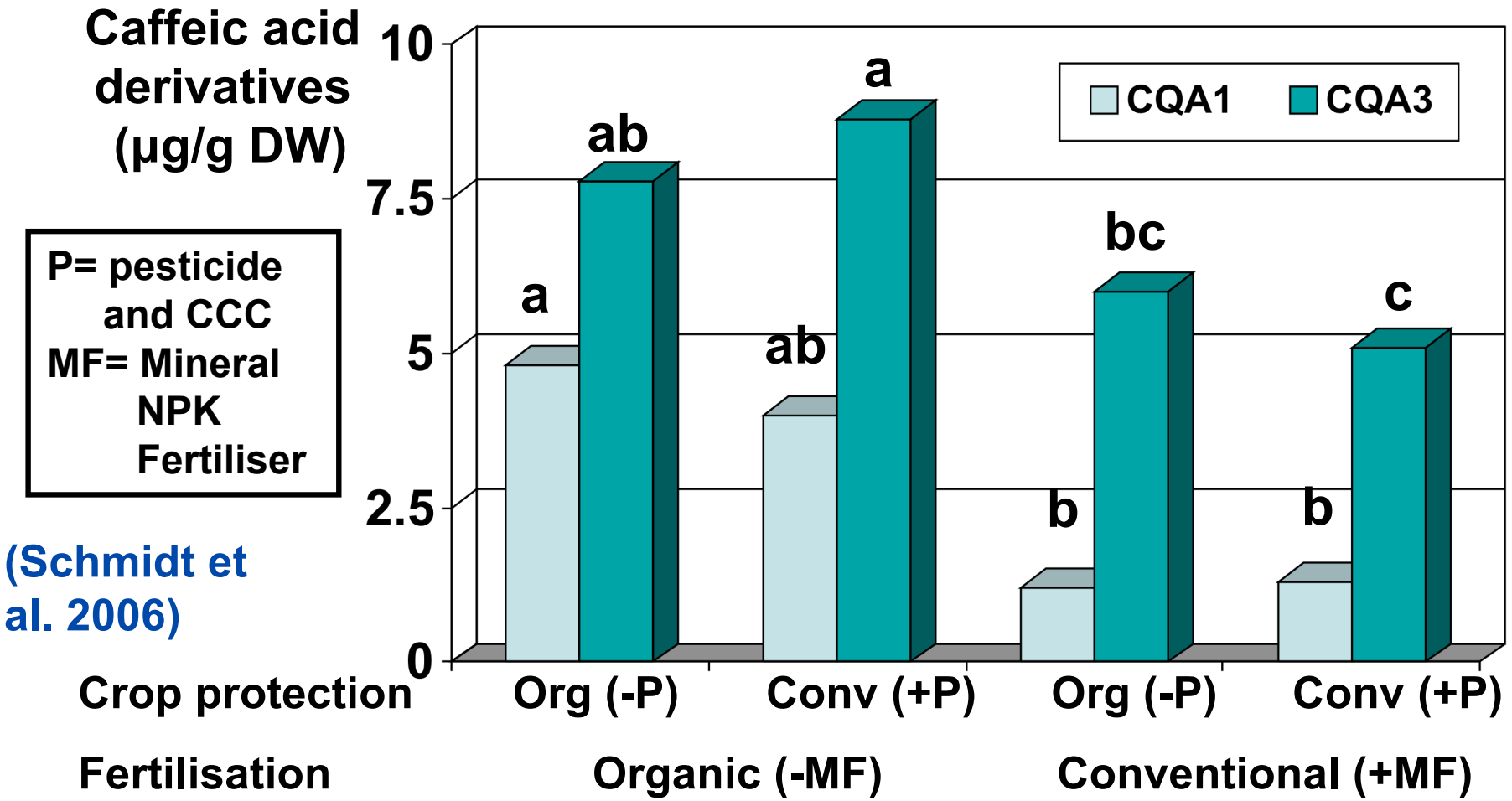
Phenolic compounds in wheat leaves (2005)

Phenolic compounds in wheat leaves are increased under organic fertility management

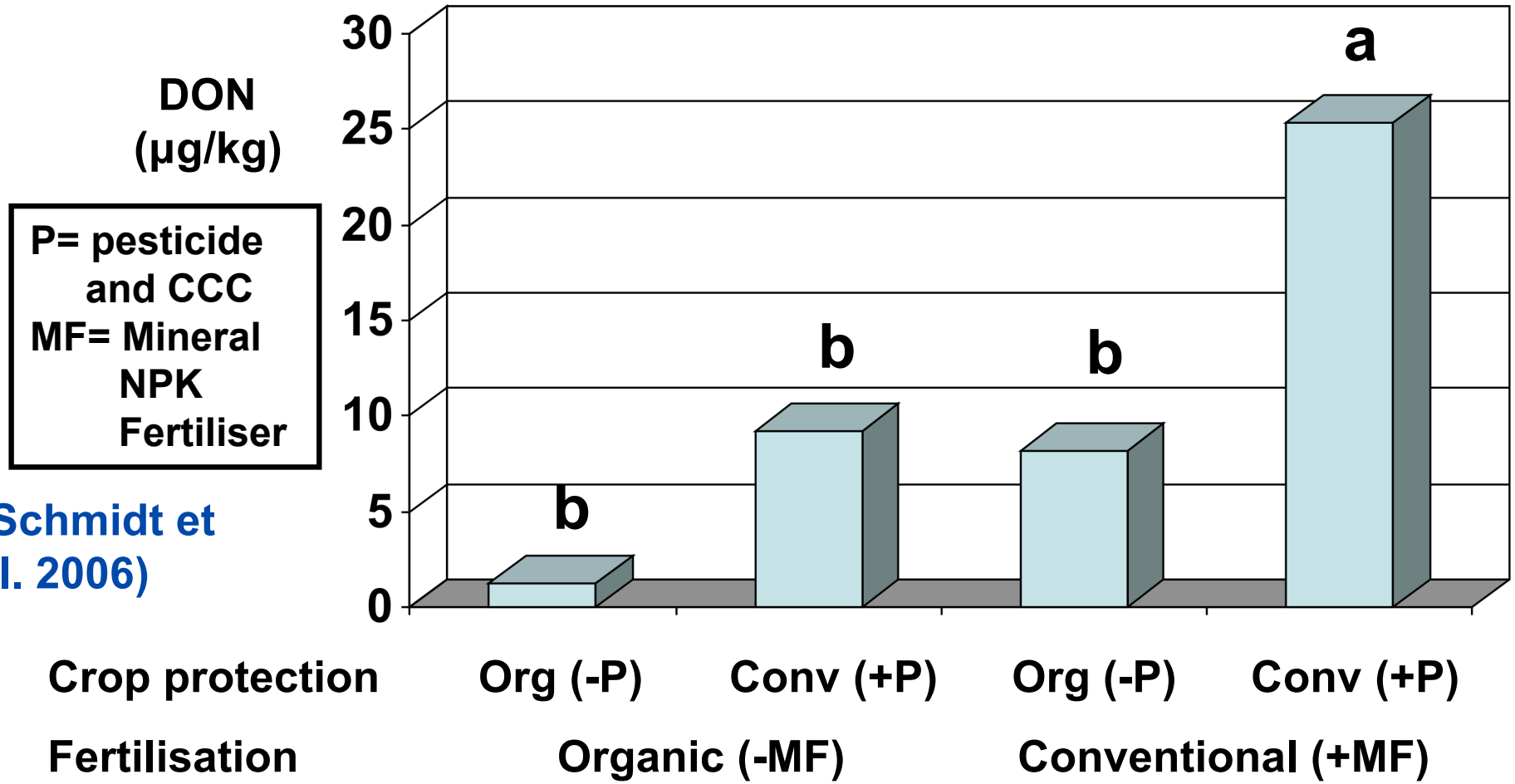


P= pesticide and CCC
MF= Mineral NPK Fertiliser

(Schmidt et al. 2006)

Mycotoxin loads in Winter Wheat (2005) – Desoxy-Nivalenol (DON)

Adding both mineral fertilisers and pesticides/growth regulator increased Fusarium mycotoxin loads in wheat



(Schmidt et al. 2006)

Effect of nutrient supply on quality of apples (Otava)

High N (Annual clovergrass)

Medium N (Perennial clovergrass)

Low N (Perennial grass)

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Effect of nutrient supply on resistance of apples

Treatment % of fruit with:	Annual clovergrass (high N)	Perennial clovergrass (medium N)	Perennial grass (low N)
Apple scab *(Venturia inaequalis)*	17.9	8.9	2.3
Sooty blotch *(Gloeodes pomigena)*	11.8	8.7	8.0
Apple saw fly *(Hoplocampa testudinea)*	8.4	5.8	4.6

(Berthelsen & Pedersen 2002)

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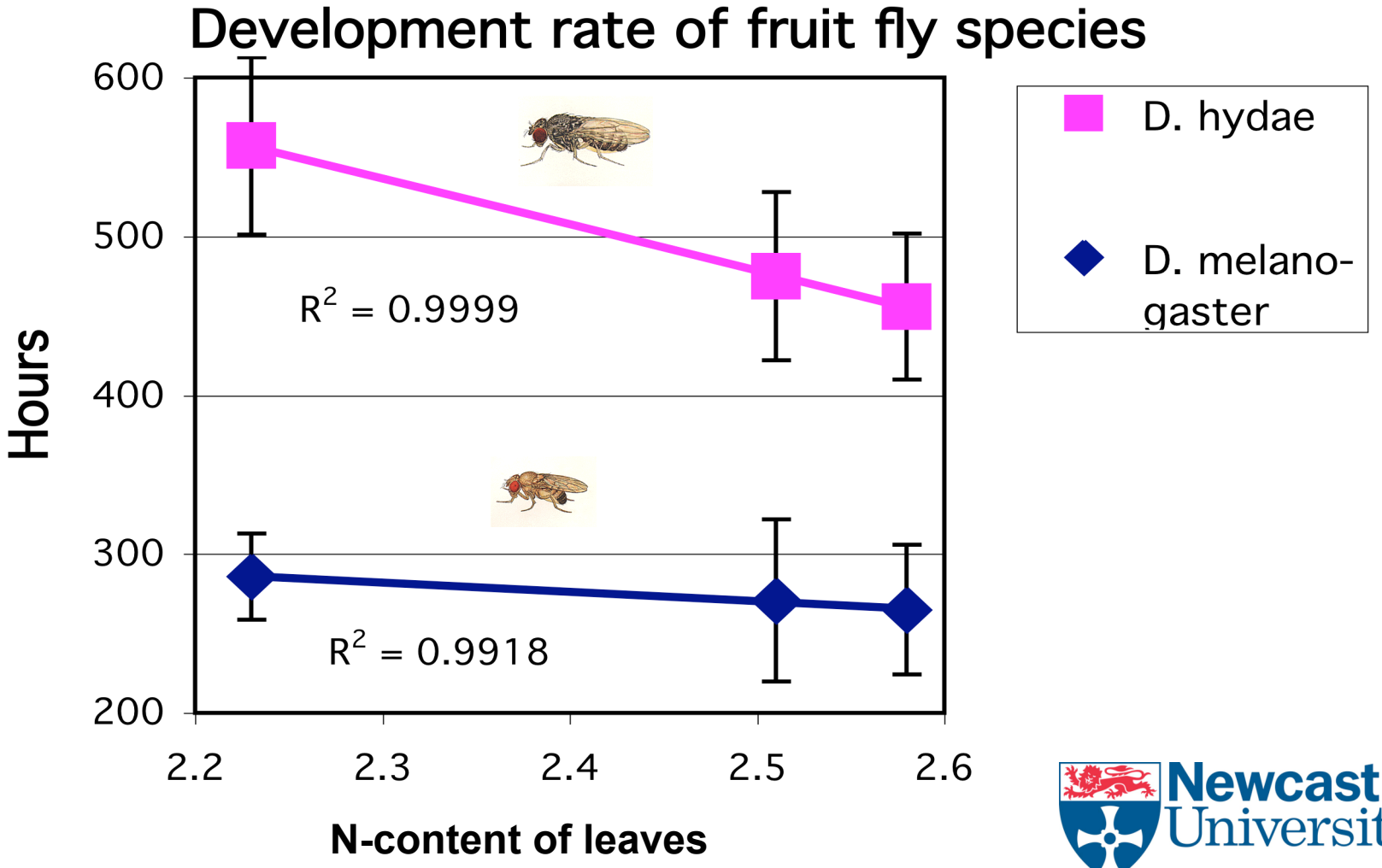
Effects of nutrient supply to apples on health of fruit flies



(Brandt et al. 2003)

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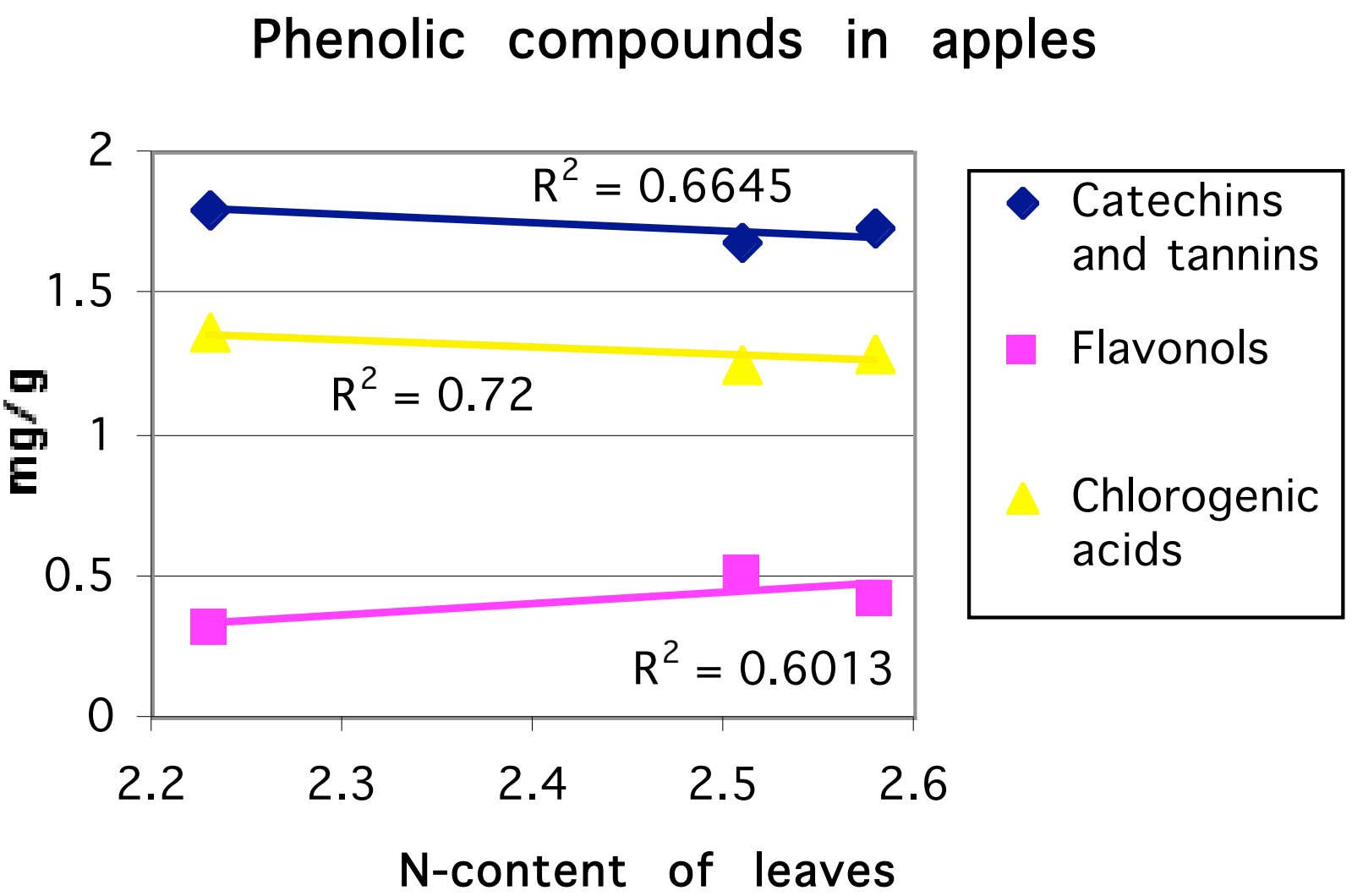
Effects of nutrient supply on chemical composition of apples



(Brandt et al. 2003)

Effect of increased intake of fruits and vegetables on human health

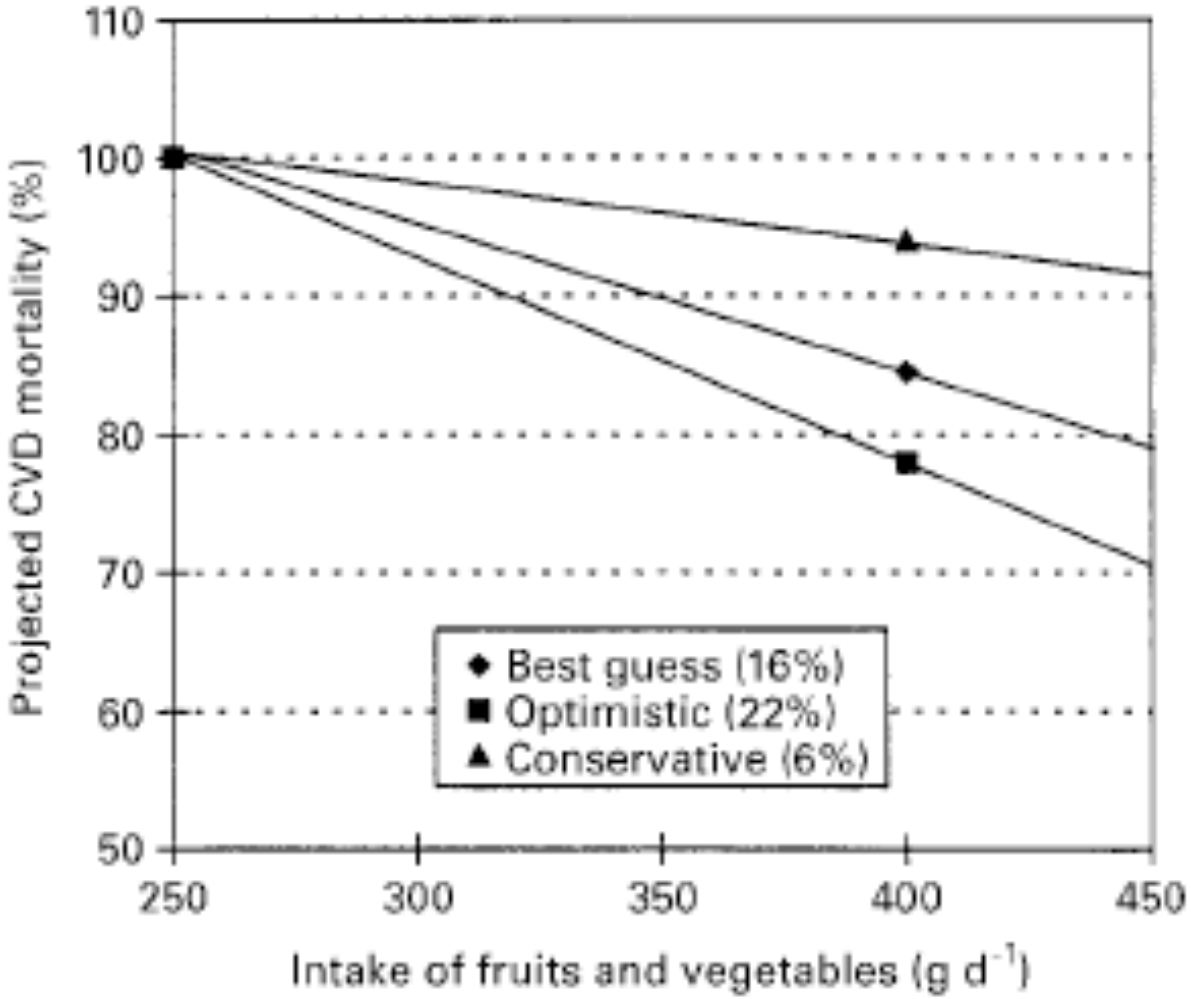
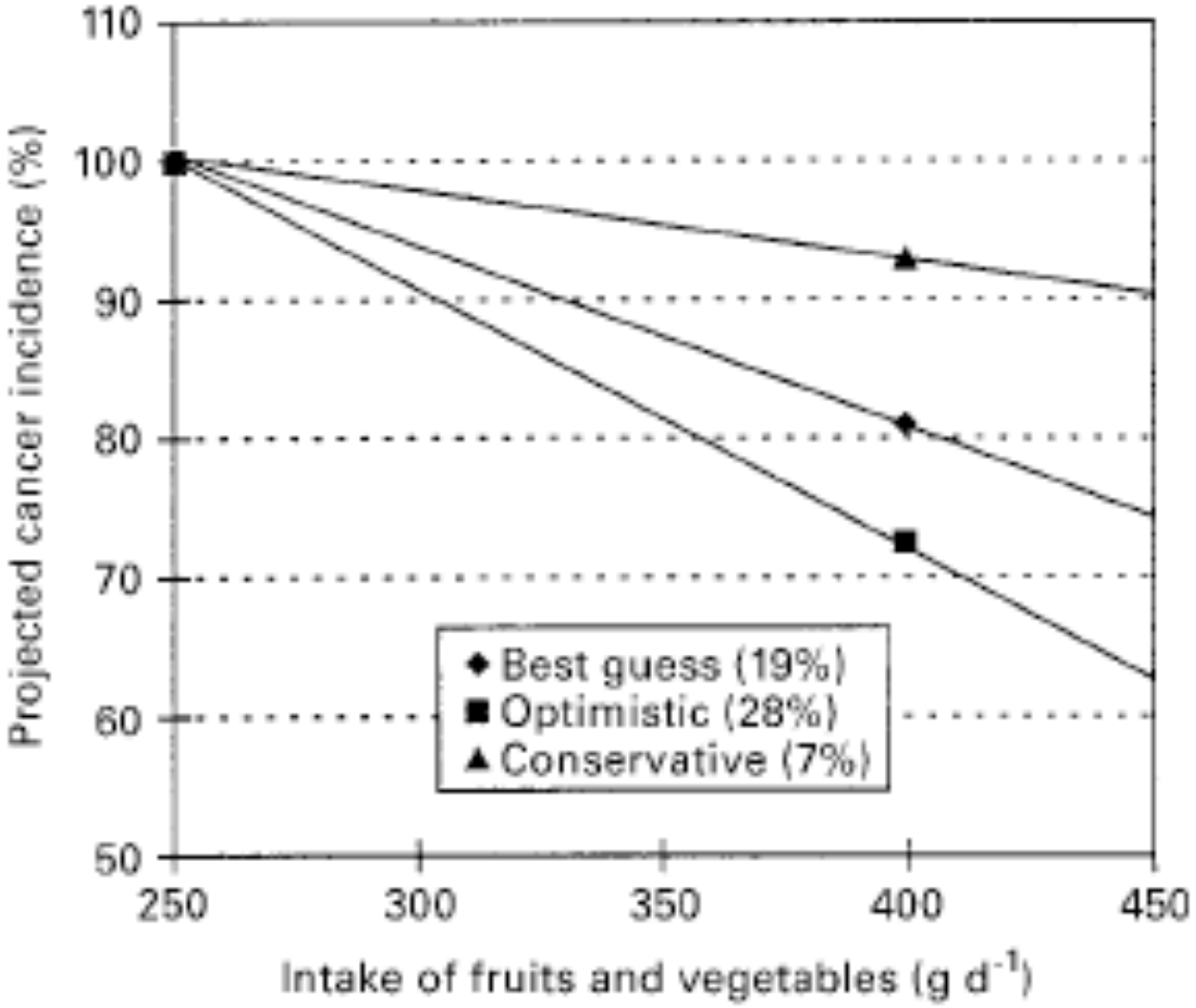


Fig. 1 Preventable proportion of chronic diseases as related to the intake of fruits and vegetables

(van't Veer et al. 2000)

Effect of increased intake of fruits and vegetables on human health



(van't Veer et al. 2000)

Estimated effects on health by switching to organic fruits and vegetables

- Average concentrations of plant defence compounds:
  - 10-50% higher in organic than in conventional products
- Impact on life expectancy from doubling of vegetable intake:
  - 1.3 years for cancer, approx. 1 year for CVD.
- Estimated impact of organic food:
  - 1-12 months additional life expectancy

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Overview of studies on effects of increased intake of organic food

Food/ consumer	Physiological effects	Other effects
Plant foods/rats	Preference	Higher intake?
Diet/nuns	Reduced blood pressure	Improved well-being
Tomato puree/students	No change in oxidative status nor in bioavailability	None recorded
Diet/students	Higher protein turnover	None recorded
Diet/rats	Little or no change in fertility, less body fat, more antibodies	Improved sleep pattern
Diet etc./children	Decreased allergy and colds	None recorded

(Brandt & Leifert 2005, www.orgprints.org)

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Where we are now

- There are many indications that organic foods generally are better for health than corresponding conventional ones.
- These benefits can be explained through standard scientific concepts.
- The benefits are easily lost, if any methods for plant protection and/or soil fertility enhancement are over-used.

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Future progress

- Definitive understanding of an(y) effect of food on health requires parallel, complementary studies of foods, animal models and human beings (Brandt & Seal 2006).
- Future studies should be designed to test the most likely beneficial effects.
- Better understanding of cause and effect is the necessary and sufficient prerequisite for improvements of the benefits of (organic) food on human health.

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Thank you for your attention!