Climate change and crop protection

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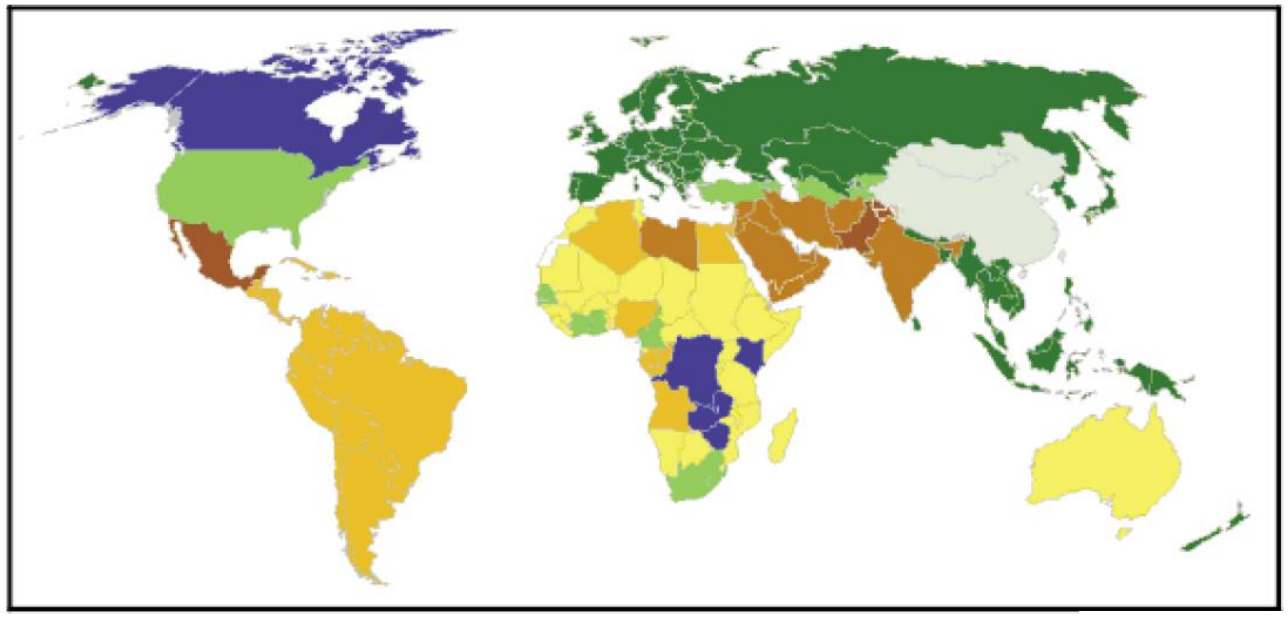
General effect of climate change on crops

- An increase in temperaturę by 1°C may reduce the yield of wheat, soyabean, peanut and potato by 3-10%....
- Increased frequency and intensity of outbreaks of pests: outbreak of sugarcane woolly aphid on sugarcane in India during 2002-03 resulted in 30% yield losses…
- Increasing infestation of rice crop by swarming caterpillar, stem borer and bacterial blight….

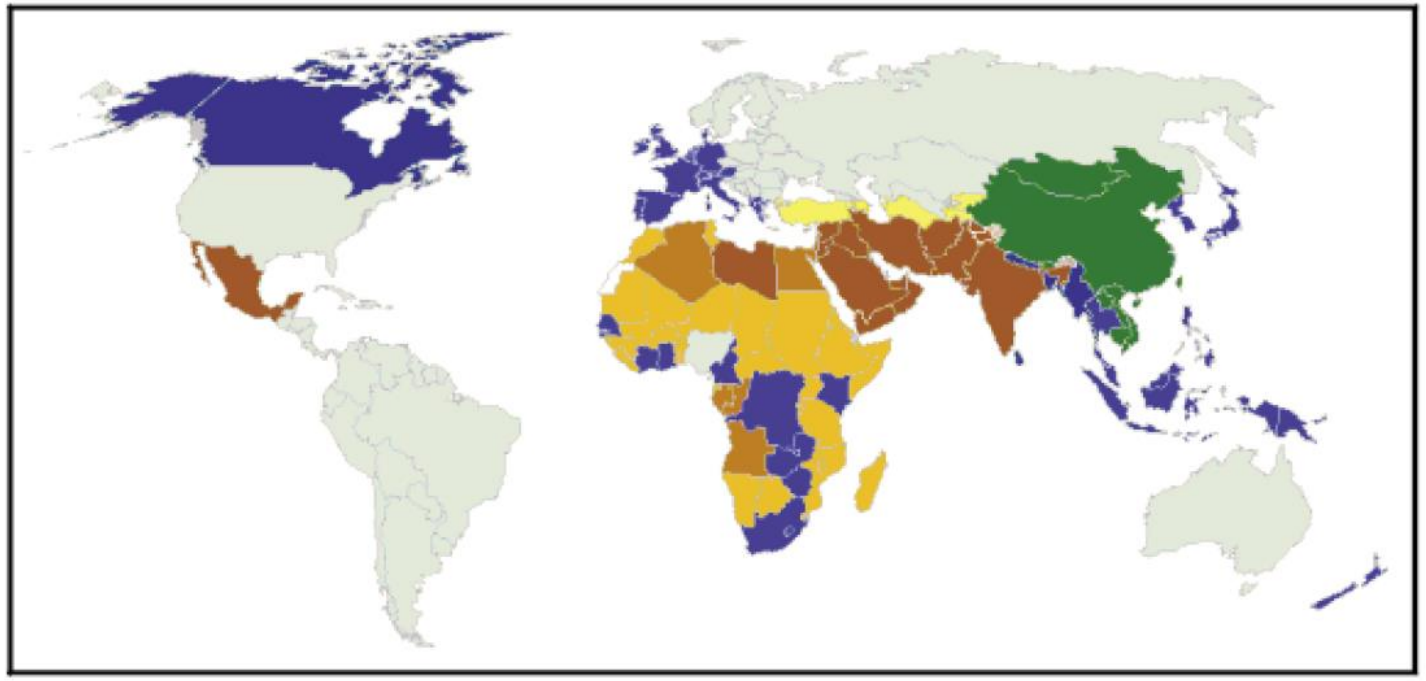
2020s



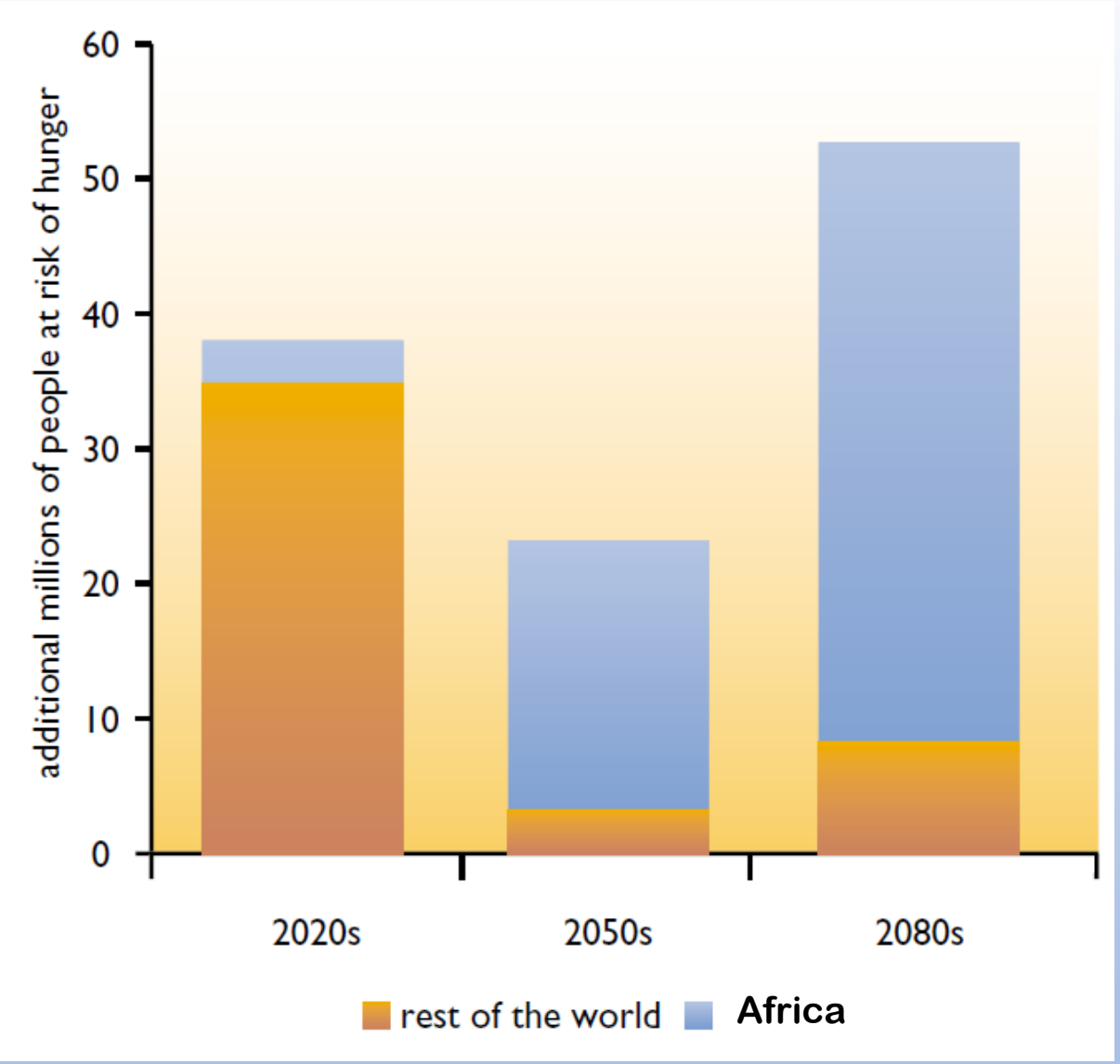
Yield change (%)

-60 -30 -20 -10 -5 -2.5 0 2.5 5 10 20 30 40

2050s



Percentage of changes in crop yields (wheat, maize and rice) for Hadley Center global climate change scenario due to physiological effects of CO_2 and crop adaptation (Rosenzweig et al. 2001 - NASA)



Projected additional numer of people at risk of hunger under the Hadley Center global climate change scenario (Parry et al. 1999)

Changes triggered by climate changes to pests

- Geographical distribution
- Increased overwintering
- Changes in population growth rates,
- Increases in the number of generations,
- Changes in crop-pest synchrony,
- Changes in interspecific interactions,
- Increased risks of invasion by migrant pests,
- Activity and abundance of natural enemies,
- Species extinction,
- Reduced efficacy of crop protection technologies

Effect of higher temperatures on pests

- Temperature increase associated with climate change affect insects reproduction, development and survival.
- High temperatures increase reproductive rates and reduce time between generations
- An increase of 2°C temperature can result in up to five additional life cycles per season of the insects (e.g. Cabbage maggot, Onion maggot, European corn borer, Colorado potato beetle)
- Insect population under increasing temperature moves towards higher latitudes and elevation
- Warmer winters reduce winterkill and consequently induce increased insect populations

Climate change will also reduce

- Host plant resistance:

abiotic stresses result in weakening of plants defensive system, and thus increasing the level of susceptibility to insect pests

- Efficacy of biopesticides (natural plant products, entomopathogenic fungi, bacteria, nematodes) and synthetic chemicals:

being highly thermo unstable they degrade faster at higher temperature, requiring more frequent insecticide applications for effective control

Climate change has already increased pesticide use and a 2.4 to 2.7-fold increase in pesticide use is expected by 2050

Effect of CO_2 increase

- CO_2 would increase canopy size and density of plants, with microclimates becoming more conducive for foliar pathogens (e.g. rusts, mildews, leaf spots)
- Greenhouse and lab studies have shown that high CO_2 atmosphere increase C:N ratio. Insects respond to this ratio by increasing their feeding in order to fulfill their metabolic needs for nitrogen. A dilution of N by 10-30% can cause 40% increase in food consumption by herbivores.
- Increased CO_2 may cause a slight decrease in N-based defenses (alkaloid) and slight increase in C-based defenses (tanins) in plants which breaks down resistance of plants to insects
- Increase pests damage could occur through indirect effects on host biochemical composition, i.e. increased simple sugars in the leaves

Effect on beneficial insects

- Even a mid-range climate warming scenario predicts that 15% to 37% of the beneficial species may become extinct by 2050 and according to a survey of over 1700 wild species, 50% of them are already affected.
- Enhanced mortality of beneficials is observed with increasing temperatures.
- Increased temperature has profound effect on fecundity and sex ratio of parasites
- Decreased effectiveness in controlling pests when pest distribution shift into regions outside the distribution of natural enemies
- Alteration of the timing of diurnal activity patterns of different groups of insects and change in interspecific interactions could also alter the effectiveness of natural enemies for pest management

Climate change and pollination

- The plant phenology:

Insect pollinated plants react more strongly to increased warming than wind pollinated plants.

- The daily activity patterns of pollinators:

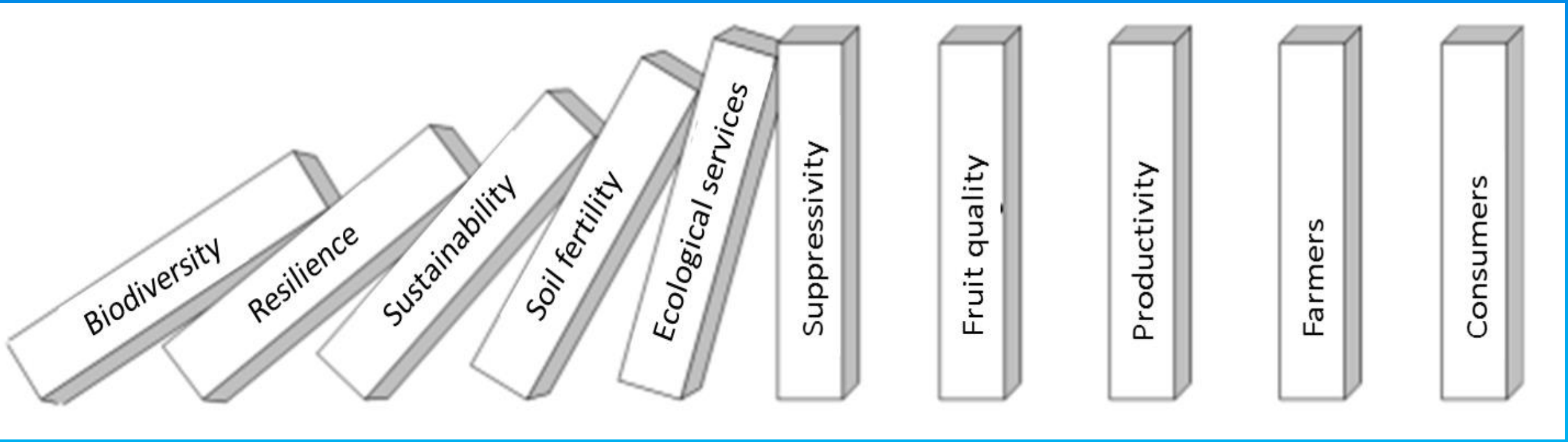
disruption of natural synchronization between the flower opening and visit of the pollinators like honey bees, wasps and butterflies

- The mutualistic interactions:

Increasing spring temperatures may decrease flower abundance and affect the relative abundance of pollinators. For every degree celsius rise in temperature a 14% loss in butterfly population was calculated.

How to fight climate change effects in orchards?

Concept of DOMINO



Plant species for row management

Alchemilla vulgaris

Pulmonaria sp.

Hierochloë australis

Tropaeolum sp.

Galium odoratum

Mentha piperita

Viola odorata

Stachys officinalis

Veronica officinalis

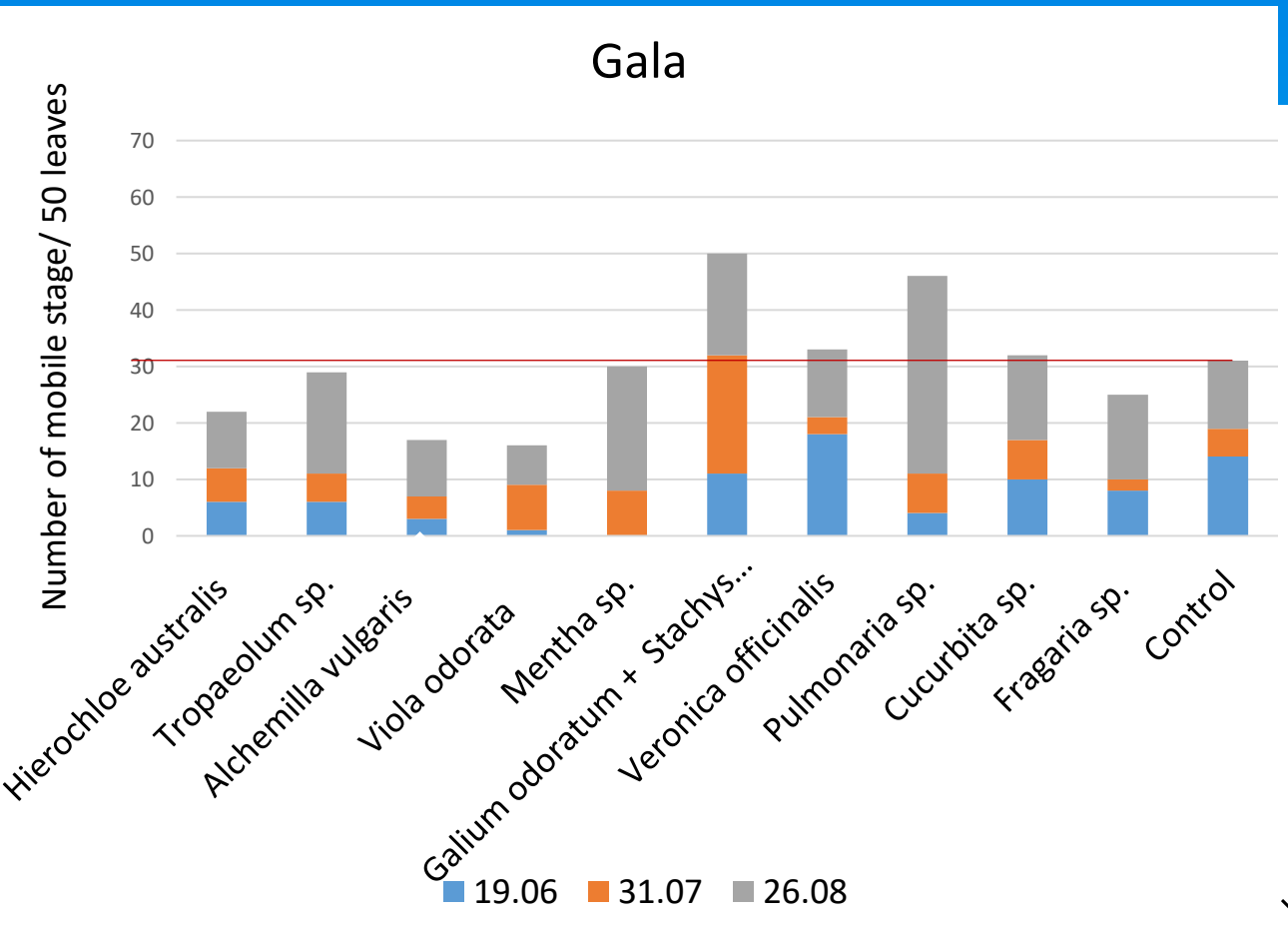
Fragaria vesca

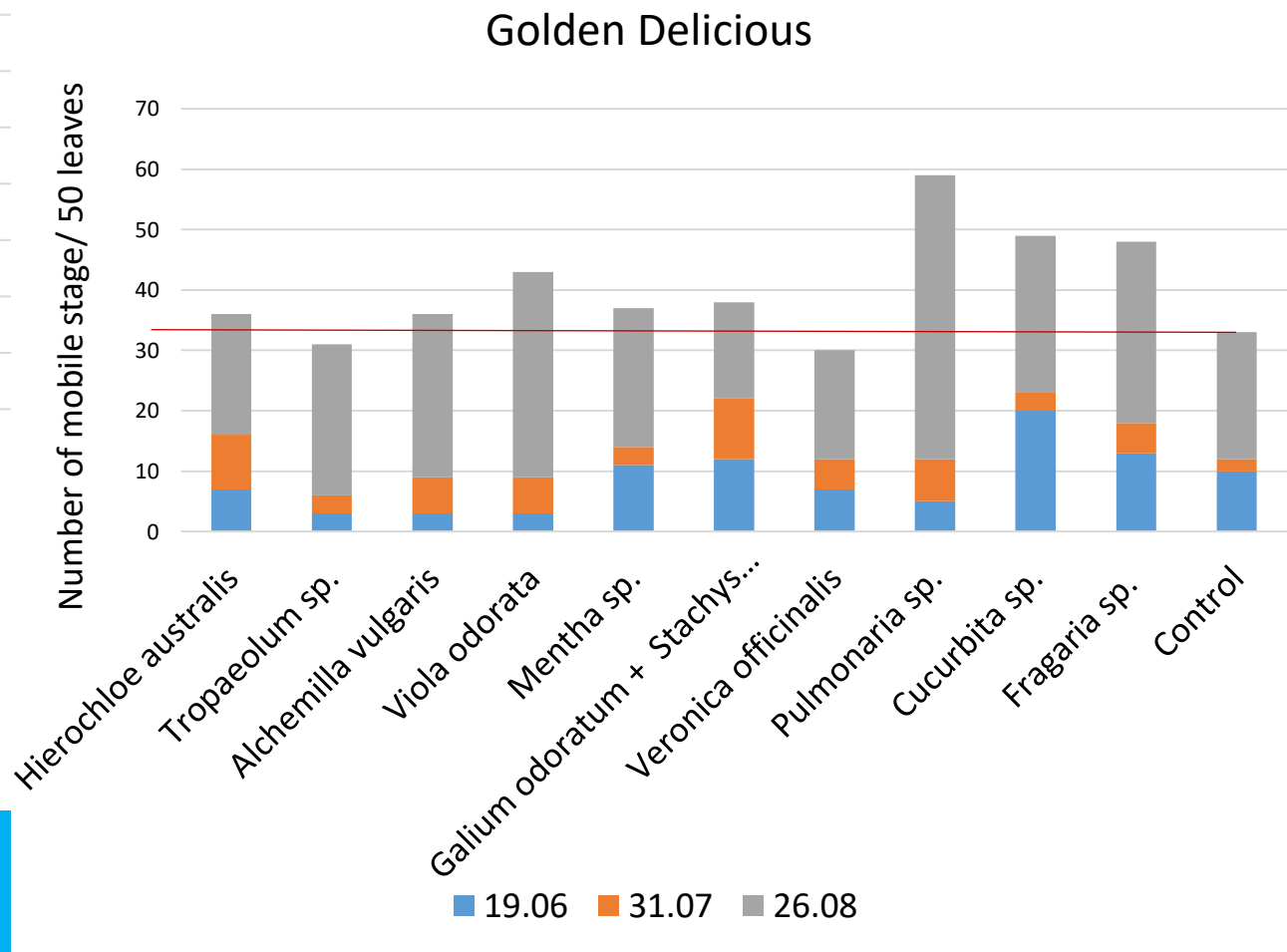
Cucurbita pepo






Effect of row cropping on cumulative number of phytoseiid mites (Phytoseiidae)





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