A review of the latest worldwide strawberry research

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Teagasc
Agriculture and Food Development Authority

ISHS

COST

Worldwide Review

- Sixth international Strawberry symposium
- 66 oral presentations
- 272 posters presented
- 7 different scientific topics
- Genetics & Breeding, physiology, nurseries, soil disinfestation, crop production, crop protection, post harvest & quality.

Physiology

INTERNATIONAL MAGAZINE FOR PRODUCTION MARKETING AND TECHNOLOGY OF FRUITS AND VEGETABLES WORLDWIDE VOLUME 5 NO.4 2005

Fruit &Veg TECH

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New generation of ultrathermic films

LIGHTING
Challenging the 1% rule of thumb

IRRIGATION
Automating the fertigation system

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New variety with potential to replace Elsanta

Reed Business Information

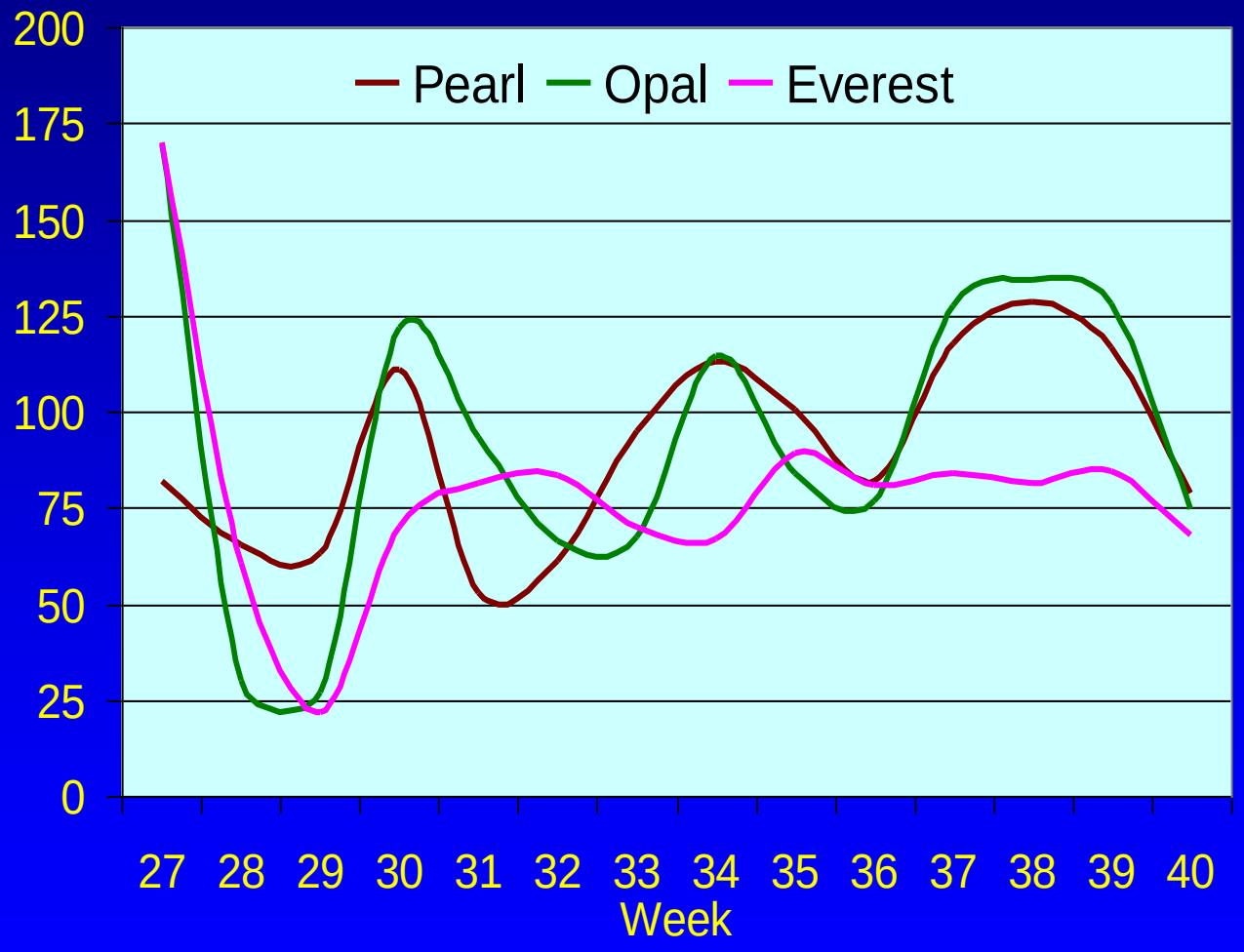
Sonata & Figaro

Chilling Requirement of the Strawberry cv. 'Sonata' & 'Figaro'

- P.Lieten- Fragaria Holland BV.
- Sonata- 1575 chill units optimum!! For yield and vegetative development
- Figaro much lower chilling requirement
- Highest yield – 1093 units and quality superior at 1254 units.
- Excessive chilling led Figaro to be too vigorous & yield decreased & delayed

Malling Pearl and Malling Opal

Class 1 yield (grams per plant). EMR Everbearer Trial 2003

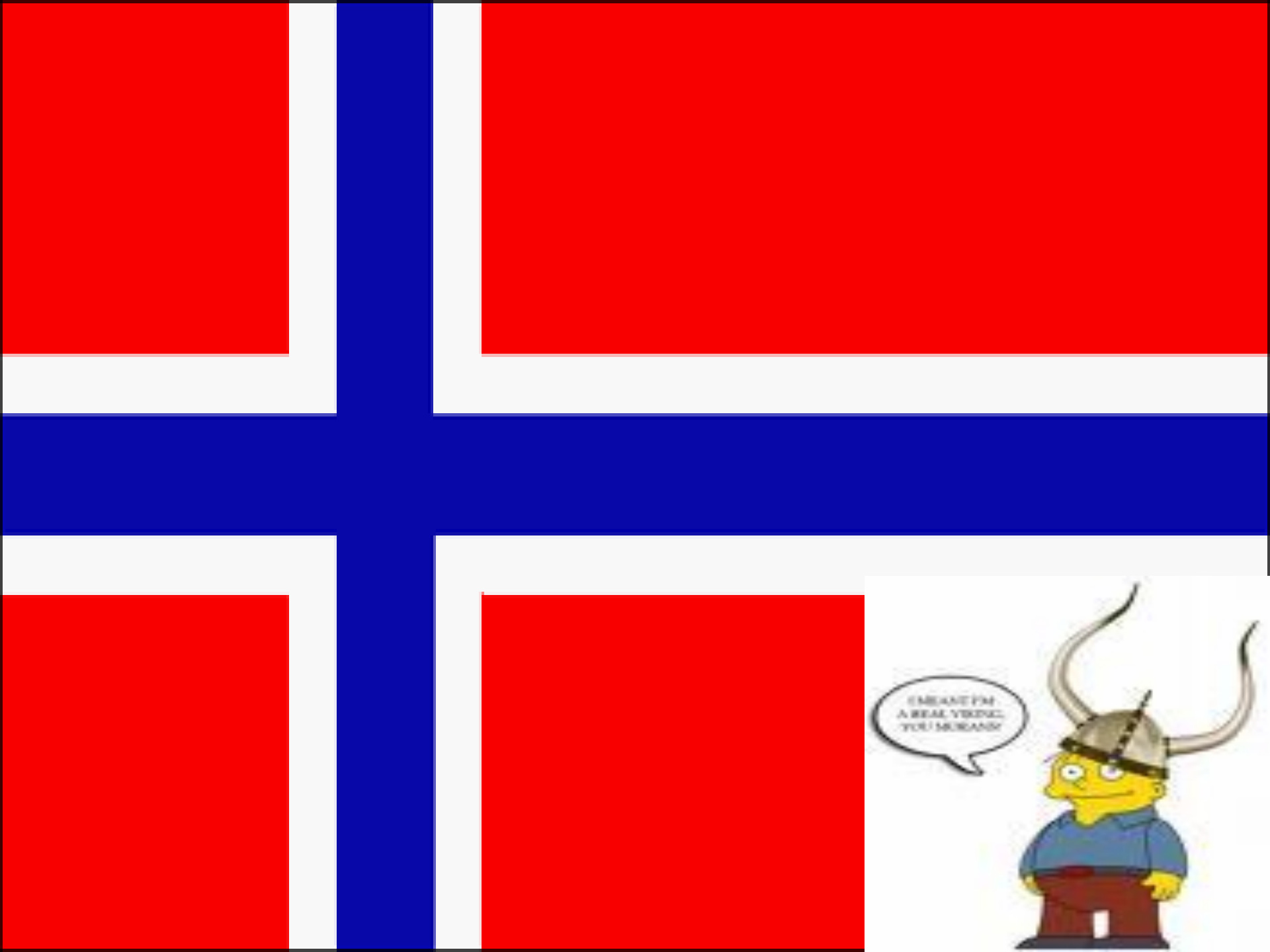


Manipulation of the production pattern of everbearing cultivars by Defoliation Treatments

- A. Whitehouse, A. Johnson & D.Simpson
- Effect of defoliating plants on production pattern of ‘Flamenco’.
- Plants mowed off with strimmer on 3 dates
- All leaf & flower removed, crown left.
- Total yield remained unaffected
- Plants must be defoliated before second half of July
- Peak production occurred 2 weeks later

Second Experiment

- Three defoliation compared on four everbearers
- Flamenco,Everest,Malling Opal & Pearl
- No effect on Class I yield of Flamenco but yields of others significantly reduced.
- Clear everbearers respond differently to defoliation treatments
- Response will vary between seasons due to different weather patterns
- Could be used as a tool for preventing extreme peaks and troughs in production
- In summers which include a prolonged period of high temperatures


I MEANT I'M
A REAL VIKING,
YOU MORANS!

Long-Day Flowering Response of Everbearing Strawberries

- Anita Sonsteby, NIAER,Norway.
- Strawberry cv.classified into Everbearing or June bearing types
- Literature on control of flowering of everbearers is inconsistent
- Study looked at the effect of photoperiod & temperature on the control of flowering in several everbearers
- Everest, Flamenco, Elan,Ridder,Rita,Rondo.
- LD+ 9°C; LD+ 15°C and 21°C ; LD+ 27°C.
- Flowering was highly significantly increased by LD & High temperature

Long-Day Flowering Response of Everbearing Strawberries

- **Everbearer strawberry cultivars of the older European type or modern Californian are:**

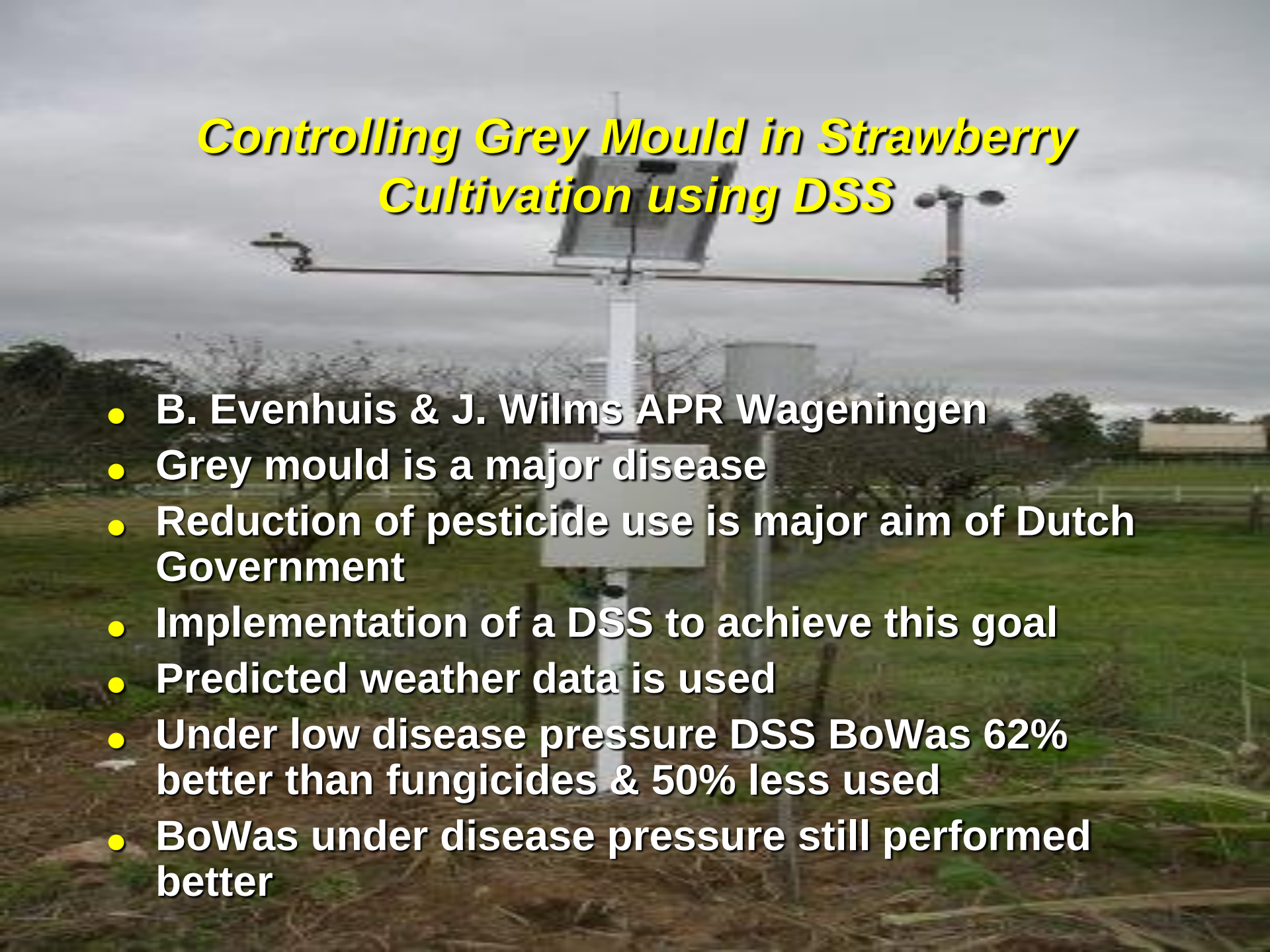
- **Qualitative LD plants at high temperature (27°C)**
- **Quantitative LD plants at intermediate temperatures (15 and 21°C)**

Crop Production

Quality & Performance of Strawberry Tray Plants in High Latitude Conditions

- S Karhu MTT Agrifood Research Finland
- Carbohydrate concentration higher in crowns and roots of tray plants v waiting bed plants
- Leaf removal prior to cold storage enhanced cropping potential of waiting bed plants
- Planted into black v white mulch
- Carbo content reduced greater where black mulch used but yield not affected

Crop Protection



Controlling Grey Mould in Strawberry Cultivation using DSS

- B. Evenhuis & J. Wilms APR Wageningen
- Grey mould is a major disease
- Reduction of pesticide use is major aim of Dutch Government
- Implementation of a DSS to achieve this goal
- Predicted weather data is used
- Under low disease pressure DSS BoWas 62% better than fungicides & 50% less used
- BoWas under disease pressure still performed better

Evaluation of an Empirical Model for the Control of Strawberry Powdery Mildew

- C.Blanco *et al*, IFAPA, Seville,Spain
- Soil grown, tunnels, Camarosa, Ventana, Marina.
- Efficiency of DSS for p mildew tested
- Two DSS systems compared
- 20% reduction in total fungicide application over 3 years
- Application of ‘chemical’ fungicides reduced by 42% compared to standard method

Influence of Heat Spread System on Malformation of 'Elsanta' strawberries in Spring

- Els Desmet, National Research Centre for Strawberries,Meerle,Belgium
- Malformation of 'Elsanta' in spring cultivation in a heated glasshouse subject to different speculations
- Insufficient pollination? Shortage of cold units? Reduced development of stamens?
- Two systems of heat spread tested
- Warm water pipes and warm air tubes tested
- Warm air tubes = reduction of malformed fruits, increase in production of 21% and improved plant vigour!

Two spotted spider mite

Strawberry Complex Protection against Fungal Diseases & Two Spotted Spider Mite using Strobilurin Fungicides

- **B.Meszka *et al*, RIPF, Skierniewice,Poland**
- **New Strobilurins (Signum & Zato) v Euparen M, Switch & Domark 100**
- **Three experiments- using Senga Sengana, Elsanta and Marmolada**
- **Both very good at controlling *Botrytis* and P.Mildew**
- **Signum also helped to reduce levels of Two Spotted Spider Mite**

Industry Development


Photo: China Daily
12.8

Strawberry Industry in China

- Shuping Yin, Beijing & Kirk Larson California USA
- 84,300 hectares & 1.96 million tonnes (2005)
- Open field & protected culture
- Protected culture harvest Nov-May
- Open field culture harvest April-June
- Fresh market- Japanese cultivars while US and European cultivars used for processing
- Nearly all processed strawberries exported.
- Poor plant quality, inefficient systems, lack of education, poor post harvest & quality control etc.

Nurseries

Optimisation of Nitrogen Fertilisation Prior to and during Flowering Process on Performance of 'Elsanta'.

- Els Desmet, National Research Centre for Strawberries,Meerle,Belgium
- Influenced period of flower initiation & subsequent development
- Reducing N prior to the flowering process advanced flower initiation
- Increasing N in September increased fruit number and yield
- Optimum yield with total N of 120 and 135 kg/ha
- 30 kg/ha at start, 60 kg/ha in September and 30 kg/ha N in October

Developing a Breeding Strategy for Improved Performance in Programmed Cropping Systems

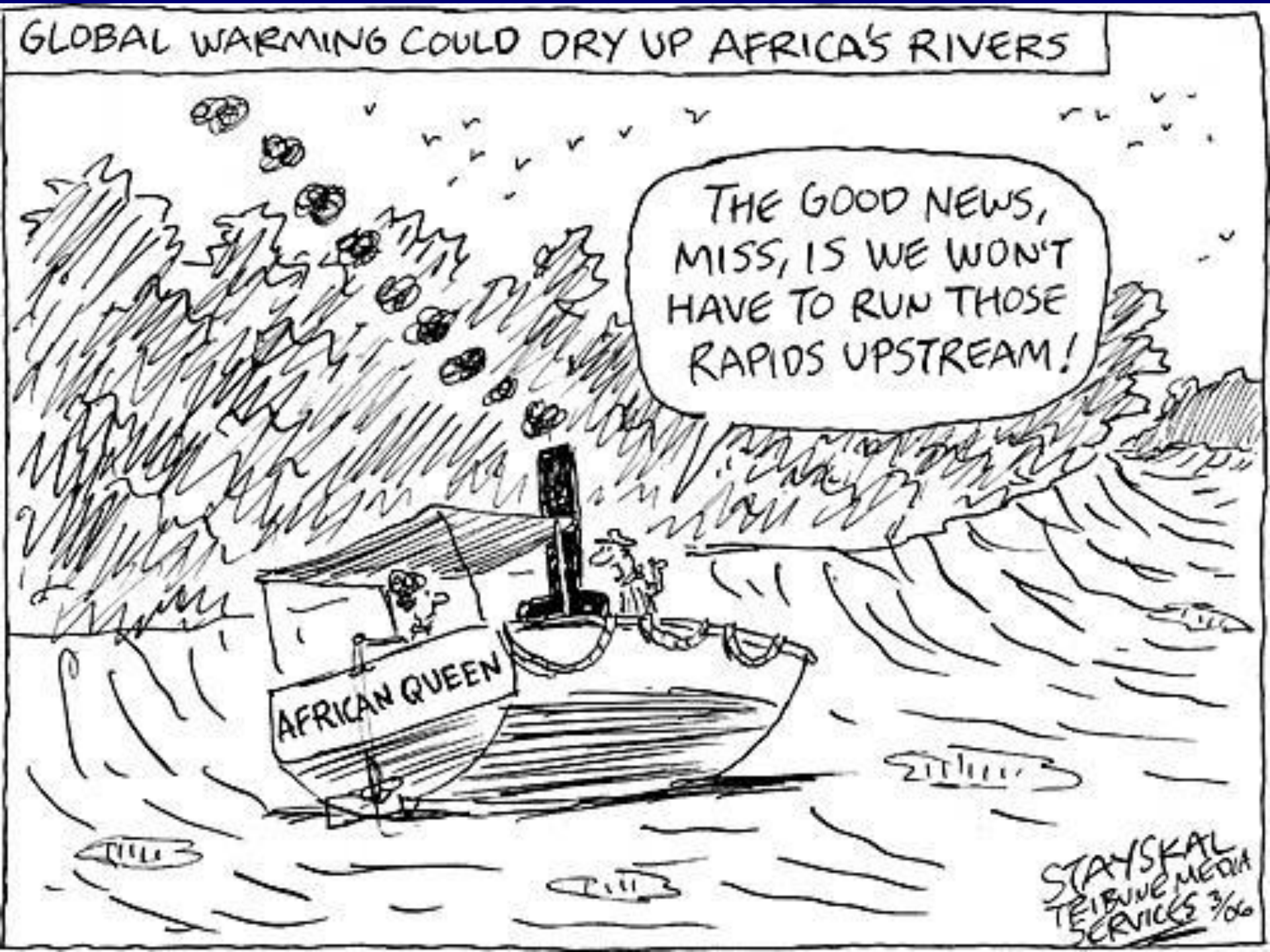
- **Adam Whitehouse *et al*, EMR, Kent, UK.**
- **With 60-day production only 'Elsanta' consistently performs well in this system**
- **Other cultivars are very unpredictable**
- **e.g. Emily & Symphony are not adapted for 60 day cropping and will not produce an acceptable yield**
- **Breeders will test a range of germplasm to see which perform well in a 60-day system**
- **Investigate the inheritance of traits related to 60-day performance**
- **Three lines EM1119,EM1159, EM1281 were identified as good parents.**

Boron & Calcium Deficiency

Foliar Application of Calcium & Boron Influences Physiological Disorders, Fruit Yield & Quality of Strawberry

- **R. Singh *et al* Abohar India.**
- **Pre-harvest foliar application of Ca & B**
- **$CaCl_2$ x 5 times from petal fall**
- **B as Boric acid x 3 times from at start of flowering and then 15 day intervals**
- **B reduced fruit malformation significantly**
- **20% more marketable fruit with the Ca & B treatment combined**
- **Fruit receiving Ca or Ca & B were also firmer, higher acidity and vitamin C.**

Post Harvest & Quality


GLOBAL WARMING COULD DRY UP AFRICA'S RIVERS
THE GOOD NEWS, MISS, IS WE WON'T HAVE TO RUN THOSE RAPIDS UPSTREAM!
AFRICAN QUEEN
STAYSKAL TRIBUNE MEDIA SERVICES 3/06

Effect of Water Deficit Irrigation on Strawberry Fruit Quality

- **Leon Terry *et al* Cranfield University, UK.**
- **Growers under pressure to justify that their water abstraction in justified and env. sustainable**
- **DI can reduce berry size and yield**
- **Study showed it did effect berry size**
- **Dry matter was increased**
- **Higher levels of Abscisic acid (ABA)**
- **Glucose and fructose levels**
- **Total Phenolics 1.4 times higher V control**
- **Premium price for 'healthfulness' product?**

Effect of IPM & Organic Cropping Systems on Strawberry Health Components & Quality.

- **S.Magnani *et al*, Forli, Italy**
- **Three year study using Italian jb cultivars 'Alba','Onda' and 'Queen Elisa'.**
- **Cesena area of the Po Valley**
- **Organic system showed lower yield**
- **Higher sugar content and antioxidant compounds**

Teagasc Research

Effect of different transplanting dates and runner types on quality and yield of Elsanta Cv.

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Key words:- Mother plant, primary runner and secondary runner

Introduction

Today module strawberry production on Irish farms is estimated at 4 million Euro. This had resulted from a major increase in protected cultivation in glasshouses and tunnels within which the environment is controlled. This maximizes fruit yield and quality. It has also resulted in an extension of the production season from June to early autumn.

To complement the ongoing improved strawberry module (tray) production in Ireland, research is being undertaken at Kinsealy Research Centre to establish an exact protocol for the successful production of strawberry module plants for the Irish soft fruit producers.

Materials and Methods

An experiment was set up to investigate the effects of different planting dates and runner types on yield and fruit quality of module produced strawberries.

Super elite Elsanta mother plants were planted in 20 L modules filled with peat to produce primary and secondary runners to produce planting material.

The runners were transplanted outdoors in nine cell trays for further rooting and fertigated with nutrient solution (0.8-1.2 E.C).

In the autumn data on crown diameter, leaf number, initiated flower numbers and stages was generated at two different dates at an interval of 30 days prior to the onset of full dormancy. Six treatments were established and placed on to gutters for fruit production.

During the fruit production phase data on flower number at 50% flowering, fruit number, total fruit yield per plant, fruit titratable acidity, soluble solids content, electrical conductivity and phonelic content will be measured


Primary runners


Secondary runners


Tray planted runners for further rooting


Runners misted using sprinkler irrigation


First round transplanted runners


Second round transplanted runners


Third round transplanted runners


Tray rooted runners

Tray rooted runners planted for fruit production

Results

Crown diameter

A significant difference in crown diameter of primary and secondary runners occurred for both rounds of plant dissections. Crown diameters transplanted in the first round were the biggest (Figure 1).

Flower numbers

The number of flowers from the first round dissection were not significantly different. However, in the second round they were highly significant (Figure 2).

Flower stages.

The stages of flowers identified in the first plant dissection were highly diversified. In the second round dissection the flower stages in all treatments were more developed and grouped into three distinctive stages (G,H and I) (Figure 3)

Leaf number

There was no significant difference in leaf numbers among the different treatments during the first round plant dissection. In the second round, the number of leaves among treatments was highly significant. More leaves were found from treatments transplanted in the first date and decreased with delay in date of transplanting (Figure 4).

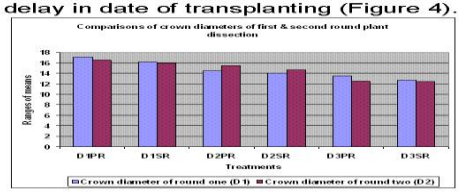

Figure 1:- Comparisons crown diameter

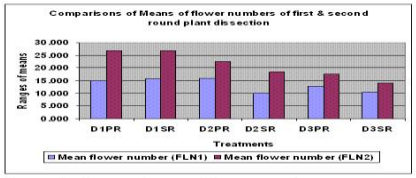

Figure 2:- Comparisons of flower numbers

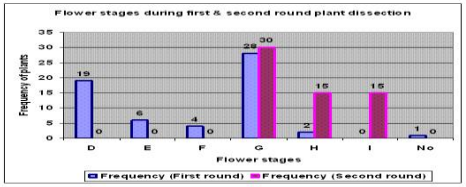

Figure 3:- Comparisons of flower stages

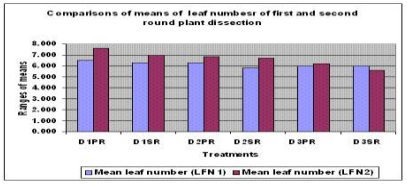

Figure 4:- Comparisons of leaf numbers

Conclusion

Data to date showed that transplanting date and runner types have an impact on crown diameter, leaf number, flower number and flower stages before the onset of full dormancy. In all cases, primary runners transplanted from the first rooting round were best.

Reference

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Pollination Efficiency of Imported Bumblebees on cv. Elsanta Strawberries

Stimulus Project RSF 06 348

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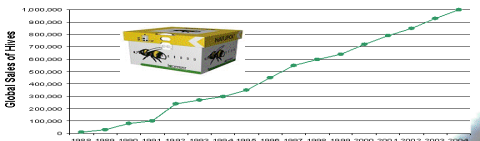

Figure 1. Global sales of bumblebee hives from 1988-2004 (Velthuis & van Doorn, 2006)

Commercialisation of Bumblebees

Bumblebees (*Bombus* spp.) pollinate a wide range of crops and can be used where honeybee pollination is poor. For example, bumblebees forage under a wide range of weather conditions, including low temperatures, wind and rain. Currently, over 19 countries worldwide have production facilities for bumblebees with sales of bumblebee hives worth over €55 M p.a. (Fig. 1; Velthuis & van Doorn, 2006). Typically, the increased yields produced by bumblebee pollination far outweigh the cost of the hives. In 2009 Irish growers imported approx. 1,500 hives at a cost of €75,000; but €22 million of protected strawberry crops were grown, of which €5.5 million was produced as a result of bumblebee pollination.

Teagasc cv. Elsanta Strawberry Pollination Experiments

1. How does bumblebee pollination impact fruit production cv. Elsanta?

The precise strawberry yield due to bee pollination is highly dependant on both the species of bee and the cultivar of strawberry plant. Typically, in the absence of bee pollination, strawberry plants produce 30-56% deformed fruit and the fresh weight of fruit declines by 16-49% (Goodman & Oldroyd, 1988; Braga & Kleinert, 2004; Dimou *et al.*, 2008). However, these experiments have never been conducted for cv. Elsanta and bumblebees, the predominant cultivar and pollinator in protected strawberry crop systems in North and West Europe. In the summer of 2008, two commercial plastic tunnels were established with 2,400 cv. Elsanta strawberry plants in Teagasc Oakpark, Carlow. To assess the impact of bumblebee pollination, 80 plants were selected randomly. On each plant, one flower was bagged with a fine mesh throughout the experiment to exclude any bees, and three other flowers selected according to floral rank (see Fig. 2) and allowed unlimited access to bees. The fresh weight, the no. of achenes, the fertilisation rate and the fruit shape were then recorded for all fruit produced. There was a strong relationship between the number of fertilised achenes and the fresh weight of the berry for each floral rank (Fig. 3). Overall, bumblebee pollination increased the fresh weight of cv. Elsanta strawberries by 25.95% and decreased the incidence of deformed fruit by 13.14% (Table 1).

2. How efficient are bumblebees vs. honeybees at pollinating cv. Elsanta?

To assess the number of bumblebee visits required to maximally pollinate cv. Elsanta strawberries, 60 plants with unopened flowers were randomly selected and a fine mesh bag placed over one flower per plant. Once the flower had opened, the number of bumblebee visits were recorded and the flower bagged until the fruit had ripened. The number of fertilised achenes (seeds set) per fruit were then recorded and Spear's (1983) measure of pollinator effectiveness (PE) applied (Fig. 4). For cv. Elsanta, honeybees have a PE = 0.17 (Chagnon *et al.*, 1989), whereas we found bumblebees had a PE = 0.43. In other words, bumblebees are 2.5 times more efficient than honeybees in achieving maximal pollination and fruit yield in cv. Elsanta strawberries.

3. What density of bumblebee hives are required for protected cv. Elsanta crops?

Each of the two commercial plastic tunnels located in Oakpark were partitioned into four replicate experimental compartments, each compartment containing either 240 plants or 360 plants. Two commercial hives, each containing one queen and 10 workers to replicate on a smaller scale commercial environments, were placed in each compartment when 30% of the flowers had opened. All fruit from each compartment were harvested at the end of the experiment and the fresh weight, no. of achenes, fertilisation rate and fruit shape recorded. Overall, no statistical difference in any of the fruit metrics measured occurred between the high and low density compartments. Therefore, one averaged sized commercial colony (one queen and 50-70 workers) should sufficiently pollinate 5,000 cv. Elsanta plants in protected crop systems.

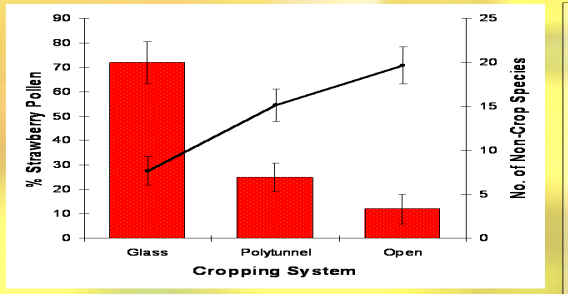

Figure 5. % Strawberry pollen (bars) and no. of non-crop plant species (line) present in pollen loads collected from returning bumblebee workers to imported hives (N = 540).

Teagasc Cropping System Permeability Surveys

In protected tomato crop systems in Canada, bumblebees were recorded spending as much as 75% of their time escaping glasshouses and pollinating non-crop plants (Whittington & Winston, 2004). Not only does this represent a loss of pollination services to the grower buying hives, it also increases the risk of competition, disease transmission and hybridisation with native bumblebees.

In collaboration with six commercial strawberry growers, the quantity of strawberry pollen collected by imported bumblebees was recorded in each cropping system over the growing season. From 540 pollen samples: bumblebees in glasshouses returned with 71.9 ± 8.6% strawberry pollen, compared to 25.0 ± 5.9% in plastic tunnels and 12.0 ± 6.1% in field crops (Fig. 5). Therefore, where possible, we would strongly recommend that growers 'bee-proof' glasshouses and plastic tunnels with fine netting, and advise against the purchase of bumblebees for field crops unless the grower is certain there are insufficient numbers of wild bees present.

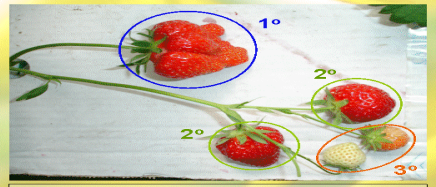

Figure 2. Fruit produced by different floral ranks, in order of the time the flowers are grown and open for pollination.

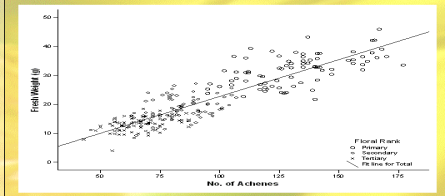

Figure 3. The strong relationship between fresh weight of fruit (g) and the no. of fertilised achenes (strawberry seeds) for each floral rank of fruit.

Table 1. Summary of fresh fruit weight according to floral rank and with or without bumblebee pollination.

Floral Rank	1°	2°	3°
No. of Achenes	131.86 ± 2.28	84.29 ± 1.30	65.86 ± 1.13
Fruit Weight W/out Bees (g)	20.31 ± 4.60	12.98 ± 3.94	10.14 ± 3.29
Fruit Weight With Bees (g)	25.58 ± 4.21	16.35 ± 3.08	12.78 ± 2.26
Increase in Fruit Weight	25.95%		

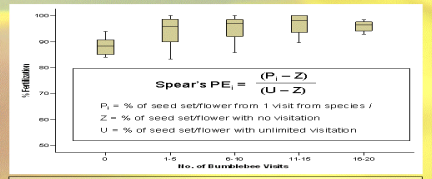

Figure 4. The number of bumblebee visits required to maximally pollinate cv. Elsanta strawberries and Spear's (1983) PE equation.

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