Universitetet i Stavanger

DET TEKNISK-NATURVITENSKAPELIGE FAKULTET

MASTEROPPGAVE

Studieprogram/spesialisering: Biologisk Kjemi – Master i realfag	Vårsemesteret, 2014 Åpen
Forfatter: Linda Renate Johnsen	(signatur forfatter)
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Tittel på masteroppgaven: Quality of Norwegian cucumbers: Effect of greenhouse praxis on taste and taste related constituents, and GC-FID analysis on content of fatty acids and aldehydes Engelsk tittel: -	
Studiepoeng: 60	
Emneord: Cucumber Constituents Taste Gas chromatography Aroma Fatty acid	Sidetall: 83 + vedlegg/annet: 76 Stavanger, 14.07.2014

Quality of Norwegian cucumbers: Effect of greenhouse praxis on taste and taste related constituents, and GC-FID analysis on content of fatty acids and aldehydes

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Acknowledgments

This thesis was performed at Bioforsk Vest Særheim, in cooperation with the University of Stavanger, as a part of a research project financially supported by the Research Council of Norway, Programme for Regional R&D and Innovation (VRI), NCE- Culinology, and Norwegian cucumber producers.

I would like to thank my supervisor at Bioforsk Vest Særheim, Michèl Verheul for his valuable help during this study. I would also like to thank Rune Slimestad for supervising the part of the thesis which comprises gas chromatography of aroma compounds and fatty acids.

I would also thank Peter Ruoff, my supervisor at the University of Stavanger, for follow-up, and for all his help who enabled me to write my thesis at Bioforsk.

Last, I would thank my friends and family for support and patience during this study.

Abbreviations

ANOVA	Analysis of variance
CAR	Carboxen
DLI	Daily light integral
DMC	Dry matter content
DVB	Divinylbenzene
EC	Electrical conductivity
FAME	Fatty acid methyl esters
FID	Flame ionizing detector
FW	Fresh weight
GC	Gas Chromatography
GLC	Gas-liquid chromatography
GLM	General linear models
GSC	Gas-solid chromatography
HS-SPME	Head space solid phase microextraction
PA	Poly(acrylate)
PAR	Photosynthetically active radiation
Pearsons'r	Pearson's correlation coefficient
PDMS	Poly(dimethylsiloxane)
PPFD	Photosynthetic Photon flux density
RH	Relative humidity
R^2/R-spuare	Regression coefficient
SAS	Statistical analysis system

SD	Standard deviation
SNK	Student Newman Keuls test
SPME	Solid phase microextraction
SSC	Soluble Solid Content
t_R	Retention time
TTA	Total Titratable Acids
VPD	Vapour pressure deficit

Abstract

Earlier studies have shown that sugars (SSC), salts (EC) and the relationships between sugars/salts and sugars/acids (TTA- total titratable acids) may impact taste in cucumber. In this study, the impacts of environmental conditions in greenhouses on appearance, taste, and content of taste related constituents in cucumber are examined.

Cucumber were sampled from eight different greenhouses, and analyzed regarding appearance of morphological features as well as constituents. The daily light integral, average temperature, CO_2, and vapour pressure deficit were calculated from measurements and registrations from the greenhouse's climate control program. EC and pH levels of the irrigation- and drain water were measured each harvest day. Statistical analysis showed significant relationships between greenhouse practices and taste related constituents. Both the daily light integral, CO_2 and EC found in drain and irrigation water had significant effects on the EC measured in fruits, and could explain between 11 and 33 % of the variation of EC in fruit. Regarding pH in fruit, it seemed as the pH in both drain and irrigation water had strongest impact, with explanatory values of around 12 %. SSC show significant negative correlations to DLI(plant), temperature, and VPD, and may be positively affected by maximum CO_2 levels 4 days (and earlier) before harvesting, and pH levels in irrigation and drain water. But all explanatory values for SSC were relatively low.

Flavour in fruit is a function of both the taste parameters described above, and aroma. The aroma compounds ((*E*)-2-nonenal and *(E,Z*)-2,6-nonadienal) in cucumber are known to be derivates of fatty acids (linoleic- and linolenic acid). In order to examine the relationship between these compounds in different varieties of cucumber, chromatographic methods were improved. (HS-SPME) GC-FID analysis was used to quantify the levels of aroma compounds, and (FAME) GC-FID analysis to quantify the level of fatty acids. Significant correlations were found between content of the two aromas (*E,Z*)-2,6-nonadienal and (*E*)-2-nonenal, and between the two fatty acids linoleic-, and linolenic acid. The results also indicate that the different varieties of cucumber may vary in content of fatty acids and aroma's. Further study is required to confirm if this variance is relevant for taste in cucumber.

Table of content

1. Introduction

1.1 Background and scope of the assignment

Cucumber (*Cucumis sativus L.*) is the fourth most widely cultivated vegetable in the world (faostat.fao.org) yet there is little research done in the field of what affect the taste in slicing cucumber. Earlier, two Bachelor students at the University of Stavanger have performed experiences at Bioforsk Vest Særheim, regarding the differences in content and taste in cucumbers.

In a previous study (Johnsen, 2012; Verheul et al., 2013) the relationship between physiochemical changes and sensory evaluation of slicing cucumbers for cucumbers of different origins (native versus imported cucumbers) were examined. It was found that significant variations regarding morphology and constituents might occur between producers and between locally produced and imported cucumbers. Furthermore, significant variations in physiochemical attributes also existed between ecologically and non-ecologically produced cucumbers, and during storage (Johnsen, 2012). The results from paired preference testing, also suggested that customers found the taste in the imported cucumbers favourable (Verheul et al., 2013), and that taste might be negatively correlated to TTA/SSC (total titratable acids/soluble solid content) and EC (electrical conductivity), and positively correlated to SSC/EC and SSC (Johnsen, 2012).

Norwegian producers are eager to optimise their production and harvesting conditions to give the best quality to their customers. Based on the study of Johnsen (2012), two more assignments regarding taste in cucumber were performed at Bioforsk Vest Særheim in cooperation with University of Stavanger.

Differences in taste and taste related attributes might be caused by differences in genotypes and/or environments. In 2013, taste and content in different varieties of cucumbers grown in the same environment were explored (Kjos, 2013). Only small differences were observed between the different genotypes.

In the present study, influences of cultivation conditions on the taste and content of taste related constituents in cucumber (limited number of genotypes) are examined.

The main aim is to test if, and how, cucumber taste and taste related constituents (SSC, TTA, EC, DMC (dry matter content), (Johnsen, 2012; Kjos, 2013)) are related to the different environmental conditions in the greenhouses (climatic conditions: DLI (daily light integral), CO_2, temperature, VPD (vapour pressure deficit) and nutrient conditions: EC and pH level in irrigation and drain water).

Flavour in fruits and vegetables are a function of both taste (e.g. sugars and acids) and aroma (Malundo et al., 1995). In order to examine correlations between fatty acids and content of two major aroma compounds ((*E,Z)*-2,6-nonadienal and *(E)*-2-nonenal), chromatographic methods were improved. Fatty acids and aroma aldehydes were analysed in different varieties by means of fatty acid methyl esterification (FAME's) and gas chromatography with flame ionization detector (GC-FID), and head space solid phase micoextraction (HS-SPME) and GC-FID, respectively.

1.2 Biology and content of cucumber

There are many types of cucumber, but the one most ordinary found in the shops are the types who are called "slicing cucumber", or "salad cucumber" (frukt.no).

The cucumber plant has long stalked leaves which are placed singly on the hairy stem. The leafs are pointed, whit 3 to 5 points, where the middle one are the biggest. The flowers are big and yellow (Bjelland, 1997).

The fruit is oblong, and consists of the dark green outer skin (also referred to as the exocarp), the middle layer (the mesocarp), which are white and juicy and succulent in consistence. The inner layer is the endocarp (who contains the cucumber's seed) which are smooth and totally edible (Hine, 2008; frukt.no). Figure 1.2.1 shows cucumber fruits in greenhouse.

Figure 1.2.1: Cucumber fruits in greenhouse

The fruit contain approximately 96 % water, and is generally low in nutrition content, but contain some A and C vitamins, calcium and iron. The content of proteins, carbohydrates and fats are only 0,8 %, 1,2 % and 0,1 % respectively (frukt.no). Still, earlier studies suggest that content of sugars, acids and salt, and the relationship between them, are factors that might influence consumers sense of taste in cucumber (Verheul et al., 2013).

Malic acid is an organic acid specially found in the juice of immature, green fruits (Daintith, 2008), and are claimed to be 14 % more sour than citric acid (Yilmaz, 2000).

In pickling cucumbers, the concentration of malic acid is found to be highest in the outer mesocarp, followed by the endocarp, the inner mesocarp, and the exocarp, respectively (McFeeters et al., 1982). Citric acid is naturally occurring in many fruits, and its salt or ester, citrate, is an important intermediate product in the Krebs cycle (Daintith, 2008).

Hirose (1976) found that in an undefined type of cucumber, malic acid was present in largest amount, followed by citric acid. The main organic acids in pickling cucumber are malic and citric acid, with malic acid as the one present in largest amount (McFeeters et al., 1982). This was also found to be the case in slicing cucumbers, where malic acid counted 64 % of organic acid content (Verheul et al., 2013).

Fructose, glucose and sucrose are the main sugars present in slicing cucumbers. It has in earlier studies been found to have a relative distribution of 48, 35 and 15 %, respectively (Verheul et al., 2013). The total sugar concentration of pickling cucumbers are found to be between 3,8 and 5,8 times higher in the cucumber peel (exocarp), than in meso-, or endocarp tissue. Which of endocarp and mesocarp tissues that contributes mostly to total sugar concentration depends on size of cucumber (McFeeters and Lovdal, 1987).

Glucose ($C_6H_{12}O_6$) is an energy source for organisms and is the product of photosynthesis in plants. Glucose is an aldose, e.g. an aldehyde sugar, because the carbonyl group are located in the end of the carbon chain. It is also a hexose, since there are six carbon atoms in the carbon skeleton. Different isomers of glucose exist, depending on where the hydroxyl groups are placed (Campbell et al., 2008).

Another monosaccharide is fructose, which is a glucose stereoisomer (also $C_6H_{12}O_6$). The carbonyl group of fructose is located inside the carbon chain, which makes it a ketose sugar. This is also a natural energy source, and, like glucose, a hexose (Campbell et al., 2008).

Sucrose ($C_{12}H_{22}O_{11}$) consists of one glucose molecule and one fructose molecule, which makes it a disaccharide. It is formed in a dehydration reaction, where glucose and fructose forms a glycoside bond, and reacts into sucrose and water. Plants transport generally carbohydrates from leafs to roots and other non-photosynthetic parts of the plant as sucrose (Campbell et al., 2008).

Fatty acids and aromas

Fatty acids, which are long chain alkanoic acids, are ubiquitous in nature. In free, unestrified form, they are only found in trace amount in living cells, but they are important components of lipids (Mann et al., 1994). Fatty acids are organic compounds, and consists of a hydrocarbon chain that vary from 1 to 30 carbon atoms, and a terminal carboxyl group (C=O, and OH bound to the C atom). They are further divided into saturated fatty acids (no double bonds between C atoms), unsaturated fatty acids (one double bond) or polyunsaturated fatty acids (more than one double bond) (Daintith, 2008).

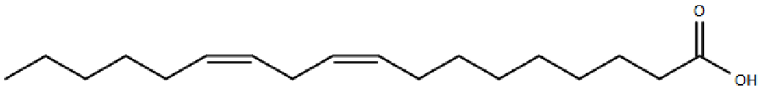
The fatty acids physical properties depend on chain length, degree of unsaturation and branching and isomerization. Longer chains are less soluble in water and have higher melting point, while, branching and higher degree of unsaturation tends to lower melting points (Daintith, 2008).

Some fatty acids are essential, which means that they must normally be present in the diet of human, and certain other animals. Essential fatty acids all have double bonds at the same two positions along their hydrocarbon chain. This makes them act as precursors of prostaglandins (Daintith, 2008).

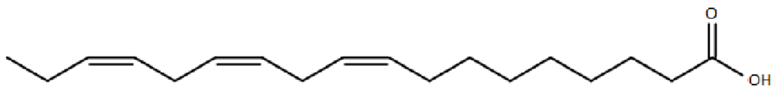
Even though fatty acids in total represent only 0.1 % of content in cucumber (frukt.no), the fatty acids are important for taste because of the formation of aroma compounds. Grosh and Schwarz (1971) suggested that a dioxygenase-like reaction brakes the double bound of the unsaturated fatty acids, leading to formation of, among others, (*(Z,Z)*-3,6-nonadienal) from linolenic acid, and (*(Z)*-3-nonenal) from linoleic acid, and that isomeration the *cis*-3 double bond to the 2-*trans* in the aldehydes , leading to formation of *(E,Z)*-2,6-nonadienal and *(E)*-2-nonenal, may occur after the enzyme catalyzed oxidation. Grosh and Schwarz (1971) also found that both linoleic and linolenic are precursors for other aroma compounds than *(E,Z)*-2,6-nonadienal and *(E)*-2-nonenal. Figure 1.2.2 shows chemical structure of linoleic and linolenic acid, while Figure 1.2.3 shows structure of *(E,Z)*-2,6-nonadienal and *(E)*-2-nonenal.

Linoleic acid is a liquid, polyunsaturated, essential fatty acid with two double bonds, which consists in quite large volumes in plant fats and oils (Daintith, 2008) The formula is $C_{18}H_{32}O_2$, the molecular mass 280.2402 and the systemic name 9Z,12Z-octadecadienoic acid (lipidmaps.org). It is an omega-6 fatty acid (McKee and McKee, 2009). Linoleic acid is also precursor for, among other, γ-linolenic acid in animals, and α-linolenic acid in plants (Fokou, 2009).

Linolenic acid is a liquid, polyunsaturated, essential fatty acid with three double bonds in the structure. The fatty acid occurs in certain plant oils (Daintith, 2008) and has two isomers; α-linolenic acid (omega-3 fatty acid) and γ-linolenic acid (omega-6 fatty acid) (McKee and McKee, 2009). In plants, α-linolenic acid can be formed as a result of desaturation of linoleic acid (Fokou, 2009). α-linolenic acid has formula $C_{18}H_{30}O_2$, molecular mass of 278.2246 and systemic name 9*Z*,12*Z*,15*Z*-octadecatrienoic acid (lipidmaps.org).



Linoleic acid



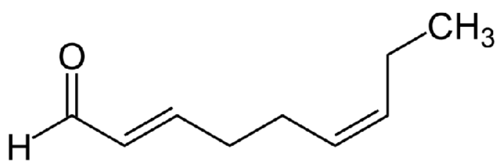
α-linolenic acid

Figure 1.2.2: Linoleic and α-linolenic acid. Drawings from lipidmaps.org

Fleming et al. (1968) found that volatile compounds in cucumber forms as an enzymatically reaction rapidly after tissue disruption. The volatile compounds responsible for aroma in cucumber are determined to be (*E,Z)*-2,6-nonadienal and *(E)*-2-nonenal, whereas it's suggested that (*E,Z)*-2,6-nonadienal stands for most of most of the pleasant "cucumber-like" odour, and *(E)*-2-nonenal has more of a unpleasant astringent note (Forss et al., 1962).

Both (*E,Z)*-2,6-nonadienal and *(E)*-2-nonenal are aldehydes, since they contain a carbonyl group (C=O) with an H atom bound to the C atom, at the end of the carbon chain. Aldehydes are, together with ketones, responsible for the fragrant odours of many perfumes, and fruits (Hart et al., 2007). (*E,Z)*-2,6-Nonadienal has chemical formula $C_9H_{14}O$, and molecular weight of 138.2069, and *(E)*-2-nonenal has formula $C_9H_{16}O$, and a molecular weight of 140.2227 (webbook.nist.gov).

(*E,Z)*-2,6-Nonadienal



(E)-2-Nonenal

Figure 1.2.3: (*E,Z)*-2,6-Nonadienal and *(E)*-2-nonenal. Drawings from ChemSketch.

(*E,Z)*-2,6-Nonadienal is present in approximately 5 times the amount of and *(E)*-2-nonenal in disrupted cucumber tissue, which makes the odour impact of (*E,Z)*-2,6-nonadienal approximately 50 times the one of *(E)*-2-nonenal when considering the odour threshold for the two compounds (Schieberle et al., 1990). Cucumbers are considered the best source for (*E,Z)*-2,6-nonadienal, and most of the amount of (*E,Z)*-2,6-nonadienal in cucumber are located in mesocarp and endocarp tissue, only small amounts have been isolated from exocarp tissue (Buescher and Buescher, 2001).

According to Palma-Harris et al. (2001), no detecteble amounts of either (*E,Z)*-2,6-nonadienal or *E)*-2-nonenal were detected after heating the cucumbers to < 70 °C, which means that the enzymatic reactions forming (*E,Z)*-2,6-nonadienal and *(E)*-2-nonenal from linolenic and linoleic is not functional in high temperatures.

1.3 Cultivation conditions and fertilization

Cucumber is a demanding plant in terms of climatic conditions. Factors as humidity, air temperature and light intensity are critical factors determine crops quantity and quality (Gajc-Wolska et al., 2008). Little is known about effects of environmental conditions on taste and taste related constituentsin cucumber (Verheul et al., 2013)

Light is an important climate condition for greenhouse cultivars. In tomatoes, Canham (1972), concludes that supplemental artificial light is the single most effective factor between the environmental factors CO_2, temperature and supplemental lightning, in both improving plant growth, time to first flower and the early crop.

Fierro et al. (1994)'s results also shows that both seedling growth, quality and volume of yield for tomato and pepper were improved with supplemental lightning and CO_2 enrichment. The results can indicate that the most critical factor was the supplemental lightning, but also CO_2 enrichment increased marketable yield and all yield of tomato and pepper in most of their experiments. Behboudian and Tod (1995) showed improvement of fruit quality parameters in tomato, and longer shelf life on tomato fruits when CO_2 levels were increased.

Supplemental lightning is also shown to promote plant development, increase leaf chlorophyll and photosynthesis, plant biomass, early marketable yield production, increase biomass allocation to fruit, fruit DMC and skin chlorophyll content in cucumber (Hao and Papadopoulos,1999).

Due to low irradiation in spring, cucumber cultivation from summer has a higher yield, and the fruits are measured to have a higher content of, among other, dry matter and total sugars than spring cultivars (Gajc-Wolska et al., 2008)

A cucumbers shelf life is also shown to be affected by the light intensity. Lin and Ehret (1991) found that shelf life of cucumber fruits vary between the different locations of where they grow the plant, and that fruit color at harvest was indicator of the fruits shelf life post-harvest. Further research showed that the lower the light intensity was on a cucumber, the shorter its shelf life was in 13 degree storage (Lin and Jolliffe, 1994). The relationship between longer shelf life when grown in higher light intensities is explained with higher chlorophyll content in the peel of cucumber (Lin and Jolliffe, 1996).

Riga et al. (2008) found that quality of tomatoes was more depended on the daily temperature, than on light intensity. But they also points that the yield decrease if the light intensity decrease. In bell pepper, Ottosen et al. (2003) suggested that the warmest climate initially gave most fruit, but variation in harvests arose probably because of fruit overload causing source/sink imbalance. The fruits in the warmest climate also had slightly lower DMC. They also presented that the best overall results in fruit harvest were obtained during dynamic climate control with minimum night temperature of 17 °C, 80 % photosyntesis and CO_2 levels following the dynamic climate control system.

The concentration of total soluble salts in the hydroponic system is depended on the salinity (from for example the irrigation water) and the contribution from fertilizers. This is referred to as the fertilization level (greenhousegrower.com).

Na^+ and Cl^- ions from the irrigation water (and fertilizer if added there) can further potentially influence the total salt level in fruit. Due to Babu et al. (2012), NaCl levels in tomato fruit increased with increasing NaCl concentration of water added to the growing medium.

Hydrophonic, or soilless, systems were discovered for professional use around 1970. In modern soilless cultures, nutrient solutions contain almost all the necessary nutrition’s for the crop, even though the growing substrates often also contain nutrient elements. But since this nutrient elements are strongly pH depended, and pH not is a stable factor in substrate growing, the availability of this elements are quite uncertain (Sonneveld and Voogt, 2009).

The elements added to nutrient solutions are the macro elements N, P, S, K Ca, Mg, and the micro elements Fe, Mn, Zn, B, Cu and Mo, and the relationship between these elements can then hence be described as the fertilizer composition (Sonneveld and Voogt, 2009).

Essential elements who deliberately not are added to the nutrient solutions are Cl and Ni, (for some plants essential, and for some just beneficial) and Na and Co. Si is not essential, just beneficial for some plants. Cl and Na are usually in high enough concentration in the irrigation water, and are therefore not added. The need for adding Ni and Co are not yet clear, and Si is as mentioned above not considered as essential (Sonneveld and Voogt, 2009). Table 1.3.1 show some of the mentioned elements, and their physiological function.

Table 1.3.1: Some elements with importance for plant nutrition and their physiological function. From Slater et al. (2008).

N	Component of proteins, nucleic acids, and some coenzymes; element required in the greatest amounts
K	Regulate osmotic potential, principal inorganic cation
Ca	Cell-wall synthesis, membrane function, cell signalling
Mg	Enzyme cofactor, component of chlorophyll
P	Component of nucleic acids; energy transfer; component of intermediates in respiration and photosynthesis
S	Component of some amino acids and some cofactors
Cl	Required for photosyntesis
Fe	Electron transfer as a component of cytochromes
Mn	Enzyme cofactor
Co	Component for some vitamins
Cu	Enzyme cofactor; electron-transfer reactions
Zn	Enzyme cofactor; chlorophyll biosyntesis
Mo	Enzyme cofactor; component of nitrate reductase

Also air humidity effects quality of fruits and vegetables. Bakker (1990) found that mean fruit weight and keeping quality were reduced under high humidity conditions for tomato.

1.5 Fatty acid methyl esters (FAME)

GC can be used to analyze either fatty acids in "free form", or as FAME's. In their free form, fatty acids may be hard to analyze because of their tendency to form hydrogen bonds, leading to adsorption problems, and by reducing their polarity they become more readily analyzable. The unsaturated fatty acids are also quite alike, and the polar carboxyl functional groups must be neutralized to distinguish between them (sigmaaldrich.com, guide).

This esterification of fatty acids to FAME, is done by using an alkylation derivatization reagent, and involve the condensation of the carboxyl group of an acid and the hydroxyl group of an alcohol. The reaction is best done with a catalyst, who protonates an oxygen atom of the carboxyl group in the acid, so an alcohol can combines with it, and make a ester (with the loss of water, which the catalyst is removed with). Methyl esters offer excellent stability, and provide quick and quantitative samples for GC analysis (sigmaaldrich.com, guide).

This reaction is also referred to as methanolysis, and makes the fatty acids are more volatile before GC analysis (Schutter and Dick, 2000)

1.6 Head space solid phase micro extraction (HS-SPME)

HS-SPME is a fast and solvent less alternative to conventional sample extraction and injection techniques (sigmaaldrich.com, SPME). It is applied for the determination of a wide spectrum of analytes, in a variety of matrices, but the most common use of the SPME technique are analysis of volatile and semi-volatile compounds in water (Górecki et al., 1999).

SPME makes advantage of compounds establish equilibrium in sample matrix, the space above the sample, and a polymer-coated fused fiber (sigmaaldrich.com, SPME). The molecules of an analyte is first attached to the surface of the SPME coating, and are then, depended on the diffusion coefficient, either extracted into the coating via absorption or migrated into pores of the coating, via adsorption (Górecki et al., 1999).

Sevral types of SPME coating are available:

Coatings which extract analytes via absortion:

The most commonly used are poly(dimethylsiloxane) (PDMS). PDMS is, even though it looks like a solid, a high viscosity rubbery liquid, while poly(acrylate) (PA) is a solid crystalline coating who turns in to liquid at desorption temperatures.

Coatings which mainly extract analytes via adsorption:

PDMS-DVB (divinylbenzene), Carbowax-DVB, Carbowax-TR (template resin) and Carboxen. These are mixed coatings, where the primary extracting phase is a porous solid.

Using adsorption fibre makes quantitative analysis more difficult than if using an absorbing fibre, since the amounts of analyte which are extracted by the adsorption fibre are affected by both matrix composition and extraction conditions. Generally, the adsorption coatings are expected to have best performance in quite clean/or constant matrices, assumed low concentration of analyte (Górecki et al., 1999).

The SPME with the sample are after finishing extraction placed in the GC, so the sample can be desorbed from the fiber to a chromatography column, as the “injection” metod (sigmaaldrich.com, SPME).

1.7 Gas chromatography with flame ionization detector (GC-FID)

Chromatography is separation methods based on the principle that substances which are separated are distributed into two phases; mobile phase and stationary phase. When gas is used as the mobile phase in a chromatographic system, the technique is called gas chromatography (GC). GC gives rapid analyses, high resolving power and detection in ng and pg range, and can mainly be separated into two main categories, depended on the stationary phase: GSC (Gas-solid chromatography) or GLC (gas-liquid chromatography. GLC is most commonly used (Greibrokk et al., 1998).

To use GC as a technique for separating substances, the substances in question has to be volatile and stabile in the temperature range applied, thus, sepration is mainly achived by differences in boiling points. The range in which the compound will move through the column is depended on the compounds volatility, its solubility in stationary phase, and the temperature. When capillary columns (columns with inner diameter of < 1 mm) are used in GC, it is referred to as capillary GC (Greibrokk et al., 1998).

Short described, the GC system in general starts with a gas contained in a high pressure container, which are the mobile phase, in GC called carrier gas. The carrier gas (mobile phase) enters through reducing valves in to the injector and further trough the column and to the detector. The sample in question is introduced through the heated injector, where it evaporates and is brought to the column containing the stationary phase, by the carrier gas. The content in the sample are separated in the column and then passes the detector where electrical signals after reinforcement are written as a chromatogram. A thermostatic oven controls the temperature of the column (Greibrokk et al., 1998).

Carrier gas

The intention of the carrier gas is to transport volatile compounds through the column, without reacting with either the sample or the stationary phase. It should also be fitted to match the detector in use. The carrier gas must be inert, and the most commonly used carrier gasses are nitrogen, hydrogen and helium. It must also have a high degree of purity, since contaminations of for example oxygen or water can damage the column, and traces of hydrocarbons will decrease the sensibility of the FID (Greibrokk et al., 1998).

The type of carrier gas will also influence the analysis time, and the efficiency. The relationship between gas velocity and the columns efficiency are given by van Deemters equation, which is an empirical formula which describes the relationship between plate height (H) and linear velocity (μ). The plate height is the length needed for one theoretical plate, which again is a measure of column efficiency. Smaller plate height values corresponds to greater peak efficiencies (i.e. better separation) since more analyte partitioning then can occur over a fixed length of column (restek.com).

A carrier gas with high molecular weight will give higher plate numbers than one with lower molecular weight. With optimal gas flow, both efficiency and analytical time will diminish as following nitrogen > helium > hydrogen. For example will switching from nitrogen to helium with optimal gas flow decrease the efficiency with 25 %, but the analytical time will also decrease with 40% (Greibrokk et al., 1998).

Optimizing of flow is necessary to increase efficiency and decrease analytical time as much as possible. In praxis, the flow is usually a bit higher than what is optimum for maximal plate number, to make the analytical time shorter (Greibrokk et al., 1998).

Injection system

Most chromatographs have a evaporation injector, which makes introduction of liquids, gas and solids possible. The GC-injector is heated by a thermostatic oven, and the carrier gas is pre-heated to the set temperature before it is directed into upper part of injector. In capillary GC special injection systems are needed, since the columns have low capacity, and maximum 50-100 ng of sample can be injected. The most common injection systems for capillary columns are:

1. Split injection

Split injection is a evaporation injection where the sample evaporates, but is split up before it enters the column, such as most of the sample is ventilated out and never enters the column. Common split ratio are from 1:10 to 1:100. 1:10 means than 1 part is brought to column, and 10 parts are ventilated out. The split ratio are hard to control, and varies with factors as injector temperature, flow, pressure and volume injected.

2. Splittless injection

Splitless injection is an evaporation injection where the total sample volume (~ 95 %) is brought to the column.

3. On column injection

On column injection is a injection method where the sample is injected directly into the capillary column (not a evaporation reaction), and the columns temperature is held lower then the samples boiling point under the injection. The sample is injected through a valve with a syringe. This is a careful way to inject sample since the high temperatures needed for evaporation reactions are avoided. The sample has to be clean and not contain any non-volatile compounds, or else the column entrance will be contaminated (Greibrokk et al., 1998).

Column

Column used in capillary GC are capillary- columns which are used to separate complex mixtures like in, petrochemical, contamination or biological material analysis. The stationary phase is in this column covering the wall. They are between 0,2 and 0,7 mm wide, and have a length of 10 to 100 meters. They have a high plate number, since they don't contain carrier material, and are long. The most ideal columns used in capillary GC are the fused silica columns. They have advantages in being highly flexible, easily manageable and not easily broken despite that they are weary thin (ca 25 μm). They also only contain traces of metal pollution (> 1 ppm) (Greibrokk et al., 1998).

The stationary phase is characterized with a backbone containing silisium and oxygen, and has the general formulae $[R_2SiO]_n$, where the R groups are different organic groups. Silica has good thermic stability and can be used over a wide range of temperatures, but their properties depends on the relationship between SiO and the organic groups (Greibrokk et al., 1998). Examples of columns to be used in capillary GC:

1. SLB™ – 5ms Fused Silica Capillary Column 30 m * 0,25 mm * 0,25 μm film thickness

The column is made by fused silica, and the stationary phase is bonded and highly cross linked silphenylene polymer (virtual equivalent in polarity to poly(5%diphenyl95% dimethyl siloxane)). Its temperature limits are -60 degrees to 340 degrees (isothermal) or 360 degrees (programmed) (sigmaaldrich.com, SLB).

2. Omegawax™ 250 Fused Silica Capillary Column 30 m * 0,25 mm * 0,25 μm film thickness

The Omegawax™ 250 Fused Silica Capillary Column gives highly reproducible analyses of FAME's, especially omega 3 and omega 6 fatty acids. Its stationary phase is bonded poly(ethylene glycol), and its temperature limits are from 50 °C to 280 °C (sigmaaldrich.com, omegawax).

Flame ionizing detector (FID)

The FID is a mass sensitive detector, with selectivity on organic compounds. The principle for a ionizing detector is that the electric conductivity is proportional with the concentration of charged particles in the gas. Briefly described, the carrier gas and sample from the column is mixed with H_2 and combust with excess of air. Between two electrodes (positive charged flame tip, and negatively charged collector electrode) a charge of 300 V is made. Under the combustion in the flame, ions and free electrons are made in the reducing part of the flame. An electrical signal runs in the detector which is proportional with amount of compound which are combusted, and this electrical signal is reinforced by a electrometer and written as a peak (Greibrokk et al., 1998).

The response is here proportional with the mass of compound in the carrier gas:

$S = R_M * C * F$, where R_M is the response factor.

The area is given by the formulae $A = R_M * m * k$, and are not depended by gas velocity, which is a big advantage in quantitative analysis since gas velocity is difficult to properly manage (Greibrokk et al., 1998).

Separation and retention

Variation in velocity is the basis for a chromatographic separation, and is determined by the compounds equilibrium distribution between stationary and mobile phase, and the speed witch the compound used through a column are decided by the fraction of the compounds molecules in mobile phase. This speed are again determinated by the composition of mobile and stationary phase, and the temperature. At the end, the different compouns will reach the end of the column, and the detector will measure its consentration in mobile phase as a function of seperation time. This gives the chromatogram (Greibrokk et al., 1998).

A chromatogram has characteristic features important to describe the result of the separation. Retention time (t_R), which is the characteristic time in which each bond comes out of the column, measured from when sample is applied on column to the maximum of band leaves detector. The retention time are used to identify the compound. In addition, bandseperation is another importante separation feature. Bandseperation is the difference in retention time between nearby band (t_R for compound A – t_R fr compound B). The lager the difference, the better separation of bands (Greibrokk et al., 1998).

Quantitative analysis

Since it is difficult to inject µL in GC with good reproducibility, quantitative analysis is usually preformed with internal standard who compensate for variations in injected amount. Internal standard can also be used to correct for variation in the chromograpic system during analysis, and for variations during obtaining the sample (Greibrokk et al., 1998).

A standard curve is made after analyzing solution with known weight of compounds to be analyzed and internal standard. The area of the peeks (or height of them) is plotted against the weight. When known amount of internal standard then is added to samples to be analyzed, the peek-area (or height) relationship can be determined, and the weight relationship can be read from the standard curve, and the sample amount calculated (Greibrokk et al., 1998).

The internal standard should:

- Be separated from other compounds in sample
- Have retention time close to the compound who should be determined
- Behave as compound who should be determined
- Not be present in the sample
- Be stable
- Be available in pure form

(Greibrokk et al., 1998).

2. Materials and Methods

2.1 Harvesting and laboratory analyzes

2.1.1 Harvesting of cucumbers

A total of 337 cucumbers samples (6-9 cucumbers pr sample) from 9 different producers (5 in Rogaland and 4 in eastern Norway (Lier and Østfold)), and harvested 4-6 times during the production period were analyzed in regarding to appearance, firmness and constituents. Additional 48 cucumbers were harvested for customer taste testing, and 21 for sensory tasting at Nofima. Cucumber were harvested in the time period between 16.09.2013 and 10.12.2013. Table 2.1.1.1 shows an overview over the different producers participating in this study, the cucumber varieties used, planting date and installed light level in greenhouse.

Table 2.1.1.1: Overview over producers, cucumber varieties, planting dates and installed light level in watt/m^2

Producer's Nr.	Producer	Cucumber variety	Planting date (2013)	Installed light level (W/m2)
P1	Aase gartneri	1-Rapides 2-Keirin 3-Shakira	1/9	0
P2	Johannes Wiig	4-Eminent 2-Keirin 3-Shakira	15/8	-
P3	Jone Wiig	1-Rapides 2-Keirin 3-Shakira	19/8	240
P4	Kåre Wiig	1-Rapides 2-Keirin 3-Shakira	1/10	178
P5	Norsk Agurk	1-Rapides 2-Keirin 3-Shakira	1/10	220
P6	Guren gartneri	1-Rapides 2-Keirin	Uke 35	110
P7	Sandaker gartneri	1-Rapides 2-Keirin	Uke 35	230
P8	Kikut gartneri	1-Rapides 2-Keirin	Uke 35	230
P9	O. Espedal	1-Rapides 2-Keirin	5/9	110

For analysis, cucumbers were harvested 2, 4, 5, 6 and 8 weeks after planting (harvest number 1,2,3,4 and 5). Taste testing was performed on cucumbers harvested 21.10.2013 and 28.10.2013.

It is assumed that cucumbers grown in greenhouses of different producers in Norway will experience different environmental conditions, both outside and inside the greenhouse. Moreover, cucumbers will experience different conditions during the production period in autumn, when outside conditions are changing drastically. Cucumbers with a weight of 300 g (± 20 g) and a length of 30 cm (±5 cm) were individually labeled and numbered, while the light conditions (PAR) were measured with a HD 9021 Quantum Photo/Radiometer.

Light was t measured on the stem of the labeled cucumber, and just above the top of the plant. For each labeled cucumber, the light measurements were also done on the stem of a cucumber that could have been harvested, and the top of the plant were it grew.

Measurements were used to calculate the reduction in light (%) from the top of the plant to the harvested cucumber. To minimize the sources of error caused by shadowing at the exact moment of harvesting, the average values for the two measurements on top of plant, and the two measurements on cucumber stem, were used to calculate the reduction in light from top of plant down to cucumber, for each individual cucumber which was harvested.

Date and time were written down before starting harvesting the cucumbers. The fruit stalk was cut with a sharp knife, the weight of the cucumbers measured with an accuracy of 0,5 g, and the length measured with an accuracy of 0,5 cm.

On each harvesting, the EC and the pH was measured both from irrigation water and drain water in the greenhouse, using an EC (Priva) and a pH (Priva) meter.

2.1.2 Appearance and dry matter content (DMC)

To determine the color of the cucumber skin, a standardized color-card (Munsell) was used. The color was determined visually, and given as color- character between five (who is a very light color) and nine (who is a thoroughly dark grass-green color).

The cucumber was cut in the middle and 3 slices of about 3 mm each were cut off and weighed on accuracy weighing. In order to determine the dry content of the slice samples, the samples were inserted into a drying cabinet at 60 degrees Celsius for

48 hours. Dry weight and water contents were measured by weighing the samples once again, and DMCwas calculated.

2.1.3 Measuring of soluble solid content, salts and pH

The reminding cucumber was added in a one liter plastic container and blended with an immersion blender until the mixture was uniform. One tea spoon of the mixture was added on a Palette PR-101α digital refractometer for measurements of content of SSC (soluble solid content), which is an indicator for sugar content. The Palette PR-101α digital refractometer gives the SSC in % Brix, which can roughly be used as content of sugar in per cent.

The measuring cup on a Priva EC-meter was then filled with the mixture and the total salt level in the mixture, given in mS cm-2 was measured.

pH was measured in the reminding mixture, using a Priva pH-meter. A calibration curve using some measurements also from instrumental titration with a Metrohm 794 Basic titrino was supposed to be created to be able to calculate acid content in CAE/100g. However, this could not be done (sources of error and appendix 2), so the pH measurements were used as an indicator of acidity in the cucumbers.

2.2 Statistics, calculations and data processing

The statistics are based on measurements and analysis of two varieties (Rapides and Keirin) cucumbers since they were grown by all producers, except for P2.

P2 used a climate control system not compatible with excel, which meant that if the data should be used, it had to be manually put in to excel. Since P2 did not cultivate Rapides at all, it was not an option to manually put in values for each 5 minutes for a period over +/- 8 weeks, when the lack of Rapides already would represent a potential source of error, so P2 is therefore excluded from the statistical analysis.

Analysis of variance was performed on in total: 8 production environments x 2 varieties x 5 harvests x 3 replications = 240 samples. Thus, 234 (6 missing samples) of 337 of the analysed cucumbers were included in the statistics analysis. Few parameters were missing, for some producers at some harvests, n-values will show were. All measurements and data used in the statistics are included in appendix 1.

Calculations and data processing

Since it is not known in what extent climatic conditions can influence taste related constituents, correlations were calculated for measurements over different periods of time: at harvest day, harvest day +1 day before, harvest day +2 days before, harvest day +4 days before and harvest day +8 days before.

All calculations based on climatic data are calculated with the day beginning at 8.30 am., so;

- Calculations from harvest day are done from 8.30 am, until time of harvest.
- Calculations for +1 day are done from 8.30 the day before harvest, until time of harvest.
- Calculations for +2 days are done from 8.30 two days before harvest, until time of harvest.
- Calculations for +4 days are done from 8.30 four days before harvest, until time of harvest.
- Calculations for +8 days are done from 8.30 eight days before harvest, until time of harvest.

Eg.

- +8 average is average for the last 8 days prior to harvest.
- +8 min is the minimum measured in the last 8 days prior to harvest.
- +8 max is the minimum measured in the last 8 days prior to harvest.
- +8 Δmin/max is the difference between minimum and maximum measured in all the last 8 days prior to harvest.

DLI

The DLI (plant) is the daily light integral (in mol/m^2/day) reaching the top of the plant stand and was calculated as the sum of global radiation (Watt/m^2) measured outside the greenhouse x 2.3 (calculation from Watt/m^2 to µmol s-1m-2 PAR) x 0,7 (estimated greenhouse transmission coefficient) and the PPFD (Photosynthetic photon flux density in μmol s-1m-2) of the artificial light installed in the greenhouses.

The DLI (fruit) estimated the daily light integral reaching the fruit and was calculated by multiplying the DLI (plant) with the reduction factor calculated from light measurements just above the top of the plant and at the height of harvested cucumber fruits.

CO_2 and temperature

CO_2 and temperature were calculated directly from the registrated climatic data as mentioned above. CO_2 is calculated in ppm, and temperature in °C.

VPD

Some climatic data gave the VPD in g/m^3 directly, while others (P5, P6 and P7) did only measure RH in per cent in their climatic control system. The average VPD for harvest day, +1, +2, +4 and +8 days were then hence calculated from RH values and temperature, using table derived from Bævre and Gislerød (1992).

EC and pH

The pH and EC were measured in irrigation water and drain water at the time of harvest, and used in the statistics without further processing.

Statistics

In the present experiment, Pearson’s correlation coefficient (Pearson’s r) was used to estimate relations between environmental conditions and taste parameters.

Pearson's correlation coefficient between two variables is defined as the covariance of the two variables divided by the product of their standard deviations. How high the Pearson's correlation coefficient must be to be significantly different from zero, depends on the sample size, se Figure 2.2.1 (wikipedia.org, Pearson). Since the sampling size in this assignment is quite large (≈234), the Pearson's correlation coefficient can be quite low (around (negative or positive) 0,13) to be significantly different from zero (p < 0.05). Further, Pearson's correlation coefficient also shows if the trend is positive or negative, depended if the value is positive or negative.

The R^2 value on the other hand, explains how much of the variance in a dataset who is explained by the model, where $R^2 = 1$ indicates that the fitted model explains all variability, and $R^2 = 0$ indicates no 'linear' relationship (wikipedia.org, R^2)

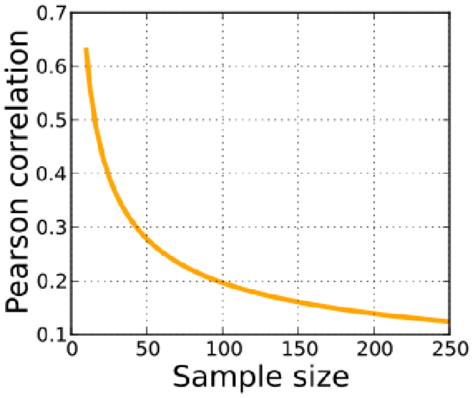


Figure 2.2.1: Minimum value of Pearson's r that is significantly different from zero at the 0.05 level, for a given sample size. Figure from wikipedia.org, Pearson.

The experimental design included eight producer environments, two varieties, four-six harvests and three replications. A variation analysis (ANOVA, fitted GLM) were also performed in Minitab (v. 16) to find if there were significant variations between cucumbers from different producers and the environmental factors in the greenhouse.

Data were then subjected to analysis of variance (ANOVA) using the GLM procedure from the SAS program (v. 9.2). The Student Newman Keuls (SNK) multiple range test was used to determine significant differences among varieties and environmental conditions for the measured parameters (weight, length, color, and taste related parameters; SSC, EC, pH and dry matter content) at a level of significance of P < 0.05. ().

Minitab (v. 16) was used to check that the data were normally distributed (in a probability plot), before a Pearson correlation test was performed between all the physiochemical parameters mentioned above, and all relevant information about cultivation conditions obtained from both measuring conducted in greenhouses and climate data's. The correlation test showed p-values and Pearson's correlation coefficient (Pearson's r). Pearson's r were then squared (R^2), to find how much of the variation who could be explained with the correlations.

2.3 Taste and sensory tests

Taste testings were performed twice at Bioforsk Vest Særheim, and twice at Regnskapslaget. Each test included 12 test persons, giving 48 parallels totally. First test in both places missed cucumbers from producers 4 and 8, so for these two producers there were only 24 parallels available.

The taste testing was performed with handing out one slice of cucumber from each producer in a small plastic disc to each test person. The discs were placed on ordered sequence which was different for each person, to avoid that individual preferences could be influenced by other persons in the test.

Each test person was given a feedback form (appendix 3.1). The form asked the test persons age and gender, and to rate each cucumber slice with a grade between -3 and +3, where -3 was really bad taste, 0= neutral and +3, really good.

Sensory testing was performed once at Nofima, with their trained sensory judges. Here cucumbers were given scores between 1 and 9 for different qualities regarding taste, smell and consistency.

In both taste and sensory testing, cucumbers of the variety Rapides, between approximately 280 and 320 g, and about 30 cm long from all producers except from P2 were used. From P2 the variety Keirin was used in both sensory and taste testing. In sensory testing, cucumbers from P4 and P8 were not delivered in time and therefore excluded. .

2.4 GC-FID analysis for aroma and fatty acids

In order to improve chromatographic methods, 125 GC-analysis were done while adjusting method, and finally analyze samples in regard to aroma compounds, and 70 GC-analysis when learning method, and analyze, in regard to the fatty acids.

In each of the final GC-FID analysis ((HS-SPME)GC-FID analysis of aroma compounds and (FAME)GC-FID analysis of fatty acids) of cucumbers, three cucumbers were analyzed from each type except for Cadence, where seven cucumbers were analyzed, giving the total of (3 x 6 + 1) x 2 = 38 cucumbers used in the analysis. Cadence was used to examine how the plants age affected the concentration of the compounds, and also to examine if the method is replicable.

Cucumber varieties which were expected to differ from each other were selected to the analysis, and the types of cucumbers which were used are presented in Figure 2.4.1 and 2.4.2.

Figure 2.4.1: The three first cucumber varieties used in GC analysis. From left; Cadence planted 10/3, Cadence planted 21/4 and Quatro, respectively.

Figure 2.4.1: The three last cucumber varieties used in GC analysis. From left; E23C.2201, Incas and SV4097CV, respectively.

2.4.1 (HS-SPME) GC-FID analysis of aroma compounds ((*E,Z)*-2,6-nonadienal and *(E)*-2-nonenal)

Sampling and sample preparation

To try to gain as much as possible of the aroma compounds, different treatments on the cucumber samples were used: Addition of different amounts of NaCl (0, 5 and 10 per cent NaCl), sampling on a variety of temperatures (5, 22,9, 30 and 50 degrees celsius) and using different SPME fibers, ((DVB/CAR/PDMS, 50µm/30µm) and (PDMS, 100µm), Fused silica/SS).

The most efficient sampling method was then chosen after evaluating the results from the different treatments:

Cucumbers around 30 cm long, and with a weight of around 300 (± 20) g were harvested in greenhouses from a local producer. The sampling was done in high room temperature, of 26,0 – 26,3 °C.

50 g cucumber was weight on a kitchen weigh, and added to a glass container. Then 11 g NaCl were weight with precision balance, and added to the container, together with 50 mL of distilled water measured in a graduate cylinder, and 10 µl of a standard

solution containing 9,9 mL methanol and 100 μL decanal were added using a variation volume pipette, giving 1 ppm amount of decanal as internal standard in the sample.

The sample was then blended into a uniform slurry, using a immersion blender. A magnet were added before the glass container were closed with a Petri-film, and stirred for 5 minutes on a magnetic stirrer. After 5 minutes, a small hole were made in the Petri-film, and 10 mm length of the SPME fiber were exposed to the still stirred sample for 3 min. The SPME fiber used was a DVB/CAR/PDMS from Supelco, hold in a 25 mm funnel stem by a rigged stand with utility clamps

Calibration and response time

To be able to quantitative calculate the amount of (*E,Z)*-2,6-nonadienal and *(E)*-2-nonenal in the cucumber, a calibration curve were determinate. This by adding different amounts (0,1 to 5 ppm) of a standard solution to 100 mL distilled water, and give the sample the same treatment as the cucumber samples. The standard solution contained equal amount of (*E,E)*-2,6-nonadienal (since no (*E,Z)*-2,6-nonadienal were not available, and the two compounds have approximately the same properties), *(E)*-2-nonenal and decanal (100 μl each), resolved in 9,7 mL methanol.

To be able to determine when the response time for the two aldehydes, and then hence determine which peak in the chromatogram that were which fatty acid, two standard solutions were made, one containing 1 ppm of (*E,E)*-2,6-nonadienal and one containing 1 ppm of *(E)*-2-nonenal, further prepared and analyzed the same way as the cucumber samples.

Chemicals used in standard solutions

- (*E,E)*-2,6-nonadienal (sigma-aldrich, p.code: 1001709648)
- *(E)*-2-nonenal (sigma-aldrich, p.code: 101116394)
- decanal (sigma-aldrich, p.code: 1001216259)

(HS-SPME) GC-FID analysis

A GC-2014 Shimadzu Gas Chromatograph with a FID (flame ionization detector) was used to analyze the samples.

The sample which were extracted on the SPME fibre were injected to the machine through the injection port and absorbed in 10 minutes at 250 °C before the fibre were removed. The injection mode were spilt, and the split ratio used were 10.

The column used were a SLB^{TM} – 5ms Fused Silica Capillary Column (30 m * 0,25 mm * 0,25 µm from Supelco). The temperature program was as followed in Table 2.4.1 underneath, with a max temperature of 150 °C. The total run time of the program were 26,96 minutes.

Table 2.4.1: Column temperatures at different times

Temperatuere °C	Rate (per min)	Hold time (min)
60	0	5
85	3	0
95	1	0
150	40	0
60	-40	0

No detectable carry over after sample desorption was discovered.

Calculations

The standard curves derived from (HS-SPME) GC-FID analysis of standard samples were used to calculate the ppm (*E,Z*)-2,6-nonadienal and (*E*)-2-nonenal in ppm FW in cucumber, with using decanals area's in the cucumber analysis together with the standard curves for both (*E,E*)-2,6-nonadienal and (*E*)-2-nonenal.

The standard curve derived for decanal had to big deviations, so a "true value" for decanal were used instead, calculated from the average of all cucumber samples = 37786,7. Decanal is then hence still used as a internal standard, but the results are weighted, so the concentrations of decanal is not considered, but only a relative number value. This gives not a true internal standard, but an average value much more like the true value.

Amount of decanal used as internal standard in samples were 1 ppm.

Calculation example for concentration of (E,Z)-2,6-nonadienal:

Average decanal in all samples/ area decanal in sample

1. Put in area value from (HS-SPME)-GC analysis into formulae derived from (*E,E*)-2,6-nonadienal standard curve, and calculate to find x (ppm)
   y = 72972x + 4685,8

2. Then;
   - divide with area decanal in sample
   - multiply with average decanal in all samples

Then concentration of (*E,Z*)-2,6-nonadienal are given in ppm

Same calculation were done for (*E*)-2-nonenal, only using areas found for (*E*)-2-nonenal instead of the ones for (*E,E*)-2,6-nonadienal, and formulae derived from (*E*)-2-nonenal standard curve: y = 180062x – 15900

Standard curves are found in appendix 5.

2.3.2 (FAME) GC-FID analysis of fatty acids (linoleic- and linolenic acid)

Sampling and sample preparation

Cucumbers around 30 cm long, and with a weight of around 280-320 g were harvested in greenhouses from a local producer. They were then heated for 80 °C in 20 minutes to stop all enzymatic activity necessary to gain voltaire flavor compounds. The cucumbers were then sliced in the middle, on its whole length, and put in a drying cabinet for 72 hours on 60 °C.

After completed drying, the cucumbers were minced with using a mortar.

Internal standard solution were made by accuracy weighing 0,0317 g heneicosanoic acid and add to 33 mL dichloromethane in a clean and dry test tube with screw cap and gasket.

1 mL (giving 960 µg/mL) of internal standard solution was then added to a new clean and dry test tube with screw cap and gasket, and dichloromethane were evaporated

using a hot plate. When the dichloromethane had evaporated, 100 mg of the minced cucumber powder were weight using accuracy weighing and added, to the test tube containing internal standard. Then 600 µL of anhydrous methanol containing 2 M HCl were added, and the screw cap with gasket was carefully tightened. After 30 minutes, the test tubes were checked for leaks, and then left for boiling over night.

Next day the screw cap were opened and methanol evaporated, 600 µL of distilled water and 1,5 mL of hexane were added. The screw cap were closed, and the test tube mixed with vortex mixer, and centrifuged for 5 minutes on strenght 5. The top layer were then transferred to a new clean and dry test tube. To the bottom layer there were added 1,5 mL hexane, the screw cap was closed and the test tube mixed with vortex mixer and centrifuged for 5 min on strenght 5. The top layer was then added to the same test tube as the other top layer. The content of the two top layers were evaporated down to 0,5 mL using test tube block heater, and the reminding 0,5 mL were added to 2 mL sample bottles who were then ready to be analyzed.

Calibration and response time

To be able to quantitative calculate the amount of Linoleic and linolenic acid in the cucumber, a calibration curve were determinate. This by adding equal amounts of linoleic acid, linolenic acid, and heneicosanoic acid to heksan, giving a total 3 mL sample. Different standard samples were prepared, containing concentrations of the three compounds as listed in Table 2.4.2 underneath.

Table 2.4.2: Standard solutions used to make calibration curves.

Sample	Linoleic (µg/mL)	Linolenic (µg/mL)	Heneicosanoic acid (µg/mL)
1A	398	389	389
2A	780	761	761
3A	1179	1150	1150
4A		1523	1523
5A			1905
6A			3807
7A			7630
8A			15244

To be able to determine when the response time for two fatty acids were, and then hence determine which peak in the chromatogram that were which fatty acid, two standard solutions were made, one containing 10 mg of linoleic acid, and one containing 10 mg of linolenic acid, further prepared and analyzed the same way as the cucumber samples (see above)

Chemicals used in standard solution

- linoleic acid (sigma-aldrich, p.code: 1001509442)
- linolenic acid (sigma-aldrich, p.code: 1001346497)
- heneicosanoic acid (sigma-aldrich, p.code: 1001614383)

(FAME) GC-FID analysis

A GC-2014 Shimadzu Gas Chromatograph with an AOC-20i Auto injector from Shimadzu with a FID (flame ionization detector) was used to analyze the samples.

The injection temperature was 250 °C, and injection volume 1,0 µL using a 10 µL syringe. Two rinses with solvent were used on the syringe before injection, and one rinse after injection. Two rinses were also used on the syringe with sample before sample injection. The column used were a Omegawax^{TM} 250 Fused Silica Capillary Column 30 m * 0,25 mm * 0,25 µm film thickness from Supelco). The temperature program was as followed in Table 2.4.3 underneath, with a max temperature of 275 °C. The total run time of the program were 15 minutes.

Table 2.4.3: Column temperatures at different times

Temperatuere °C	Rate (per min)	Hold time (min)
175	0	2
275	10	0
175	-50	1

No detectable carry over after sample desorption was discovered.

Calculations

The standard curves derived from (FAME) GC-FID analysis of standard samples were used to calculate the mg/100g FW of linoleic and linolenic acid in cucumber, with using heneicosanoic acids area's in the cucumber analysis together with the standard curves for bot heneicosanoic acid, linoleic acid, and linolenic acid:

Amount of heneicosanoic acid used as internal standard in samples were 960 µg/mL.

<u>*Calculation example for concentration of linoleic acid in mg/100g FW:*</u>

1. Calculate area (y) of heneicosanoic acid when concentration is 960 µg/mL (x) with using formulae derived from heneicosanoic acids standard curve:

   y = 442,01x - 164267

   (y (when x = 960 µg/mL)) / (y heneicosanoic acid found in sample))

   * (y linoleic acid found in sample)

2. Put in area value derived into formulae derived from Linoleic acids standard curve, and calculate to find x (concentration in µg/mL)

   y = 320x - 5977,3

3. Then;
   - multiply concentration found in with 0,5 ml (size of sample),
   - divide with amount of dried cucumber sample,
   - multiply with (100/DMCin sample)
   - multiply again with 10, to get concentration in mg/100g FW.

Same calculation were done for linolenic acid, only using areas found for linolenic acid instead of the ones for linoleic acid, and formulae derived from linolenic acids standard curve: y = 328,92x – 31775.

Standard curves are found in appendix 5.

3 Results

3.1 Environmental conditions (DLI, temperature, CO_2 VPD, EC and pH) measured in different greenhouse environments (average of eight days before harvesting)

Results show that environmental conditions vary for the different greenhouse environments and different harvesting dates. Only average environmental conditions over eight days before harvesting are shown (average of 4-6 harvests).

The daily light integral reaching the top of the plants (DLI (plant)) was significantly different in different greenhouse environments (ANOVA, Fitted GLM, df=7, F=136.77, P<0.001), ranging from 10- to 31,7 mol/m2/day (Figure 3.1.1)

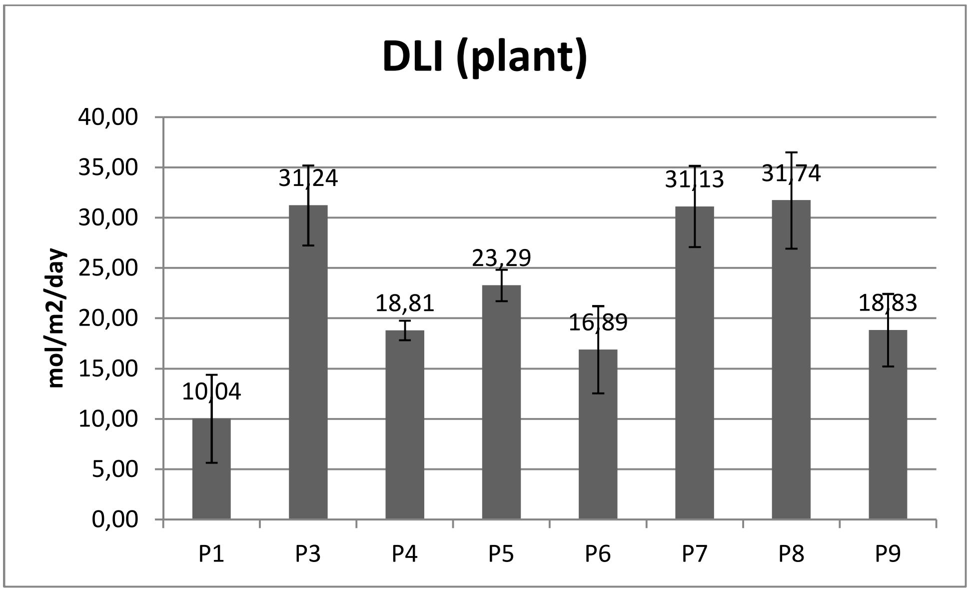


Figure 3.1.1. Average DLI(plant) (and standard deviations) for the last 8 days prior harvesting at different Norwegian producers of cucumber. n=24 (P4,P8), n = 27 (P5), n = 30 (P3,P6,P7,P8), n= 33 (P1)

Figure 3.1.2 shows the estimated average daily light integral that reaches the fruit the last 8 days before cucumbers were harvested. DLI (fruit) from the different producers varied significantly (ANOVA, Fitted GLM, df=7, f=2,46, p=0,019).

The results demonstrate a major reduction in light intensity from the top (DLI (plant)) of the plant to the site of the fruit (DLI fruit), and varied from 1,56- 4,62 mol/m^2/day among the different greenhouse environments.

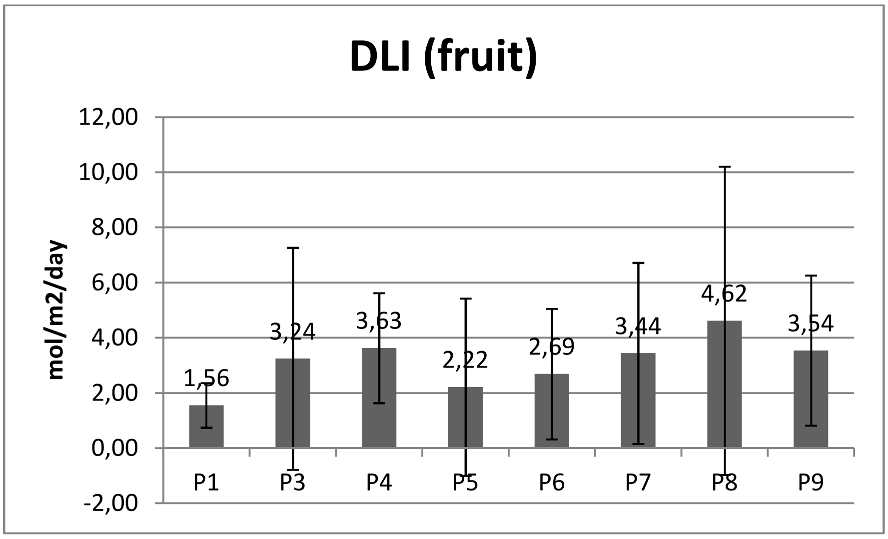


Figure 3.1.2. Average DLI(fruit) (and standard deviations) for the last 8 days prior harvesting at different Norwegian producers of cucumber. Numbers are estimated from DLI top of plant (figure 3.1.1.) by using a reduction factor based on PAR results. n=24 (P4,P8), n = 27 (P5), n = 30 (P3,P6,P7,P8), n= 33 (P1)

Figure 3.1.3 shows the average temperature during the last 8 days prior to harvesting . The differences between producers were significant (ANOVA, Fitted GLM, DF=7, F=163,85, $p<0,001$).The average temperature ranged from 19,4 to 25°C in the different greenhouse environments.

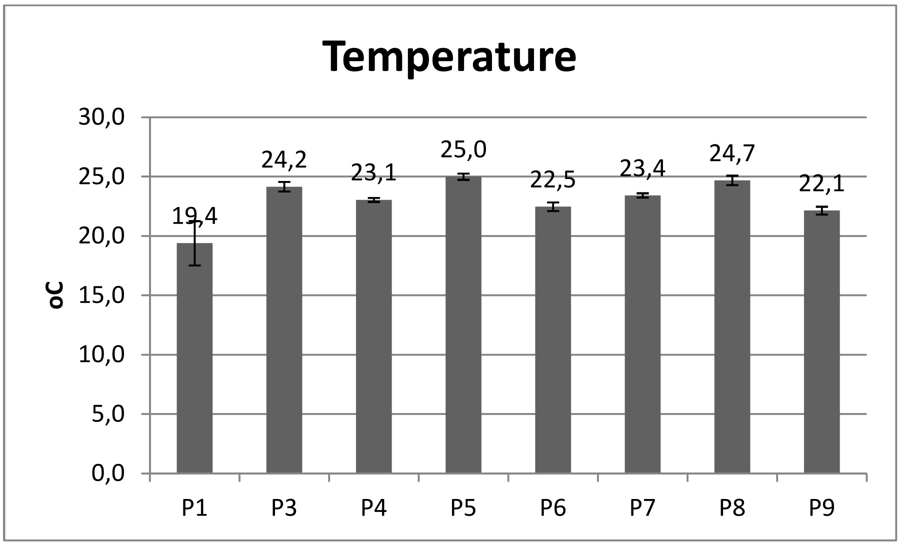


Figure 3.1.3: Average daily temperature in °C (and standard deviations) in greenhouses of the different producers measured over eight days prior harvesting. n=24 (P4,P8), n = 27 (P5), n = 30 (P3,P6,P7,P8), n= 33 (P1)

CO_2 levels (Figure 3.1.4) measured as average ppm the last 8 days prior to harvesting varied significantly among the different producers (ANOVA, Fitted GLM, Df=7, F=480.94, $p<0.001$), ranging from 376 to 1030 ppm.

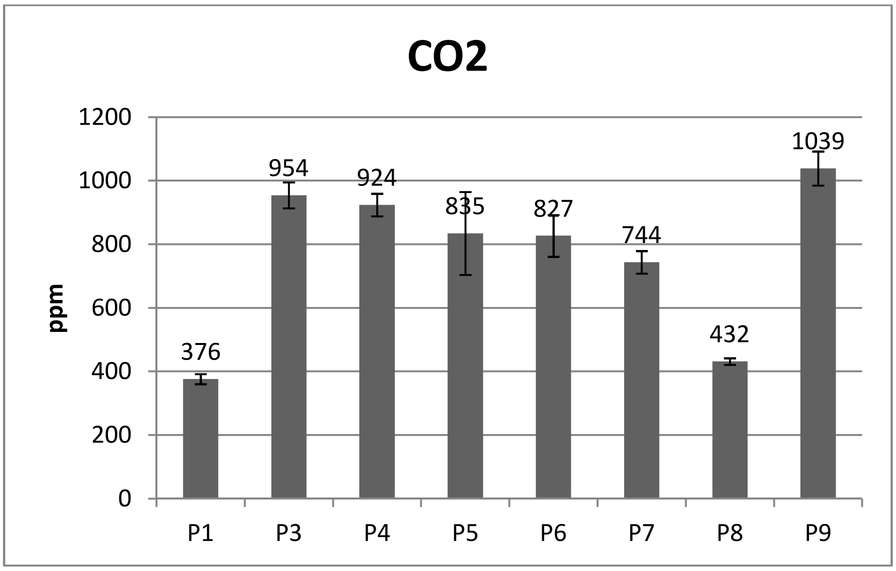


Figure 3.1.4: Average CO2 levels in ppm (and standard deviations) in greenhouses of the different producers measured over eight days prior harvesting. n=24 (P4,P8), n = 27 (P5), n = 30 (P3,P6,P7,P8), n= 33 (P1)

Figure 3.1.5 shows the average vapour pressure deficiency (VPD) for the last 8 days before cucumber was harvested. The variability in VPD among the greenhouses of the eight producers where highly significant (ANOVA, Fitted GLM, Df=7, F=97.91, P<0.001), and varied from 2,64 to 9,03 g/m^3.

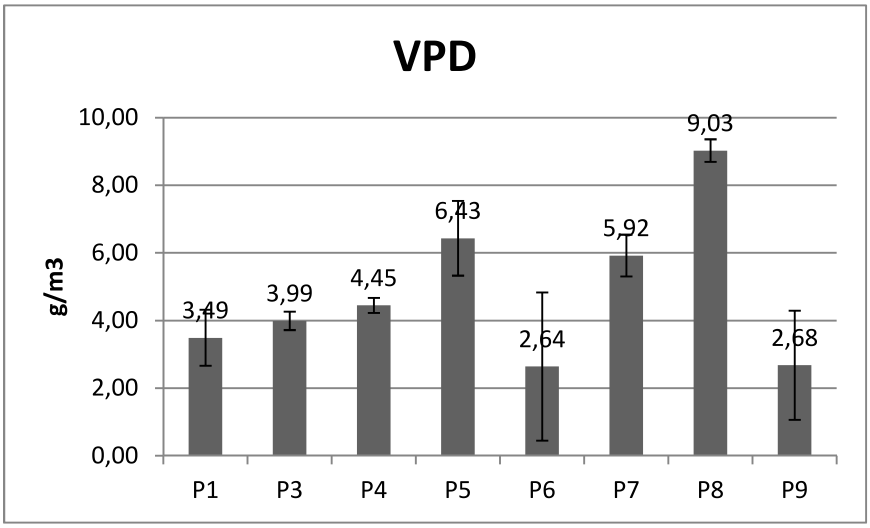


Figure 3.1.5: Average VPD levels in g/m3 (and standard deviations) in greenhouses of the different producers measured over eight days prior harvesting. n=24 (P4,P8), n = 27 (P5), n = 30 (P3,P6,P7,P8), n= 33 (P1)

Average EC at the day of harvest were significantly different among producers of cucumber for both drain water (ANOVA, Fitted GLM, DF=7, F=91.43, p<0,001) and for irrigation water (df=7, F=53.09, p<0,001). Average EC measurements for drain water ranged from 2,13 to 4,94 mS, and were higher than for irrigation water (who ranged from 2,5 to 3,62 mS) in six of the eight greenhouse environments, (Figure 3.1.6.).

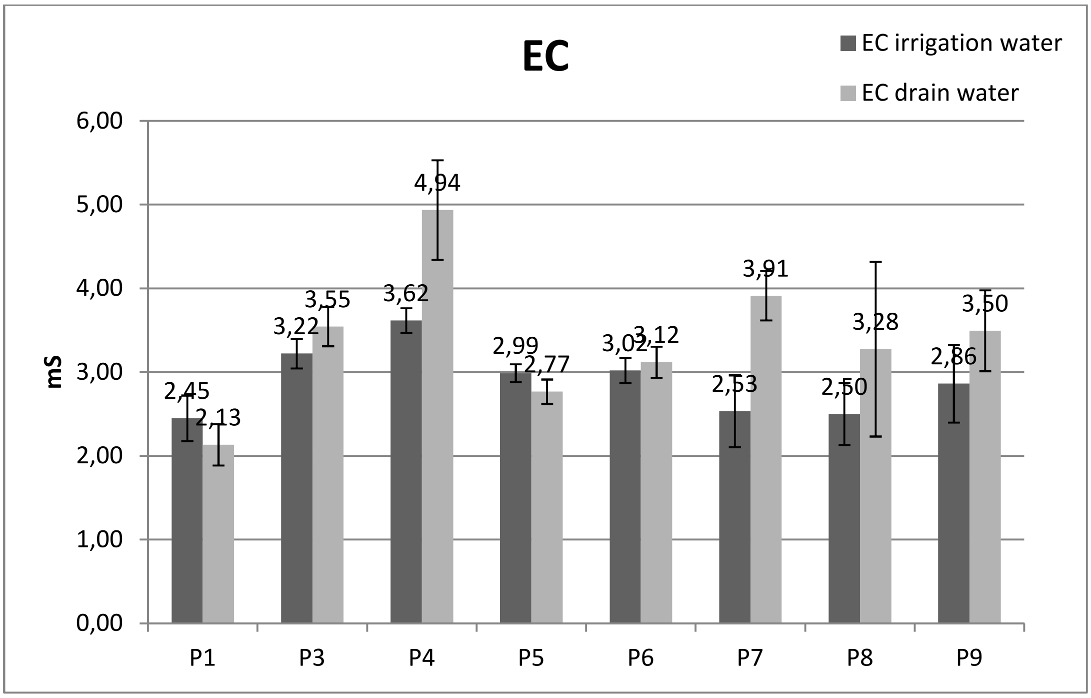


Figure 3.1.6. Average EC levels from irrigation and drain water (and standard deviations) from the different producers measured at day of harvest. Drain water: n=4 (P8,P9), n= 5 (P3,P4,P5,P6,P7), n= 6 (P1). Irrigation water: n=4 (P3, P8, P9), n=5 (P1,P4,P5,P6,P7)

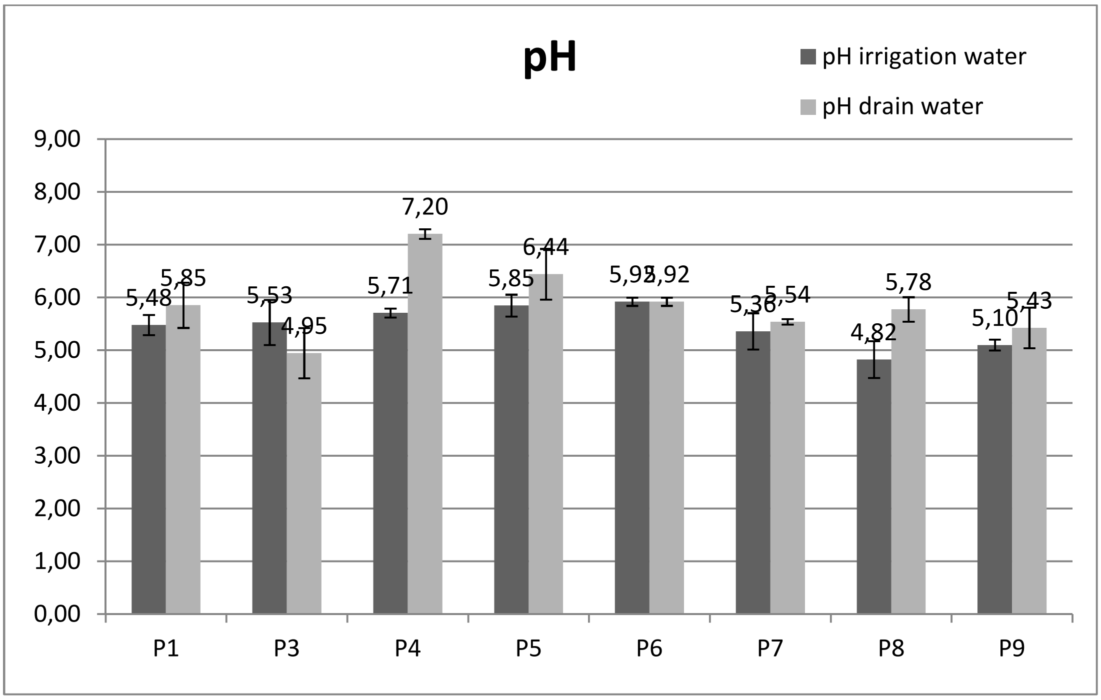


Figure 3.1.7: Average pH levels from irrigation and drain water (and standard deviations) from the different producers measured at day of harvest. n=4 (P8,P9), n= 5 (P3,P4,P5,P6), n= 6 (P1, P7). Irrigation water: n=4 (P3, P8, P9), n=5 (P1,P4,P5,P6,) n=6 (P7)

Figure 3.1.7 shows the average pH at day of harvest for the different greenhouse environments. The variation between producers were significantly different for both irrigation water (ANOVA, Fitted GLM, df=7, F=53.09, p<0,001) and for drain water (df=7, F=126.16, p<0,001). Average pH measurements for drain water ranged from 4,95 to 7,2, and were higher than for irrigation water (who ranged from 4,82 to 5,92) in six of the eight greenhouse environments.

3.2 Variations in appearance and constituents for cucumber varieties grown by different growers and harvested at different periods of time after planting

Table 3.2.1: Pr > F values from GLM procedure (SAS) Producers P1, P3-P9. Variety: Rapides & Keirin. Harvest number (1-6). n= 228 (weight, length, color, SSC, pH, EC) n= 186 (DMC)

	Weight	Length	Color	SSC	pH	EC	DMC
Producer	< 0,0001	<0,0001	< 0,0001	< 0,0001	< 0,0001	< 0,0001	< 0,0001
Variety	0,7153	0,0068	0,0448	0,6804	0,8041	0,3610	0,4597
Harvest number	0,0295	< 0,0001	0,0463	< 0,0001	< 0,0001	< 0,0001	< 0,0001
Producer * Variety	0,2529	0,5568	0,0287	< 0,0001	0,0231	0,0674	0,0108
Producer* Harvest number	< 0,0001	< 0,0001	< 0,0001	< 0,0001	< 0,0001	< 0,0001	0,0007
Variety * Harvest number	0,4762	0,6325	0,0842	0,6924	0,3634	0,2333	0,3079

Table 3.2.1 above shows Pr > F values derived from GLM procedure in SAS. Using 95 % confidence interval (Pr > F = ≤ 0,05), this results showed that there were variance in the data, that could be further studied.

Since there was no significant variation between the different varieties of cucumbers regarding potential taste attributes (SSC, pH and EC, Table 3.2.1), Rapides and Keirin (who were grown at all producers accept for P2) were treated as one homogenous group, both experimentally and statistically.

3.3 Correlations between appearance and constituents and cultivation conditions

In order to evaluate effects of the different environmental conditions (DLI, temperature, CO_2, VPD, and EC and pH in drain and irrigation water) on the appearance and constituents of cucumber, a Pearson correlation test were performed in Minitab. The results from this correlation tests are presented where the significance level is $p \leq 0.05$.

The results show many actual correlations between different measurements/ analysis of parameters regarding appearance or constituents, and many of the climatic conditions measured in the greenhouses, or derived from climatic dataset from the producers.

Table 3.3.1 to 3.3.35 presents p-values and Pearson's correlation coefficient from the correlation test, together with its regression coefficients (R-square values) where p is considered to be significant (≤ 0,05). Where p > 0,05, the value is only referred to as NS (non significant). Depended on if the Pearson's correlation coefficient is negative or positive, the trend is also negative or positive.

Correlations between appearance/constituents and daily light integral (DLI)

P-values derived from correlation test in Minitab shows some correlations between DLI(fruit) and length, color, EC, pH and DMC, and between DLI(plant) and weight, color, SSC, and EC, and only a few correlation with length and pH. But the R^2 values are low (R^2= 0,18) for all correlation tests regarding morphology/constituents and DLI.

The correlations between DLI and the various parameters, including weight, length, SSC, pH, and dry matter content, showed that a relatively small proportion of current variations could be explained by this particular statistical model (Table 3.3.1, 3.3.2, 3.3.4, 3.3.5 and 3.3.7). More important, the DLI seemed to explain a larger proportion of the variation in color (Table 3.3.3.) where color seems to be most influenced by the total DLI measured on top of plants. The electric conductivity in fruits seems to be negatively influenced by the DLI(fruit), but positively influenced by the DLI(plant) (Table 3.3.6).

Table 3.3.1: Correlations between DLI and weight (n=228)

	p value	Pearson's r	R2
DLI (fruit) harvest day	NS		
DLI (fruit) +1	NS		
DLI (fruit) +2	NS		
DLI (fruit) +4	NS		
DLI (fruit) +8	NS		
DLI (plant) harvest day	0,000	0,268	0,0717
DLI (plant) +1	0,012	0,169	0,0284
DLI (plant) +2	0,011	0,171	0,0293
DLI (plant) +4	0,034	0,142	0,0202
DLI (plant) +8	0,043	0,136	0,0184

Table 3.3.2: Correlations between DLI and length (n=228)

	p value	Pearson's r	R2
DLI (fruit) harvest day	0,000	0,285	0,0815
DLI (fruit) +1	0,000	0,236	0,0556
DLI (fruit) +2	0,000	0,243	0,0589
DLI (fruit) +4	0,000	0,243	0,0592
DLI (fruit) +8	0,000	0,238	0,0565
DLI (plant) harvest day	0,048	0,131	0,0172
DLI (plant) +1	NS		
DLI (plant) +2	NS		
DLI (plant) +4	NS		
DLI (plant) +8	NS		

Table 3.3.3: Correlations between DLI and color (n=228)

	p value	Pearson's r	R2
DLI (fruit) harvest day	0,029	0,145	0,0210
DLI (fruit) +1	0,001	0,223	0,0499
DLI (fruit) +2	0,000	0,229	0,0525
DLI (fruit) +4	0,001	0,226	0,0509
DLI (fruit) +8	0,001	0,223	0,0499
DLI (plant) harvest day	NS		
DLI (plant) +1	0,000	0,395	0,1561
DLI (plant) +2	0,000	0,408	0,1663
DLI (plant) +4	0,000	0,422	0,1782
DLI (plant) +8	0,000	0,402	0,1613

Table 3.3.4: Correlations between DLI and SSC (n=228)

	p value	Pearson's r	R2
DLI (fruit) harvest day	NS		
DLI (fruit) +1	NS		
DLI (fruit) +2	NS		
DLI (fruit) +4	NS		
DLI (fruit) +8	NS		
DLI (plant) harvest day	NS		
DLI (plant) +1	0,004	-0,190	0,0360
DLI (plant) +2	0,008	-0,175	0,0305
DLI (plant) +4	NS		
DLI (plant) +8	0,012	-0,166	0,0277

Table 3.3.5: Correlations between DLI and pH in cucumber fruits (n=228)

	p value	Pearson's r	R2
DLI (fruit) harvest day	0,001	0,209	0,0438
DLI (fruit) +1	0,036	0,139	0,0194
DLI (fruit) +2	NS		
DLI (fruit) +4	0,027	0,146	0,0214
DLI (fruit) +8	NS		
DLI (plant) harvest day	NS		
DLI (plant) +1	NS		
DLI (plant) +2	0,037	-0,138	0,0191
DLI (plant) +4	NS		
DLI (plant) +8	NS		

Table 3.3.6: Correlations between DLI and EC in cucumber fruits (n=228)

	p value	Pearson's r	R2
DLI (fruit) harvest day	0,014	-0,162	0,0262
DLI (fruit) +1	0,000	-0,232	0,0540
DLI (fruit) +2	0,000	-0,235	0,0551
DLI (fruit) +4	0,000	-0,248	0,0615
DLI (fruit) +8	0,001	-0,225	0,0507
DLI (plant) harvest day	0,001	0,209	0,0438
DLI (plant) +1	0,000	0,305	0,0928
DLI (plant) +2	0,000	0,307	0,0945
DLI (plant) +4	0,000	0,295	0,0870
DLI (plant) +8	0,000	0,337	0,1133

Table 3.3.7: Correlations between DLI and DMC (n=186)

	p value	Pearson's r	R^2
DLI (fruit) harvest day	0,017	0,177	0,0313
DLI (fruit) +1	0,018	0,177	0,0312
DLI (fruit) +2	0,018	0,176	0,0311
DLI (fruit) +4	0,008	0,197	0,0388
DLI (fruit) +8	0,018	0,176	0,0310
DLI (plant) harvest day	NS		
DLI (plant) +1	NS		
DLI (plant) +2	NS		
DLI (plant) +4	NS		
DLI (plant) +8	NS		

Correlations between appearance/constituents and temperature

The correlations for temperature are presented in Table 3.3.8- 3.3.14. There appear to be some significant positive correlations with weight, but the R2 is generally low (<0.04) and was not really consistent. A few of the correlations for length, SSC, pH and DMC were significant (Table 3.3.9, 3.3.11, 3.3.12 and 3.3.14). The low explanatory values of these parametres indicate that temperature is not important for variation in these parameters.

Temperature seems to be of more influence for color, where R^2 might explain over 20% of the observed variation for some of the variables tested (Table 3.3.10). For EC and weight there is consistent significant correlations, but the explanatory values seems to be weaker for EC (Table 3.3.8 and 3.3.13).

Table 3.3.8: Correlation values between temperature and weight (n=228)

	p value	Pearson's r	R^2
oC harvest day average	0,037	0,140	0,0196
oC harvest day min	0,016	0,162	0,0262
oC harvest day max	NS		
oC Δ min/max harvest day	0,050	-0,132	0,0174
oC +1 average	0,013	0,166	0,0275
oC +1 min	0,034	0,142	0,0202
oC +1 max	0,008	0,178	0,0317
oC Δ min/max +1	NS		
oC +2 average	0,012	0,169	0,0285
oC +2 min	0,036	0,141	0,0198
oC +2 max	0,006	0,183	0,0335
oC Δ min/max +2	NS		
oC +4 average	0,019	0,157	0,0247
oC +4 min	NS		
oC + 4 max	0,040	0,138	0,0191
oC Δ min/max + 4	NS		
oC +8 average	0,022	0,154	0,0237
oC +8 min	0,013	0,167	0,0278
oC +8 max	NS		
oC Δ min/max + 8	NS		

Table 3.3.9: Correlation values between temperature and length (n=228)

	p value	Pearson's r	R^2
oC harvest day average	NS		
oC harvest day min	NS		
oC harvest day max	NS		
oC Δ min/max harvest day	0,011	-0,169	0,0286
oC +1 average	NS		
oC +1 min	NS		
oC +1 max	NS		
oC Δ min/max +1	0,012	-0,167	0,0278
oC +2 average	NS		
oC +2 min	NS		
oC +2 max	NS		
oC Δ min/max +2	NS		
oC +4 average	NS		
oC +4 min	NS		
oC + 4 max	NS		
oC Δ min/max + 4	NS		
oC +8 average	NS		
oC +8 min	NS		
oC +8 max	NS		
oC Δ min/max + 8	NS		

Table 3.3.10: Correlation values between temperature and color (n=228)

	p value	Pearson's r	R^2
oC harvest day average	0,000	0,448	0,2009
oC harvest day min	0,000	0,395	0,1559
oC harvest day max	0,000	0,442	0,1955
oC Δ min/max harvest day	NS		
oC +1 average	0,000	0,450	0,2024
oC +1 min	0,000	0,275	0,0758
oC +1 max	0,000	0,327	0,1070
oC Δ min/max +1	NS		
oC +2 average	0,000	0,448	0,2008
oC +2 min	0,000	0,278	0,0771
oC +2 max	0,000	0,387	0,1501
oC Δ min/max +2	NS		
oC +4 average	0,000	0,439	0,1925
oC +4 min	0,000	0,288	0,0830
oC + 4 max	0,000	0,393	0,1544
oC Δ min/max + 4	NS		
oC +8 average	0,000	0,456	0,2080
oC +8 min	0,000	0,283	0,0800
oC +8 max	0,000	0,372	0,1381
oC Δ min/max + 8	NS		

Table 3.3.11: Correlation values between temperature and SSC (n=228)

	p value	Pearson's r	R^2
oC harvest day average	NS		
oC harvest day min	NS		
oC harvest day max	0,036	-0,139	0,0193
oC Δ min/max harvest day	NS		
oC +1 average	NS		
oC +1 min	NS		
oC +1 max	NS		
oC Δ min/max +1	NS		
oC +2 average	NS		
oC +2 min	NS		
oC +2 max	NS		
oC Δ min/max +2	NS		
oC +4 average	0,032	-0,142	0,0203
oC +4 min	0,005	-0,183	0,0337
oC + 4 max	NS		
oC Δ min/max + 4	NS		
oC +8 average	NS		
oC +8 min	0,001	-0,227	0,0514
oC +8 max	NS		
oC Δ min/max + 8	0,009	0,172	0,0296

Table 3.3.12: Correlation values between temperature and pH in cucumber fruits (n=228)

	p value	Pearson's r	R^2
oC harvest day average	NS		
oC harvest day min	NS		
oC harvest day max	NS		
oC Δ min/max harvest day	NS		
oC +1 average	NS		
oC +1 min	0,048	-0,131	0,0172
oC +1 max	NS		
oC Δ min/max +1	NS		
oC +2 average	NS		
oC +2 min	NS		
oC +2 max	NS		
oC Δ min/max +2	NS		
oC +4 average	NS		
oC +4 min	NS		
oC + 4 max	NS		
oC Δ min/max + 4	NS		
oC +8 average	NS		
oC +8 min	0,021	-0,152	0,0232
oC +8 max	NS		
oC Δ min/max + 8	NS		

Table 3.3.13: Correlation values between temperature and EC in cucumber fruits (n=228)

	p value	Pearson's r	R^2
oC harvest day average	0,000	0,232	0,0536
oC harvest day min	0,002	0,207	0,0428
oC harvest day max	0,000	0,241	0,0580
oC Δ min/max harvest day	NS		
oC +1 average	0,017	0,158	0,0249
oC +1 min	NS		
oC +1 max	0,000	0,272	0,0739
oC Δ min/max +1	0,000	0,263	0,0698
oC +2 average	0,036	0,139	0,0193
oC +2 min	NS		
oC +2 max	0,004	0,189	0,0356
oC Δ min/max +2	0,002	0,205	0,0419
oC +4 average	NS		
oC +4 min	NS		
oC + 4 max	0,018	0,157	0,0245
oC Δ min/max + 4	0,004	0,191	0,0363
oC +8 average	0,031	0,143	0,0204
oC +8 min	NS		
oC +8 max	0,000	0,234	0,0548
oC Δ min/max + 8	0,000	0,268	0,0721

Table 3.3.14: Correlation values between temperature and DMC (n=186)

	p value	Pearson's r	R^2
oC harvest day average	NS		
oC harvest day min	NS		
oC harvest day max	NS		
oC Δ min/max harvest day	NS		
oC +1 average	NS		
oC +1 min	NS		
oC +1 max	NS		
oC Δ min/max +1	NS		
oC +2 average	NS		
oC +2 min	NS		
oC +2 max	NS		
oC Δ min/max +2	NS		
oC +4 average	NS		
oC +4 min	NS		
oC + 4 max	NS		
oC Δ min/max + 4	NS		
oC +8 average	NS		
oC +8 min	NS		
oC +8 max	NS		
oC Δ min/max + 8	0,017	0,177	0,0314

Correlations between appearance/constituents and CO_2

P-values derived from correlation test in minitab shows consistent positive correlations between *CO_2* and color, pH and EC (Table 3.3.17, 3.3.19 and 3.3.20) but were not consistent with lengths of fruit (Table 3.3.16) For weight of fruit and CO_2, no significant correlations were found (Table 3.3.15). Regarding DMC and SSC, positive correlations were found for both constituents on +4 and +8 day maximum and Δmin/mximum (Table 3.3.18 and 3.3.21). The R^2 values are still low (< 0,1498) for allcorrelation tests regarding appearance/constituents and CO_2.

Table 3.3.15: Correlation between CO2 levels and weight (n=228)

	p value	Pearson's r	R^2
CO2 harvest day average	NS		
CO2 harvest day min	NS		
CO2 harvest day max	NS		
CO2 Δ min/max harvest day	NS		
CO2 +1 average	NS		
CO2 +1 min	NS		
CO2 +1 max	NS		
CO2 Δ min/max +1	NS		
CO2 +2 average	NS		
CO2 +2 min	NS		
CO2 + 2 max	NS		
CO2 Δ min/max +2	NS		
CO2 +4 average	NS		
CO2 +4 min	NS		
CO2 +4 max	NS		
CO2 Δ min/max +4	NS		
CO2 +8 average	NS		
CO2 +8 min	NS		
CO2 +8 max	NS		
CO2 Δ min/max +8	NS		

Table 3.3.16: Correlation values between CO2 levels and length (n=228)

	p value	Pearson's r	R^2
CO2 harvest day average	NS		
CO2 harvest day min	0,025	0,148	0,0219
CO2 harvest day max	NS		
CO2 Δ min/max harvest day	NS		
CO2 +1 average	NS		
CO2 +1 min	0,010	0,171	0,0292
CO2 +1 max	NS		
CO2 Δ min/max +1	NS		
CO2 +2 average	NS		
CO2 +2 min	NS		
CO2 + 2 max	NS		
CO2 Δ min/max +2	NS		
CO2 +4 average	NS		
CO2 +4 min	NS		
CO2 +4 max	NS		
CO2 Δ min/max +4	NS		
CO2 +8 average	NS		
CO2 +8 min	NS		
CO2 +8 max	0,005	0,185	0,0341
CO2 Δ min/max +8	0,009	0,173	0,0300

Table 3.3.17: Correlation values between CO2 levels and color (n=228)

	p value	Pearson's r	R^2
CO2 harvest day average	0,000	0,242	0,0587
CO2 harvest day min	0,002	0,202	0,0407
CO2 harvest day max	0,000	0,241	0,0581
CO2 Δ min/max harvest day	0,024	0,149	0,0223
CO2 +1 average	0,000	0,256	0,0655
CO2 +1 min	0,000	0,251	0,0630
CO2 +1 max	0,029	0,145	0,0210
CO2 Δ min/max +1	NS		
CO2 +2 average	0,000	0,251	0,0628
CO2 +2 min	0,000	0,233	0,0545
CO2 + 2 max	0,006	0,183	0,0334
CO2 Δ min/max +2	NS		
CO2 +4 average	0,000	0,266	0,0706
CO2 +4 min	0,000	0,236	0,0558
CO2 +4 max	0,010	0,171	0,0291
CO2 Δ min/max +4	NS		
CO2 +8 average	0,000	0,288	0,0831
CO2 +8 min	0,001	0,224	0,0503
CO2 +8 max	0,000	0,249	0,0621
CO2 Δ min/max +8	0,002	0,200	0,0398

Table 3.3.18: Correlation values between CO2 and SSC (n=228)

	p value	Pearson's r	R^2
CO2 harvest day average	NS		
CO2 harvest day min	NS		
CO2 harvest day max	NS		
CO2 Δ min/max harvest day	NS		
CO2 +1 average	NS		
CO2 +1 min	NS		
CO2 +1 max	NS		
CO2 Δ min/max +1	NS		
CO2 +2 average	NS		
CO2 +2 min	NS		
CO2 + 2 max	NS		
CO2 Δ min/max +2	NS		
CO2 +4 average	NS		
CO2 +4 min	NS		
CO2 +4 max	0,020	0,153	0,0236
CO2 Δ min/max +4	0,021	0,152	0,0232
CO2 +8 average	NS		
CO2 +8 min	NS		
CO2 +8 max	0,003	0,193	0,0372
CO2 Δ min/max +8	0,006	0,180	0,0324

Table 3.3.19: Correlation values between CO2 and pH in cucumber fruits (n=228)

	p value	Pearson's r	R^2
CO2 harvest day average	NS		
CO2 harvest day min	NS		
CO2 harvest day max	NS		
CO2 Δ min/max harvest day	0,019	0,155	0,0241
CO2 +1 average	NS		
CO2 +1 min	NS		
CO2 +1 max	0,009	0,173	0,0301
CO2 Δ min/max +1	0,001	0,211	0,0445
CO2 +2 average	NS		
CO2 +2 min	NS		
CO2 + 2 max	0,003	0,197	0,0386
CO2 Δ min/max +2	0,000	0,232	0,0538
CO2 +4 average	NS		
CO2 +4 min	NS		
CO2 +4 max	0,000	0,260	0,0674
CO2 Δ min/max +4	0,000	0,289	0,0835
CO2 +8 average	NS		
CO2 +8 min	NS		
CO2 +8 max	0,000	0,251	0,0629
CO2 Δ min/max +8	0,000	0,263	0,0693

Table 3.3.20: Correlation values between CO2 and EC in cucumber fruits (n=228)

	p value	Pearson's r	R^2
CO2 harvest day average	0,000	0,374	0,1399
CO2 harvest day min	0,000	0,269	0,0721
CO2 harvest day max	0,000	0,369	0,1363
CO2 Δ min/max harvest day	0,000	0,261	0,0679
CO2 +1 average	0,000	0,344	0,1185
CO2 +1 min	NS		
CO2 +1 max	0,000	0,362	0,1311
CO2 Δ min/max +1	0,000	0,342	0,1168
CO2 +2 average	0,000	0,387	0,1498
CO2 +2 min	0,000	0,253	0,0640
CO2 + 2 max	0,000	0,304	0,0922
CO2 Δ min/max +2	0,001	0,228	0,0519
CO2 +4 average	0,000	0,374	0,1400
CO2 +4 min	0,000	0,267	0,0712
CO2 +4 max	0,000	0,319	0,1020
CO2 Δ min/max +4	0,000	0,251	0,0630
CO2 +8 average	0,000	0,345	0,1187
CO2 +8 min	0,000	0,267	0,0716
CO2 +8 max	0,001	0,211	0,0446
CO2 Δ min/max +8	0,024	0,150	0,0224

Table 3.3.21: Correlation values between CO2 and DMC (n=186)

	p value	Pearson's r	R^2
CO2 harvest day average	NS		
CO2 harvest day min	NS		
CO2 harvest day max	NS		
CO2 Δ min/max harvest day	NS		
CO2 +1 average	NS		
CO2 +1 min	NS		
CO2 +1 max	NS		
CO2 Δ min/max +1	NS		
CO2 +2 average	NS		
CO2 +2 min	NS		
CO2 + 2 max	NS		
CO2 Δ min/max +2	NS		
CO2 +4 average	NS		
CO2 +4 min	NS		
CO2 +4 max	0,024	0,168	0,0282
CO2 Δ min/max +4	0,033	0,159	0,0254
CO2 +8 average	NS		
CO2 +8 min	NS		
CO2 +8 max	0,004	0,212	0,0448
CO2 Δ min/max +8	0,009	0,194	0,0375

Correlations between appearance/constituents and vapour pressure deficiency (VPD)

P-values derived from correlation test in minitab shows some significant positive correlations between VPD and weight, color and EC (Table 3.3.22, 3.3.24 and 3.3.27) The correlation between VPD and SSC was consistently negative (Table 3.3.25) The regression coefficients for VPD versus weights, color, pH and SSC was typically between R^2 = 0,02- 0,06). For length and DMC (Table 3.3.23 and 3.3.28) no significant correlations were found at all, and for pH (Table 3.3.26), only one, not really consistent, correlation were found.

Table 3.3.22: Correlation values between VPD and weight (n=228)

	p value	Pearson's r	R^2
VPD harvest day	0,026	0,149	0,0223
VPD +1	0,039	0,138	0,0192
VPD +2	0,009	0,176	0,0309
VPD +4	NS		
VPD +8	NS		

Table 3.3.23: Correlation values between VPD and length (n=228)

	p value	Pearson's r	R^2
VPD harvest day	NS		
VPD +1	NS		
VPD +2	NS		
VPD +4	NS		
VPD +8	NS		

Table 3.3.24: Correlation values between VPD and color (n=228)

	p value	Pearson's r	R^2
VPD harvest day	0,008	0,176	0,0310
VPD +1	0,003	0,198	0,0393
VPD +2	0,003	0,199	0,0396
VPD +4	0,001	0,221	0,0487
VPD +8	0,010	0,171	0,0292

Table 3.3.25: Correlation values between VPD and SSC (n=228)

	p value	Pearson's r	R^2
VPD harvest day	0,027	-0,146	0,0213
VPD +1	0,009	-0,173	0,0298
VPD +2	0,000	-0,250	0,0623
VPD +4	0,002	-0,209	0,0437
VPD +8	0,005	-0,184	0,0339

Table 3.3.26: Correlation values between VPD and pH in cucumber fruits (n=228)

	p value	Pearson's r	R^2
VPD harvest day	NS		
VPD +1	NS		
VPD +2	0,031	-0,143	0,0205
VPD +4	NS		
VPD +8	NS		

Table 3.3.27: Correlation values between VPD and EC in cucumber fruits (n=228)

	p value	Pearson's r	R^2
VPD harvest day	NS		
VPD +1	NS		
VPD +2	NS		
VPD +4	NS		
VPD +8	NS		

Table 3.3.28: Correlation values between VPD and DMC (n=228)

	p value	Pearson's r	R^2
VPD harvest day	NS		
VPD +1	NS		
VPD +2	NS		
VPD +4	NS		
VPD +8	NS		

Correlations between appearance/constituents and EC and pH level in greenhouse at harvest day

P-values derived from correlation test shows some correlations between EC levels in irrigation water and pH and EC measured in the cucumbers (Table 3.3.33 and 3.3.34). The regression coefficient were > 0,33 for the correlation between EC in irrigation water and EC measured in fruit. For pH in irrigation water correlations were found for color, pH measured in cucumber, SSC and DMC (Table 3.3.31, 3.3.32, 3.3.33 and 3.3.35). The highest regression coefficient were here < 0,12, for correlations between pH measured in irrigation water, and pH measured in fruit. Further, correlations between EC in drain water and weight, color and EC measured in cucumber fruit were discovered (Table 3.3.29, 3.3.31 and 3.3.34), with best regression coefficient value of 0,13, for correlations between EC in drain water and EC measured in cucumber fruit. Correlations between pH in drain water and weight, length, color, pH measured in cucumber fruit and SSC (Table 3.3.29, 3.3.30, 3.3.31, 3.3.32 and 3.3.33) were found, and also here, the highest regression coefficient were found for correlations between pH in drain water and pH measured in cucumber fruit (R^2 = 0,12).

Table 3.3.29: Correlation values between EC and pH levels in greenhouse at harvest day and weight. (n = 219 (EC drain), n = 225 (pH drain, n = 207 (EC irrigation) n = 213 (pH irrigation))

	p value	Pearson's r	R2
EC irrigation water	NS		
pH irrigation water	NS		
EC drain water	0,002	0,212	0,0450
pH drain water	0,020	0,155	0,0240

Table 3.3.30: Correlation values between EC and pH levels in greenhouse at harvest day and length. (n = 219 (EC drain), n = 225 (pH drain, n = 207 (EC irrigation) n = 213 (pH irrigation))

	p value	Pearson's r	R2
EC irrigation water	NS		
pH irrigation water	NS		
EC drain water	NS		
pH drain water	0,000	0,244	0,0594

Table 3.3.31: Correlation values between EC and pH levels in greenhouse at harvest day and collar. (n = 219 (EC drain), n = 225 (pH drain, n = 207 (EC irrigation) n = 213 (pH irrigation))

	p value	Pearson's r	R2
EC irrigation water	NS		
pH irrigation water	0,010	-0,176	0,0310
EC drain water	0,034	0,143	0,0204
pH drain water	0,005	-0,187	0,0350

Table 3.3.32: Correlation values between EC and pH levels in greenhouse at harvest day and SSC. (n = 219 (EC drain), n = 225 (pH drain, n = 207 (EC irrigation) n = 213 (pH irrigation))

	p value	Pearson's r	R2
EC irrigation water	NS		
pH irrigation water	0,000	0,302	0,0911
EC drain water	NS		
pH drain water	0,007	0,179	0,0321

Table 3.3.33: Correlation values between EC and pH levels in greenhouse at harvest day and pH in cucumber fruit. (n = 219 (EC drain), n = 225 (pH drain, n = 207 (EC irrigation) n = 213 (pH irrigation))

	p value	Pearson's r	R2
EC irrigation water	0,014	0,171	0,0292
pH irrigation water	0,000	0,349	0,1216
EC drain water	NS		
pH drain water	0,000	0,348	0,1209

Table 3.3.34: Correlation values between EC and pH levels in greenhouse at harvest day and EC in cucumber fruit. (n = 219 (EC drain), n = 225 (pH drain, n = 207 (EC irrigation) n = 213 (pH irrigation))

	p value	Pearson's r	R2
EC irrigation water	0,000	0,576	0,3315
pH irrigation water	NS		
EC drain water	0,000	0,361	0,1306
pH drain water	NS		

Table 3.3.35: Correlation values between EC and pH levels in greenhouse at harvest day and DMCin cucumber fruit. (n = 219 (EC drain), n = 225 (pH drain, n = 207 (EC irrigation) n = 213 (pH irrigation))

	p value	Pearson's r	R2
EC irrigation water	NS		
pH irrigation water	0,001	0,246	0,0604
EC drain water	NS		
pH drain water	NS		

3.4 Taste tests

3.4.1 NOFIMA sensory test

In Table 3.4.1.1- 3.4.1.3 below, the scores concerning taste, smell and consistency, from the different producers are presented respectively. Appendix 3.3 shows all scores from sensory testing.

The spider diagram in Figure 3.4.1.1 shows that there are none special greenhouse environment that are particularly different from the others regarding the sensory test. But cucumbers from some (P1, P5 and P6) are judged to be slightly more sweat than the other, and that P9 has higher score than the other producers in both green taste and bitterness, and also slightly higher scores for sourness.

.**Table 3.4.1.1:** Taste score, NOFIMA . n =15

Prod	Total taste intensity	Fruitiness	Greenness	Sweatness	Sourness	Bitterness
1	5,8	5,2	4,5	5,8	2,1	2,5
2	5,7	5,0	4,8	4,9	2,1	2,7
3	5,9	5,1	4,9	5,3	2,1	2,7
5	6,1	5,5	4,7	5,9	2,1	2,7
6	6,1	5,5	4,7	5,9	2,1	2,6
7	5,5	5,0	4,7	4,9	2,3	2,7
9	5,8	4,7	5,5	4,7	2,5	3,4

Table 3.4.1.2: Smell score, NOFIMA. n=15

Prod	Total smell intensity	Fruitiness	Greenness
1	5,5	5,5	4,3
2	5,7	5,5	4,7
3	5,7	5,7	4,7
5	5,4	5,5	4,5
6	5,9	5,9	4,4
7	5,7	5,7	4,4
9	5,3	5,0	4,6

Table 3.4.1.3: Consistency score, NOFIMA. n=15

Prod	Firmness	Brittleness	Dryness
1	6,3	5,7	2,9
2	6,9	6,6	3,5
3	6,7	6,6	2,5
5	6,5	6,1	2,5
6	6,6	6,2	2,5
7	6,7	6,6	3,1
9	6,7	6,1	2,8

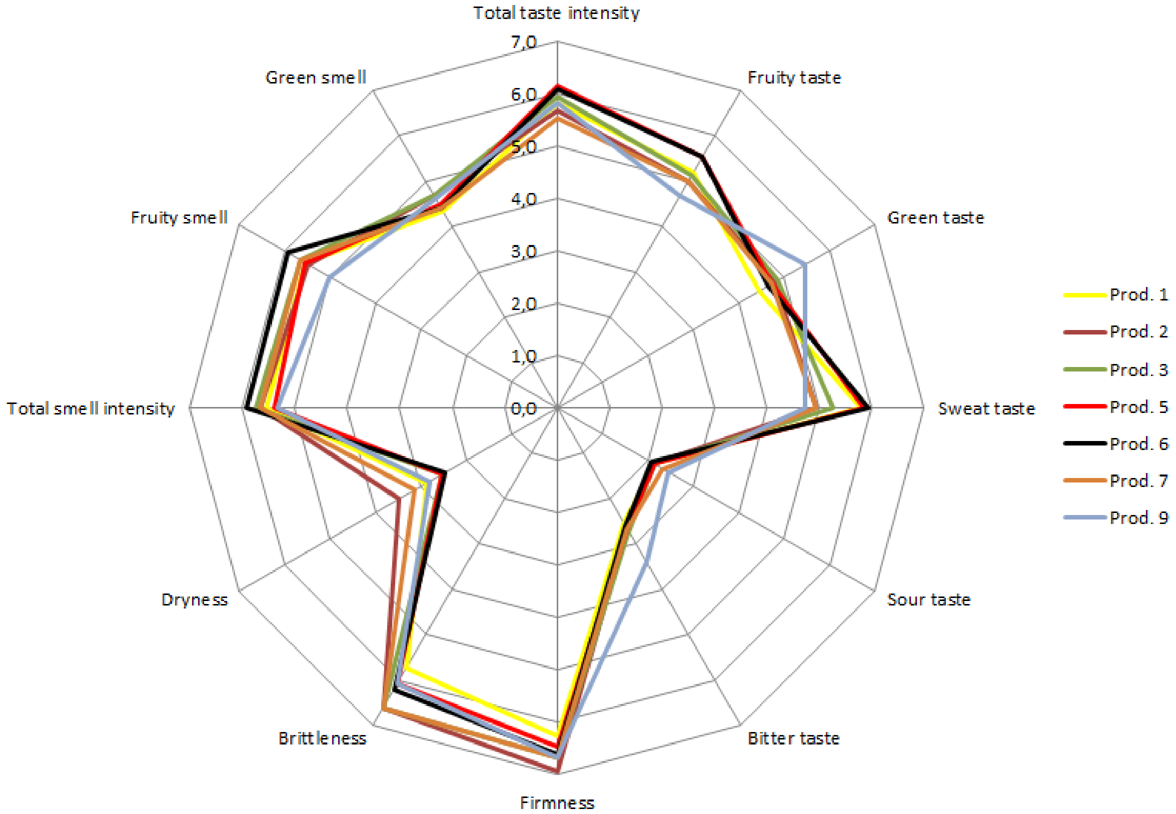


Figure 3.4.1.1: Spider diagram with results from sensory testing of cucumbers from different greenhouse environments at NOFIMA. n=15

3.4.2 Consumer test of taste

Figure 3.4.2.1 underneath presents the average taste scores from the different greenhouse environments (here also including P2). Results show that there was a clear difference in taste score between cucumbers from different greenhouse environments. Appendix 3.2 show all scores from consumer taste tests.

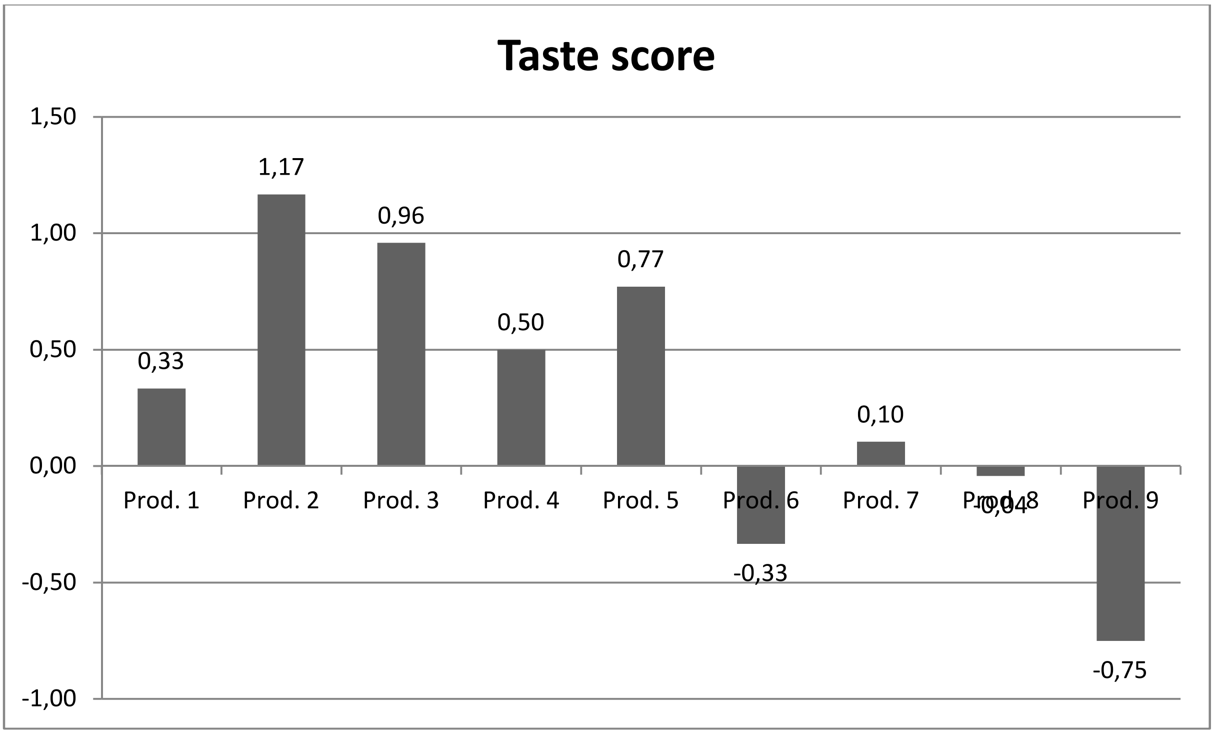


Figure 3.4.2.1: Diagram over average taste scores for different greenhouse environments. n= 48 (P1,P2,P3,P5,P6,P7,P9), n=24 (P4,P8)

3.5 GC-FID analysis on content of fatty acids and aldehydes

The results from (FAME) GC-FID and (HS-SPME) GC-FID analysis of fatty acids and aroma compounds, respectively, in cucumber shows variance between the different varieties of cucumber (Figure 3.5.9 and 3.5.10). Also significant correlations were found between the content of (*E,Z*)-2,6-nonadienal and (*E*)-2-nonenal and between the content of linolenic and linoleic acid (Table 3.5.2).

Chromatograms and retention times for the compounds

The GC analysis of four different standard solutions, each containing either (*E,E*)-2,6-nonadienal, (*E*)-2-nonenal, linolenic acid, or linoleic acid showed that these compounds had a retention time of 21.633, 22.532, 10.881 and 10.274 min, respectively, when using the method adapted for volatile compounds for (*E,E*)-2,6-nonadienal, (*E*)-2-nonenal (Figure 3.5.1 and 3.5.2), and the method adapted for fatty acids for linolenic and linoleic acids (Figure 3.5.3 and 3.5.4).

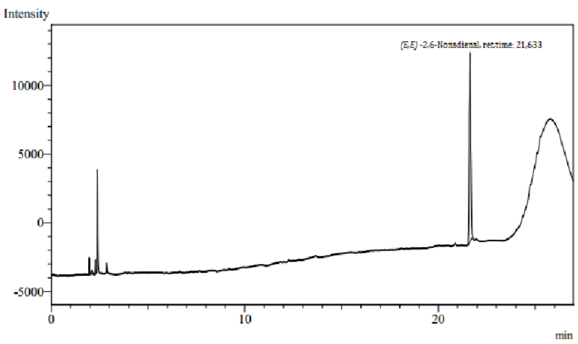


Figure 3.5.1: Chromatogram of (*E,E*)-2,6-nonadienal.

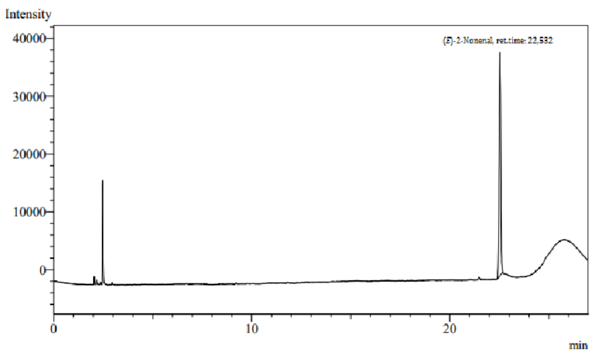


Figure 3.5.2: Chromatogram of (*E*)-2-nonenal.

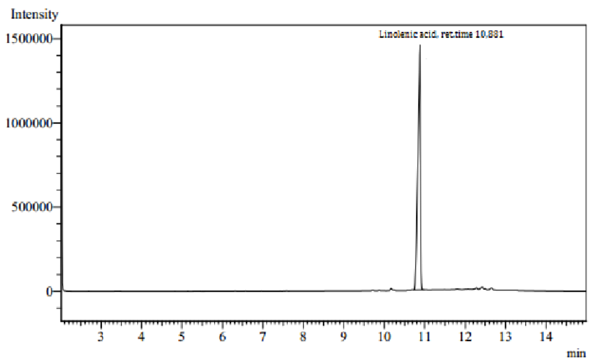


Figure 3.5.3: Chromatogram of linolenic acid.

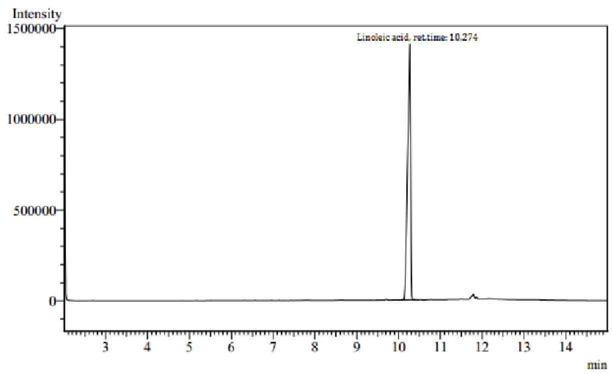


Figure 3.5.4: Chromatogram of linoleic acid.

Table 3.5.1 shows retention times found for the different compounds analyzed for, and the internal standards used.

Table 3.5.1: Retention times for the different compounds

Compound	Retention time
(*E,E*)-2,6-nonadienal	21,6
(*E,Z*)-2,6-nonadienal	21,9
(*E*)-2-nonenal	22,5
dekanal	24,7
linoleic acid	10,2
linolenic acid	10,8
heneicosanoic acid	12,2

The cucumber groups which differ the most from each other in average concentration of (*E,Z*)-2,6-nonadienal and (*E*)-2-nonenal in fresh weight of cucumber were Cadence planted 10/3 (average (*E,Z*)-2,6-nonadienal 7 ppm, average (E)-2-nonenal: 2,6 ppm, chromatogram shown in Figure 3.5.5) and SV4097CV (average (*E,Z*)-2,6-nonadienal: 2,4 ppm, average (E)-2-nonenal: 0,6 ppm, chromatogram shown in Figure 3.5.6). These chromatograms were typical for the (HS-SPME) GC-FID analysis. As seen in Figure 3.5.5 and 3.5.6 also other aroma compounds are found in the analysis, but the aroma compounds in question ((*E,Z*)-2,6-nonadienal and (*E*)-2-nonenal), and the internal standard used (decanal) were clearly the ones present in largest amount when using this method.

Regarding fatty acid concentration in fresh weight of cucumber, the cucumber groups which differ the most from each other were SV4097CV (average linolenic acid: 20,5 mg/100g FW, average linoleic acid: 14,1 mg/100g FW, chromatogram shown in Figure 3.5.7) and Incas (average linolenic acid: 9,3 mg/100g FW, average linoleic acid: 8,8 mg/100g FW, chromatogram shown in Figure 3.5.8). These chromatograms were typical for the (FAME) GC-FID analysis. As seen in Figure 3.5.7 and 3.5.8 also other compounds are found in the analysis, but the fatty acids in question (linoleic- and linolenic acid), and the internal standard used (heneicosanoic acid) were clearly also present in large amount when using this method.

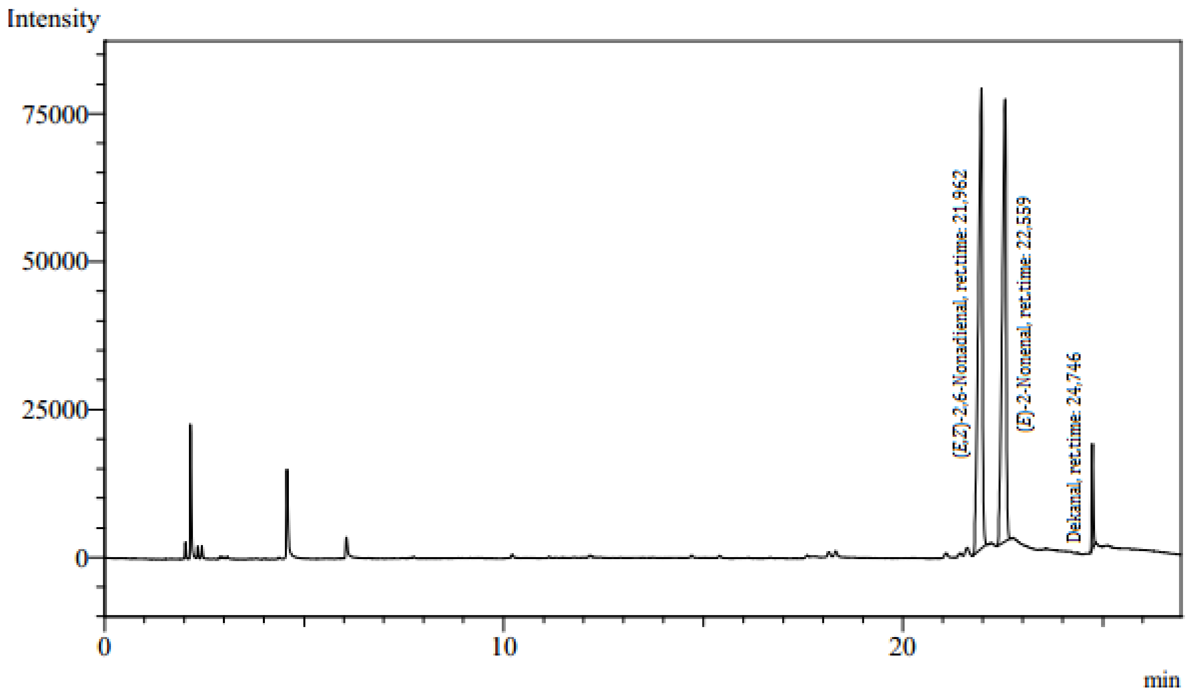


Figure 3.5.5: (HS-SPME) GC-FID chromatogram of Cadence planted 10/3. (*E,Z*)-2,6-Nonadienal, (*E*)-2-nonenal and dekanal are identified peaks.

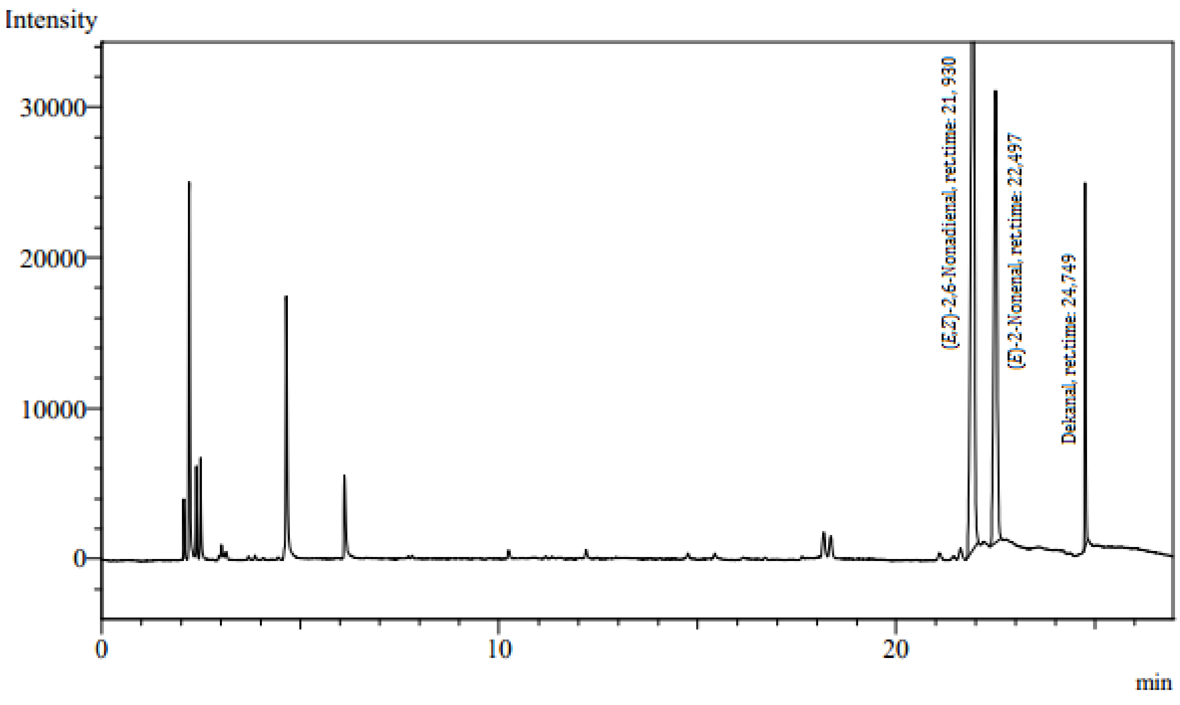


Figure 3.5.6: (HS-SPME) GC-FID chromatogram of SV4097CV. (*E,Z*)-2,6-Nonadienal, (*E*)-2-nonenal and dekanal are identified peaks.

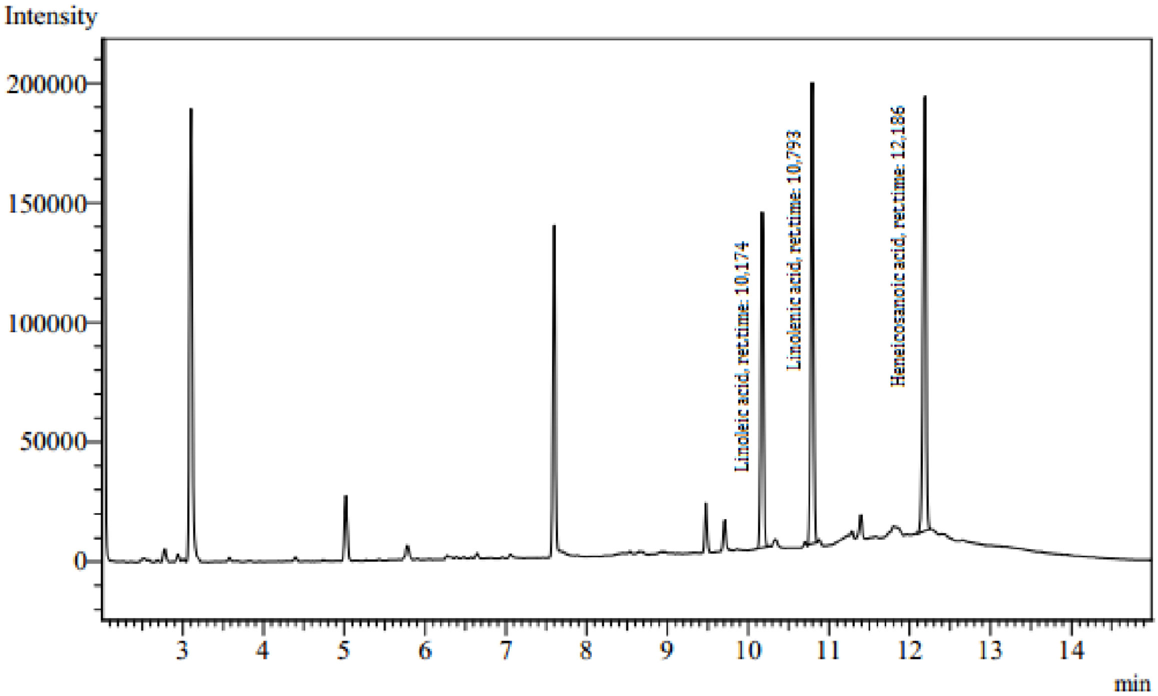


Figure 3.5.7: (FAME) GC-FID chromatogram of SV4097CV. Linoleic, lionlenic and heneicosanoic acid are identified peaks.

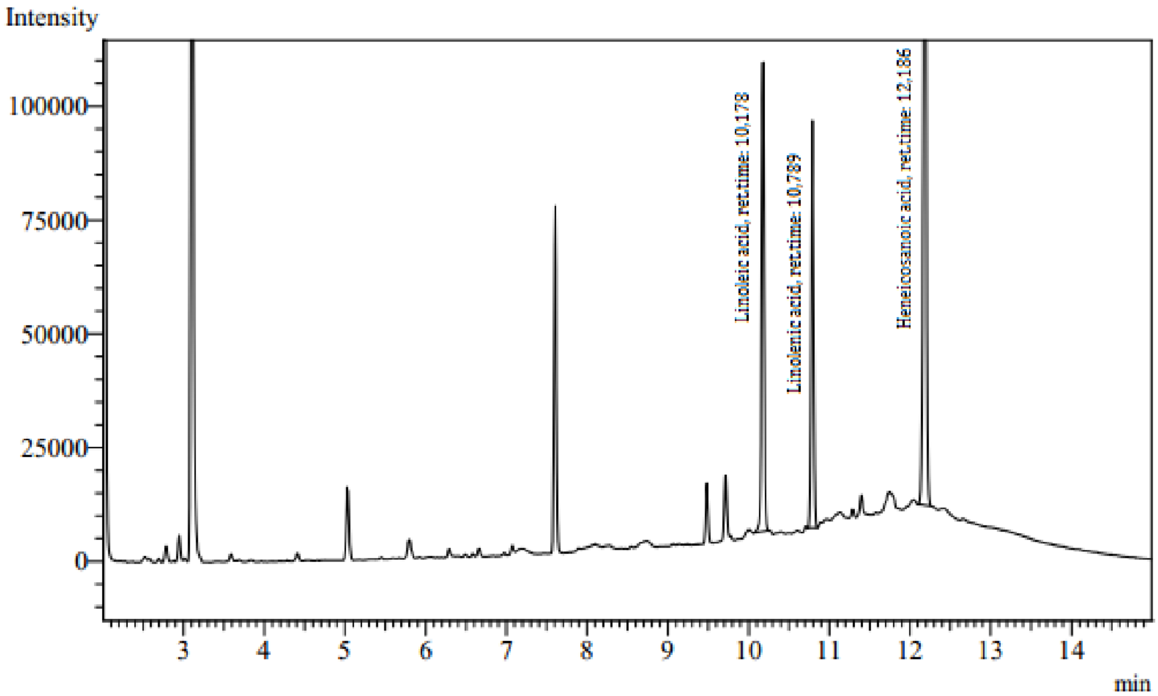


Figure 3.5.8: (FAME) GC-FID chromatogram of Incas. Linoleic, lionlenic and heneicosanoic acid are identified peaks.

Variance among varieties and correlations between compounds

A correlation test (Table 3.5.2) showed significant, positive correlations between fresh weight concentrations of (*E,Z*)-2,6-nonadienal and (*E*)-2-nonenal (p< 0,001, R^2 = 0,90), linolenic and linoleic acid (p < 0,001, R^2 = 0,79) and the relationships of (*E,Z*)-2,6-nonadienal/(*E*)-2-nonenal and linolenic/linoleic acid (p = 0,027, R^2 = 0,22) in cucumber. There was also found a significant negative correlation between linoleic acid and (*E*)-2-nonenal (p = 0,001, R^2 = 0,42), and no correlations of significance between linolenic acid and (*E,Z*)-2,6-nonadienal.

Table 3.5.2: Correlation tests with p-values, Pearson's correlation coefficient and R^2 values. n=18.

	p-value	Pearson's r	R2
(*E,Z*)-2,6-Nonadienal and (*E*)-2-nonenal	0,000	0,951	0,9044
Linolenic acid and (*E,Z*)-2,6-nonadienal	0,250	-0,256	0,0655
Linoleic acid and (*E*)-2-nonenal	0,001	-0,651	0,4238
Linolenic acid and linoleic acid	0,000	0,888	0,7885
(*E,Z*)-2,6-Nonadienal/(*E*)-2-nonenal and linolenic acid/linoleic acid	0,027	0,472	0,2228

In all analysis, the concentration of (*E,Z*)-2,6-nonadienal was higher than the concentration of (*E*)-2-nonenal, and this was also the case for the concentration of linolenic and linoleic acid in all analysis except for one. The analysed cucumber varied in concentration of (*E,Z*)-2,6-nonadienal from 2,25 to 9,37 ppm and of (*E*)-2-nonenal from 0,53 to 3,21 ppm in fresh weight of cucumber. And from 8,40 to 20,85 mg/100g (FW cucumber) of linolenic acid, and from 6,19 to 14,54 mg/100g (FW cucumber) of linoleic acid.

The average concentrations with standard deviations are presented in Table 3.5.3 for all four compounds in the six groups (five varieties) of cucumbers. The results are also presented in Figure 3.5.9 for (*E,Z*)-2,6-nonadienal and (*E*)-2-nonenal, and Figure 3.5.10 for linolenic and linoleic acid. Appendix 4 show results from all final GC-FID analysis of cucumbers, and appendix 5 show results from GC-FID analysis in regard to calibration, and the determinate standard curves.

Table 3.5.3: Average concentrations (with SD) of linolenic and linoleic acid, and of (E,Z)-2,6-nonadienal and (E)-2-nonenal in the different cucumber groups. n=3 for each group.

	Linolenic acid mg/100g FW		**Linoleic acid** mg/100g FW		**(*E,Z*)-2,6-Nonadienal** ppm FW		**(*E*)-2-Nonenal** ppm FW	
	Average	*SD*	Average	*SD*	Average	*SD*	Average	*SD*
Cadence planted 10/3	14,18	*1,72*	9,06	*0,09*	7,00	*0,86*	2,61	*0,16*
Cadence planted 21/4	10,62	*1,96*	7,93	*1,65*	6,12	*1,46*	2,62	*0,70*
Quatro	12,61	*0,56*	7,90	*0,27*	6,12	*0,43*	1,96	*0,17*
E23C.2201	11,08	*1,10*	8,62	*1,04*	3,27	*0,33*	1,28	*0,13*
Incas	9,28	*1,12*	8,80	*1,25*	3,34	*0,49*	1,37	*0,18*
SV4097CV	20,46	*0,50*	14,05	*0,54*	2,40	*0,26*	0,61	*0,09*

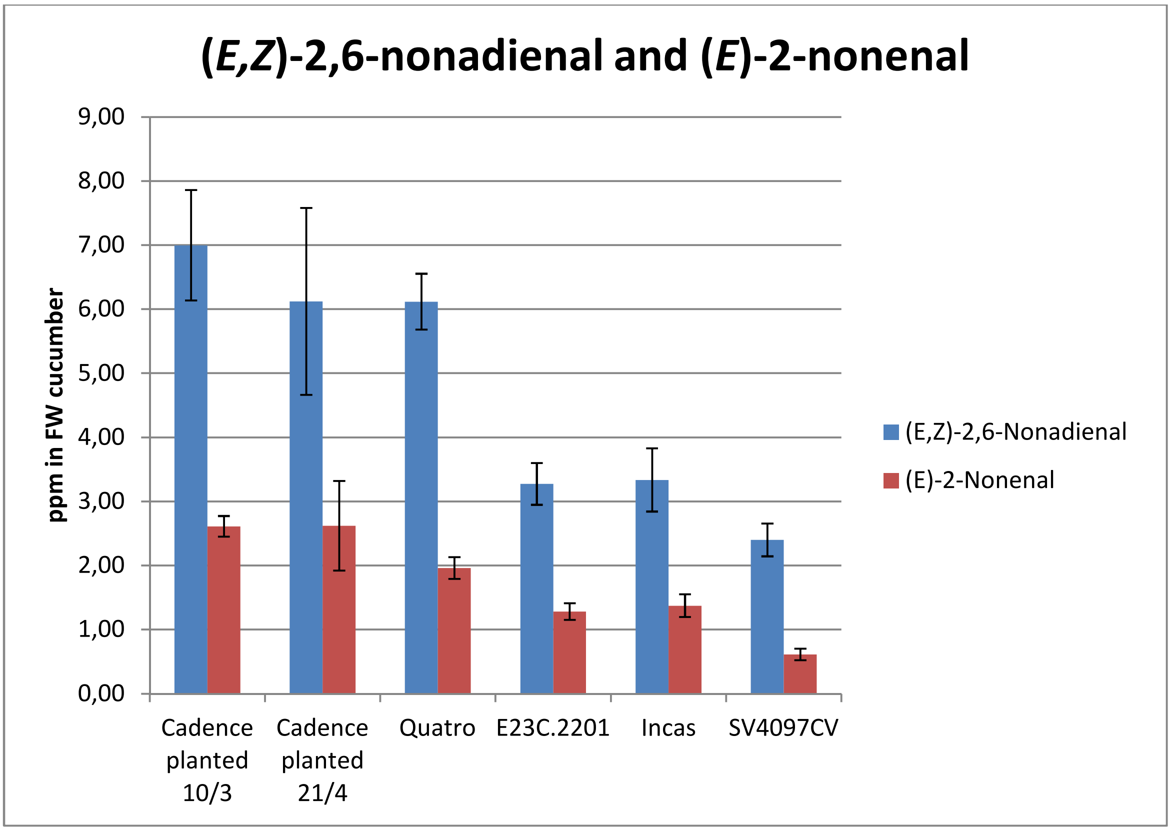


Figure 3.5.9: Average concentrations in ppm in fresh weight of cucumber(with SD) of (*E*,*Z*)-2,6-nonadienal and (*E*)-2-nonenal in the different cucumber groups. n=3 for each group.

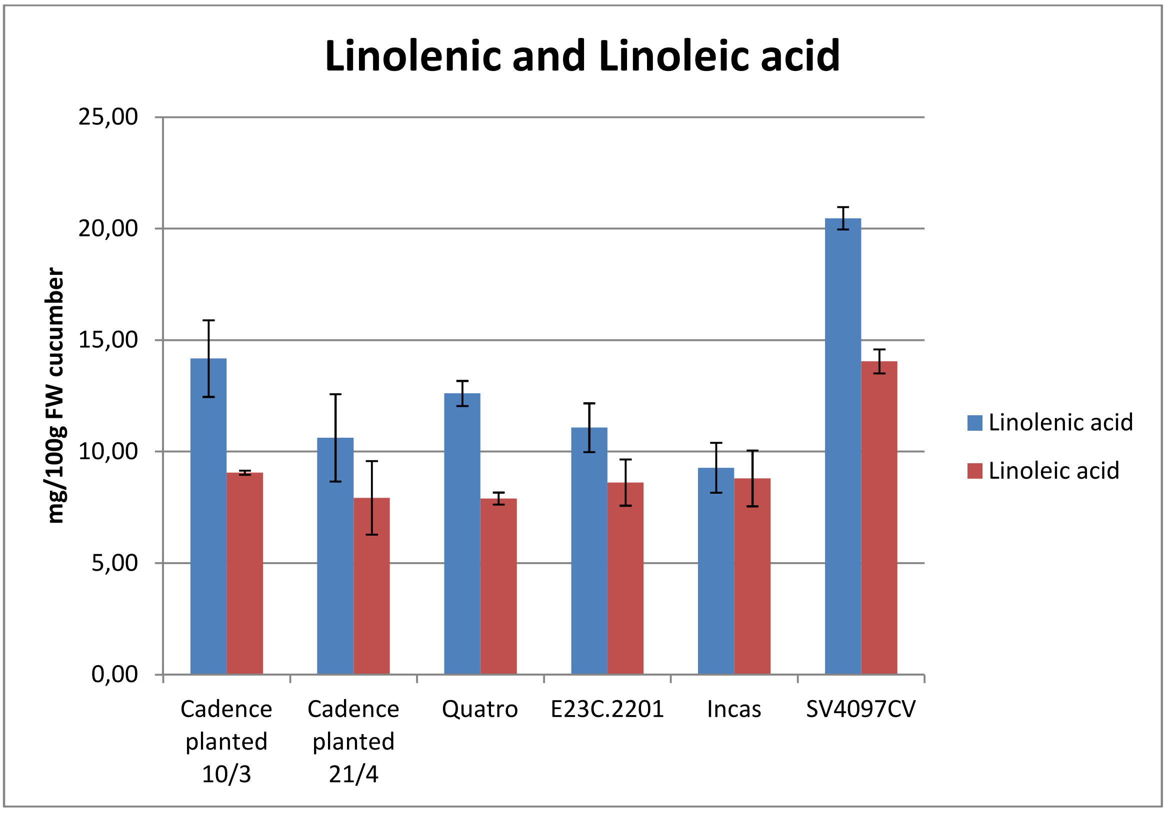


Figure 3.5.10: Average concentrations in mg/100g fresh weight of cucumber (with SD) of linolenic and linoleic acid in the different cucumber groups. n=3 for each group.

4 Discussion

4.1 Cultivation conditions influencing appearance, constituents and taste

Results show that environmental conditions vary for the different greenhouse environments and different harvesting dates, as assumed before the start of the experiments

Significant correlation coefficients between DLI and EC are found, which demonstrate an interesting relationship between the amount of light exposed to the plants and electrolytes in the fruits. EC shows negative correlations to DLI estimated on the fruit which can explain < 6 % of the variance, while correlations to DLI estimated for the top of plant were positive, and can explain < 11 % of the variance in EC.

Since DLI is an estimate of daily average exposure, one could argue, that harvest day should be removed since it will always be lower than a “full” day of exposure. Excluding harvest day, the average R^2 for DLI (fruit) and DLI (plant) are higher.

In a previous study, it was found that taste preference is associated with lower EC in cucumber (Johnsen, 2012; Verheul et al., 2013), and the results for EC in this study suggest that high DLI who reaches the plant can make the salt level in cucumber to increase, which can have negative impact on taste preferences.

The DLI-color results suggested that color seems to be positively influenced by DLI and supports findings by (Hao and Papadopoulos, 1999) who found that supplemental lightning increased skin chlorophyll in cucumber. Surprisingly, the DLI estimated for top of plant, seems to be more important for color of fruits than direct radiation on the fruits itself (Table, 3.3.3).

Light intensity measured at top of plant was positively correlated with fruit weight, while DLI (fruit) were positively correlated with cucumber length. These findings supporting findings of both Marcelis (1993 (2)) who reported that shading affects both dry and fresh weight of cucumber weight in a negative way, and Hao and Papadopoulos (1999) who found that biomass in fruit and it’s DMC was increased with supplemental lightning. Marcelis (1993 (2)) and Hao and Papadopoulos (1999)’s findings then hence support the findings in the present experiment, which show a positive correlation of DLI(fruit) with DMC in cucumber. The results for SSC however, shows a weak, negative trend for DLI and SSC, this could to some extent be explained be the findings of Verheul (2012), who found that no significant change in SSC could be detected in tomato grown under different light regimes. But his findings also included increasing yield with higher light intensity and suggested that with higher light intensity, more SSC were available, but were divided over a larger number of fruits, so the SSC in the individual fruit were not impact by the increase in light.

CO_2 seems to make significant contribution to the variation found for the parameters under investigation, especially the maximum, and Δmin/max CO_2 seemed important. Furthermore, CO_2 was positively correlated with EC and seems to explain up to 15% of the variation in the data. This might translate into a possible quality improvement in taste, since Johnsen (2012) found that preference was improved with lower EC in cucumber, which can indicate that lower CO_2 levels in greenhouse environment may impact taste positively.

The correlation tests were not significant or showed only weak relationships between levels of CO2 with weight and length of the fruits. While for color, the correlations were consistently positive. This results can indicate that carbon dioxide concentrations are a limiting factor for photosynthesis in the fruits. Regarding correlations for SSC and $CO_{2,}$ and DMC and CO_2, some positive correlations were found for maximum, and Δmin/max values over the last four and eight days. This contrasts the findings of Õçcelik et al. (1997) who found no impact of either SSC or DMC with CO_2 enrichment of tomato. Õçcelik et al. (1997) did not find any influence of CO_2 enrichment on TTA's or pH, which contrasts the present study where it was found a positive correlation between pH in cucumber maximum and Δmin/max values of CO_2.

Present temperature data suggest a positive influence of temperature on weight, and a lack of consistent correlations for length, pH and dry matter content. The positive correlation found for weight, is supported by the findings of Marcelis (1993 (1)), who found increased biomass with increasing temperature in cucumber. Temperature also seems to be of positive influential for color, where R^2 might explain over 20% of the observed variation for some of the variables tested (Table 3.3.10). This is supported by Pastenesz and Horton (1996), who found that photosynthesis increased with increasing temperature (20-35°C) in beans.

SSC have a few negative correlations with temperature. This is coinciding with the result to Pardossi et al. (2000), who found decreasing DMC and lower sucrose production in green house melons from summer production, than from spring production.

Temperature appear to also influence levels of fruit EC since there are consistent, significant, but low, positive correlations indicating higher levels of EC with increasing temperatures. This indicates accumulation of salinity in fruits grown under slightly different temperature regimes. One explanation might be that higher temperatures (in addition to higher VPD) might increase transpiration and water uptake by the plant. A higher water uptake might increase EC in the growth medium and thus EC in the fruit. Increased levels of EC is negatively associated with taste (Johnsen, 2012; Verheul et al., 2013)

By correlating VPD with the various parameters under study VPD appears to have a positive impact on and color, while SSC seems to be influenced negatively. This findings contrasts findings in tomato (Leonardi et al., 2000), who found higher SSC and lower fresh weight with higher VPD, but complies with their results for color, that increasing VPD increases color intensity.

Present data suggest a positive but weak relationship between EC- and pH levels in drain water for weight of the fruits, but the correlation for irrigation water, however, was not significant. For lengths, this relationship was not detectable, except for pH level in drain water. For fruit color, 3 of 4 correlations were weakly, but significantly, correlated. There are indications that pH influence color negatively with a magnitude of 2-4%, while result for EC is not consistent or insignificant.

SSC levels appear to be positively related to the measures for pH levels both in drain- and irrigation water. This may indicate that soluble sugars more easily form or accumulate in less acidic environments. There might also exist a relation between pH level in irrigation and pH in the fruits (12%), indicating that taste might be directly influenced by pH in the growth environment. This is the same found for EC measured in cucumbers, where EC measured in the fruits under study varied positively with the levels of EC in both irrigation water and with drain water. As much as 33% of the observed variation in EC in fruits is explained by EC in irrigation water. This is consistent with Babu et al., (2012)'s study, where NaCl in tomato increased with increasing NaCl content of growth medium. Since levels of EC might have impact on taste and preferences (Johnsen, 2012; Verheul et al., 2013), hence, this could be a opportunity for optimizing taste in cucumber in the greenhouse. Connection to taste is also done for TTA in cucumber. But since this study only have acidity in cucumbers measured as pH, the results can not directly be linked to taste.

Regarding the consumer taste tests and NOFIMA sensory tests, the most interesting result is that P9, who had the lowest score in the consumer taste tests, also had clearly highest scores in regard to bitterness, sourness and “green taste” in the NOFIMA sensory test. Since “green taste” is linked to the aroma in cucumbers, this can be interesting for further investigation. Otherwise comparing the two tests showed no clear results in regard to what is preferred sensory attributes in cucumber.

Further, all results who have show positive impact on SSC, negative impact on EC, or will influence on the relationships between SSC/EC, or SSC/TTA positively are clearly interesting for further investigation, since there is likely to believe that these constituents (and the relationships between them) have impact on taste in cucumbers. This study found that DLI, CO_2 and EC found in both drain and irrigation water had significant effects on the EC measured in fruits, and could each explain between 11 and 33 % of the variation of EC in fruit. Regarding pH in fruit, it seemed as the pH in both drain and irrigation water had strongest impact, with explanatory values of around 12 %. SSC show significant negative correlations to DLI(plant), temperature, and VPD but may be positively affected by maximum CO_2 levels 4 days (and earlier) before harvesting, and pH levels in irrigation and drain water.

Sources of error, cultivation conditions and taste tests

The time of harvest varied from each harvest, which resulted in variation of day length at harvest day ranging from 0 to aproximatly 7 hours. Further the producers often had harvested earlier the same day, which limited the selections and could make it difficult to find cucumbers in right size.

Also the producers did not all plant the cucumbers the same day, some planted weeks after the others. Regarding the taste tests, this can be a major source of error, since variation test (Table 3.2.1) showed significant variations in the content of cucumber depending on harvest number.

EC and pH levels at drain and irrigation water is only measured at the time of harvest, and then variations occurring in the growing period of the cucumber fruit has not been taken into consideration.

The climate control system used in the greenhouses was also a source of error. Firstly because P5, P6 and P7 did not measure VPD, but only RF. The VPD were then hence calculated from table derived from Bævre and Gislerød (1992) but only average temperatures and average RF were used as foundation for the calculations, since there is no formulae to calculate VPD from RF and temperature, and all had to be manually typed into excel, it was not a option to manually put in values for each 5 minutes for a period over +/- 8 weeks.

Second because the registration system some times failed, which is the case for the calculations for first harvest from P4, and the calculations also from second harvest where calculations over climate are done until + 8 day (8 days before harvest).

pH meter were used to measure acidity in the cucumber samples, but a standard curve was attempted created, using cucumber samples measured both with pH meter and run in instrumental titration against 0,8 M NaOH in a Metrohm 794 Basic Titrino apperature. The problem was that the pH meter was not sensitive enough. The pH measured in the calibration cucumbers with pH meter an average of 5,6, while the titration aparature measured an average start pH of 4,9. And when trying to measure standard solutions, the pH-meter never came up to the level of the cucumber samples. Even when using a many times diluted standard sample which should contain only 0,00000002 mg of citric acid, the pH- meter shoved a pH of 4,5, and the titration aperture a pH of 7,6! The pH-meter was also tried in calibration liquids, but it showed nothing wrong.

The measurements of EC in cucumber were done by wand mixer, which gave air bubbles in the sample. This air bubbles will impact the electrical conductivity so it is pourer than what is really the case, so that the salinity in the sample gets underestimated (Kjos, 2013). Estimates done by Kristine Kjos (who in 2013 used the same method as done in this assignment) showed that the salinity could be 20-30 % higher than what is measured with the EC-meter, when using a wand mixer to make the sample homogeneous.

Another source of error regarding the taste testing's, is that P2 reported that he did not cultivate Rapides at all. For this reason Keirin were harvested from him as cucumber for taste testing. Keirin P2 got the best scores in the consumer taste testing.

When transferring the data's from excel to minitab, the firmness measurements where formatted wrongly, without this being noticed before in the final steps before handing in the assignment. It was too late to run all the minitab statistics over again, so the measurements of firmness were not used in the statistics.

Other sources of error are standard measuring unsecurity conserving the aparatures used in weighing and measuring, together with insecurity regarding readout and use of instruments.

4.2 GC-FID analysis on content of fatty acids and aldehydes

Table 3.5.2 and Figure 3.5.9 shows that the average concentrations of (*E,Z*)-2,6-nonadienal (*E*)-2-nonenal in the different types of cucumbers, (Cadence, Quatro, E23C.2201, Incas and SV4097CV) varied quite a lot (between 2,4 and 7 ppm for (*E,Z*)-2,6-nonadienal and between 0,61 and 2,62 ppm for (*E*)-2-nonenal), but also Cadence cucumbers from plants who differed from each other in 6 weeks age, were different in average concentration of (*E,Z*)-2,6-nonadienal, but not for (*E*)-2-nonenal.

The concentrations of (*E,Z*)-2,6-nonadienal and (*E*)-2-nonenal is found to be highly positively correlated in cucumbers, with p-value of <0,001 (Table 3.5.2). The high R-square shows that this correlation relationship explains over 90 % of the variations in the measurements. Also the concentrations of linolenic acid and linoleic acid were found to be strongly positively correlated, also with p-value of < 0,001 (Table 3.5.2), and a high R-square value which suggest that over 78 % of the variation in concentration of linolenic and linoleic acid in cucumber can be explained by the correlation relationship between them.

The average concentration relationship (*E,Z*)-2,6-nonadienal/(*E*)-2-nonenal is 2,8, which means that there are around 2,8 times more (*E,Z*)-2,6-nonadienal in the sample analysed, then there are (*E*)-2-nonenal, this is also clear from the graphs in figure 3.7.5. That there is more (*E,Z*)-2,6-nonadienal present in cucumber than there is (*E*)-2-nonenal consists with the findings of Schieberle et al. (1990). But their findings suggested that (*E,Z*)-2,6-nonadienal were present in 5 times the amount of (*E*)-2-nonenal.

The concentration relationship are 1,4 in average for linolenic/linoleic acid. That more linolenic acid is present in cucumber than linoleic acid are also in consistence with earlier findings, where Grosch and Schwarz (1971) findings suggest that 43 % of the fatty acids occurring in cucumbers are linolenic, and 20 % linoleic acid. But the results of the present study, were also for relationship between the fatty acids, a bit lower than earlier works have shown.

A significant positive correlation (p=0,027, Table 3.5.2) is found also between these concentration relationships of (E,Z)-2,6-nonadienal/(E)-2-nonenal and linolenic acid/linoleic acid. The R-spuare value here is quite low, so this relationship will only exlain around 22 % of the variation.

Regarding the average concentrations of linoleic and linolenic acid, also those varied in the different types of cucumbers, (Cadence, Quatro, E23C.2201, Incas and SV4097CV). But even though the averages varied a lot (between 9,3 and 20,5 mg/100g FW for linolenic, and between 7,9 and 14 mg/100g FW for linoleic), SV4097CV stood out as the type with clearly highest concentration of both fatty acids, while the other once had less variation in average concentrations (Table 3.5.3 and Figure 3.5.10). Cadence cucumbers from plants who differed from each other in 6 weeks age, were different in average concentration of both linolenic and linoleic acid.

But since the cucumber analyses differed from each other also inside a group (appendix 4) analysis of larger quantities has to be done to safely conclude how much the types differ from each other in regard to content of(*E,Z*)-2,6-nonadienal, (*E*)-2-nonenal, linolenic and linoleic acid in cucumbers.

That there was found no significant correlations between linolenic acid and (*E,Z*)-2,6-nonadienal, and a negative correlation between linoleic acid and (*E*)-2-nonenal (table 3.7.1) were not expected. That no correlation were found can be explained by linolenic acids other derivates also represent a large amount of compounds enzymatic synthesized when cucumber tissue is disrupted. Grosch and Schwarz (1971) found propanal and cis-3- hexanal formation from linolenic acid in cucumber, in addition to (*E,Z*)-2,6-nonadienal. The negative correlation found in the present study remains unexplained.

Also the reproducibility of the methods used and developed has to be taken into concern, since there also was found variations in the control group (4 samples from same cucumber), Table 4.2.1.

Table 4.2.1: Control group, showing variations in concentrations of (*E,Z*)-2,6-nonadienal, (*E*)-2-nonenal, linolenic- and linoleic acid in samples who were supposed to be equal.

	(E,Z)-2,6-Nonadienal (ppm)	(E)-2-Nonenal (ppm)	Linolenic acid (mg/100g FW)	Linoleic acid (mg/100g FW)
1A: Cadence 10/3	9,37	3,20	12,56	8,13
1B: Cadence 10/3	6,78	2,42	12,10	8,08
1C: Cadence 10/3	5,47	2,23	12,90	9,21
1D: Cadence 10/3	7,09	2,96	9,51	6,93
Average	7,18	2,70	11,77	8,09
Min.	5,47	2,23	9,51	6,93
Max.	9,37	3,20	12,90	9,21
SD	1,62	0,45	1,54	0,93

Sources of error, GC-FID analysis

Regarding the standard curves made for the fatty acids, the standard curves chosen was the ones not made optimal regarding preparation (appendix 5) This since it was diluted after methanolysis and not before. Then the dilution and transferring into new test tubes and sample bottles source of error are not taken into the account. But when trying to make standard curve using dilution before methanolysis, problems were to dissolve heneicosanoic acid properly. This led to a standard curve that was not useable.

Another major contribution to source of error was measuring error using a variation volume pipette, taking small amounts of sample. For learning, there should have been used more dilution series instead of the small amounts.

Other sources of error are standard measuring insecurity conserving the instruments used in weighing and measuring, together with insecurity regarding readout and use of instruments.

5 Conclusions

Many significant relationships between greenhouse practices and taste related constituents were found. This gives producers information they can use to optimize different environmental conditions in regard to parameters important for quality and taste in cucumbers; color, salinity, soluble solid content, acidity and dry matter content,

Regarding GC-FID analysis of FAME's and aroma in cucumber, significant correlations are found between content of the aromas (*E,Z*)-2,6-nonadienal and (*E*)-2-nonenal, and between the fatty acids linoleic-, and linolenic acid. The results also indicate that the different varieties of cucumber may vary in content of, and relationships between, the fatty acids and aroma's. Further study is required to confirm if the variance is significant.

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Appendix 1

All measurements and climatic data used in the statistical analysis

Nr	Prod.	Variety	Harvest	Weight	Lenght	Color	SSC	pH	EC	EC drain water	pH drain water	EC irrigation water	pH irrigation water
121-2	1	1	1	361	30,5	7	2,9	5,54	3,6	1,8	5,8		
122-2	1	1	1	359	30	7	2,9	5,52	3,84	1,8	5,8		
123-2	1	1	1	387	29	7	2,9	5,5	3,78	1,8	5,8		
131-2	1	2	1	304	28	7	2,9	5,53	3,77	1,8	5,8		
132-2	1	2	1	296	27,5	6	3,2	5,54	3,75	1,8	5,8		
133-2	1	2	1	418	31	7	3,1	5,5	4	1,8	5,8		
121-4	1	1	2	254	25,5	7	3,4	5,64	3,85	2,02	6,7	2,7	5,5
122-4	1	1	2	291	26	7	3,3	5,58	3,53	2,02	6,7	2,7	5,5
123-4	1	1	2	218	24,5	7	3,6	5,73	3,85	2,02	6,7	2,7	5,5
131-4	1	2	2	258	25,5	8	3,7	5,73	3,98	2,02	6,7	2,7	5,5
132-4	1	2	2	264	26	7	4,1	5,76	4,1	2,02	6,7	2,7	5,5
133-4	1	2	2	345	31	7	3,7	5,68	4,39	2,02	6,7	2,7	5,5
121-5	1	1	3	305	30	7	3,2	5,29	3,41	2,35	5,8	2,5	5,4
122-5	1	1	3	311	31	8	3,3	5,3	3,43	2,35	5,8	2,5	5,4
123-5	1	1	3	289	28,5	8	3,2	5,28	3,65	2,35	5,8	2,5	5,4
131-5	1	2	3	258	29	7	3,5	5,27	3,48	2,35	5,8	2,5	5,4
132-5	1	2	3	282	31	7	3,3	5,35	3,69	2,35	5,8	2,5	5,4
133-5	1	2	3	282	31	7	3,2	5,36	4,01	2,35	5,8	2,5	5,4
121-6	1	1	4	324	29,5	8	3,6	5,3	3,18	1,95	5,4	1,98	5,2
122-6	1	1	4	295	30,5	8	3,4	5,26	3,29	1,95	5,4	1,98	5,2
123-6	1	1	4	275	30	8	3,6	5,25	3,1	1,95	5,4	1,98	5,2
131-6	1	2	4	289	27	8	4	5,14	3,33	1,95	5,4	1,98	5,2
132-6	1	2	4	294	28,5	7	3,8	5,27	3,23	1,95	5,4	1,98	5,2
133-6	1	2	4	276	29	7	3,6	5,27	3,14	1,95	5,4	1,98	5,2
121-7	1	1	5	237	25,5	7	3	5,7	3,81	2,33	5,6	2,71	5,7
122-7	1	1	5	251	27	7	3,6	5,6	3,63	2,33	5,6	2,71	5,7
123-7	1	1	5	215	26,5	7	3,6	5,7	3,59	2,33	5,6	2,71	5,7
121-8	1	1	6	251	27,5	7	3,4	5,55	3,59	2,45	5,7	2,49	5,7
122-8	1	1	6	256	28	7	3,5	5,6	3,85	2,45	5,7	2,49	5,7
123-8	1	1	6	283	28	8	3,8	5,55	3,6	2,45	5,7	2,49	5,7
131-8	1	2	6	281	29,5	8	3,7	5,64	3,76	2,45	5,7	2,49	5,7
132-8	1	2	6	263	28	7	3,7	5,56	3,7	2,45	5,7	2,49	5,7

Nr	Dry matter content	DLI fruit harvest day	DLI fruit +1	DLI fruit +2	DLI fruit +4	DLI fruit +8	DLI plant harvest day	DLI plant +1	DLI plant +2
121-2		0,00	1,09	1,19	1,16	1,32	0,00	11,96	13,08
122-2		0,00	0,23	0,25	0,25	0,28	0,00	11,96	13,08
123-2		0,00	0,82	0,89	0,87	0,99	0,00	11,96	13,08
131-2		0,00	0,80	0,87	0,85	0,96	0,00	11,96	13,08
132-2		0,00	0,64	0,70	0,69	0,78	0,00	11,96	13,08
133-2		0,00	0,65	0,71	0,70	0,79	0,00	11,96	13,08
121-4		0,13	1,53	1,31	1,22	1,06	1,93	22,47	19,18
122-4		0,06	0,68	0,58	0,54	0,47	1,93	22,47	19,18
123-4		0,06	0,74	0,63	0,58	0,51	1,93	22,47	19,18
131-4		0,26	3,01	2,57	2,39	2,08	1,93	22,47	19,18
132-4		0,15	1,78	1,52	1,42	1,23	1,93	22,47	19,18
133-4		0,10	1,22	1,04	0,97	0,84	1,93	22,47	19,18
121-5	3,66	0,08	1,56	1,64	2,07	2,91	0,26	5,22	5,51
122-5	3,73	0,07	1,38	1,46	1,84	2,59	0,26	5,22	5,51
123-5	3,63	0,11	2,29	2,42	3,05	4,28	0,26	5,22	5,51
131-5	3,63	0,05	0,99	1,05	1,32	1,86	0,26	5,22	5,51
132-5	3,80	0,04	0,87	0,91	1,15	1,62	0,26	5,22	5,51
133-5	3,70	0,05	1,11	1,17	1,47	2,07	0,26	5,22	5,51
121-6	4,11	0,01	1,78	1,87	1,94	1,39	0,07	11,35	11,90
122-6	4,02	0,01	2,11	2,22	2,30	1,65	0,07	11,35	11,90
123-6	4,08	0,01	1,97	2,07	2,15	1,54	0,07	11,35	11,90
131-6	4,59	0,02	3,34	3,50	3,63	2,61	0,07	11,35	11,90
132-6	4,41	0,02	2,63	2,76	2,86	2,05	0,07	11,35	11,90
133-6	4,50	0,02	3,07	3,22	3,33	2,39	0,07	11,35	11,90
121-7	4,09	0,14	1,20	0,99	1,45	1,59	0,57	4,82	3,97
122-7	3,98	0,12	1,00	0,83	1,22	1,33	0,57	4,82	3,97
123-7	4,05	0,21	1,77	1,46	2,15	2,35	0,57	4,82	3,97
121-8	3,88	0,39	3,10	2,21	1,88	1,27	1,04	8,39	5,98
122-8	4,08	0,48	3,88	2,77	2,35	1,58	1,04	8,39	5,98
123-8	4,23	0,36	2,88	2,05	1,74	1,17	1,04	8,39	5,98
131-8	4,15	0,45	3,61	2,57	2,18	1,47	1,04	8,39	5,98
132-8	4,18	0,34	2,72	1,94	1,64	1,11	1,04	8,39	5,98

Nr	DLI plant +4	DLI plant +8	oC harvestday average	oC harvestday min	oC harvestday max	oC harvestday Δ min/max	oC + 1 average
121-2	12,80	14,47	21,2	21,2	21,2	0	20,3
122-2	12,80	14,47	21,2	21,2	21,2	0	20,3
123-2	12,80	14,47	21,2	21,2	21,2	0	20,3
131-2	12,80	14,47	21,2	21,2	21,2	0	20,3
132-2	12,80	14,47	21,2	21,2	21,2	0	20,3
133-2	12,80	14,47	21,2	21,2	21,2	0	20,3
121-4	17,87	15,54	22,3	20,8	24,1	3,3	20,8
122-4	17,87	15,54	22,3	20,8	24,1	3,3	20,8
123-4	17,87	15,54	22,3	20,8	24,1	3,3	20,8
131-4	17,87	15,54	22,3	20,8	24,1	3,3	20,8
132-4	17,87	15,54	22,3	20,8	24,1	3,3	20,8
133-4	17,87	15,54	22,3	20,8	24,1	3,3	20,8
121-5	6,94	9,74	20,3	19,6	21,3	1,7	20
122-5	6,94	9,74	20,3	19,6	21,3	1,7	20
123-5	6,94	9,74	20,3	19,6	21,3	1,7	20
131-5	6,94	9,74	20,3	19,6	21,3	1,7	20
132-5	6,94	9,74	20,3	19,6	21,3	1,7	20
133-5	6,94	9,74	20,3	19,6	21,3	1,7	20
121-6	12,34	8,86	20	19,4	20,4	1	20
122-6	12,34	8,86	20	19,4	20,4	1	20
123-6	12,34	8,86	20	19,4	20,4	1	20
131-6	12,34	8,86	20	19,4	20,4	1	20
132-6	12,34	8,86	20	19,4	20,4	1	20
133-6	12,34	8,86	20	19,4	20,4	1	20
121-7	5,84	6,38	19,1	18,2	20,2	2	18,2
122-7	5,84	6,38	19,1	18,2	20,2	2	18,2
123-7	5,84	6,38	19,1	18,2	20,2	2	18,2
121-8	5,07	3,42	17,1	12,7	19,6	6,9	14,5
122-8	5,07	3,42	17,1	12,7	19,6	6,9	14,5
123-8	5,07	3,42	17,1	12,7	19,6	6,9	14,5
131-8	5,07	3,42	17,1	12,7	19,6	6,9	14,5
132-8	5,07	3,42	17,1	12,7	19,6	6,9	14,5

Nr	oC + 1 min	oC + 1 max	oC + 1 Δ min/max	oC + 2 average	oC +2 min	oC + 2 max	oC +2 min/max	oC +4 average	oC +4 min	oC +4 max
121-2	18,5	24,2	5,7	20,4	18,5	24,2	5,7	20,4	18,4	24,5
122-2	18,5	24,2	5,7	20,4	18,5	24,2	5,7	20,4	18,4	24,5
123-2	18,5	24,2	5,7	20,4	18,5	24,2	5,7	20,4	18,4	24,5
131-2	18,5	24,2	5,7	20,4	18,5	24,2	5,7	20,4	18,4	24,5
132-2	18,5	24,2	5,7	20,4	18,5	24,2	5,7	20,4	18,4	24,5
133-2	18,5	24,2	5,7	20,4	18,5	24,2	5,7	20,4	18,4	24,5
121-4	18,8	24,1	5,3	20,7	18,8	24,1	5,3	20,7	18,8	24,2
122-4	18,8	24,1	5,3	20,7	18,8	24,1	5,3	20,7	18,8	24,2
123-4	18,8	24,1	5,3	20,7	18,8	24,1	5,3	20,7	18,8	24,2
131-4	18,8	24,1	5,3	20,7	18,8	24,1	5,3	20,7	18,8	24,2
132-4	18,8	24,1	5,3	20,7	18,8	24,1	5,3	20,7	18,8	24,2
133-4	18,8	24,1	5,3	20,7	18,8	24,1	5,3	20,7	18,8	24,2
121-5	18,7	22,2	3,5	20	18,4	22,2	3,8	20,1	18,4	22,9
122-5	18,7	22,2	3,5	20	18,4	22,2	3,8	20,1	18,4	22,9
123-5	18,7	22,2	3,5	20	18,4	22,2	3,8	20,1	18,4	22,9
131-5	18,7	22,2	3,5	20	18,4	22,2	3,8	20,1	18,4	22,9
132-5	18,7	22,2	3,5	20	18,4	22,2	3,8	20,1	18,4	22,9
133-5	18,7	22,2	3,5	20	18,4	22,2	3,8	20,1	18,4	22,9
121-6	17	24,6	7,6	20,1	17	25	8	20,1	17	25
122-6	17	24,6	7,6	20,1	17	25	8	20,1	17	25
123-6	17	24,6	7,6	20,1	17	25	8	20,1	17	25
131-6	17	24,6	7,6	20,1	17	25	8	20,1	17	25
132-6	17	24,6	7,6	20,1	17	25	8	20,1	17	25
133-6	17	24,6	7,6	20,1	17	25	8	20,1	17	25
121-7	17,5	20,2	2,7	18,1	17,4	20,2	2,8	18,8	17,4	23,8
122-7	17,5	20,2	2,7	18,1	17,4	20,2	2,8	18,8	17,4	23,8
123-7	17,5	20,2	2,7	18,1	17,4	20,2	2,8	18,8	17,4	23,8
121-8	11,9	20,3	8,4	14,3	11,9	20,3	8,4	14,1	11,6	20,3
122-8	11,9	20,3	8,4	14,3	11,9	20,3	8,4	14,1	11,6	20,3
123-8	11,9	20,3	8,4	14,3	11,9	20,3	8,4	14,1	11,6	20,3
131-8	11,9	20,3	8,4	14,3	11,9	20,3	8,4	14,1	11,6	20,3
132-8	11,9	20,3	8,4	14,3	11,9	20,3	8,4	14,1	11,6	20,3

Nr	oC + 4 Δ min/max	oC + 8 average	oC + 8 min	oC + 8 max	oC + 8 Δ min/max	CO2 harvest day average	CO2 harvest day min
121-2	6,1	20,7	18,4	25,9	7,5	309	309
122-2	6,1	20,7	18,4	25,9	7,5	309	309
123-2	6,1	20,7	18,4	25,9	7,5	309	309
131-2	6,1	20,7	18,4	25,9	7,5	309	309
132-2	6,1	20,7	18,4	25,9	7,5	309	309
133-2	6,1	20,7	18,4	25,9	7,5	309	309
121-4	5,4	20,6	18,6	24,2	5,6	350	271
122-4	5,4	20,6	18,6	24,2	5,6	350	271
123-4	5,4	20,6	18,6	24,2	5,6	350	271
131-4	5,4	20,6	18,6	24,2	5,6	350	271
132-4	5,4	20,6	18,6	24,2	5,6	350	271
133-4	5,4	20,6	18,6	24,2	5,6	350	271
121-5	4,5	20,2	18,4	24,1	5,7	438	307
122-5	4,5	20,2	18,4	24,1	5,7	438	307
123-5	4,5	20,2	18,4	24,1	5,7	438	307
131-5	4,5	20,2	18,4	24,1	5,7	438	307
132-5	4,5	20,2	18,4	24,1	5,7	438	307
133-5	4,5	20,2	18,4	24,1	5,7	438	307
121-6	8	20	17	25	8	376	323
122-6	8	20	17	25	8	376	323
123-6	8	20	17	25	8	376	323
131-6	8	20	17	25	8	376	323
132-6	8	20	17	25	8	376	323
133-6	8	20	17	25	8	376	323
121-7	6,4	19,1	16,2	24,6	8,4	491	299
122-7	6,4	19,1	16,2	24,6	8,4	491	299
123-7	6,4	19,1	16,2	24,6	8,4	491	299
121-8	8,7	15,6	11,6	20,3	8,7	320	182
122-8	8,7	15,6	11,6	20,3	8,7	320	182
123-8	8,7	15,6	11,6	20,3	8,7	320	182
131-8	8,7	15,6	11,6	20,3	8,7	320	182
132-8	8,7	15,6	11,6	20,3	8,7	320	182

Nr	CO2 harvest day max	CO2 harvest day Δmin/max	CO2 + 1 average	CO2 + 1 min	CO2 + 1 max	CO2 +1 Δ min/max	CO2 +2 average
121-2	309	0	374	244	559	315	371
122-2	309	0	374	244	559	315	371
123-2	309	0	374	244	559	315	371
131-2	309	0	374	244	559	315	371
132-2	309	0	374	244	559	315	371
133-2	309	0	374	244	559	315	371
121-4	536	265	362	253	536	283	368
122-4	536	265	362	253	536	283	368
123-4	536	265	362	253	536	283	368
131-4	536	265	362	253	536	283	368
132-4	536	265	362	253	536	283	368
133-4	536	265	362	253	536	283	368
121-5	582	275	378	306	731	425	378
122-5	582	275	378	306	731	425	378
123-5	582	275	378	306	731	425	378
131-5	582	275	378	306	731	425	378
132-5	582	275	378	306	731	425	378
133-5	582	275	378	306	731	425	378
121-6	398	75	411	266	527	261	419
122-6	398	75	411	266	527	261	419
123-6	398	75	411	266	527	261	419
131-6	398	75	411	266	527	261	419
132-6	398	75	411	266	527	261	419
133-6	398	75	411	266	527	261	419
121-7	1152	853	412	287	1152	865	408
122-7	1152	853	412	287	1152	865	408
123-7	1152	853	412	287	1152	865	408
121-8	640	458	365	182	1138	956	380
122-8	640	458	365	182	1138	956	380
123-8	640	458	365	182	1138	956	380
131-8	640	458	365	182	1138	956	380
132-8	640	458	365	182	1138	956	380

Nr	CO2 + 2 min	CO2+ 2 max	CO2 +2 Δ min/max	CO2 + 4 average	CO2 + 4 min	CO2 + 4 max	CO2 + 4 Δ min/max	CO2 + 8 average	CO2 + 8 min
121-2	244	956	712	369	238	956	718	363	238
122-2	244	956	712	369	238	956	718	363	238
123-2	244	956	712	369	238	956	718	363	238
131-2	244	956	712	369	238	956	718	363	238
132-2	244	956	712	369	238	956	718	363	238
133-2	244	956	712	369	238	956	718	363	238
121-4	253	544	291	374	235	731	496	369	235
122-4	253	544	291	374	235	731	496	369	235
123-4	253	544	291	374	235	731	496	369	235
131-4	253	544	291	374	235	731	496	369	235
132-4	253	544	291	374	235	731	496	369	235
133-4	253	544	291	374	235	731	496	369	235
121-5	287	731	444	355	222	1122	900	362	222
122-5	287	731	444	355	222	1122	900	362	222
123-5	287	731	444	355	222	1122	900	362	222
131-5	287	731	444	355	222	1122	900	362	222
132-5	287	731	444	355	222	1122	900	362	222
133-5	287	731	444	355	222	1122	900	362	222
121-6	266	527	261	420	259	628	369	393	259
122-6	266	527	261	420	259	628	369	393	259
123-6	266	527	261	420	259	628	369	393	259
131-6	266	527	261	420	259	628	369	393	259
132-6	266	527	261	420	259	628	369	393	259
133-6	266	527	261	420	259	628	369	393	259
121-7	287	1225	938	390	255	1225	970	411	255
122-7	287	1225	938	390	255	1225	970	411	255
123-7	287	1225	938	390	255	1225	970	411	255
121-8	182	1138	956	379	182	1138	956	376	182
122-8	182	1138	956	379	182	1138	956	376	182
123-8	182	1138	956	379	182	1138	956	376	182
131-8	182	1138	956	379	182	1138	956	376	182
132-8	182	1138	956	379	182	1138	956	376	182

Nr	CO2 + 8 max	CO2 + 8 Δ min/max	VPD harvest day average	VPD +1 average	VPd + 2 average	VPD +4 average	VPD + 8 average
121-2	956	718	3,9	3,4	3,6	3,6	3,9
122-2	956	718	3,9	3,4	3,6	3,6	3,9
123-2	956	718	3,9	3,4	3,6	3,6	3,9
131-2	956	718	3,9	3,4	3,6	3,6	3,9
132-2	956	718	3,9	3,4	3,6	3,6	3,9
133-2	956	718	3,9	3,4	3,6	3,6	3,9
121-4	731	496	5,1	4,4	4,2	4,2	4
122-4	731	496	5,1	4,4	4,2	4,2	4
123-4	731	496	5,1	4,4	4,2	4,2	4
131-4	731	496	5,1	4,4	4,2	4,2	4
132-4	731	496	5,1	4,4	4,2	4,2	4
133-4	731	496	5,1	4,4	4,2	4,2	4
121-5	1122	900	3,4	3,4	3,2	3,7	4
122-5	1122	900	3,4	3,4	3,2	3,7	4
123-5	1122	900	3,4	3,4	3,2	3,7	4
131-5	1122	900	3,4	3,4	3,2	3,7	4
132-5	1122	900	3,4	3,4	3,2	3,7	4
133-5	1122	900	3,4	3,4	3,2	3,7	4
121-6	847	588	3,4	3,5	3,7	3,8	3,8
122-6	847	588	3,4	3,5	3,7	3,8	3,8
123-6	847	588	3,4	3,5	3,7	3,8	3,8
131-6	847	588	3,4	3,5	3,7	3,8	3,8
132-6	847	588	3,4	3,5	3,7	3,8	3,8
133-6	847	588	3,4	3,5	3,7	3,8	3,8
121-7	1225	970	2,9	3,3	3,2	3,7	3,4
122-7	1225	970	2,9	3,3	3,2	3,7	3,4
123-7	1225	970	2,9	3,3	3,2	3,7	3,4
121-8	1152	970	1,5	1,1	0,9	1,1	1,8
122-8	1152	970	1,5	1,1	0,9	1,1	1,8
123-8	1152	970	1,5	1,1	0,9	1,1	1,8
131-8	1152	970	1,5	1,1	0,9	1,1	1,8
132-8	1152	970	1,5	1,1	0,9	1,1	1,8

Nr	Prod.	Variety	Harvest	Weight	Lenght	Color	SSC	pH	EC	EC drain water	pH drain water	EC irrigation water	pH irrigation water
133-8	1	2	6	270	28	7	3,7	5,53	3,69	2,45	5,7	2,49	5,7
n =	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**27**	**27**
311-2	3	1	1	298	26,5	8	3,3	5,5	4,21	3,6	5,3		
312-2	3	1	1	243	23	8	2,6	5,4	4,06	3,25	4,9		
313-2	3	1	1	338	26,5	8	3,1	5,4	4,12	3,43	4,7		
321-2	3	2	1	281	25	8	2,3	5,3	4,03	3,55	4,7		
322-2	3	2	1	314	23,5	9	2,5	5,4	3,78	3,78	4,5		
323-2	3	2	1	330	26,5	8	2,5	5,4	3,69	3,45	4,8		
311-4	3	1	2	321	29,5	8	3,5	5,6	4,67	3,34	5,7	3,15	6,1
312-4	3	1	2	327	29	8	3,8	5,64	3,99	3,34	5,7	3,15	6,1
313-4	3	1	2	311	28	9	3,9	5,63	4,53	3,34	5,7	3,15	6,1
321-4	3	2	2	331	30,5	8	3,2	5,59	4,16	3,34	5,7	3,15	6,1
322-4	3	2	2	305	28	8	3,5	5,62	4,54	3,34	5,7	3,15	6,1
323-4	3	2	2	283	28	7	3,6	5,68	4,68	3,34	5,7	3,15	6,1
311-5	3	1	3	264	29,5	8	3,6	5,41	4,44	3,59	4,6	3,41	5,1
312-5	3	1	3	297	29,5	9	3,4	5,4	4,18	3,59	4,6	3,41	5,1
313-5	3	1	3	282	30	9	4,5	5,26	5	3,59	4,6	3,41	5,1
321-5	3	2	3	266	28	8	3,5	5,44	4,05	3,59	4,6	3,41	5,1
322-5	3	2	3	244	29,5	8	3,4	5,42	4,58	3,59	4,6	3,41	5,1
323-5	3	2	3	266	29,5	8	3,7	5,52	4,32	3,59	4,6	3,41	5,1
311-6	3	1	4	271	30	9	3,3	5,37	3,96	3,46	5	3,01	5,6
312-6	3	1	4	279	30	9	3,5	5,35	4,19	3,46	5	3,01	5,6
313-6	3	1	4	314	31	9	3,6	5,37	3,98	3,46	5	3,01	5,6
321-6	3	2	4	297	32	9	3,3	5,32	4,32	3,46	5	3,01	5,6
322-6	3	2	4	324	33	9	3,1	5,26	4,6	3,46	5	3,01	5,6
323-6	3	2	4	269	30,5	9	3,1	5,31	4,34	3,46	5	3,01	5,6
311-7	3	1	5	328	29,5	9	4,4	5,75	4,17	4,11	4,3	3,41	5,1
312-7	3	1	5	271	28	9	3,3	5,67	3,76	4,11	4,3	3,41	5,1
313-7	3	1	5	268	28	8	3,4	5,6	3,85	4,11	4,3	3,41	5,1
311-8	3	1	6	359	31,5	9	3,6	5,5	3,57				
312-8	3	1	6	291	31,5	9	3,4	5,44	3,54				

Nr	Dry matter content	DLI fruit harvest day	DLI fruit +1	DLI fruit +2	DLI fruit +4	DLI fruit +8	DLI plant harvest day	DLI plant +1	DLI plant +2
133-8	4,64	0,39	3,15	2,25	1,90	1,29	1,04	8,39	5,98
n =	**21**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**
311-2		0,07	3,09	2,59	2,55	2,54	0,87	39,84	33,50
312-2		0,13	5,87	4,93	4,85	4,82	0,87	39,84	33,50
313-2		0,03	1,41	1,19	1,16	1,16	0,87	39,84	33,50
321-2		0,08	3,63	3,05	3,00	2,98	0,87	39,84	33,50
322-2		0,01	0,56	0,47	0,46	0,46	0,87	39,84	33,50
323-2		0,07	3,13	2,63	2,58	2,57	0,87	39,84	33,50
311-4		0,26	2,55	2,28	2,15	1,95	4,98	48,23	43,08
312-4		0,08	0,78	0,70	0,66	0,60	4,98	48,23	43,08
313-4		0,08	0,81	0,72	0,68	0,62	4,98	48,23	43,08
321-4		0,03	0,27	0,24	0,22	0,20	4,98	48,23	43,08
322-4		0,14	1,39	1,24	1,17	1,06	4,98	48,23	43,08
323-4		0,12	1,15	1,03	0,97	0,88	4,98	48,23	43,08
311-5	4,30	0,04	0,40	0,38	0,40	0,44	2,61	27,32	26,16
312-5	4,07	0,25	2,58	2,47	2,60	2,90	2,61	27,32	26,16
313-5	5,15	0,12	1,21	1,16	1,22	1,36	2,61	27,32	26,16
321-5	4,04	0,17	1,80	1,72	1,81	2,02	2,61	27,32	26,16
322-5	4,08	0,28	2,94	2,81	2,96	3,30	2,61	27,32	26,16
323-5	4,39	0,37	3,88	3,71	3,91	4,36	2,61	27,32	26,16
311-6	3,96	0,03	0,54	0,53	0,52	0,44	1,83	38,14	37,16
312-6	4,19	0,16	3,32	3,24	3,22	2,68	1,83	38,14	37,16
313-6	4,18	0,14	2,93	2,86	2,84	2,36	1,83	38,14	37,16
321-6	3,81	0,07	1,38	1,34	1,33	1,11	1,83	38,14	37,16
322-6	3,69	0,04	0,89	0,86	0,86	0,71	1,83	38,14	37,16
323-6	3,75	0,05	0,99	0,97	0,96	0,80	1,83	38,14	37,16
311-7	5,20	1,52	7,45	6,82	7,41	7,47	5,55	27,25	24,97
312-7	3,89	0,94	4,61	4,23	4,59	4,63	5,55	27,25	24,97
313-7	3,87	0,41	2,03	1,86	2,02	2,04	5,55	27,25	24,97
311-8	4,13	2,68	23,69	20,86	19,68	18,29	3,37	29,78	26,22
312-8	4,07	1,51	13,32	11,73	11,07	10,29	3,37	29,78	26,22

Nr	DLI plant +4	DLI plant +8	oC harvestday average	oC harvestday min	oC harvestday max	oC harvestday Δ min/max	oC + 1 average
133-8	5,07	3,42	17,1	12,7	19,6	6,9	14,5
n =	**33**	**33**	**33**	**33**	**33**	**33**	**33**
311-2	32,90	32,74	24,5	24,5	24,5	0	24,1
312-2	32,90	32,74	24,5	24,5	24,5	0	24,1
313-2	32,90	32,74	24,5	24,5	24,5	0	24,1
321-2	32,90	32,74	24,5	24,5	24,5	0	24,1
322-2	32,90	32,74	24,5	24,5	24,5	0	24,1
323-2	32,90	32,74	24,5	24,5	24,5	0	24,1
311-4	40,73	36,88	25,5	24,5	26,1	1,6	24,6
312-4	40,73	36,88	25,5	24,5	26,1	1,6	24,6
313-4	40,73	36,88	25,5	24,5	26,1	1,6	24,6
321-4	40,73	36,88	25,5	24,5	26,1	1,6	24,6
322-4	40,73	36,88	25,5	24,5	26,1	1,6	24,6
323-4	40,73	36,88	25,5	24,5	26,1	1,6	24,6
311-5	27,53	30,70	24,7	23,9	25,3	1,4	24,2
312-5	27,53	30,70	24,7	23,9	25,3	1,4	24,2
313-5	27,53	30,70	24,7	23,9	25,3	1,4	24,2
321-5	27,53	30,70	24,7	23,9	25,3	1,4	24,2
322-5	27,53	30,70	24,7	23,9	25,3	1,4	24,2
323-5	27,53	30,70	24,7	23,9	25,3	1,4	24,2
311-6	36,90	30,70	25,2	24,6	25,5	0,9	24,2
312-6	36,90	30,70	25,2	24,6	25,5	0,9	24,2
313-6	36,90	30,70	25,2	24,6	25,5	0,9	24,2
321-6	36,90	30,70	25,2	24,6	25,5	0,9	24,2
322-6	36,90	30,70	25,2	24,6	25,5	0,9	24,2
323-6	36,90	30,70	25,2	24,6	25,5	0,9	24,2
311-7	27,12	27,34	24,7	23,6	25,4	1,8	24,1
312-7	27,12	27,34	24,7	23,6	25,4	1,8	24,1
313-7	27,12	27,34	24,7	23,6	25,4	1,8	24,1
311-8	24,74	23,00	25,3	24,6	26	1,4	24,5
312-8	24,74	23,00	25,3	24,6	26	1,4	24,5

Nr	oC + 1 min	oC + 1 max	oC + 1 Δ min/max	oC + 2 average	oC +2 min	oC + 2 max	oC +2 min/max	oC +4 average	oC +4 min	oC +4 max
133-8	11,9	20,3	8,4	14,3	11,9	20,3	8,4	14,1	11,6	20,3
n =	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**
311-2	19	27,6	8,6	24,2	19	27,6	8,6	24,5	19	27,9
312-2	19	27,6	8,6	24,2	19	27,6	8,6	24,5	19	27,9
313-2	19	27,6	8,6	24,2	19	27,6	8,6	24,5	19	27,9
321-2	19	27,6	8,6	24,2	19	27,6	8,6	24,5	19	27,9
322-2	19	27,6	8,6	24,2	19	27,6	8,6	24,5	19	27,9
323-2	19	27,6	8,6	24,2	19	27,6	8,6	24,5	19	27,9
311-4	18,8	29,6	10,8	24,2	18,8	29,6	10,8	24,07	18,6	29,6
312-4	18,8	29,6	10,8	24,2	18,8	29,6	10,8	24,07	18,6	29,6
313-4	18,8	29,6	10,8	24,2	18,8	29,6	10,8	24,07	18,6	29,6
321-4	18,8	29,6	10,8	24,2	18,8	29,6	10,8	24,07	18,6	29,6
322-4	18,8	29,6	10,8	24,2	18,8	29,6	10,8	24,07	18,6	29,6
323-4	18,8	29,6	10,8	24,2	18,8	29,6	10,8	24,07	18,6	29,6
311-5	20,6	26	5,4	24,1	20,3	26	5,7	23,9	20,1	26
312-5	20,6	26	5,4	24,1	20,3	26	5,7	23,9	20,1	26
313-5	20,6	26	5,4	24,1	20,3	26	5,7	23,9	20,1	26
321-5	20,6	26	5,4	24,1	20,3	26	5,7	23,9	20,1	26
322-5	20,6	26	5,4	24,1	20,3	26	5,7	23,9	20,1	26
323-5	20,6	26	5,4	24,1	20,3	26	5,7	23,9	20,1	26
311-6	20,2	26,1	5,9	24,1	20,2	26,4	6,2	24	20	26,4
312-6	20,2	26,1	5,9	24,1	20,2	26,4	6,2	24	20	26,4
313-6	20,2	26,1	5,9	24,1	20,2	26,4	6,2	24	20	26,4
321-6	20,2	26,1	5,9	24,1	20,2	26,4	6,2	24	20	26,4
322-6	20,2	26,1	5,9	24,1	20,2	26,4	6,2	24	20	26,4
323-6	20,2	26,1	5,9	24,1	20,2	26,4	6,2	24	20	26,4
311-7	21,3	25,4	4,1	24,1	21,3	25,4	4,1	24	21,3	25,9
312-7	21,3	25,4	4,1	24,1	21,3	25,4	4,1	24	21,3	25,9
313-7	21,3	25,4	4,1	24,1	21,3	25,4	4,1	24	21,3	25,9
311-8	21,7	26	4,3	24,5	21,7	26,2	4,5	24,5	21,4	26,2
312-8	21,7	26	4,3	24,5	21,7	26,2	4,5	24,5	21,4	26,2

Nr	oC + 4 Δ min/max	oC + 8 average	oC + 8 min	oC + 8 max	oC + 8 Δ min/max	CO2 harvest day average	CO2 harvest day min
133-8	8,7	15,6	11,6	20,3	8,7	320	182
n =	**33**	**33**	**33**	**33**	**33**	**33**	**33**
311-2	8,9	24,9	19	27,9	8,9	882	882
312-2	8,9	24,9	19	27,9	8,9	882	882
313-2	8,9	24,9	19	27,9	8,9	882	882
321-2	8,9	24,9	19	27,9	8,9	882	882
322-2	8,9	24,9	19	27,9	8,9	882	882
323-2	8,9	24,9	19	27,9	8,9	882	882
311-4	11	24	18,6	29,6	11	946	760
312-4	11	24	18,6	29,6	11	946	760
313-4	11	24	18,6	29,6	11	946	760
321-4	11	24	18,6	29,6	11	946	760
322-4	11	24	18,6	29,6	11	946	760
323-4	11	24	18,6	29,6	11	946	760
311-5	5,9	23,8	18,6	29,6	11	873	786
312-5	5,9	23,8	18,6	29,6	11	873	786
313-5	5,9	23,8	18,6	29,6	11	873	786
321-5	5,9	23,8	18,6	29,6	11	873	786
322-5	5,9	23,8	18,6	29,6	11	873	786
323-5	5,9	23,8	18,6	29,6	11	873	786
311-6	6,4	23,9	19,9	26,4	6,5	972	790
312-6	6,4	23,9	19,9	26,4	6,5	972	790
313-6	6,4	23,9	19,9	26,4	6,5	972	790
321-6	6,4	23,9	19,9	26,4	6,5	972	790
322-6	6,4	23,9	19,9	26,4	6,5	972	790
323-6	6,4	23,9	19,9	26,4	6,5	972	790
311-7	4,6	24	20,2	26,1	5,9	914	739
312-7	4,6	24	20,2	26,1	5,9	914	739
313-7	4,6	24	20,2	26,1	5,9	914	739
311-8	4,8	24,3	21,3	26,2	4,9	769	655
312-8	4,8	24,3	21,3	26,2	4,9	769	655

Nr	CO2 harvest day max	CO2 harvest day Δmin/max	CO2 + 1 average	CO2 + 1 min	CO2 + 1 max	CO2 +1 Δ min/max	CO2 +2 average
133-8	640	458	365	182	1138	956	380
n =	**33**	**33**	**33**	**33**	**33**	**33**	**33**
311-2	882	0	1018	654	1435	781	981
312-2	882	0	1018	654	1435	781	981
313-2	882	0	1018	654	1435	781	981
321-2	882	0	1018	654	1435	781	981
322-2	882	0	1018	654	1435	781	981
323-2	882	0	1018	654	1435	781	981
311-4	1342	581	966	619	1492	873	970
312-4	1342	581	966	619	1492	873	970
313-4	1342	581	966	619	1492	873	970
321-4	1342	581	966	619	1492	873	970
322-4	1342	581	966	619	1492	873	970
323-4	1342	581	966	619	1492	873	970
311-5	1033	247	896	541	1461	920	911
312-5	1033	247	896	541	1461	920	911
313-5	1033	247	896	541	1461	920	911
321-5	1033	247	896	541	1461	920	911
322-5	1033	247	896	541	1461	920	911
323-5	1033	247	896	541	1461	920	911
311-6	1463	673	1042	720	1542	821	1019
312-6	1463	673	1042	720	1542	821	1019
313-6	1463	673	1042	720	1542	821	1019
321-6	1463	673	1042	720	1542	821	1019
322-6	1463	673	1042	720	1542	821	1019
323-6	1463	673	1042	720	1542	821	1019
311-7	1252	513	999	739	1345	606	988
312-7	1252	513	999	739	1345	606	988
313-7	1252	513	999	739	1345	606	988
311-8	1000	345	834	563	1219	655	841
312-8	1000	345	834	563	1219	655	841

Nr	CO2 + 2 min	CO2+ 2 max	CO2 +2 Δ min/max	CO2 + 4 average	CO2 + 4 min	CO2 + 4 max	CO2 + 4 Δ min/max	CO2 + 8 average	CO2 + 8 min
133-8	182	1138	956	379	182	1138	956	376	182
n =	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**
311-2	654	1435	781	931	557	1435	878	899	531
312-2	654	1435	781	931	557	1435	878	899	531
313-2	654	1435	781	931	557	1435	878	899	531
321-2	654	1435	781	931	557	1435	878	899	531
322-2	654	1435	781	931	557	1435	878	899	531
323-2	654	1435	781	931	557	1435	878	899	531
311-4	619	1492	873	974	568	1904	1336	965	560
312-4	619	1492	873	974	568	1904	1336	965	560
313-4	619	1492	873	974	568	1904	1336	965	560
321-4	619	1492	873	974	568	1904	1336	965	560
322-4	619	1492	873	974	568	1904	1336	965	560
323-4	619	1492	873	974	568	1904	1336	965	560
311-5	541	1461	920	969	541	1507	966	989	541
312-5	541	1461	920	969	541	1507	966	989	541
313-5	541	1461	920	969	541	1507	966	989	541
321-5	541	1461	920	969	541	1507	966	989	541
322-5	541	1461	920	969	541	1507	966	989	541
323-5	541	1461	920	969	541	1507	966	989	541
311-6	632	1560	927	1040	632	1941	1308	987	541
312-6	632	1560	927	1040	632	1941	1308	987	541
313-6	632	1560	927	1040	632	1941	1308	987	541
321-6	632	1560	927	1040	632	1941	1308	987	541
322-6	632	1560	927	1040	632	1941	1308	987	541
323-6	632	1560	927	1040	632	1941	1308	987	541
311-7	662	1350	688	978	598	1350	752	978	596
312-7	662	1350	688	978	598	1350	752	978	596
313-7	662	1350	688	978	598	1350	752	978	596
311-8	563	1219	655	867	563	1284	721	886	561
312-8	563	1219	655	867	563	1284	721	886	561

Nr	CO2 + 8 max	CO2 + 8 Δ min/max	VPD harvest day average	VPD +1 average	VPd + 2 average	VPD +4 average	VPD + 8 average
133-8	1152	970	1,5	1,1	0,9	1,1	1,8
n =	**33**	**33**	**33**	**33**	**33**	**33**	**33**
311-2	1435	904	4,2	3,9	4,2	4,1	4,4
312-2	1435	904	4,2	3,9	4,2	4,1	4,4
313-2	1435	904	4,2	3,9	4,2	4,1	4,4
321-2	1435	904	4,2	3,9	4,2	4,1	4,4
322-2	1435	904	4,2	3,9	4,2	4,1	4,4
323-2	1435	904	4,2	3,9	4,2	4,1	4,4
311-4	1904	1344	3,9	3,6	3,7	3,9	4
312-4	1904	1344	3,9	3,6	3,7	3,9	4
313-4	1904	1344	3,9	3,6	3,7	3,9	4
321-4	1904	1344	3,9	3,6	3,7	3,9	4
322-4	1904	1344	3,9	3,6	3,7	3,9	4
323-4	1904	1344	3,9	3,6	3,7	3,9	4
311-5	1518	977	3,6	3,7	3,8	3,8	3,8
312-5	1518	977	3,6	3,7	3,8	3,8	3,8
313-5	1518	977	3,6	3,7	3,8	3,8	3,8
321-5	1518	977	3,6	3,7	3,8	3,8	3,8
322-5	1518	977	3,6	3,7	3,8	3,8	3,8
323-5	1518	977	3,6	3,7	3,8	3,8	3,8
311-6	1941	1400	4,1	4	4	4	3,9
312-6	1941	1400	4,1	4	4	4	3,9
313-6	1941	1400	4,1	4	4	4	3,9
321-6	1941	1400	4,1	4	4	4	3,9
322-6	1941	1400	4,1	4	4	4	3,9
323-6	1941	1400	4,1	4	4	4	3,9
311-7	1542	945	4,4	4,5	4,5	4,3	4,2
312-7	1542	945	4,4	4,5	4,5	4,3	4,2
313-7	1542	945	4,4	4,5	4,5	4,3	4,2
311-8	1345	784	2,9	2,8	2,7	2,7	3,5
312-8	1345	784	2,9	2,8	2,7	2,7	3,5

Nr	Prod.	Variety	Harvest	Weight	Lenght	Color	SSC	pH	EC	EC drain water	pH drain water	EC irrigation water	pH irrigation water
313-8	3	1	6	294	29	7	4,4	5,61	3,96				
n=	30	30	30	30	30	30	30	30	30	27	27	21	21
411-2	4	1	1	376	28,5	9	3,4	5,43	4,14	5,55	7,25	3,84	5,78
412-2	4	1	1	318	26,5	8	3,2	5,44	4,3	5,55	7,25	3,84	5,78
413-2	4	1	1	351	28,5	8	3	5,39	4,43	5,55	7,25	3,84	5,78
421-2	4	2	1	326	30,5	9	3,3	5,58	4,12	5,55	7,25	3,84	5,78
422-2	4	2	1	285	31,5	9	3,1	5,6	3,89	5,55	7,25	3,84	5,78
423-2	4	2	1	358	29	8	3,4	5,58	4,09	5,55	7,25	3,84	5,78
411-4	4	1	2	279	24,5	8	2,8	5,27	4,08	4,75	7,11	3,44	5,73
412-4	4	1	2	260	26,5	7	3,1	5,34	4,09	4,75	7,11	3,44	5,73
413-4	4	1	2	345	30,5	8	3,1	5,36	3,95	4,75	7,11	3,44	5,73
421-4	4	2	2	278	30,5	8	3,4	5,46	4,88	4,75	7,11	3,44	5,73
422-4	4	2	2	246	28	8	3,5	5,47	4,95	4,75	7,11	3,44	5,73
423-4	4	2	2	252	27	8	2,7	5,29	4	4,75	7,11	3,44	5,73
411-5	4	1	3	346	30	8	3,3	5,58	4,31	4,31	7,19	3,63	5,56
412-5	4	1	3	276	30	7	3,8	5,77	4,62	4,31	7,19	3,63	5,56
413-5	4	1	3	356	29	7	3,6	5,61	4,68	4,31	7,19	3,63	5,56
421-5	4	2	3	269	30	7	3,6	5,72	4,56	4,31	7,19	3,63	5,56
422-5	4	2	3	400	33,5	8	3,5	5,63	4,42	4,31	7,19	3,63	5,56
423-5	4	2	3	393	31	6	3,4	5,63	4,27	4,31	7,19	3,63	5,56
411-6	4	1	4	361	30,5	8	3,5	5,61	3,92	5,7	7,12	3,69	5,79
412-6	4	1	4	405	33	8	3,7	5,63	3,8	5,7	7,12	3,69	5,79
413-6	4	1	4	365	32	8	3,5	5,67	3,81	5,7	7,12	3,69	5,79
421-6	4	2	4	328	33	8	3,3	5,59	3,99	5,7	7,12	3,69	5,79
422-6	4	2	4	278	32,5	8	3,3	5,62	3,75	5,7	7,12	3,69	5,79
423-6	4	2	4	281	33	7	3,6	5,72	3,95	5,7	7,12	3,69	5,79
411-8	4	1	5	325	30,5	7	2,9	5,6	4,38	4,37	7,35	3,48	5,68
412-8	4	1	5	351	33	7	3,4	5,59	4,09	4,37	7,35	3,48	5,68
413-8	4	1	5	303	33,5	7	3,8	5,62	4,38	4,37	7,35	3,48	5,68
421-8	4	2	5	310	34	8	4,6	5,57	4	4,37	7,35	3,48	5,68
422-8	4	2	5	319	31	7	4	5,52	4,38	4,37	7,35	3,48	5,68

Nr	Dry matter content	DLI fruit harvest day	DLI fruit +1	DLI fruit +2	DLI fruit +4	DLI fruit +8	DLI plant harvest day	DLI plant +1	DLI plant +2
313-8	5,38	1,80	15,88	13,98	13,19	12,26	3,37	29,78	26,22
n=	**18**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
411-2	3,91								
412-2	3,97								
413-2	3,73								
421-2	3,89								
422-2	3,80								
423-2	4,03								
411-4	3,25	0,74	3,91	3,19	3,05	2,97	4,99	26,31	21,45
412-4	3,79	1,02	5,39	4,39	4,21	4,09	4,99	26,31	21,45
413-4	3,80	0,58	3,07	2,50	2,40	2,33	4,99	26,31	21,45
421-4	4,08	1,29	6,78	5,53	5,29	5,15	4,99	26,31	21,45
422-4	4,15	1,72	9,07	7,40	7,08	6,89	4,99	26,31	21,45
423-4	3,21	1,94	10,21	8,33	7,97	7,75	4,99	26,31	21,45
411-5	3,85	2,10	9,34	8,28	7,42	7,31	5,38	23,91	21,20
412-5	4,49	1,07	4,74	4,20	3,77	3,71	5,38	23,91	21,20
413-5	4,26	0,64	2,84	2,52	2,26	2,22	5,38	23,91	21,20
421-5	4,11	0,96	4,25	3,77	3,38	3,33	5,38	23,91	21,20
422-5	4,12	0,93	4,15	3,68	3,30	3,25	5,38	23,91	21,20
423-5	4,00	0,61	2,69	2,39	2,14	2,11	5,38	23,91	21,20
411-6	4,17	0,83	2,85	2,43	2,25	2,09	7,56	26,14	22,23
412-6	4,47	1,46	5,05	4,30	3,99	3,70	7,56	26,14	22,23
413-6	4,17	1,46	5,04	4,29	3,98	3,70	7,56	26,14	22,23
421-6	3,92	3,02	10,45	8,89	8,26	7,67	7,56	26,14	22,23
422-6	4,21	1,08	3,75	3,19	2,96	2,75	7,56	26,14	22,23
423-6	4,46	1,84	6,35	5,40	5,02	4,66	7,56	26,14	22,23
411-8	3,47	0,66	1,86	1,66	1,53	1,48	7,74	21,85	19,58
412-8	3,97	0,84	2,38	2,13	1,95	1,89	7,74	21,85	19,58
413-8	4,76	0,32	0,89	0,80	0,73	0,71	7,74	21,85	19,58
421-8	5,70	1,06	2,98	2,67	2,45	2,37	7,74	21,85	19,58
422-8	4,70	1,31	3,69	3,30	3,03	2,93	7,74	21,85	19,58

Nr	DLI plant +4	DLI plant +8	oC harvestday average	oC harvestday min	oC harvestday max	oC harvestday Δ min/max	oC + 1 average
313-8	24,74	23,00	25,3	24,6	26	1,4	24,5
n=	**30**	**30**	**30**	**30**	**30**	**30**	**30**
411-2							
412-2							
413-2							
421-2							
422-2							
423-2							
411-4	20,53	19,98	23,9	23,5	24,2	0,7	23,1
412-4	20,53	19,98	23,9	23,5	24,2	0,7	23,1
413-4	20,53	19,98	23,9	23,5	24,2	0,7	23,1
421-4	20,53	19,98	23,9	23,5	24,2	0,7	23,1
422-4	20,53	19,98	23,9	23,5	24,2	0,7	23,1
423-4	20,53	19,98	23,9	23,5	24,2	0,7	23,1
411-5	19,00	18,72	23,5	22,9	24,1	1,2	23,1
412-5	19,00	18,72	23,5	22,9	24,1	1,2	23,1
413-5	19,00	18,72	23,5	22,9	24,1	1,2	23,1
421-5	19,00	18,72	23,5	22,9	24,1	1,2	23,1
422-5	19,00	18,72	23,5	22,9	24,1	1,2	23,1
423-5	19,00	18,72	23,5	22,9	24,1	1,2	23,1
411-6	20,64	19,16	24	23,3	24,6	1,3	23
412-6	20,64	19,16	24	23,3	24,6	1,3	23
413-6	20,64	19,16	24	23,3	24,6	1,3	23
421-6	20,64	19,16	24	23,3	24,6	1,3	23
422-6	20,64	19,16	24	23,3	24,6	1,3	23
423-6	20,64	19,16	24	23,3	24,6	1,3	23
411-8	17,94	17,37	24,5	24	25,5	1,5	23,6
412-8	17,94	17,37	24,5	24	25,5	1,5	23,6
413-8	17,94	17,37	24,5	24	25,5	1,5	23,6
421-8	17,94	17,37	24,5	24	25,5	1,5	23,6
422-8	17,94	17,37	24,5	24	25,5	1,5	23,6

Nr	oC + 1 min	oC + 1 max	oC + 1 Δ min/max	oC + 2 average	oC +2 min	oC + 2 max	oC +2 min/max	oC +4 average	oC +4 min	oC +4 max
313-8	21,7	26	4,3	24,5	21,7	26,2	4,5	24,5	21,4	26,2
n=	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
411-2										
412-2										
413-2										
421-2										
422-2										
423-2										
411-4	19,3	24,7	5,4	23,2	19,3	25	5,7	23,2	19,3	25
412-4	19,3	24,7	5,4	23,2	19,3	25	5,7	23,2	19,3	25
413-4	19,3	24,7	5,4	23,2	19,3	25	5,7	23,2	19,3	25
421-4	19,3	24,7	5,4	23,2	19,3	25	5,7	23,2	19,3	25
422-4	19,3	24,7	5,4	23,2	19,3	25	5,7	23,2	19,3	25
423-4	19,3	24,7	5,4	23,2	19,3	25	5,7	23,2	19,3	25
411-5	18,7	25,6	6,9	23,2	19,4	25,6	6,2	23,3	19,2	25,6
412-5	18,7	25,6	6,9	23,2	19,4	25,6	6,2	23,3	19,2	25,6
413-5	18,7	25,6	6,9	23,2	19,4	25,6	6,2	23,3	19,2	25,6
421-5	18,7	25,6	6,9	23,2	19,4	25,6	6,2	23,3	19,2	25,6
422-5	18,7	25,6	6,9	23,2	19,4	25,6	6,2	23,3	19,2	25,6
423-5	18,7	25,6	6,9	23,2	19,4	25,6	6,2	23,3	19,2	25,6
411-6	18,5	24,6	6,1	23,1	18,5	25,2	6,7	23,1	18,5	25,2
412-6	18,5	24,6	6,1	23,1	18,5	25,2	6,7	23,1	18,5	25,2
413-6	18,5	24,6	6,1	23,1	18,5	25,2	6,7	23,1	18,5	25,2
421-6	18,5	24,6	6,1	23,1	18,5	25,2	6,7	23,1	18,5	25,2
422-6	18,5	24,6	6,1	23,1	18,5	25,2	6,7	23,1	18,5	25,2
423-6	18,5	24,6	6,1	23,1	18,5	25,2	6,7	23,1	18,5	25,2
411-8	19,6	25,5	5,9	23,3	18,6	25,5	6,9	22,6	15,2	25,5
412-8	19,6	25,5	5,9	23,3	18,6	25,5	6,9	22,6	15,2	25,5
413-8	19,6	25,5	5,9	23,3	18,6	25,5	6,9	22,6	15,2	25,5
421-8	19,6	25,5	5,9	23,3	18,6	25,5	6,9	22,6	15,2	25,5
422-8	19,6	25,5	5,9	23,3	18,6	25,5	6,9	22,6	15,2	25,5

Nr	oC + 4 Δ min/max	oC + 8 average	oC + 8 min	oC + 8 max	oC + 8 Δ min/max	CO2 harvest day average	CO2 harvest day min
313-8	4,8	24,3	21,3	26,2	4,9	769	655
n=	**30**	**30**	**30**	**30**	**30**	**30**	**30**
411-2							
412-2							
413-2							
421-2							
422-2							
423-2							
411-4	5,7	23,2	19,2	25	5,8	928	686
412-4	5,7	23,2	19,2	25	5,8	928	686
413-4	5,7	23,2	19,2	25	5,8	928	686
421-4	5,7	23,2	19,2	25	5,8	928	686
422-4	5,7	23,2	19,2	25	5,8	928	686
423-4	5,7	23,2	19,2	25	5,8	928	686
411-5	6,4	23,2	18,7	25,6	6,9	995	725
412-5	6,4	23,2	18,7	25,6	6,9	995	725
413-5	6,4	23,2	18,7	25,6	6,9	995	725
421-5	6,4	23,2	18,7	25,6	6,9	995	725
422-5	6,4	23,2	18,7	25,6	6,9	995	725
423-5	6,4	23,2	18,7	25,6	6,9	995	725
411-6	6,7	23	18,5	25,6	7,1	965	751
412-6	6,7	23	18,5	25,6	7,1	965	751
413-6	6,7	23	18,5	25,6	7,1	965	751
421-6	6,7	23	18,5	25,6	7,1	965	751
422-6	6,7	23	18,5	25,6	7,1	965	751
423-6	6,7	23	18,5	25,6	7,1	965	751
411-8	10,3	22,8	15,2	25,5	10,3	877	548
412-8	10,3	22,8	15,2	25,5	10,3	877	548
413-8	10,3	22,8	15,2	25,5	10,3	877	548
421-8	10,3	22,8	15,2	25,5	10,3	877	548
422-8	10,3	22,8	15,2	25,5	10,3	877	548

Nr	CO2 harvest day max	CO2 harvest day Δmin/max	CO2 + 1 average	CO2 + 1 min	CO2 + 1 max	CO2 +1 Δ min/max	CO2 +2 average
313-8	1000	345	834	563	1219	655	841
n=	**30**	**30**	**30**	**30**	**30**	**30**	**30**
411-2							
412-2							
413-2							
421-2							
422-2							
423-2							
411-4	1134	448	997	635	1730	1095	996
412-4	1134	448	997	635	1730	1095	996
413-4	1134	448	997	635	1730	1095	996
421-4	1134	448	997	635	1730	1095	996
422-4	1134	448	997	635	1730	1095	996
423-4	1134	448	997	635	1730	1095	996
411-5	1429	704	900	336	1807	1471	864
412-5	1429	704	900	336	1807	1471	864
413-5	1429	704	900	336	1807	1471	864
421-5	1429	704	900	336	1807	1471	864
422-5	1429	704	900	336	1807	1471	864
423-5	1429	704	900	336	1807	1471	864
411-6	1212	461	1012	635	1769	1134	974
412-6	1212	461	1012	635	1769	1134	974
413-6	1212	461	1012	635	1769	1134	974
421-6	1212	461	1012	635	1769	1134	974
422-6	1212	461	1012	635	1769	1134	974
423-6	1212	461	1012	635	1769	1134	974
411-8	1286	738	843	465	1484	1019	876
412-8	1286	738	843	465	1484	1019	876
413-8	1286	738	843	465	1484	1019	876
421-8	1286	738	843	465	1484	1019	876
422-8	1286	738	843	465	1484	1019	876

Nr	CO2 + 2 min	CO2+ 2 max	CO2 +2 Δ min/max	CO2 + 4 average	CO2 + 4 min	CO2 + 4 max	CO2 + 4 Δ min/max	CO2 + 8 average	CO2 + 8 min
313-8	563	1219	655	867	563	1284	721	886	561
n=	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
411-2									
412-2									
413-2									
421-2									
422-2									
423-2									
411-4	488	1730	1242	941	354	1730	1376	944	354
412-4	488	1730	1242	941	354	1730	1376	944	354
413-4	488	1730	1242	941	354	1730	1376	944	354
421-4	488	1730	1242	941	354	1730	1376	944	354
422-4	488	1730	1242	941	354	1730	1376	944	354
423-4	488	1730	1242	941	354	1730	1376	944	354
411-5	336	1588	1252	858	336	1689	1353	883	336
412-5	336	1588	1252	858	336	1689	1353	883	336
413-5	336	1588	1252	858	336	1689	1353	883	336
421-5	336	1588	1252	858	336	1689	1353	883	336
422-5	336	1588	1252	858	336	1689	1353	883	336
423-5	336	1588	1252	858	336	1689	1353	883	336
411-6	517	1769	1252	972	517	1769	1252	970	417
412-6	517	1769	1252	972	517	1769	1252	970	417
413-6	517	1769	1252	972	517	1769	1252	970	417
421-6	517	1769	1252	972	517	1769	1252	970	417
422-6	517	1769	1252	972	517	1769	1252	970	417
423-6	517	1769	1252	972	517	1769	1252	970	417
411-8	465	1561	1095	879	385	1666	1281	899	385
412-8	465	1561	1095	879	385	1666	1281	899	385
413-8	465	1561	1095	879	385	1666	1281	899	385
421-8	465	1561	1095	879	385	1666	1281	899	385
422-8	465	1561	1095	879	385	1666	1281	899	385

Nr	CO2 + 8 max	CO2 + 8 Δ min/max	VPD harvest day average	VPD +1 average	VPd + 2 average	VPD +4 average	VPD + 8 average
313-8	1345	784	2,9	2,8	2,7	2,7	3,5
n=	**30**	**30**	**30**	**30**	**30**	**30**	**30**
411-2							
412-2							
413-2							
421-2							
422-2							
423-2							
411-4	1807	1453	5,2	4,8	4,6	4,7	4,7
412-4	1807	1453	5,2	4,8	4,6	4,7	4,7
413-4	1807	1453	5,2	4,8	4,6	4,7	4,7
421-4	1807	1453	5,2	4,8	4,6	4,7	4,7
422-4	1807	1453	5,2	4,8	4,6	4,7	4,7
423-4	1807	1453	5,2	4,8	4,6	4,7	4,7
411-5	1730	1394	4,5	4,5	4,6	4,5	4,5
412-5	1730	1394	4,5	4,5	4,6	4,5	4,5
413-5	1730	1394	4,5	4,5	4,6	4,5	4,5
421-5	1730	1394	4,5	4,5	4,6	4,5	4,5
422-5	1730	1394	4,5	4,5	4,6	4,5	4,5
423-5	1730	1394	4,5	4,5	4,6	4,5	4,5
411-6	1769	1352	4,7	4,2	4,3	4,4	4,5
412-6	1769	1352	4,7	4,2	4,3	4,4	4,5
413-6	1769	1352	4,7	4,2	4,3	4,4	4,5
421-6	1769	1352	4,7	4,2	4,3	4,4	4,5
422-6	1769	1352	4,7	4,2	4,3	4,4	4,5
423-6	1769	1352	4,7	4,2	4,3	4,4	4,5
411-8	1992	1607	4,5	4,1	4,1	4	4,1
412-8	1992	1607	4,5	4,1	4,1	4	4,1
413-8	1992	1607	4,5	4,1	4,1	4	4,1
421-8	1992	1607	4,5	4,1	4,1	4	4,1
422-8	1992	1607	4,5	4,1	4,1	4	4,1

Nr	Prod.	Variety	Harvest	Weight	Lenght	Color	SSC	pH	EC	EC drain water	pH drain water	EC irrigation water	pH irrigation water
423-8	4	2	5	369	34,5	8	3,8	5,61	4,02	4,37	7,35	3,48	5,68
n=	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
511-2	5	1	1	294	26,5	9	3,2	5,49	3,93	2,71	5,78	2,84	5,78
512-2	5	1	1	233	24,5	9	3,2	5,49	3,64	2,71	5,78	2,84	5,78
513-2	5	1	1	286	28	9	3,7	5,53	3,76	2,71	5,78	2,84	5,78
521-2	5	2	1	288	26,5	8	3,3	5,44	4,06	2,71	5,78	2,84	5,78
522-2	5	2	1	273	26	8	3,1	5,39	4,09	2,71	5,78	2,84	5,78
523-2	5	2	1	249	25	9	3	5,46	4,08	2,71	5,78	2,84	5,78
511-3	5	1	2	295	29,5	8	3,4	5,59	3,37	2,95	5,98	2,97	5,87
512-3	5	1	2	325	30	9	3,4	5,55	3,35	2,95	5,98	2,97	5,87
513-3	5	1	2	250	29	7	3,7	5,68	4,19	2,95	5,98	2,97	5,87
511-4	5	1	3	255	29	9	3,5	5,67	4,05	2,85	6,71	3,15	6,13
512-4	5	1	3	252	28	9	3,5	5,65	3,05	2,85	6,71	3,15	6,13
513-4	5	1	3	337	32,5	8	4	5,71	3,66	2,85	6,71	3,15	6,13
521-4	5	2	3	276	30	9	3,7	5,6	3,84	2,85	6,71	3,15	6,13
522-4	5	2	3	320	33	8	3,4	5,58	3,46	2,85	6,71	3,15	6,13
523-4	5	2	3	276	30,5	8	3,4	5,56	3,49	2,85	6,71	3,15	6,13
511-5	5	1	4	300	30	9	3,3	5,39	3,48	2,88	7,06	3	5,93
512-5	5	1	4	307	31	9	3,7	5,49	3,71	2,88	7,06	3	5,93
513-5	5	1	4	316	32	9	3,7	5,45	3,61	2,88	7,06	3	5,93
521-5	5	2	4	323	30	9	3,3	5,38	3,97	2,88	7,06	3	5,93
522-5	5	2	4	331	33	8	3,4	5,48	4,02	2,88	7,06	3	5,93
523-5	5	2	4	329	31,5	9	3,3	5,38	3,64	2,88	7,06	3	5,93
511-6	5	1	5	232	27,5	8	4	5,78	3,51	2,54	6,45	2,97	5,54
512-6	5	1	5	278	30	8	3,7	5,61	3,41	2,54	6,45	2,97	5,54
513-6	5	1	5	285	32	9	3,9	5,61	3,85	2,54	6,45	2,97	5,54
521-6	5	2	5	341	33,5	9	3,2	5,45	3,55	2,54	6,45	2,97	5,54
522-6	5	2	5	321	34	9	3,8	5,57	3,66	2,54	6,45	2,97	5,54
523-6	5	2	5	309	30,5	9	3,6	5,52	3,46	2,54	6,45	2,97	5,54
n=	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**

Nr	Dry matter content	DLI fruit harvest day	DLI fruit +1	DLI fruit +2	DLI fruit +4	DLI fruit +8	DLI plant harvest day	DLI plant +1	DLI plant +2
423-8	4,62	0,96	2,71	2,43	2,22	2,15	7,74	21,85	19,58
n=	**30**	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**
511-2	3,86	0,20	2,67	2,54	2,84	2,85	1,80	24,09	22,89
512-2	4,02	0,10	1,39	1,32	1,48	1,48	1,80	24,09	22,89
513-2	4,38	0,12	1,59	1,51	1,69	1,70	1,80	24,09	22,89
521-2	3,64	0,17	2,29	2,18	2,43	2,44	1,80	24,09	22,89
522-2	3,54	0,06	0,77	0,73	0,82	0,82	1,80	24,09	22,89
523-2	3,74	0,04	0,57	0,54	0,61	0,61	1,80	24,09	22,89
511-3	4,16	0,03	0,81	0,74	0,71	0,69	0,97	25,19	23,08
512-3	4,08	0,01	0,38	0,35	0,33	0,32	0,97	25,19	23,08
513-3	4,52	0,05	1,43	1,31	1,25	1,22	0,97	25,19	23,08
511-4	4,06	0,12	1,99	1,99	1,93	1,92	1,53	24,76	24,86
512-4	4,19	0,09	1,54	1,54	1,49	1,48	1,53	24,76	24,86
513-4	4,90	0,09	1,49	1,50	1,45	1,44	1,53	24,76	24,86
521-4	4,32	1,13	18,33	18,40	17,84	17,69	1,53	24,76	24,86
522-4	3,99	0,18	2,93	2,94	2,85	2,83	1,53	24,76	24,86
523-4	4,12	0,02	0,36	0,36	0,35	0,35	1,53	24,76	24,86
511-5	3,91	0,17	4,30	3,85	3,85	3,94	0,99	24,95	22,36
512-5	4,37	0,09	2,24	2,01	2,01	2,05	0,99	24,95	22,36
513-5	4,21	0,14	3,49	3,13	3,12	3,20	0,99	24,95	22,36
521-5	3,84	0,09	2,19	1,97	1,96	2,01	0,99	24,95	22,36
522-5	4,05	0,08	2,07	1,86	1,86	1,90	0,99	24,95	22,36
523-5	3,95	0,03	0,82	0,73	0,73	0,75	0,99	24,95	22,36
511-6	4,60	0,05	1,31	1,19	1,13	1,14	0,98	24,84	22,57
512-6	4,17	0,05	1,36	1,23	1,17	1,18	0,98	24,84	22,57
513-6	4,42	0,06	1,57	1,43	1,35	1,37	0,98	24,84	22,57
521-6	3,50	0,05	1,20	1,09	1,03	1,04	0,98	24,84	22,57
522-6	4,34	0,10	2,49	2,26	2,14	2,17	0,98	24,84	22,57
523-6	4,13	0,06	1,46	1,33	1,25	1,27	0,98	24,84	22,57
n=	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**

Nr	DLI plant +4	DLI plant +8	oC harvestday average	oC harvestday min	oC harvestday max	oC harvestday Δ min/max	oC + 1 average
423-8	17,94	17,37	24,5	24	25,5	1,5	23,6
n=	**24**	**24**	**24**	**24**	**24**	**24**	**24**
511-2	25,55	25,66	26,1	25,8	26,5	0,7	25,2
512-2	25,55	25,66	26,1	25,8	26,5	0,7	25,2
513-2	25,55	25,66	26,1	25,8	26,5	0,7	25,2
521-2	25,55	25,66	26,1	25,8	26,5	0,7	25,2
522-2	25,55	25,66	26,1	25,8	26,5	0,7	25,2
523-2	25,55	25,66	26,1	25,8	26,5	0,7	25,2
511-3	22,09	21,50	25	24,7	25,3	0,6	24,8
512-3	22,09	21,50	25	24,7	25,3	0,6	24,8
513-3	22,09	21,50	25	24,7	25,3	0,6	24,8
511-4	24,09	23,89	26,2	25,9	26,7	0,8	25,2
512-4	24,09	23,89	26,2	25,9	26,7	0,8	25,2
513-4	24,09	23,89	26,2	25,9	26,7	0,8	25,2
521-4	24,09	23,89	26,2	25,9	26,7	0,8	25,2
522-4	24,09	23,89	26,2	25,9	26,7	0,8	25,2
523-4	24,09	23,89	26,2	25,9	26,7	0,8	25,2
511-5	22,33	22,87	25,8	25,6	26,1	0,5	25,3
512-5	22,33	22,87	25,8	25,6	26,1	0,5	25,3
513-5	22,33	22,87	25,8	25,6	26,1	0,5	25,3
521-5	22,33	22,87	25,8	25,6	26,1	0,5	25,3
522-5	22,33	22,87	25,8	25,6	26,1	0,5	25,3
523-5	22,33	22,87	25,8	25,6	26,1	0,5	25,3
511-6	21,35	21,61	24,5	24,2	25	0,8	24,4
512-6	21,35	21,61	24,5	24,2	25	0,8	24,4
513-6	21,35	21,61	24,5	24,2	25	0,8	24,4
521-6	21,35	21,61	24,5	24,2	25	0,8	24,4
522-6	21,35	21,61	24,5	24,2	25	0,8	24,4
523-6	21,35	21,61	24,5	24,2	25	0,8	24,4
n=	**27**	**27**	**27**	**27**	**27**	**27**	**27**

Nr	oC + 1 min	oC + 1 max	oC + 1 Δ min/max	oC + 2 average	oC +2 min	oC + 2 max	oC +2 min/max	oC +4 average	oC +4 min	oC +4 max
423-8	19,6	25,5	5,9	23,3	18,6	25,5	6,9	22,6	15,2	25,5
n=	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**
511-2	20,4	26,5	6,1	25,3	19,2	27,1	7,9	25,2	18	27,7
512-2	20,4	26,5	6,1	25,3	19,2	27,1	7,9	25,2	18	27,7
513-2	20,4	26,5	6,1	25,3	19,2	27,1	7,9	25,2	18	27,7
521-2	20,4	26,5	6,1	25,3	19,2	27,1	7,9	25,2	18	27,7
522-2	20,4	26,5	6,1	25,3	19,2	27,1	7,9	25,2	18	27,7
523-2	20,4	26,5	6,1	25,3	19,2	27,1	7,9	25,2	18	27,7
511-3	19,7	26,8	7,1	24,9	19,7	26,8	7,1	24,9	19,7	26,8
512-3	19,7	26,8	7,1	24,9	19,7	26,8	7,1	24,9	19,7	26,8
513-3	19,7	26,8	7,1	24,9	19,7	26,8	7,1	24,9	19,7	26,8
511-4	19	26,7	7,7	25,1	19	27,1	8,1	24,8	18,6	27,1
512-4	19	26,7	7,7	25,1	19	27,1	8,1	24,8	18,6	27,1
513-4	19	26,7	7,7	25,1	19	27,1	8,1	24,8	18,6	27,1
521-4	19	26,7	7,7	25,1	19	27,1	8,1	24,8	18,6	27,1
522-4	19	26,7	7,7	25,1	19	27,1	8,1	24,8	18,6	27,1
523-4	19	26,7	7,7	25,1	19	27,1	8,1	24,8	18,6	27,1
511-5	18,2	27,6	9,4	25,2	18,2	27,6	9,4	25,1	18,2	27,6
512-5	18,2	27,6	9,4	25,2	18,2	27,6	9,4	25,1	18,2	27,6
513-5	18,2	27,6	9,4	25,2	18,2	27,6	9,4	25,1	18,2	27,6
521-5	18,2	27,6	9,4	25,2	18,2	27,6	9,4	25,1	18,2	27,6
522-5	18,2	27,6	9,4	25,2	18,2	27,6	9,4	25,1	18,2	27,6
523-5	18,2	27,6	9,4	25,2	18,2	27,6	9,4	25,1	18,2	27,6
511-6	21,3	26,3	5	24,1	21,3	26,3	5	24,2	19,8	27,3
512-6	21,3	26,3	5	24,1	21,3	26,3	5	24,2	19,8	27,3
513-6	21,3	26,3	5	24,1	21,3	26,3	5	24,2	19,8	27,3
521-6	21,3	26,3	5	24,1	21,3	26,3	5	24,2	19,8	27,3
522-6	21,3	26,3	5	24,1	21,3	26,3	5	24,2	19,8	27,3
523-6	21,3	26,3	5	24,1	21,3	26,3	5	24,2	19,8	27,3
n=	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**

Nr	oC + 4 Δ min/max	oC + 8 average	oC + 8 min	oC + 8 max	oC + 8 Δ min/max	CO2 harvest day average	CO2 harvest day min
423-8	10,3	22,8	15,2	25,5	10,3	877	548
n=	**24**	**24**	**24**	**24**	**24**	**24**	**24**
511-2	9,7	25,4	18	27,8	9,8	976	608
512-2	9,7	25,4	18	27,8	9,8	976	608
513-2	9,7	25,4	18	27,8	9,8	976	608
521-2	9,7	25,4	18	27,8	9,8	976	608
522-2	9,7	25,4	18	27,8	9,8	976	608
523-2	9,7	25,4	18	27,8	9,8	976	608
511-3	7,1	25	19,6	26,8	7,2	1017	768
512-3	7,1	25	19,6	26,8	7,2	1017	768
513-3	7,1	25	19,6	26,8	7,2	1017	768
511-4	8,5	24,8	18,6	27,1	8,5	1078	765
512-4	8,5	24,8	18,6	27,1	8,5	1078	765
513-4	8,5	24,8	18,6	27,1	8,5	1078	765
521-4	8,5	24,8	18,6	27,1	8,5	1078	765
522-4	8,5	24,8	18,6	27,1	8,5	1078	765
523-4	8,5	24,8	18,6	27,1	8,5	1078	765
511-5	9,4	25,1	18,2	27,6	9,4	849	712
512-5	9,4	25,1	18,2	27,6	9,4	849	712
513-5	9,4	25,1	18,2	27,6	9,4	849	712
521-5	9,4	25,1	18,2	27,6	9,4	849	712
522-5	9,4	25,1	18,2	27,6	9,4	849	712
523-5	9,4	25,1	18,2	27,6	9,4	849	712
511-6	7,5	24,7	18,2	27,6	9,4	439	318
512-6	7,5	24,7	18,2	27,6	9,4	439	318
513-6	7,5	24,7	18,2	27,6	9,4	439	318
521-6	7,5	24,7	18,2	27,6	9,4	439	318
522-6	7,5	24,7	18,2	27,6	9,4	439	318
523-6	7,5	24,7	18,2	27,6	9,4	439	318
n=	**27**	**27**	**27**	**27**	**27**	**27**	**27**

Nr	CO2 harvest day max	CO2 harvest day Δmin/max	CO2 + 1 average	CO2 + 1 min	CO2 + 1 max	CO2 +1 Δ min/max	CO2 +2 average
423-8	1286	738	843	465	1484	1019	876
n=	**24**	**24**	**24**	**24**	**24**	**24**	**24**
511-2	1660	1052	959	587	2141	1553	943
512-2	1660	1052	959	587	2141	1553	943
513-2	1660	1052	959	587	2141	1553	943
521-2	1660	1052	959	587	2141	1553	943
522-2	1660	1052	959	587	2141	1553	943
523-2	1660	1052	959	587	2141	1553	943
511-3	1625	857	860	393	2076	1683	850
512-3	1625	857	860	393	2076	1683	850
513-3	1625	857	860	393	2076	1683	850
511-4	1802	1037	1052	574	2457	1883	1008
512-4	1802	1037	1052	574	2457	1883	1008
513-4	1802	1037	1052	574	2457	1883	1008
521-4	1802	1037	1052	574	2457	1883	1008
522-4	1802	1037	1052	574	2457	1883	1008
523-4	1802	1037	1052	574	2457	1883	1008
511-5	994	282	811	515	1070	555	822
512-5	994	282	811	515	1070	555	822
513-5	994	282	811	515	1070	555	822
521-5	994	282	811	515	1070	555	822
522-5	994	282	811	515	1070	555	822
523-5	994	282	811	515	1070	555	822
511-6	564	246	467	301	902	601	419
512-6	564	246	467	301	902	601	419
513-6	564	246	467	301	902	601	419
521-6	564	246	467	301	902	601	419
522-6	564	246	467	301	902	601	419
523-6	564	246	467	301	902	601	419
n=	**27**	**27**	**27**	**27**	**27**	**27**	**27**

Nr	CO2 + 2 min	CO2+ 2 max	CO2 +2 Δ min/max	CO2 + 4 average	CO2 + 4 min	CO2 + 4 max	CO2 + 4 Δ min/max	CO2 + 8 average	CO2 + 8 min
423-8	465	1561	1095	879	385	1666	1281	899	385
n=	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**
511-2	536	2510	1975	934	412	2510	2098	877	372
512-2	536	2510	1975	934	412	2510	2098	877	372
513-2	536	2510	1975	934	412	2510	2098	877	372
521-2	536	2510	1975	934	412	2510	2098	877	372
522-2	536	2510	1975	934	412	2510	2098	877	372
523-2	536	2510	1975	934	412	2510	2098	877	372
511-3	393	2076	1683	916	393	2204	1810	904	233
512-3	393	2076	1683	916	393	2204	1810	904	233
513-3	393	2076	1683	916	393	2204	1810	904	233
511-4	398	2489	2092	995	351	2489	2139	952	351
512-4	398	2489	2092	995	351	2489	2139	952	351
513-4	398	2489	2092	995	351	2489	2139	952	351
521-4	398	2489	2092	995	351	2489	2139	952	351
522-4	398	2489	2092	995	351	2489	2139	952	351
523-4	398	2489	2092	995	351	2489	2139	952	351
511-5	515	1185	670	786	356	1185	829	873	356
512-5	515	1185	670	786	356	1185	829	873	356
513-5	515	1185	670	786	356	1185	829	873	356
521-5	515	1185	670	786	356	1185	829	873	356
522-5	515	1185	670	786	356	1185	829	873	356
523-5	515	1185	670	786	356	1185	829	873	356
511-6	263	902	639	430	230	1153	923	602	230
512-6	263	902	639	430	230	1153	923	602	230
513-6	263	902	639	430	230	1153	923	602	230
521-6	263	902	639	430	230	1153	923	602	230
522-6	263	902	639	430	230	1153	923	602	230
523-6	263	902	639	430	230	1153	923	602	230
n=	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**

Nr	CO2 + 8 max	CO2 + 8 Δ min/max	VPD harvest day average	VPD +1 average	VPd + 2 average	VPD +4 average	VPD + 8 average
423-8	1992	1607	4,5	4,1	4,1	4	4,1
n=	**24**	**24**	**24**	**24**	**24**	**24**	**24**
511-2	2547	2175	5,2	4,9	4,9	7,2	7,2
512-2	2547	2175	5,2	4,9	4,9	7,2	7,2
513-2	2547	2175	5,2	4,9	4,9	7,2	7,2
521-2	2547	2175	5,2	4,9	4,9	7,2	7,2
522-2	2547	2175	5,2	4,9	4,9	7,2	7,2
523-2	2547	2175	5,2	4,9	4,9	7,2	7,2
511-3	2204	1971	4,9	7,2	4,9	4,9	4,9
512-3	2204	1971	4,9	7,2	4,9	4,9	4,9
513-3	2204	1971	4,9	7,2	4,9	4,9	4,9
511-4	2654	2304	5,2	4,9	4,9	7,2	7,2
512-4	2654	2304	5,2	4,9	4,9	7,2	7,2
513-4	2654	2304	5,2	4,9	4,9	7,2	7,2
521-4	2654	2304	5,2	4,9	4,9	7,2	7,2
522-4	2654	2304	5,2	4,9	4,9	7,2	7,2
523-4	2654	2304	5,2	4,9	4,9	7,2	7,2
511-5	2902	2550	5,2	7,2	4,9	4,9	4,9
512-5	2902	2550	5,2	7,2	4,9	4,9	4,9
513-5	2902	2550	5,2	7,2	4,9	4,9	4,9
521-5	2902	2550	5,2	7,2	4,9	4,9	4,9
522-5	2902	2550	5,2	7,2	4,9	4,9	4,9
523-5	2902	2550	5,2	7,2	4,9	4,9	4,9
511-6	1171	941	9,5	9	5,8	5,8	7,2
512-6	1171	941	9,5	9	5,8	5,8	7,2
513-6	1171	941	9,5	9	5,8	5,8	7,2
521-6	1171	941	9,5	9	5,8	5,8	7,2
522-6	1171	941	9,5	9	5,8	5,8	7,2
523-6	1171	941	9,5	9	5,8	5,8	7,2
n=	**27**	**27**	**27**	**27**	**27**	**27**	**27**

Nr	Prod.	Variety	Harvest	Weight	Lenght	Color	SSC	pH	EC	EC drain water	pH drain water	EC irrigation water	pH irrigation water
611-2	6	2	1	350	27	8	2,9	5,29	4,07	2,9	5,8	3,2	5,8
612-2	6	2	1	322	27,5	8	2,8	5,33	4	2,9	5,8	3,2	5,8
613-2	6	2	1	317	28	8	3	5,35	4,2	2,9	5,8	3,2	5,8
621-2	6	1	1	317	27	9	2,7	5,33	4,07	2,9	5,8	3,2	5,8
622-2	6	1	1	303	25	8	3,2	5,41	4,59	2,9	5,8	3,2	5,8
623-2	6	1	1	306	25	8	2,9	5,42	4,06	2,9	5,8	3,2	5,8
611-3	6	2	2	296,5	29	8	3,1	5,27	3,83	2,9	6	3,2	6
612-3	6	2	2	316	29,5	8	2,9	5,25	3,9	2,9	6	3,2	6
613-3	6	2	2	316	29	8	2,9	5,23	3,9	2,9	6	3,2	6
621-3	6	1	2	310	27,5	8	2,8	5,21	3,88	2,9	6	3,2	6
622-3	6	1	2	294,5	26	8	2,7	5,16	3,97	2,9	6	3,2	6
623-3	6	1	2	297,5	28	8	2,9	5,23	4,16	2,9	6	3,2	6
611-4	6	2	3	293,5	29	8	3,8	5,28	3,63	3,3	6	2,9	6
612-4	6	2	3	309,5	30,5	8	3,1	5,26	3,79	3,3	6	2,9	6
613-4	6	2	3	286	29	8	3,2	5,25	3,77	3,3	6	2,9	6
621-4	6	1	3	297	28	8	3	5,21	3,54	3,3	6	2,9	6
622-4	6	1	3	314	31	7	3,1	5,3	4,28	3,3	6	2,9	6
623-4	6	1	3	309	29	7	3,1	5,26	3,55	3,3	6	2,9	6
611-5	6	2	4	300	31	9	4,3	5,42	4,18	3,2	5,9	2,9	5,9
612-5	6	2	4	328,5	31	9	3,5	5,2	3,74	3,2	5,9	2,9	5,9
613-5	6	2	4	300	29,5	8	3,3	5,22	3,59	3,2	5,9	2,9	5,9
621-5	6	1	4	375	33,5	8	3,4	5,36	4,09	3,2	5,9	2,9	5,9
622-5	6	1	4	320	31	9	3	5,3	3,53	3,2	5,9	2,9	5,9
623-5	6	1	4	295	30,5	8	3,2	5,33	3,7	3,2	5,9	2,9	5,9
611-6	6	2	5	275	28	9	3,1	5,34	3,56	3,3	5,9	2,9	5,9
612-6	6	2	5	295	28	9	3,2	5,39	2,82	3,3	5,9	2,9	5,9
613-6	6	2	5	275	28	8	3	5,33	3,22	3,3	5,9	2,9	5,9
621-6	6	1	5	281	30	8	3,2	5,41	3,16	3,3	5,9	2,9	5,9
622-6	6	1	5	298	31	9	2,9	5,35	4,06	3,3	5,9	2,9	5,9
623-6	6	1	5	315	24	7	2,5	5,13	3,51	3,3	5,9	2,9	5,9
n=	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Nr	Dry matter content	DLI fruit harvest day	DLI fruit +1	DLI fruit +2	DLI fruit +4	DLI fruit +8	DLI plant harvest day	DLI plant +1	DLI plant +2
611-2		0,02	1,06	1,05	1,16	1,19	0,37	19,53	19,37
612-2		0,01	0,64	0,63	0,70	0,72	0,37	19,53	19,37
613-2		0,02	0,83	0,82	0,91	0,93	0,37	19,53	19,37
621-2		0,02	0,89	0,89	0,98	1,01	0,37	19,53	19,37
622-2		0,02	1,33	1,31	1,46	1,49	0,37	19,53	19,37
623-2		0,02	0,99	0,98	1,09	1,12	0,37	19,53	19,37
611-3	3,60	0,21	1,16	0,96	0,77	0,83	4,85	26,85	22,23
612-3	3,54	0,14	0,78	0,64	0,52	0,56	4,85	26,85	22,23
613-3	3,56	0,37	2,05	1,70	1,35	1,47	4,85	26,85	22,23
621-3	3,53	0,78	4,33	3,58	2,86	3,10	4,85	26,85	22,23
622-3	3,48	0,24	1,35	1,12	0,89	0,97	4,85	26,85	22,23
623-3	3,60	0,14	0,75	0,62	0,49	0,54	4,85	26,85	22,23
611-4	3,34	0,18	2,15	1,95	1,64	1,50	2,27	26,56	24,10
612-4	3,54	0,14	1,59	1,44	1,21	1,11	2,27	26,56	24,10
613-4	3,85	0,23	2,64	2,40	2,02	1,85	2,27	26,56	24,10
621-4	3,62	0,22	2,56	2,32	1,95	1,79	2,27	26,56	24,10
622-4	3,77	0,17	1,94	1,76	1,48	1,36	2,27	26,56	24,10
623-4	3,63	0,15	1,70	1,54	1,30	1,19	2,27	26,56	24,10
611-5	4,60	0,47	3,77	3,53	3,81	3,73	1,87	15,08	14,11
612-5	3,68	0,39	3,13	2,93	3,16	3,09	1,87	15,08	14,11
613-5	3,89	0,40	3,24	3,03	3,27	3,21	1,87	15,08	14,11
621-5	4,06	0,53	4,29	4,01	4,34	4,25	1,87	15,08	14,11
622-5	3,52	0,31	2,53	2,37	2,56	2,50	1,87	15,08	14,11
623-5	3,74	0,42	3,40	3,18	3,44	3,37	1,87	15,08	14,11
611-6	3,63	1,41	9,62	8,27	7,56	7,20	1,90	12,92	11,11
612-6	3,90	1,31	8,91	7,66	7,00	6,67	1,90	12,92	11,11
613-6	3,68	1,41	9,64	8,29	7,58	7,21	1,90	12,92	11,11
621-6	4,04	1,44	9,79	8,42	7,70	7,33	1,90	12,92	11,11
622-6	3,61	1,67	11,40	9,80	8,96	8,53	1,90	12,92	11,11
623-6	2,90	0,17	1,17	1,01	0,92	0,88	1,90	12,92	11,11
n=	**24**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Nr	DLI plant +4	DLI plant +8	oC harvestday average	oC harvestday min	oC harvestday max	oC harvestday Δ min/max	oC + 1 average
611-2	21,55	22,03	23,6	22,4	24,4	2	22,6
612-2	21,55	22,03	23,6	22,4	24,4	2	22,6
613-2	21,55	22,03	23,6	22,4	24,4	2	22,6
621-2	21,55	22,03	23,6	22,4	24,4	2	22,6
622-2	21,55	22,03	23,6	22,4	24,4	2	22,6
623-2	21,55	22,03	23,6	22,4	24,4	2	22,6
611-3	17,76	19,27	24,2	23,2	25,6	2,4	23,2
612-3	17,76	19,27	24,2	23,2	25,6	2,4	23,2
613-3	17,76	19,27	24,2	23,2	25,6	2,4	23,2
621-3	17,76	19,27	24,2	23,2	25,6	2,4	23,2
622-3	17,76	19,27	24,2	23,2	25,6	2,4	23,2
623-3	17,76	19,27	24,2	23,2	25,6	2,4	23,2
611-4	20,27	18,56	23,4	21,2	24	2,8	22,6
612-4	20,27	18,56	23,4	21,2	24	2,8	22,6
613-4	20,27	18,56	23,4	21,2	24	2,8	22,6
621-4	20,27	18,56	23,4	21,2	24	2,8	22,6
622-4	20,27	18,56	23,4	21,2	24	2,8	22,6
623-4	20,27	18,56	23,4	21,2	24	2,8	22,6
611-5	15,25	14,93	21,7	21,6	21,9	0,3	21,4
612-5	15,25	14,93	21,7	21,6	21,9	0,3	21,4
613-5	15,25	14,93	21,7	21,6	21,9	0,3	21,4
621-5	15,25	14,93	21,7	21,6	21,9	0,3	21,4
622-5	15,25	14,93	21,7	21,6	21,9	0,3	21,4
623-5	15,25	14,93	21,7	21,6	21,9	0,3	21,4
611-6	10,16	9,67	22,5	21,3	23,6	2,3	22,3
612-6	10,16	9,67	22,5	21,3	23,6	2,3	22,3
613-6	10,16	9,67	22,5	21,3	23,6	2,3	22,3
621-6	10,16	9,67	22,5	21,3	23,6	2,3	22,3
622-6	10,16	9,67	22,5	21,3	23,6	2,3	22,3
623-6	10,16	9,67	22,5	21,3	23,6	2,3	22,3
n=	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Nr	oC + 1 min	oC + 1 max	oC + 1 Δ min/max	oC + 2 average	oC +2 min	oC + 2 max	oC +2 min/max	oC +4 average	oC +4 min	oC +4 max
611-2	18,4	25,9	7,5	22,8	18,4	25,9	7,5	22,6	18	26,8
612-2	18,4	25,9	7,5	22,8	18,4	25,9	7,5	22,6	18	26,8
613-2	18,4	25,9	7,5	22,8	18,4	25,9	7,5	22,6	18	26,8
621-2	18,4	25,9	7,5	22,8	18,4	25,9	7,5	22,6	18	26,8
622-2	18,4	25,9	7,5	22,8	18,4	25,9	7,5	22,6	18	26,8
623-2	18,4	25,9	7,5	22,8	18,4	25,9	7,5	22,6	18	26,8
611-3	19,7	25,6	5,9	23	18,6	25,6	7	22,8	18,6	25,6
612-3	19,7	25,6	5,9	23	18,6	25,6	7	22,8	18,6	25,6
613-3	19,7	25,6	5,9	23	18,6	25,6	7	22,8	18,6	25,6
621-3	19,7	25,6	5,9	23	18,6	25,6	7	22,8	18,6	25,6
622-3	19,7	25,6	5,9	23	18,6	25,6	7	22,8	18,6	25,6
623-3	19,7	25,6	5,9	23	18,6	25,6	7	22,8	18,6	25,6
611-4	19,1	24,9	5,8	22,5	17,8	25,2	7,4	22,4	17,8	25,7
612-4	19,1	24,9	5,8	22,5	17,8	25,2	7,4	22,4	17,8	25,7
613-4	19,1	24,9	5,8	22,5	17,8	25,2	7,4	22,4	17,8	25,7
621-4	19,1	24,9	5,8	22,5	17,8	25,2	7,4	22,4	17,8	25,7
622-4	19,1	24,9	5,8	22,5	17,8	25,2	7,4	22,4	17,8	25,7
623-4	19,1	24,9	5,8	22,5	17,8	25,2	7,4	22,4	17,8	25,7
611-5	17,4	23,4	6	21,5	17,4	23,9	6,5	21,8	17,1	24,8
612-5	17,4	23,4	6	21,5	17,4	23,9	6,5	21,8	17,1	24,8
613-5	17,4	23,4	6	21,5	17,4	23,9	6,5	21,8	17,1	24,8
621-5	17,4	23,4	6	21,5	17,4	23,9	6,5	21,8	17,1	24,8
622-5	17,4	23,4	6	21,5	17,4	23,9	6,5	21,8	17,1	24,8
623-5	17,4	23,4	6	21,5	17,4	23,9	6,5	21,8	17,1	24,8
611-6	18,1	23,6	5,5	22,5	18,1	24,5	6,4	22,4	17,9	24,8
612-6	18,1	23,6	5,5	22,5	18,1	24,5	6,4	22,4	17,9	24,8
613-6	18,1	23,6	5,5	22,5	18,1	24,5	6,4	22,4	17,9	24,8
621-6	18,1	23,6	5,5	22,5	18,1	24,5	6,4	22,4	17,9	24,8
622-6	18,1	23,6	5,5	22,5	18,1	24,5	6,4	22,4	17,9	24,8
623-6	18,1	23,6	5,5	22,5	18,1	24,5	6,4	22,4	17,9	24,8
n=	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Nr	oC + 4 Δ min/max	oC + 8 average	oC + 8 min	oC + 8 max	oC + 8 Δ min/max	CO2 harvest day average	CO2 harvest day min
611-2	8,8	22,9	18	26,8	8,8	952	850
612-2	8,8	22,9	18	26,8	8,8	952	850
613-2	8,8	22,9	18	26,8	8,8	952	850
621-2	8,8	22,9	18	26,8	8,8	952	850
622-2	8,8	22,9	18	26,8	8,8	952	850
623-2	8,8	22,9	18	26,8	8,8	952	850
611-3	7	22,7	18,4	26,1	7,7	537	434
612-3	7	22,7	18,4	26,1	7,7	537	434
613-3	7	22,7	18,4	26,1	7,7	537	434
621-3	7	22,7	18,4	26,1	7,7	537	434
622-3	7	22,7	18,4	26,1	7,7	537	434
623-3	7	22,7	18,4	26,1	7,7	537	434
611-4	7,9	22,7	17,8	25,7	7,9	815	761
612-4	7,9	22,7	17,8	25,7	7,9	815	761
613-4	7,9	22,7	17,8	25,7	7,9	815	761
621-4	7,9	22,7	17,8	25,7	7,9	815	761
622-4	7,9	22,7	17,8	25,7	7,9	815	761
623-4	7,9	22,7	17,8	25,7	7,9	815	761
611-5	7,7	22	17,1	25	7,9	1012	950
612-5	7,7	22	17,1	25	7,9	1012	950
613-5	7,7	22	17,1	25	7,9	1012	950
621-5	7,7	22	17,1	25	7,9	1012	950
622-5	7,7	22	17,1	25	7,9	1012	950
623-5	7,7	22	17,1	25	7,9	1012	950
611-6	6,9	22,1	17,3	24,8	7,5	827	744
612-6	6,9	22,1	17,3	24,8	7,5	827	744
613-6	6,9	22,1	17,3	24,8	7,5	827	744
621-6	6,9	22,1	17,3	24,8	7,5	827	744
622-6	6,9	22,1	17,3	24,8	7,5	827	744
623-6	6,9	22,1	17,3	24,8	7,5	827	744
n=	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Nr	CO2 harvest day max	CO2 harvest day Δmin/max	CO2 + 1 average	CO2 + 1 min	CO2 + 1 max	CO2 +1 Δ min/max	CO2 +2 average
611-2	1050	199	870	522	1088	565	843
612-2	1050	199	870	522	1088	565	843
613-2	1050	199	870	522	1088	565	843
621-2	1050	199	870	522	1088	565	843
622-2	1050	199	870	522	1088	565	843
623-2	1050	199	870	522	1088	565	843
611-3	869	435	684	434	1051	617	736
612-3	869	435	684	434	1051	617	736
613-3	869	435	684	434	1051	617	736
621-3	869	435	684	434	1051	617	736
622-3	869	435	684	434	1051	617	736
623-3	869	435	684	434	1051	617	736
611-4	868	107	843	599	1084	485	864
612-4	868	107	843	599	1084	485	864
613-4	868	107	843	599	1084	485	864
621-4	868	107	843	599	1084	485	864
622-4	868	107	843	599	1084	485	864
623-4	868	107	843	599	1084	485	864
611-5	1106	156	984	801	1106	305	981
612-5	1106	156	984	801	1106	305	981
613-5	1106	156	984	801	1106	305	981
621-5	1106	156	984	801	1106	305	981
622-5	1106	156	984	801	1106	305	981
623-5	1106	156	984	801	1106	305	981
611-6	1012	268	835	640	1091	452	760
612-6	1012	268	835	640	1091	452	760
613-6	1012	268	835	640	1091	452	760
621-6	1012	268	835	640	1091	452	760
622-6	1012	268	835	640	1091	452	760
623-6	1012	268	835	640	1091	452	760
n=	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Nr	CO2 + 2 min	CO2+ 2 max	CO2 +2 Δ min/max	CO2 + 4 average	CO2 + 4 min	CO2 + 4 max	CO2 + 4 Δ min/max	CO2 + 8 average	CO2 + 8 min
611-2	522	1088	565	844	479	1095	616	756	370
612-2	522	1088	565	844	479	1095	616	756	370
613-2	522	1088	565	844	479	1095	616	756	370
621-2	522	1088	565	844	479	1095	616	756	370
622-2	522	1088	565	844	479	1095	616	756	370
623-2	522	1088	565	844	479	1095	616	756	370
611-3	434	1101	667	785	434	1101	667	821	434
612-3	434	1101	667	785	434	1101	667	821	434
613-3	434	1101	667	785	434	1101	667	821	434
621-3	434	1101	667	785	434	1101	667	821	434
622-3	434	1101	667	785	434	1101	667	821	434
623-3	434	1101	667	785	434	1101	667	821	434
611-4	599	1090	491	844	466	1091	625	765	428
612-4	599	1090	491	844	466	1091	625	765	428
613-4	599	1090	491	844	466	1091	625	765	428
621-4	599	1090	491	844	466	1091	625	765	428
622-4	599	1090	491	844	466	1091	625	765	428
623-4	599	1090	491	844	466	1091	625	765	428
611-5	774	1139	365	951	553	1139	586	931	541
612-5	774	1139	365	951	553	1139	586	931	541
613-5	774	1139	365	951	553	1139	586	931	541
621-5	774	1139	365	951	553	1139	586	931	541
622-5	774	1139	365	951	553	1139	586	931	541
623-5	774	1139	365	951	553	1139	586	931	541
611-6	474	1091	617	830	474	1100	626	861	474
612-6	474	1091	617	830	474	1100	626	861	474
613-6	474	1091	617	830	474	1100	626	861	474
621-6	474	1091	617	830	474	1100	626	861	474
622-6	474	1091	617	830	474	1100	626	861	474
623-6	474	1091	617	830	474	1100	626	861	474
n=	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Nr	CO2 + 8 max	CO2 + 8 Δ min/max	VPD harvest day average	VPD +1 average	VPd + 2 average	VPD +4 average	VPD + 8 average
611-2	1125	754	4,5	4,4	4,4	4,4	4,4
612-2	1125	754	4,5	4,4	4,4	4,4	4,4
613-2	1125	754	4,5	4,4	4,4	4,4	4,4
621-2	1125	754	4,5	4,4	4,4	4,4	4,4
622-2	1125	754	4,5	4,4	4,4	4,4	4,4
623-2	1125	754	4,5	4,4	4,4	4,4	4,4
611-3	1101	667	4,5	4,4	4,4	4,4	4,4
612-3	1101	667	4,5	4,4	4,4	4,4	4,4
613-3	1101	667	4,5	4,4	4,4	4,4	4,4
621-3	1101	667	4,5	4,4	4,4	4,4	4,4
622-3	1101	667	4,5	4,4	4,4	4,4	4,4
623-3	1101	667	4,5	4,4	4,4	4,4	4,4
611-4	1101	672	0	4,4	4,3	4,3	4,4
612-4	1101	672	0	4,4	4,3	4,3	4,4
613-4	1101	672	0	4,4	4,3	4,3	4,4
621-4	1101	672	0	4,4	4,3	4,3	4,4
622-4	1101	672	0	4,4	4,3	4,3	4,4
623-4	1101	672	0	4,4	4,3	4,3	4,4
611-5	1139	598	0	0	0	0	0
612-5	1139	598	0	0	0	0	0
613-5	1139	598	0	0	0	0	0
621-5	1139	598	0	0	0	0	0
622-5	1139	598	0	0	0	0	0
623-5	1139	598	0	0	0	0	0
611-6	1106	632	0	0	0	0	0
612-6	1106	632	0	0	0	0	0
613-6	1106	632	0	0	0	0	0
621-6	1106	632	0	0	0	0	0
622-6	1106	632	0	0	0	0	0
623-6	1106	632	0	0	0	0	0
n=	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Nr	Prod.	Variety	Harvest	Weight	Lenght	Color	SSC	pH	EC	EC drain water	pH drain water	EC irrigation water	pH irrigation water
711-2	7	2	1	290	29	8	3,2	5,5	4,07	4	5,5	2,9	5,2
712-2	7	2	1	294	28	8	3,2	5,49	4,34	4	5,5	2,9	5,2
713-2	7	2	1	308	29	8	3,9	5,55	4,21	4	5,5	2,9	5,2
721-2	7	1	1	354	27,5	8	3	5,46	3,97	4	5,5	2,9	5,2
722-2	7	1	1	328	28,5	8	3,3	5,52	4,15	4	5,5	2,9	5,2
723-2	7	1	1	328	28	8	2,9	5,45	4,28	4	5,5	2,9	5,2
711-3	7	2	2	326	33	9	3,5	5,24	4,09	3,5	5,6	2,6	5
712-3	7	2	2	286	27	9	3,3	5,22	3,7	3,5	5,6	2,7	5
713-3	7	2	2	288	27	9	3	5,22	4,06	3,5	5,6	2,8	5
721-3	7	1	2	284	29,5	8	3,6	5,29	4,48	3,5	5,6	2,9	5
722-3	7	1	2	282	28	8	3,2	5,24	4,08	3,5	5,6	2,1	5
723-3	7	1	2	306	27,5	8	3,3	5,25	4,11	3,5	5,6	2,11	5
711-4	7	2	3	286	30	9	3,4	5,44	3,83		5,5		6
712-4	7	2	3	290	29	9	3,5	5,37	4		5,5		6
713-4	7	2	3	292	33	9	3,7	5,48	4,2		5,5		6
721-4	7	1	3	324	33	8	3,7	5,42	4,22		5,5		6
722-4	7	1	3	354	30,5	8	3,8	5,39	4,66		5,5		6
723-4	7	1	3	334	30	8	3,4	5,35	3,98		5,5		6
711-5	7	2	4	332	33,5	8	3,5	5,25	4,01	4,3	5,6	2,8	5,3
712-5	7	2	4	300	31	9	3,5	5,47	3,67	4,3	5,6	2,8	5,3
713-5	7	2	4	310	32	9	3,7	5,44	3,31	4,3	5,6	2,8	5,3
721-5	7	1	4	298	29	8	3,9	5,21	3,84	4,3	5,6	2,8	5,3
722-5	7	1	4	296	32,5	8	3,6	5,52	3,74	4,3	5,6	2,8	5,3
723-5	7	1	4	300	32,5	8	3,5	5,51	3,85	4,3	5,6	2,8	5,3
711-6	7	2	5	280	33	9	3,9	5,82	3,75	3,85	5,5	1,9	5,3
712-6	7	2	5	384	35	9	3,6	5,65	3,2	3,85	5,5	1,9	5,3
713-6	7	2	5	344	33,5	9	3,7	5,62	2,99	3,85	5,5	1,9	5,3
721-6	7	1	5	280	32	9	3,4	5,66	3,35	3,85	5,5	1,9	5,3
722-6	7	1	5	324	33,5	9	3,5	5,62	3,13	3,85	5,5	1,9	5,3
723-6	7	1	5	352	32	9	3,2	5,56	3,3	3,85	5,5	1,9	5,3
n =	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**24**	**30**	**24**	**30**

Nr	Dry matter content	DLI fruit harvest day	DLI fruit +1	DLI fruit +2	DLI fruit +4	DLI fruit +8	DLI plant harvest day	DLI plant +1	DLI plant +2
711-2		0,22	1,46	1,30	1,30	1,27	6,61	43,07	38,30
712-2		0,16	1,02	0,91	0,91	0,89	6,61	43,07	38,30
713-2		0,12	0,80	0,71	0,71	0,70	6,61	43,07	38,30
721-2		0,21	1,39	1,24	1,24	1,21	6,61	43,07	38,30
722-2		0,33	2,12	1,89	1,89	1,85	6,61	43,07	38,30
723-2		0,22	1,44	1,28	1,28	1,25	6,61	43,07	38,30
711-3	4,15	0,49	6,29	5,68	4,71	4,90	3,16	40,34	36,46
712-3	3,89	0,17	2,23	2,01	1,67	1,73	3,16	40,34	36,46
713-3	3,61	0,29	3,66	3,31	2,74	2,85	3,16	40,34	36,46
721-3	4,33	0,23	2,89	2,61	2,17	2,25	3,16	40,34	36,46
722-3	3,96	0,11	1,36	1,23	1,02	1,06	3,16	40,34	36,46
723-3	3,94	0,22	2,77	2,50	2,08	2,16	3,16	40,34	36,46
711-4	4,10	0,33	3,60	3,27	2,79	2,63	4,15	44,81	40,67
712-4	4,07	0,22	2,36	2,14	1,83	1,72	4,15	44,81	40,67
713-4	4,40	0,26	2,77	2,51	2,15	2,02	4,15	44,81	40,67
721-4	4,36	0,13	1,41	1,28	1,09	1,03	4,15	44,81	40,67
722-4	4,55	0,35	3,83	3,48	2,97	2,80	4,15	44,81	40,67
723-4	4,02	0,37	4,03	3,66	3,13	2,95	4,15	44,81	40,67
711-5	4,05	1,31	7,40	7,01	7,09	6,89	5,28	29,78	28,23
712-5	4,15	0,65	3,67	3,48	3,52	3,42	5,28	29,78	28,23
713-5	4,42	0,45	2,52	2,39	2,41	2,35	5,28	29,78	28,23
721-5	4,00	0,56	3,13	2,97	3,00	2,92	5,28	29,78	28,23
722-5	4,46	0,53	2,98	2,82	2,85	2,77	5,28	29,78	28,23
723-5	4,38	0,29	1,66	1,57	1,59	1,54	5,28	29,78	28,23
711-6	5,15	2,60	16,57	14,34	14,14	12,42	5,48	35,00	30,28
712-6	4,40	2,55	16,30	14,10	13,91	12,22	5,48	35,00	30,28
713-6	4,38	2,24	14,28	12,35	12,18	10,70	5,48	35,00	30,28
721-6	4,24	1,73	11,07	9,58	9,45	8,30	5,48	35,00	30,28
722-6	4,21	0,59	3,74	3,23	3,19	2,80	5,48	35,00	30,28
723-6	4,00	0,34	2,19	1,90	1,87	1,64	5,48	35,00	30,28
n =	**24**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Nr	DLI plant +4	DLI plant +8	oC harvestday average	oC harvestday min	oC harvestday max	oC harvestday Δ min/max	oC + 1 average
711-2	38,32	37,50	24,7	24	26,5	2,5	23,7
712-2	38,32	37,50	24,7	24	26,5	2,5	23,7
713-2	38,32	37,50	24,7	24	26,5	2,5	23,7
721-2	38,32	37,50	24,7	24	26,5	2,5	23,7
722-2	38,32	37,50	24,7	24	26,5	2,5	23,7
723-2	38,32	37,50	24,7	24	26,5	2,5	23,7
711-3	30,24	31,42	24,5	23,6	24,9	1,3	23,8
712-3	30,24	31,42	24,5	23,6	24,9	1,3	23,8
713-3	30,24	31,42	24,5	23,6	24,9	1,3	23,8
721-3	30,24	31,42	24,5	23,6	24,9	1,3	23,8
722-3	30,24	31,42	24,5	23,6	24,9	1,3	23,8
723-3	30,24	31,42	24,5	23,6	24,9	1,3	23,8
711-4	34,77	32,74	24	23,3	24,5	1,2	23,5
712-4	34,77	32,74	24	23,3	24,5	1,2	23,5
713-4	34,77	32,74	24	23,3	24,5	1,2	23,5
721-4	34,77	32,74	24	23,3	24,5	1,2	23,5
722-4	34,77	32,74	24	23,3	24,5	1,2	23,5
723-4	34,77	32,74	24	23,3	24,5	1,2	23,5
711-5	28,54	27,74	23,4	22,9	23,9	1	23,4
712-5	28,54	27,74	23,4	22,9	23,9	1	23,4
713-5	28,54	27,74	23,4	22,9	23,9	1	23,4
721-5	28,54	27,74	23,4	22,9	23,9	1	23,4
722-5	28,54	27,74	23,4	22,9	23,9	1	23,4
723-5	28,54	27,74	23,4	22,9	23,9	1	23,4
711-6	29,87	26,23	24	23,4	24,5	1,1	23,2
712-6	29,87	26,23	24	23,4	24,5	1,1	23,2
713-6	29,87	26,23	24	23,4	24,5	1,1	23,2
721-6	29,87	26,23	24	23,4	24,5	1,1	23,2
722-6	29,87	26,23	24	23,4	24,5	1,1	23,2
723-6	29,87	26,23	24	23,4	24,5	1,1	23,2
n =	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Nr	oC + 1 min	oC + 1 max	oC + 1 Δ min/max	oC + 2 average	oC +2 min	oC + 2 max	oC +2 min/max	oC +4 average	oC +4 min	oC +4 max
711-2	19,6	26,5	6,9	23,6	19,6	26,5	6,9	23,5	19,6	26,5
712-2	19,6	26,5	6,9	23,6	19,6	26,5	6,9	23,5	19,6	26,5
713-2	19,6	26,5	6,9	23,6	19,6	26,5	6,9	23,5	19,6	26,5
721-2	19,6	26,5	6,9	23,6	19,6	26,5	6,9	23,5	19,6	26,5
722-2	19,6	26,5	6,9	23,6	19,6	26,5	6,9	23,5	19,6	26,5
723-2	19,6	26,5	6,9	23,6	19,6	26,5	6,9	23,5	19,6	26,5
711-3	20,1	26,1	6	23,8	19,6	27,3	7,7	23,6	19,6	27,3
712-3	20,1	26,1	6	23,8	19,6	27,3	7,7	23,6	19,6	27,3
713-3	20,1	26,1	6	23,8	19,6	27,3	7,7	23,6	19,6	27,3
721-3	20,1	26,1	6	23,8	19,6	27,3	7,7	23,6	19,6	27,3
722-3	20,1	26,1	6	23,8	19,6	27,3	7,7	23,6	19,6	27,3
723-3	20,1	26,1	6	23,8	19,6	27,3	7,7	23,6	19,6	27,3
711-4	19,6	26	6,4	23,5	19,6	26	6,4	22,3	19,5	26
712-4	19,6	26	6,4	23,5	19,6	26	6,4	22,3	19,5	26
713-4	19,6	26	6,4	23,5	19,6	26	6,4	22,3	19,5	26
721-4	19,6	26	6,4	23,5	19,6	26	6,4	22,3	19,5	26
722-4	19,6	26	6,4	23,5	19,6	26	6,4	22,3	19,5	26
723-4	19,6	26	6,4	23,5	19,6	26	6,4	22,3	19,5	26
711-5	22,9	23,9	1	23,1	19,4	24,8	5,4	23	19,3	25,3
712-5	22,9	23,9	1	23,1	19,4	24,8	5,4	23	19,3	25,3
713-5	22,9	23,9	1	23,1	19,4	24,8	5,4	23	19,3	25,3
721-5	22,9	23,9	1	23,1	19,4	24,8	5,4	23	19,3	25,3
722-5	22,9	23,9	1	23,1	19,4	24,8	5,4	23	19,3	25,3
723-5	22,9	23,9	1	23,1	19,4	24,8	5,4	23	19,3	25,3
711-6	19,8	24,5	4,7	23,3	19,6	26	6,4	23,3	19,6	26
712-6	19,8	24,5	4,7	23,3	19,6	26	6,4	23,3	19,6	26
713-6	19,8	24,5	4,7	23,3	19,6	26	6,4	23,3	19,6	26
721-6	19,8	24,5	4,7	23,3	19,6	26	6,4	23,3	19,6	26
722-6	19,8	24,5	4,7	23,3	19,6	26	6,4	23,3	19,6	26
723-6	19,8	24,5	4,7	23,3	19,6	26	6,4	23,3	19,6	26
n =	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Nr	oC + 4 Δ min/max	oC + 8 average	oC + 8 min	oC + 8 max	oC + 8 Δ min/max	CO2 harvest day average	CO2 harvest day min
711-2	6,9	23,6	19,2	27,3	8,1	831	516
712-2	6,9	23,6	19,2	27,3	8,1	831	516
713-2	6,9	23,6	19,2	27,3	8,1	831	516
721-2	6,9	23,6	19,2	27,3	8,1	831	516
722-2	6,9	23,6	19,2	27,3	8,1	831	516
723-2	6,9	23,6	19,2	27,3	8,1	831	516
711-3	7,7	23,5	19,6	27,3	7,7	965	778
712-3	7,7	23,5	19,6	27,3	7,7	965	778
713-3	7,7	23,5	19,6	27,3	7,7	965	778
721-3	7,7	23,5	19,6	27,3	7,7	965	778
722-3	7,7	23,5	19,6	27,3	7,7	965	778
723-3	7,7	23,5	19,6	27,3	7,7	965	778
711-4	6,5	23,6	19,5	27,3	7,8	960	678
712-4	6,5	23,6	19,5	27,3	7,8	960	678
713-4	6,5	23,6	19,5	27,3	7,8	960	678
721-4	6,5	23,6	19,5	27,3	7,8	960	678
722-4	6,5	23,6	19,5	27,3	7,8	960	678
723-4	6,5	23,6	19,5	27,3	7,8	960	678
711-5	6	23,2	19,3	26,6	7,3	1152	1024
712-5	6	23,2	19,3	26,6	7,3	1152	1024
713-5	6	23,2	19,3	26,6	7,3	1152	1024
721-5	6	23,2	19,3	26,6	7,3	1152	1024
722-5	6	23,2	19,3	26,6	7,3	1152	1024
723-5	6	23,2	19,3	26,6	7,3	1152	1024
711-6	6,4	23,2	19,5	26	6,5	504	430
712-6	6,4	23,2	19,5	26	6,5	504	430
713-6	6,4	23,2	19,5	26	6,5	504	430
721-6	6,4	23,2	19,5	26	6,5	504	430
722-6	6,4	23,2	19,5	26	6,5	504	430
723-6	6,4	23,2	19,5	26	6,5	504	430
n =	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Nr	CO2 harvest day max	CO2 harvest day Δmin/max	CO2 + 1 average	CO2 + 1 min	CO2 + 1 max	CO2 +1 Δ min/max	CO2 +2 average
711-2	1333	817	798	417	1467	1050	735
712-2	1333	817	798	417	1467	1050	735
713-2	1333	817	798	417	1467	1050	735
721-2	1333	817	798	417	1467	1050	735
722-2	1333	817	798	417	1467	1050	735
723-2	1333	817	798	417	1467	1050	735
711-3	1273	496	689	409	1548	1139	730
712-3	1273	496	689	409	1548	1139	730
713-3	1273	496	689	409	1548	1139	730
721-3	1273	496	689	409	1548	1139	730
722-3	1273	496	689	409	1548	1139	730
723-3	1273	496	689	409	1548	1139	730
711-4	1381	703	739	379	1415	1035	737
712-4	1381	703	739	379	1415	1035	737
713-4	1381	703	739	379	1415	1035	737
721-4	1381	703	739	379	1415	1035	737
722-4	1381	703	739	379	1415	1035	737
723-4	1381	703	739	379	1415	1035	737
711-5	1436	412	1152	1024	1436	412	812
712-5	1436	412	1152	1024	1436	412	812
713-5	1436	412	1152	1024	1436	412	812
721-5	1436	412	1152	1024	1436	412	812
722-5	1436	412	1152	1024	1436	412	812
723-5	1436	412	1152	1024	1436	412	812
711-6	646	216	544	415	854	439	544
712-6	646	216	544	415	854	439	544
713-6	646	216	544	415	854	439	544
721-6	646	216	544	415	854	439	544
722-6	646	216	544	415	854	439	544
723-6	646	216	544	415	854	439	544
n =	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Nr	CO2 + 2 min	CO2+ 2 max	CO2 +2 Δ min/max	CO2 + 4 average	CO2 + 4 min	CO2 + 4 max	CO2 + 4 Δ min/max	CO2 + 8 average	CO2 + 8 min
711-2	408	1527	1119	753	397	1527	1130	749	388
712-2	408	1527	1119	753	397	1527	1130	749	388
713-2	408	1527	1119	753	397	1527	1130	749	388
721-2	408	1527	1119	753	397	1527	1130	749	388
722-2	408	1527	1119	753	397	1527	1130	749	388
723-2	408	1527	1119	753	397	1527	1130	749	388
711-3	408	1589	1181	765	394	1589	1195	775	394
712-3	408	1589	1181	765	394	1589	1195	775	394
713-3	408	1589	1181	765	394	1589	1195	775	394
721-3	408	1589	1181	765	394	1589	1195	775	394
722-3	408	1589	1181	765	394	1589	1195	775	394
723-3	408	1589	1181	765	394	1589	1195	775	394
711-4	379	1489	1110	732	371	1489	1118	708	371
712-4	379	1489	1110	732	371	1489	1118	708	371
713-4	379	1489	1110	732	371	1489	1118	708	371
721-4	379	1489	1110	732	371	1489	1118	708	371
722-4	379	1489	1110	732	371	1489	1118	708	371
723-4	379	1489	1110	732	371	1489	1118	708	371
711-5	372	1543	1172	808	372	1543	1172	787	310
712-5	372	1543	1172	808	372	1543	1172	787	310
713-5	372	1543	1172	808	372	1543	1172	787	310
721-5	372	1543	1172	808	372	1543	1172	787	310
722-5	372	1543	1172	808	372	1543	1172	787	310
723-5	372	1543	1172	808	372	1543	1172	787	310
711-6	399	1286	887	616	377	1471	1094	700	372
712-6	399	1286	887	616	377	1471	1094	700	372
713-6	399	1286	887	616	377	1471	1094	700	372
721-6	399	1286	887	616	377	1471	1094	700	372
722-6	399	1286	887	616	377	1471	1094	700	372
723-6	399	1286	887	616	377	1471	1094	700	372
n =	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Nr	CO2 + 8 max	CO2 + 8 Δ min/max	VPD harvest day average	VPD +1 average	VPd + 2 average	VPD +4 average	VPD + 8 average
711-2	1770	1382	7,3	6	6,6	7	6,7
712-2	1770	1382	7,3	6	6,6	7	6,7
713-2	1770	1382	7,3	6	6,6	7	6,7
721-2	1770	1382	7,3	6	6,6	7	6,7
722-2	1770	1382	7,3	6	6,6	7	6,7
723-2	1770	1382	7,3	6	6,6	7	6,7
711-3	1589	1195	4	6,2	5,5	5,5	5,7
712-3	1589	1195	4	6,2	5,5	5,5	5,7
713-3	1589	1195	4	6,2	5,5	5,5	5,7
721-3	1589	1195	4	6,2	5,5	5,5	5,7
722-3	1589	1195	4	6,2	5,5	5,5	5,7
723-3	1589	1195	4	6,2	5,5	5,5	5,7
711-4	1589	1218	6,7	6,8	6,9	6,8	6,3
712-4	1589	1218	6,7	6,8	6,9	6,8	6,3
713-4	1589	1218	6,7	6,8	6,9	6,8	6,3
721-4	1589	1218	6,7	6,8	6,9	6,8	6,3
722-4	1589	1218	6,7	6,8	6,9	6,8	6,3
723-4	1589	1218	6,7	6,8	6,9	6,8	6,3
711-5	1661	1350	4,9	4,9	5,9	6,5	6
712-5	1661	1350	4,9	4,9	5,9	6,5	6
713-5	1661	1350	4,9	4,9	5,9	6,5	6
721-5	1661	1350	4,9	4,9	5,9	6,5	6
722-5	1661	1350	4,9	4,9	5,9	6,5	6
723-5	1661	1350	4,9	4,9	5,9	6,5	6
711-6	1522	1150	4,2	3,6	3,7	4,5	4,9
712-6	1522	1150	4,2	3,6	3,7	4,5	4,9
713-6	1522	1150	4,2	3,6	3,7	4,5	4,9
721-6	1522	1150	4,2	3,6	3,7	4,5	4,9
722-6	1522	1150	4,2	3,6	3,7	4,5	4,9
723-6	1522	1150	4,2	3,6	3,7	4,5	4,9
n =	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Nr	Prod.	Variety	Harvest	Weight	Lenght	Color	SSC	pH	EC	EC drain water	pH drain water	EC irrigation water	pH irrigation water
811-3	8	2	1	302	25,5	9	2,6	5,3	3,65	4,5	5,6	2,4	5,3
812-3	8	2	1	344	27	9	2,7	5,27	3,45	4,5	5,6	2,4	5,3
813-3	8	2	1	320	27	8	2,7	5,29	3,68	4,5	5,6	2,4	5,3
821-3	8	1	1	323	25,5	8	2,6	5,27	3,97	4,5	5,6	2,4	5,3
822-3	8	1	1	304	25	8	2,7	5,29	3,85	4,5	5,6	2,4	5,3
823-3	8	1	1	316	24,5	8	2,6	5,19	3,8	4,5	5,6	2,4	5,3
811-4	8	2	2	335	27,5	8	2,5	5,01	3,71	3,7	5,5	2,6	4,5
812-4	8	2	2	346	30	9	2,8	5,17	3,99	3,7	5,5	2,6	4,5
813-4	8	2	2	292	27	8	2,7	5,15	4,09	3,7	5,5	2,6	4,5
821-4	8	1	2	314	27,5	8	2,6	5,16	4	3,7	5,5	2,6	4,5
822-4	8	1	2	311	28	8	2,7	5,1	4,07	3,7	5,5	2,6	4,5
823-4	8	1	2	320	28	8	2,7	5,13	4,13	3,7	5,5	2,6	4,5
811-5	8	2	3	383	32	9	2,8	5,27	3,71	3,2	6	3	4,5
812-5	8	2	3	306	31,5	9	2,7	5,24	3,7	3,2	6	3	4,5
813-5	8	2	3	292	29	9	2,8	5,28	3,7	3,2	6	3	4,5
821-5	8	1	3	362	30,5	9	2,7	5,24	3,84	3,2	6	3	4,5
822-5	8	1	3	317	29,5	9	2,9	5,3	3,88	3,2	6	3	4,5
823-5	8	1	3	321	30	9	2,7	5,25	3,76	3,2	6	3	4,5
811-7	8	2	4	297	30	9	3,1	5,45	3,32	1,7	6	2	5
812-7	8	2	4	338	31,5	8	3	5,39	3,6	1,7	6	2	5
813-7	8	2	4	262	30,5	9	3,1	5,48	3,62	1,7	6	2	5
821-7	8	1	4	337	30,5	9	3,1	5,41	3,21	1,7	6	2	5
822-7	8	1	4	359	31	9	3,3	5,49	3,58	1,7	6	2	5
823-7	8	1	4	336	30,5	8	2,9	5,42	3,34	1,7	6	2	5
n=	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**
911-2	9	1	1		24	9	3,3	5,34	4,36				
912-2	9	1	1		24	9	3,5	5,36	4,1				
913-2	9	1	1		25	9	3,1	5,36	4,26				
921-2	9	2	1		27	8	3,4	5,43	4,09				
922-2	9	2	1		27,5	9	2,8	5,35	4,04				
923-2	9	2	1		28	9	2,8	5,34	4,04				

Nr	Dry matter content	DLI fruit harvest day	DLI fruit +1	DLI fruit +2	DLI fruit +4	DLI fruit +8	DLI plant harvest day	DLI plant +1	DLI plant +2
811-3		0,58	2,96	2,59	2,51	2,44	9,01	46,32	40,60
812-3		0,14	0,73	0,64	0,62	0,60	9,01	46,32	40,60
813-3		0,46	2,38	2,08	2,02	1,96	9,01	46,32	40,60
821-3		0,25	1,28	1,12	1,09	1,05	9,01	46,32	40,60
822-3		0,20	1,05	0,92	0,89	0,87	9,01	46,32	40,60
823-3		0,28	1,42	1,24	1,20	1,17	9,01	46,32	40,60
811-4	2,91	0,35	2,64	2,39	2,00	2,07	5,29	39,95	36,05
812-4	3,48	0,35	2,63	2,37	1,98	2,05	5,29	39,95	36,05
813-4	3,34	0,36	2,74	2,48	2,07	2,14	5,29	39,95	36,05
821-4	3,26	0,20	1,52	1,37	1,15	1,19	5,29	39,95	36,05
822-4	3,37	0,39	2,96	2,67	2,24	2,32	5,29	39,95	36,05
823-4	3,35	0,22	1,68	1,51	1,27	1,31	5,29	39,95	36,05
811-5	3,23	0,28	2,28	2,03	1,75	1,63	5,62	45,74	40,56
812-5	3,17	0,15	1,22	1,08	0,94	0,87	5,62	45,74	40,56
813-5	3,39	0,74	6,05	5,36	4,64	4,31	5,62	45,74	40,56
821-5	3,38	0,25	2,06	1,83	1,58	1,47	5,62	45,74	40,56
822-5	3,51	0,48	3,90	3,46	2,99	2,78	5,62	45,74	40,56
823-5	3,26	0,27	2,21	1,96	1,69	1,57	5,62	45,74	40,56
811-7	4,03	3,70	18,75	16,77	16,74	15,26	6,05	30,71	27,47
812-7	3,78	2,27	11,54	10,32	10,30	9,39	6,05	30,71	27,47
813-7	3,96	3,79	19,21	17,18	17,14	15,63	6,05	30,71	27,47
821-7	3,76	1,55	7,89	7,05	7,04	6,42	6,05	30,71	27,47
822-7	4,18	4,85	24,61	22,01	21,97	20,03	6,05	30,71	27,47
823-7	3,81	3,01	15,26	13,65	13,62	12,42	6,05	30,71	27,47
n=	**18**	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**
911-2		0,22	1,18	0,98	0,96	0,92	5,77	31,29	26,16
912-2		0,16	0,84	0,70	0,69	0,66	5,77	31,29	26,16
913-2		1,12	6,06	5,07	4,95	4,73	5,77	31,29	26,16
921-2		0,17	0,93	0,78	0,76	0,73	5,77	31,29	26,16
922-2		0,21	1,13	0,94	0,92	0,88	5,77	31,29	26,16
923-2		0,14	0,77	0,64	0,63	0,60	5,77	31,29	26,16

Nr	DLI plant +4	DLI plant +8	oC harvestday average	oC harvestday min	oC harvestday max	oC harvestday Δ min/max	oC + 1 average
811-3	39,34	38,17	25,16	24,44	26,19	1,75	24,63
812-3	39,34	38,17	25,16	24,44	26,19	1,75	24,63
813-3	39,34	38,17	25,16	24,44	26,19	1,75	24,63
821-3	39,34	38,17	25,16	24,44	26,19	1,75	24,63
822-3	39,34	38,17	25,16	24,44	26,19	1,75	24,63
823-3	39,34	38,17	25,16	24,44	26,19	1,75	24,63
811-4	30,18	31,24	24,93	24,05	25,99	1,94	24,49
812-4	30,18	31,24	24,93	24,05	25,99	1,94	24,49
813-4	30,18	31,24	24,93	24,05	25,99	1,94	24,49
821-4	30,18	31,24	24,93	24,05	25,99	1,94	24,49
822-4	30,18	31,24	24,93	24,05	25,99	1,94	24,49
823-4	30,18	31,24	24,93	24,05	25,99	1,94	24,49
811-5	35,05	32,56	25,07	24,32	26,38	2,06	24,69
812-5	35,05	32,56	25,07	24,32	26,38	2,06	24,69
813-5	35,05	32,56	25,07	24,32	26,38	2,06	24,69
821-5	35,05	32,56	25,07	24,32	26,38	2,06	24,69
822-5	35,05	32,56	25,07	24,32	26,38	2,06	24,69
823-5	35,05	32,56	25,07	24,32	26,38	2,06	24,69
811-7	27,41	24,99	25,27	22,95	26,92	3,97	25,63
812-7	27,41	24,99	25,27	22,95	26,92	3,97	25,63
813-7	27,41	24,99	25,27	22,95	26,92	3,97	25,63
821-7	27,41	24,99	25,27	22,95	26,92	3,97	25,63
822-7	27,41	24,99	25,27	22,95	26,92	3,97	25,63
823-7	27,41	24,99	25,27	22,95	26,92	3,97	25,63
n=	**24**	**24**	**24**	**24**	**24**	**24**	**24**
911-2	25,56	24,41	23,6	22,1	25,4	3,3	22,5
912-2	25,56	24,41	23,6	22,1	25,4	3,3	22,5
913-2	25,56	24,41	23,6	22,1	25,4	3,3	22,5
921-2	25,56	24,41	23,6	22,1	25,4	3,3	22,5
922-2	25,56	24,41	23,6	22,1	25,4	3,3	22,5
923-2	25,56	24,41	23,6	22,1	25,4	3,3	22,5

Nr	oC + 1 min	oC + 1 max	oC + 1 Δ min/max	oC + 2 average	oC +2 min	oC + 2 max	oC +2 min/max	oC +4 average	oC +4 min	oC +4 max
811-3	21,94	26,19	4,25	24,62	21,94	26,19	4,25	24,49	21,42	26,19
812-3	21,94	26,19	4,25	24,62	21,94	26,19	4,25	24,49	21,42	26,19
813-3	21,94	26,19	4,25	24,62	21,94	26,19	4,25	24,49	21,42	26,19
821-3	21,94	26,19	4,25	24,62	21,94	26,19	4,25	24,49	21,42	26,19
822-3	21,94	26,19	4,25	24,62	21,94	26,19	4,25	24,49	21,42	26,19
823-3	21,94	26,19	4,25	24,62	21,94	26,19	4,25	24,49	21,42	26,19
811-4	21,98	26,68	4,7	24,51	21,98	27,2	5,22	24,46	21,92	27,2
812-4	21,98	26,68	4,7	24,51	21,98	27,2	5,22	24,46	21,92	27,2
813-4	21,98	26,68	4,7	24,51	21,98	27,2	5,22	24,46	21,92	27,2
821-4	21,98	26,68	4,7	24,51	21,98	27,2	5,22	24,46	21,92	27,2
822-4	21,98	26,68	4,7	24,51	21,98	27,2	5,22	24,46	21,92	27,2
823-4	21,98	26,68	4,7	24,51	21,98	27,2	5,22	24,46	21,92	27,2
811-5	22,15	26,47	4,32	24,65	22,05	26,47	4,42	24,51	21,5	27,5
812-5	22,15	26,47	4,32	24,65	22,05	26,47	4,42	24,51	21,5	27,5
813-5	22,15	26,47	4,32	24,65	22,05	26,47	4,42	24,51	21,5	27,5
821-5	22,15	26,47	4,32	24,65	22,05	26,47	4,42	24,51	21,5	27,5
822-5	22,15	26,47	4,32	24,65	22,05	26,47	4,42	24,51	21,5	27,5
823-5	22,15	26,47	4,32	24,65	22,05	26,47	4,42	24,51	21,5	27,5
811-7	22,95	27,19	4,24	25,94	22,95	27,81	4,86	25,76	22,95	27,81
812-7	22,95	27,19	4,24	25,94	22,95	27,81	4,86	25,76	22,95	27,81
813-7	22,95	27,19	4,24	25,94	22,95	27,81	4,86	25,76	22,95	27,81
821-7	22,95	27,19	4,24	25,94	22,95	27,81	4,86	25,76	22,95	27,81
822-7	22,95	27,19	4,24	25,94	22,95	27,81	4,86	25,76	22,95	27,81
823-7	22,95	27,19	4,24	25,94	22,95	27,81	4,86	25,76	22,95	27,81
n=	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**
911-2	17,6	25,4	7,8	22,41	17,6	25,4	7,8	22,28	17,6	25,5
912-2	17,6	25,4	7,8	22,41	17,6	25,4	7,8	22,28	17,6	25,5
913-2	17,6	25,4	7,8	22,41	17,6	25,4	7,8	22,28	17,6	25,5
921-2	17,6	25,4	7,8	22,41	17,6	25,4	7,8	22,28	17,6	25,5
922-2	17,6	25,4	7,8	22,41	17,6	25,4	7,8	22,28	17,6	25,5
923-2	17,6	25,4	7,8	22,41	17,6	25,4	7,8	22,28	17,6	25,5

Nr	oC + 4 Δ min/max	oC + 8 average	oC + 8 min	oC + 8 max	oC + 8 Δ min/max	CO2 harvest day average	CO2 harvest day min
811-3	4,77	24,46	21,42	27,4	5,98	635	340
812-3	4,77	24,46	21,42	27,4	5,98	635	340
813-3	4,77	24,46	21,42	27,4	5,98	635	340
821-3	4,77	24,46	21,42	27,4	5,98	635	340
822-3	4,77	24,46	21,42	27,4	5,98	635	340
823-3	4,77	24,46	21,42	27,4	5,98	635	340
811-4	5,28	24,46	21,9	27,2	5,3	409	285
812-4	5,28	24,46	21,9	27,2	5,3	409	285
813-4	5,28	24,46	21,9	27,2	5,3	409	285
821-4	5,28	24,46	21,9	27,2	5,3	409	285
822-4	5,28	24,46	21,9	27,2	5,3	409	285
823-4	5,28	24,46	21,9	27,2	5,3	409	285
811-5	6	24,49	21,5	27,88	6,38	574	431
812-5	6	24,49	21,5	27,88	6,38	574	431
813-5	6	24,49	21,5	27,88	6,38	574	431
821-5	6	24,49	21,5	27,88	6,38	574	431
822-5	6	24,49	21,5	27,88	6,38	574	431
823-5	6	24,49	21,5	27,88	6,38	574	431
811-7	4,86	25,36	21,38	27,81	6,43	319	261
812-7	4,86	25,36	21,38	27,81	6,43	319	261
813-7	4,86	25,36	21,38	27,81	6,43	319	261
821-7	4,86	25,36	21,38	27,81	6,43	319	261
822-7	4,86	25,36	21,38	27,81	6,43	319	261
823-7	4,86	25,36	21,38	27,81	6,43	319	261
n=	**24**	**24**	**24**	**24**	**24**	**24**	**24**
911-2	7,9	22,51	17,4	26,7	9,3	780	442
912-2	7,9	22,51	17,4	26,7	9,3	780	442
913-2	7,9	22,51	17,4	26,7	9,3	780	442
921-2	7,9	22,51	17,4	26,7	9,3	780	442
922-2	7,9	22,51	17,4	26,7	9,3	780	442
923-2	7,9	22,51	17,4	26,7	9,3	780	442

Nr	**CO2 harvest day max**	**CO2 harvest day Δmin/max**	**CO2 + 1 average**	**CO2 + 1 min**	**CO2 + 1 max**	**CO2 +1 Δ min/max**	**CO2 +2 average**
811-3	1222	882	459	239	1222	983	448
812-3	1222	882	459	239	1222	983	448
813-3	1222	882	459	239	1222	983	448
821-3	1222	882	459	239	1222	983	448
822-3	1222	882	459	239	1222	983	448
823-3	1222	882	459	239	1222	983	448
811-4	574	289	403	253	966	713	431
812-4	574	289	403	253	966	713	431
813-4	574	289	403	253	966	713	431
821-4	574	289	403	253	966	713	431
822-4	574	289	403	253	966	713	431
823-4	574	289	403	253	966	713	431
811-5	924	493	548	321	1078	757	517
812-5	924	493	548	321	1078	757	517
813-5	924	493	548	321	1078	757	517
821-5	924	493	548	321	1078	757	517
822-5	924	493	548	321	1078	757	517
823-5	924	493	548	321	1078	757	517
811-7	390	129	329	261	403	142	337
812-7	390	129	329	261	403	142	337
813-7	390	129	329	261	403	142	337
821-7	390	129	329	261	403	142	337
822-7	390	129	329	261	403	142	337
823-7	390	129	329	261	403	142	337
n=	**24**	**24**	**24**	**24**	**24**	**24**	**24**
911-2	1300	858	970	442	1337	895	986
912-2	1300	858	970	442	1337	895	986
913-2	1300	858	970	442	1337	895	986
921-2	1300	858	970	442	1337	895	986
922-2	1300	858	970	442	1337	895	986
923-2	1300	858	970	442	1337	895	986

Nr	CO2 + 2 min	CO2+ 2 max	CO2 +2 Δ min/max	CO2 + 4 average	CO2 + 4 min	CO2 + 4 max	CO2 + 4 Δ min/max	CO2 + 8 average	CO2 + 8 min
811-3	239	1222	983	452	218	1287	1069	439	218
812-3	239	1222	983	452	218	1287	1069	439	218
813-3	239	1222	983	452	218	1287	1069	439	218
821-3	239	1222	983	452	218	1287	1069	439	218
822-3	239	1222	983	452	218	1287	1069	439	218
823-3	239	1222	983	452	218	1287	1069	439	218
811-4	253	1023	770	421	246	1023	777	435	239
812-4	253	1023	770	421	246	1023	777	435	239
813-4	253	1023	770	421	246	1023	777	435	239
821-4	253	1023	770	421	246	1023	777	435	239
822-4	253	1023	770	421	246	1023	777	435	239
823-4	253	1023	770	421	246	1023	777	435	239
811-5	261	1137	876	491	253	1137	884	438	253
812-5	261	1137	876	491	253	1137	884	438	253
813-5	261	1137	876	491	253	1137	884	438	253
821-5	261	1137	876	491	253	1137	884	438	253
822-5	261	1137	876	491	253	1137	884	438	253
823-5	261	1137	876	491	253	1137	884	438	253
811-7	261	418	157	342	254	500	246	414	225
812-7	261	418	157	342	254	500	246	414	225
813-7	261	418	157	342	254	500	246	414	225
821-7	261	418	157	342	254	500	246	414	225
822-7	261	418	157	342	254	500	246	414	225
823-7	261	418	157	342	254	500	246	414	225
n=	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**
911-2	442	1454	1012	1015	442	1454	1012	987	350
912-2	442	1454	1012	1015	442	1454	1012	987	350
913-2	442	1454	1012	1015	442	1454	1012	987	350
921-2	442	1454	1012	1015	442	1454	1012	987	350
922-2	442	1454	1012	1015	442	1454	1012	987	350
923-2	442	1454	1012	1015	442	1454	1012	987	350

Nr	CO2 + 8 max	CO2 + 8 Δ min/max	VPD harvest day average	VPD +1 average	VPd + 2 average	VPD +4 average	VPD + 8 average
811-3	1287	1069	8,82	9,4	9,2	8,8	9,3
812-3	1287	1069	8,82	9,4	9,2	8,8	9,3
813-3	1287	1069	8,82	9,4	9,2	8,8	9,3
821-3	1287	1069	8,82	9,4	9,2	8,8	9,3
822-3	1287	1069	8,82	9,4	9,2	8,8	9,3
823-3	1287	1069	8,82	9,4	9,2	8,8	9,3
811-4	1234	995	7,7	7,9	8,2	8,3	8,7
812-4	1234	995	7,7	7,9	8,2	8,3	8,7
813-4	1234	995	7,7	7,9	8,2	8,3	8,7
821-4	1234	995	7,7	7,9	8,2	8,3	8,7
822-4	1234	995	7,7	7,9	8,2	8,3	8,7
823-4	1234	995	7,7	7,9	8,2	8,3	8,7
811-5	1137	884	8,5	9,1	9,1	9,1	8,7
812-5	1137	884	8,5	9,1	9,1	9,1	8,7
813-5	1137	884	8,5	9,1	9,1	9,1	8,7
821-5	1137	884	8,5	9,1	9,1	9,1	8,7
822-5	1137	884	8,5	9,1	9,1	9,1	8,7
823-5	1137	884	8,5	9,1	9,1	9,1	8,7
811-7	1167	941	12	11,4	11,8	10,8	9,4
812-7	1167	941	12	11,4	11,8	10,8	9,4
813-7	1167	941	12	11,4	11,8	10,8	9,4
821-7	1167	941	12	11,4	11,8	10,8	9,4
822-7	1167	941	12	11,4	11,8	10,8	9,4
823-7	1167	941	12	11,4	11,8	10,8	9,4
n=	**24**	**24**	**24**	**24**	**24**	**24**	**24**
911-2	1461	1111	0	0	2,4	2,4	0
912-2	1461	1111	0	0	2,4	2,4	0
913-2	1461	1111	0	0	2,4	2,4	0
921-2	1461	1111	0	0	2,4	2,4	0
922-2	1461	1111	0	0	2,4	2,4	0
923-2	1461	1111	0	0	2,4	2,4	0

Nr	Prod.	Variety	Harvest	Weight	Lenght	Color	SSC	pH	EC	EC drain water	pH drain water	EC irrigation water	pH irrigation water
911-3	9	1	2	284	26	8	2,6	5,07	4,05	4,1	5	3	5
912-3	9	1	2	346	28,5	8	2,7	5,13	3,83	4,1	5	3	5
913-3	9	1	2	313	28,5	9	2,7	5,14	4,06	4,1	5	3	5
921-3	9	2	2	282	26,5	8	2,5	5,09	4,01	4,1	5	3	5
922-3	9	2	2	340	29	9	2,6	5,07	3,86	4,1	5	3	5
923-3	9	2	2	302	28	9	2,7	5,24	4,27	4,1	5	3	5
911-4	9	1	3	360	30	9	2,9	5,27	4,2	3,68	6	3,05	5
912-4	9	1	3	317	29,5	9	2,8	5,32	3,92	3,68	6	3,05	5
913-4	9	1	3	334	29,5	9	3,2	5,36	4,41	3,68	6	3,05	5
921-4	9	2	3	322	32	9	2,7	5,32	3,88	3,68	6	3,05	5
922-4	9	2	3	297	31	9	2,8	5,36	3,94	3,68	6	3,05	5
923-4	9	2	3	306	30	9	3,2	5,37	4,07	3,68	6	3,05	5
911-5	9	1	4	305	29,5	8	3,4	5,46	4,29	2,8	5,2	3,3	5,2
912-5	9	1	4	340	29,5	7	3,1	5,37	3,78	2,8	5,2	3,3	5,2
913-5	9	1	4	303	31,5	8	3,4	5,4	4,28	2,8	5,2	3,3	5,2
921-5	9	2	4	307	29,5	8	3,2	5,38	3,38	2,8	5,2	3,3	5,2
922-5	9	2	4	342	31,5	8	3,2	5,4	3,66	2,8	5,2	3,3	5,2
923-5	9	2	4	359	30,5	9	3,3	5,31	4,08	2,8	5,2	3,3	5,2
911-6	9	1	5	327	31	8	3,6	5,54	3,26	3,4	5,5	2,1	5,2
912-6	9	1	5	348	32	7	3,7	5,55	3,91	3,4	5,5	2,1	5,2
913-6	9	1	5	306	28,5	8	3,3	5,49	3,06	3,4	5,5	2,1	5,2
921-6	9	2	5	304	30	9	3,3	5,56	3,55	3,4	5,5	2,1	5,2
922-6	9	2	5	285	26,5	9	3,3	5,45	3,41	3,4	5,5	2,1	5,2
923-6	9	2	5	296	29,5	9	2,9	5,43	3,73	3,4	5,5	2,1	5,2
n=	**30**	**30**	**30**	**24**	**30**	**30**	**30**	**30**	**30**	**24**	**24**	**24**	**24**

Nr	Dry matter content	DLI fruit harvest day	DLI fruit +1	DLI fruit +2	DLI fruit +4	DLI fruit +8	DLI plant harvest day	DLI plant +1	DLI plant +2
911-3	3,30	0,79	7,77	7,39	5,85	6,20	2,45	24,03	22,83
912-3	3,31	0,65	6,34	6,02	4,77	5,05	2,45	24,03	22,83
913-3	3,37	0,47	4,64	4,41	3,49	3,70	2,45	24,03	22,83
921-3	3,10	0,25	2,44	2,32	1,84	1,95	2,45	24,03	22,83
922-3	3,17	0,33	3,26	3,10	2,46	2,60	2,45	24,03	22,83
923-3	3,26	0,32	3,16	3,00	2,38	2,52	2,45	24,03	22,83
911-4	3,58	0,36	3,61	3,22	2,65	2,45	3,03	30,19	26,94
912-4	3,60	0,36	3,59	3,20	2,64	2,44	3,03	30,19	26,94
913-4	3,85	0,30	2,95	2,63	2,17	2,00	3,03	30,19	26,94
921-4	3,22	0,13	1,28	1,14	0,94	0,87	3,03	30,19	26,94
922-4	3,74	0,18	1,83	1,64	1,35	1,25	3,03	30,19	26,94
923-4	3,96	0,08	0,84	0,75	0,62	0,57	3,03	30,19	26,94
911-5	3,96	1,18	7,97	7,49	7,87	7,66	2,38	16,03	15,06
912-5	3,71	0,62	4,17	3,92	4,12	4,01	2,38	16,03	15,06
913-5	4,06	0,50	3,36	3,16	3,31	3,23	2,38	16,03	15,06
921-5	3,80	1,09	7,35	6,90	7,25	7,06	2,38	16,03	15,06
922-5	3,72	0,44	2,95	2,77	2,91	2,83	2,38	16,03	15,06
923-5	3,66	0,32	2,15	2,02	2,12	2,06	2,38	16,03	15,06
911-6	4,55	1,69	11,79	10,12	10,13	8,51	2,91	20,35	17,46
912-6	4,69	0,61	4,29	3,68	3,69	3,10	2,91	20,35	17,46
913-6	4,00	0,74	5,15	4,42	4,42	3,72	2,91	20,35	17,46
921-6	4,16	2,22	15,56	13,35	13,36	11,23	2,91	20,35	17,46
922-6	4,10	1,06	7,43	6,38	6,38	5,36	2,91	20,35	17,46
923-6	3,90	1,47	10,31	8,85	8,85	7,44	2,91	20,35	17,46
n=	**24**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Nr	DLI plant +4	DLI plant +8	oC harvestday average	oC harvestday min	oC harvestday max	oC harvestday Δ min/max	oC + 1 average
911-3	18,09	19,15	23,45	22,5	24,3	1,8	22,59
912-3	18,09	19,15	23,45	22,5	24,3	1,8	22,59
913-3	18,09	19,15	23,45	22,5	24,3	1,8	22,59
921-3	18,09	19,15	23,45	22,5	24,3	1,8	22,59
922-3	18,09	19,15	23,45	22,5	24,3	1,8	22,59
923-3	18,09	19,15	23,45	22,5	24,3	1,8	22,59
911-4	22,22	20,51	23,21	21,5	24,4	2,9	21,99
912-4	22,22	20,51	23,21	21,5	24,4	2,9	21,99
913-4	22,22	20,51	23,21	21,5	24,4	2,9	21,99
921-4	22,22	20,51	23,21	21,5	24,4	2,9	21,99
922-4	22,22	20,51	23,21	21,5	24,4	2,9	21,99
923-4	22,22	20,51	23,21	21,5	24,4	2,9	21,99
911-5	15,82	15,41	21,85	20,7	23,2	2,5	21,95
912-5	15,82	15,41	21,85	20,7	23,2	2,5	21,95
913-5	15,82	15,41	21,85	20,7	23,2	2,5	21,95
921-5	15,82	15,41	21,85	20,7	23,2	2,5	21,95
922-5	15,82	15,41	21,85	20,7	23,2	2,5	21,95
923-5	15,82	15,41	21,85	20,7	23,2	2,5	21,95
911-6	17,47	14,69	23,39	22,6	23,9	1,3	22,68
912-6	17,47	14,69	23,39	22,6	23,9	1,3	22,68
913-6	17,47	14,69	23,39	22,6	23,9	1,3	22,68
921-6	17,47	14,69	23,39	22,6	23,9	1,3	22,68
922-6	17,47	14,69	23,39	22,6	23,9	1,3	22,68
923-6	17,47	14,69	23,39	22,6	23,9	1,3	22,68
n=	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Nr	oC + 1 min	oC + 1 max	oC + 1 Δ min/max	oC + 2 average	oC +2 min	oC + 2 max	oC +2 min/max	oC +4 average	oC +4 min	oC +4 max
911-3	18,9	25,1	6,2	22,32	17,4	25,3	7,9	22,21	17,4	25,3
912-3	18,9	25,1	6,2	22,32	17,4	25,3	7,9	22,21	17,4	25,3
913-3	18,9	25,1	6,2	22,32	17,4	25,3	7,9	22,21	17,4	25,3
921-3	18,9	25,1	6,2	22,32	17,4	25,3	7,9	22,21	17,4	25,3
922-3	18,9	25,1	6,2	22,32	17,4	25,3	7,9	22,21	17,4	25,3
923-3	18,9	25,1	6,2	22,32	17,4	25,3	7,9	22,21	17,4	25,3
911-4	16,6	24,4	7,8	21,86	16,6	24,6	8	21,66	16,5	24,8
912-4	16,6	24,4	7,8	21,86	16,6	24,6	8	21,66	16,5	24,8
913-4	16,6	24,4	7,8	21,86	16,6	24,6	8	21,66	16,5	24,8
921-4	16,6	24,4	7,8	21,86	16,6	24,6	8	21,66	16,5	24,8
922-4	16,6	24,4	7,8	21,86	16,6	24,6	8	21,66	16,5	24,8
923-4	16,6	24,4	7,8	21,86	16,6	24,6	8	21,66	16,5	24,8
911-5	20,3	23,9	3,6	21,57	16,8	23,9	7,1	21,45	16,6	24
912-5	20,3	23,9	3,6	21,57	16,8	23,9	7,1	21,45	16,6	24
913-5	20,3	23,9	3,6	21,57	16,8	23,9	7,1	21,45	16,6	24
921-5	20,3	23,9	3,6	21,57	16,8	23,9	7,1	21,45	16,6	24
922-5	20,3	23,9	3,6	21,57	16,8	23,9	7,1	21,45	16,6	24
923-5	20,3	23,9	3,6	21,57	16,8	23,9	7,1	21,45	16,6	24
911-6	20,8	23,9	3,1	22,72	20,8	25,1	4,3	22,69	20,8	25,3
912-6	20,8	23,9	3,1	22,72	20,8	25,1	4,3	22,69	20,8	25,3
913-6	20,8	23,9	3,1	22,72	20,8	25,1	4,3	22,69	20,8	25,3
921-6	20,8	23,9	3,1	22,72	20,8	25,1	4,3	22,69	20,8	25,3
922-6	20,8	23,9	3,1	22,72	20,8	25,1	4,3	22,69	20,8	25,3
923-6	20,8	23,9	3,1	22,72	20,8	25,1	4,3	22,69	20,8	25,3
n=	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Nr	oC + 4 Δ min/max	oC + 8 average	oC + 8 min	oC + 8 max	oC + 8 Δ min/max	CO2 harvest day average	CO2 harvest day min
911-3	7,9	22,08	17	25,5	8,5	928	609
912-3	7,9	22,08	17	25,5	8,5	928	609
913-3	7,9	22,08	17	25,5	8,5	928	609
921-3	7,9	22,08	17	25,5	8,5	928	609
922-3	7,9	22,08	17	25,5	8,5	928	609
923-3	7,9	22,08	17	25,5	8,5	928	609
911-4	8,3	22	16,5	25,3	8,8	939	627
912-4	8,3	22	16,5	25,3	8,8	939	627
913-4	8,3	22	16,5	25,3	8,8	939	627
921-4	8,3	22	16,5	25,3	8,8	939	627
922-4	8,3	22	16,5	25,3	8,8	939	627
923-4	8,3	22	16,5	25,3	8,8	939	627
911-5	7,4	21,64	16,6	24,5	7,9	1048	974
912-5	7,4	21,64	16,6	24,5	7,9	1048	974
913-5	7,4	21,64	16,6	24,5	7,9	1048	974
921-5	7,4	21,64	16,6	24,5	7,9	1048	974
922-5	7,4	21,64	16,6	24,5	7,9	1048	974
923-5	7,4	21,64	16,6	24,5	7,9	1048	974
911-6	4,5	22,48	20,2	25,3	5,1	863	697
912-6	4,5	22,48	20,2	25,3	5,1	863	697
913-6	4,5	22,48	20,2	25,3	5,1	863	697
921-6	4,5	22,48	20,2	25,3	5,1	863	697
922-6	4,5	22,48	20,2	25,3	5,1	863	697
923-6	4,5	22,48	20,2	25,3	5,1	863	697
n=	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Nr	CO2 harvest day max	CO2 harvest day Δmin/max	CO2 + 1 average	CO2 + 1 min	CO2 + 1 max	CO2 +1 Δ min/max	CO2 +2 average
911-3	1294	685	954	478	1477	999	999
912-3	1294	685	954	478	1477	999	999
913-3	1294	685	954	478	1477	999	999
921-3	1294	685	954	478	1477	999	999
922-3	1294	685	954	478	1477	999	999
923-3	1294	685	954	478	1477	999	999
911-4	1309	682	1062	609	1382	773	1086
912-4	1309	682	1062	609	1382	773	1086
913-4	1309	682	1062	609	1382	773	1086
921-4	1309	682	1062	609	1382	773	1086
922-4	1309	682	1062	609	1382	773	1086
923-4	1309	682	1062	609	1382	773	1086
911-5	1138	164	1103	807	1362	555	1136
912-5	1138	164	1103	807	1362	555	1136
913-5	1138	164	1103	807	1362	555	1136
921-5	1138	164	1103	807	1362	555	1136
922-5	1138	164	1103	807	1362	555	1136
923-5	1138	164	1103	807	1362	555	1136
911-6	1140	443	990	697	1244	547	968
912-6	1140	443	990	697	1244	547	968
913-6	1140	443	990	697	1244	547	968
921-6	1140	443	990	697	1244	547	968
922-6	1140	443	990	697	1244	547	968
923-6	1140	443	990	697	1244	547	968
n=	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Nr	CO2 + 2 min	CO2+ 2 max	CO2 +2 Δ min/max	CO2 + 4 average	CO2 + 4 min	CO2 + 4 max	CO2 + 4 Δ min/max	CO2 + 8 average	CO2 + 8 min
911-3	425	1499	1074	1055	425	1499	1074	1055	425
912-3	425	1499	1074	1055	425	1499	1074	1055	425
913-3	425	1499	1074	1055	425	1499	1074	1055	425
921-3	425	1499	1074	1055	425	1499	1074	1055	425
922-3	425	1499	1074	1055	425	1499	1074	1055	425
923-3	425	1499	1074	1055	425	1499	1074	1055	425
911-4	609	1450	841	1068	490	1450	960	1014	391
912-4	609	1450	841	1068	490	1450	960	1014	391
913-4	609	1450	841	1068	490	1450	960	1014	391
921-4	609	1450	841	1068	490	1450	960	1014	391
922-4	609	1450	841	1068	490	1450	960	1014	391
923-4	609	1450	841	1068	490	1450	960	1014	391
911-5	807	1362	555	1156	759	1418	659	1134	542
912-5	807	1362	555	1156	759	1418	659	1134	542
913-5	807	1362	555	1156	759	1418	659	1134	542
921-5	807	1362	555	1156	759	1418	659	1134	542
922-5	807	1362	555	1156	759	1418	659	1134	542
923-5	807	1362	555	1156	759	1418	659	1134	542
911-6	546	1281	735	977	546	1281	735	1003	546
912-6	546	1281	735	977	546	1281	735	1003	546
913-6	546	1281	735	977	546	1281	735	1003	546
921-6	546	1281	735	977	546	1281	735	1003	546
922-6	546	1281	735	977	546	1281	735	1003	546
923-6	546	1281	735	977	546	1281	735	1003	546
n=	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Nr	CO2 + 8 max	CO2 + 8 Δ min/max	VPD harvest day average	VPD +1 average	VPd + 2 average	VPD +4 average	VPD + 8 average
911-3	1499	1074	4,4	4,4	4,3	4,3	4,3
912-3	1499	1074	4,4	4,4	4,3	4,3	4,3
913-3	1499	1074	4,4	4,4	4,3	4,3	4,3
921-3	1499	1074	4,4	4,4	4,3	4,3	4,3
922-3	1499	1074	4,4	4,4	4,3	4,3	4,3
923-3	1499	1074	4,4	4,4	4,3	4,3	4,3
911-4	1530	1139	4,4	4,3	4,3	4,3	4,3
912-4	1530	1139	4,4	4,3	4,3	4,3	4,3
913-4	1530	1139	4,4	4,3	4,3	4,3	4,3
921-4	1530	1139	4,4	4,3	4,3	4,3	4,3
922-4	1530	1139	4,4	4,3	4,3	4,3	4,3
923-4	1530	1139	4,4	4,3	4,3	4,3	4,3
911-5	1418	876	4,3	4,3	4,3	3,8	2,4
912-5	1418	876	4,3	4,3	4,3	3,8	2,4
913-5	1418	876	4,3	4,3	4,3	3,8	2,4
921-5	1418	876	4,3	4,3	4,3	3,8	2,4
922-5	1418	876	4,3	4,3	4,3	3,8	2,4
923-5	1418	876	4,3	4,3	4,3	3,8	2,4
911-6	1362	816	4,4	4,4	4,4	4,4	2,4
912-6	1362	816	4,4	4,4	4,4	4,4	2,4
913-6	1362	816	4,4	4,4	4,4	4,4	2,4
921-6	1362	816	4,4	4,4	4,4	4,4	2,4
922-6	1362	816	4,4	4,4	4,4	4,4	2,4
923-6	1362	816	4,4	4,4	4,4	4,4	2,4
n=	**30**	**30**	**30**	**30**	**30**	**30**	**30**

Appendix 2
pH measurements meant to make calibration curve for TTA.

	g cucumberjuice/citric	pH-meter	pH start	ml EP1	pH EP1	ml EP2	pH EP2	ml EP3	pH Ep3
Citric	0,1018 g			5,601	2,84	17,037	6,87	17,273	8,26
Cucumber	15,8756 g	5,54	4,74	0,758	5,35	2,183	6,94		
Cucumber	15,2726 g	5,91	5,2	0,355	5,51	1,492	6,94		
Cucumber	15,1885 g	5,66	4,91	0,771	5,68	1,685	6,98		
Cucumber	15,3449 g	5,58	4,73	0,842	5,39	2,26	6,89		
Cucumber	15,7811 g	5,51	4,7	0,655	5,12	2,224	6,77		
Cucumber	15,1648 g	5,59	4,79	0,882	5,49	2,2027	6,7	4,04	8,28
Cucumber	15,2774 g	5,59	4,93	0,813	5,68	1,203	6,24	2,036	7,46
Cucumber	15,3023 g	5,53	4,76	2,125	6,78				
Cucumber	15,3645 g	5,74	5,1	1,233	6,16	2,004	7,04		
Cucumber	15,2594 g	5,53	4,76	0,445	5,13	1,885	7		
Citric	0,0998 g	5,618	4,862	5,736	2,93	11,086	4,37	16,625	7,47
Citric	0,02 mg	3,04	2,97	0,167	3,72	0,398	7,12		
Citric	0,01 mg	3,18	3,2	0,118	4,35	0,233	7,33		
Citric	0,0002 mg	3,94	7,63	0,06	8,14				
Citric	0,0001 mg	4,19	7,6	0,045	7,94				
Citric	0,000002 mg	4,41	7,61	0,049	8,11				
Citric	0,00000002 mg	4,45	7,57	0,047	8,11				

Appendix 3.1

Feedback form, consumer taste test

Smakstest agurk

Alder:____________

Kjønn:____________

Du har fått utdelt 9 skåler som inneholder en agurkskive hver. Start med den øverste skålen (den inneholder skive nr 1), smak, gi karakter og eventuelle kommentarer, før du smaker på skiven i skålen under (som da er skive nr 2) og gir karakter, osv….

Sett ring rundt den tallkarakteren du synes passer best til hvor godt du likte agurken. Der;

- +3: Liker svært godt
- 0: Verken eller
- -3: Liker ikke i det hele tatt;

Du kan gi samme karakter flere ganger

Skive nr:	Karakter	Eventuelle kommentarer
1	**-3 -2 -1 0 +1 +2 +3**	
2	**-3 -2 -1 0 +1 +2 +3**	
3	**-3 -2 -1 0 +1 +2 +3**	
4	**-3 -2 -1 0 +1 +2 +3**	
5	**-3 -2 -1 0 +1 +2 +3**	
6	**-3 -2 -1 0 +1 +2 +3**	
7	**-3 -2 -1 0 +1 +2 +3**	
8	**-3 -2 -1 0 +1 +2 +3**	
9	**-3 -2 -1 0 +1 +2 +3**	

Appendix 3.2
Consumer test, taste score

	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
P1	3	0	1	-2	-2	3	2	2	-2	2	3	0	2	2	0	-3	2	1	2	3	0	0	0	3
P2	3	1	3	0	-2	1	0	2	1	0	3	1	2	2	-2	3	3	3	2	3	2	0	2	2
P3	0	-2	2	-3	0	0	0	-1	2	1	0	1	1	1	-1	2	-1	1	1	2	1	1	2	3
P4																								
P5	1	-1	-1	1	0	-1	0	-1	1	0	0	1	3	1	-1	3	1	-3	1	2	0	0	3	0
P6	-3	-2	0	-1	2	-3	-1	-2	1	0	3	3	3	0	0	-3	3	2	2	-2	-3	-1	-3	0
P7	-3	0	1	-1	-2	1	0	-2	2	1	3	2	-2	2	1	0	-1	3	0	-2	-1	0	-1	2
P8																								
P9	-3	-1	-3	-2	-3	0	1	-3	-1	-3	-1	-2	-3	-1	-2	-2	1	-1	1	-1	-2	-2	-1	1
Gender	K	M	M	K	K	K	X	M	M	K	M	K	K	X	M	K	K	K	M	K	M	M	K	K
Age	48	54	47	49	50	X	X	53	36	34	56	31	50	X	54	44	49	28	49	66	67	36	52	24

	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	Average
P1	2	-3	0	0	-3	1	-3	1	1	-1	3	-2	1	-1	1	2	-2	-1	2	0	0	-1	-2	-1	0,33
P2	1	2	0	0	0	1	2	-1	0	1	2	0	0	2	2	0	1	2	2	1	1	0	1	1	1,17
P3	0	1	0	1	3	3	1	3	2	2	-3	3	2	0	1	3	1	3	0	1	2	2	-1	3	0,96
P4	1	2	0	1	2	-1	2	-1	2	-2	0	-1	2	0	1	2	2	-2	0	2	-1	-2	0	3	0,50
P5	0	0	0	1	0	1	2	1	1	1	3	1	1	0	2	3	2	-2	2	2	1	1	1	3	0,77
P6	0	-2	1	-2	-1	2	-2	-1	2	-1	-3	-3	0	1	0	-2	-1	3	2	2	-2	-3	-1	0	-0,33
P7	-1	-3	1	-2	0	1	-2	-1	1	-2	-2	2	0	1	1	2	0	-2	2	0	2	2	0	2	0,10
P8	-2	-3	1	-1	1	-2	0	0	-1	-1	0	2	1	0	1	1	0	-1	-2	0	2	2	0	1	-0,04
P9	-3	-3	0	0	-2	1	-1	0	1	-3	-1	1	1	1	2	1	-2	0	-3	1	1	1	1	3	-0,75
Gender	K	K	M	K	K	M	K	K	X	K	K	K	M	K	M	K	K	K	K	M	M	M	M	M	
Age	50	27	38	32	28	47	49	44	X	51	52	24	50	49	62	48	50	50	34	44	47	53	43	56	

Appendix 3.3

Results from NOFIMA sensory testing

Producer	Total smell intensity	Fruity smell	Green smell	Total taste intensity	Fruity taste	Green taste	Sweet taste	Sour taste	Bitter taste	Firmness	Brittleness	Dryness
1	7	7	4	6	6	5	7	2	3	7	6	3
1	4	6	4	6	5	5	6	2	2	4	5	2
1	5	5	4	5	5	4	4	2	2	7	6	4
1	5	5	5	6	5	6	6	2	2	7	6	2
1	6	6	5	4	5	3	6	1	2	6	6	4
1	7	7	4	6	6	5	7	2	3	7	6	3
1	5	4	4	8	7	5	8	2	2	8	5	2
1	5	5	5	5	5	4	5	3	2	7	6	2
1	4	4	5	5	4	4	6	2	3	6	5	4
1	8	6	4	6	6	4	5	2	3	5	5	2
1	7	6	4	6	5	4	5	2	3	7	7	3
1	4	6	4	7	5	5	7	3	2	5	5	2
1	5	6	5	6	4	6	4	2	3	7	6	4
1	5	5	4	5	5	4	7	2	3	6	6	3
1	6	5	4	6	5	3	4	3	3	5	6	3
2	6	5	5	6	4	6	3	2	3	7	6	3
2	6	6	5	6	5	6	5	2	3	7	7	3
2	5	4	4	5	3	5	3	2	2	7	6	6
2	4	4	5	5	6	4	7	2	3	6	6	4
2	7	6	5	6	6	4	6	1	2	7	8	2
2	6	5	5	6	5	5	5	2	3	7	7	3
2	5	6	4	6	6	5	5	3	2	6	6	3
2	5	5	5	6	5	4	4	2	2	7	6	4
2	6	7	4	6	6	5	6	2	2	7	7	2
2	6	4	6	6	5	5	7	1	2	7	7	2
2	5	5	4	5	3	5	3	2	3	8	8	3
2	5	8	4	7	5	5	5	3	3	8	6	5
2	6	5	5	5	5	5	5	2	3	7	6	5
2	6	5	6	6	5	5	5	4	4	6	6	5
2	7	7	3	4	6	3	5	2	3	7	7	2
3	6	5	5	6	3	6	2	2	4	7	6	4
3	6	7	4	6	5	6	6	3	2	6	5	2
3	6	5	5	6	6	5	5	2	3	7	7	2
3	6	7	5	6	6	5	7	2	2	7	7	3
3	7	7	5	6	6	2	7	1	2	7	8	2
3	6	3	5	6	4	5	4	2	3	7	6	4
3	5	6	5	6	5	6	5	3	4	6	5	3
3	5	5	5	5	4	5	4	3	2	7	6	2

Producer	Total smell intensity	Fruity smell	Green smell	Total taste intensity	Fruity taste	Green taste	Sweet taste	Sour taste	Bitter taste	Firmness	Brittleness	Dryness
3	6	7	4	6	6	5	7	2	3	7	8	3
3	6	6	4	6	6	4	5	1	3	7	8	2
3	5	5	4	6	6	4	6	2	2	7	8	3
3	6	6	5	6	5	6	5	3	3	6	6	3
3	5	5	5	6	4	6	4	2	3	7	6	2
3	6	7	5	6	6	5	7	2	2	6	6	2
3	5	4	4	6	5	3	5	2	3	6	7	1
5	6	6	4	6	5	4	5	2	3	7	7	3
5	6	7	5	7	6	6	6	3	4	7	6	3
5	5	5	5	6	6	5	5	2	2	7	6	2
5	6	6	5	7	6	5	7	2	2	6	5	4
5	5	5	5	6	6	3	7	1	2	7	7	2
5	7	7	4	6	6	4	6	2	3	7	6	3
5	4	4	3	6	6	6	7	3	2	5	5	2
5	5	5	5	6	5	5	4	2	2	7	6	2
5	6	7	4	6	6	5	7	2	3	7	6	3
5	6	4	5	6	4	4	5	2	2	6	5	2
5	6	6	5	6	5	5	6	2	3	7	7	3
5	4	5	5	6	5	6	7	3	4	6	6	3
5	4	4	4	6	5	4	5	2	2	7	6	2
5	6	7	4	6	6	5	5	3	4	5	6	2
5	5	5	4	6	6	4	6	1	2	6	7	2
6	6	7	4	6	6	4	7	2	3	7	6	3
6	6	6	5	6	5	6	6	3	4	6	5	2
6	6	5	5	6	5	5	4	2	3	7	6	3
6	6	6	4	6	6	4	7	2	3	6	7	2
6	7	7	2	6	6	3	5	2	2	7	7	2
6	6	6	4	6	6	5	6	2	3	7	6	3
6	6	6	5	7	5	6	5	2	3	7	6	3
6	6	6	5	6	6	5	5	2	3	7	6	2
6	6	6	4	7	6	5	8	2	2	7	7	3
6	6	5	5	5	5	4	7	2	2	5	7	3
6	6	7	4	5	5	4	5	3	3	7	6	3
6	6	6	6	7	7	5	8	2	2	8	5	2
6	5	5	5	6	4	6	5	2	2	7	6	2
6	6	7	5	7	6	5	7	2	2	6	7	2
6	5	4	3	5	5	3	4	1	2	5	6	2
7	6	5	4	5	3	5	2	2	4	7	6	4

Producer	Total smell intensity	Fruity smell	Green smell	Total taste intensity	Fruity taste	Green taste	Sweet taste	Sour taste	Bitter taste	Firmness	Brittleness	Dryness
7	7	7	5	7	5	5	7	2	2	7	6	3
7	5	5	5	6	6	5	5	2	3	7	6	3
7	5	5	4	6	6	5	6	3	3	7	8	4
7	6	5	6	5	5	5	6	1	3	6	5	3
7	6	7	4	6	5	4	6	2	3	7	8	3
7	7	8	4	5	4	6	5	3	3	6	6	3
7	6	6	6	6	5	6	2	3	2	7	6	2
7	5	5	4	6	5	6	7	2	2	6	7	3
7	5	4	3	4	4	2	4	1	2	5	6	3
7	7	7	4	5	5	4	5	2	3	7	7	3
7	5	7	4	6	6	5	5	3	3	7	7	3
7	5	5	5	6	5	5	4	3	3	7	6	3
7	4	4	5	5	6	5	6	3	2	7	8	4
7	6	5	3	5	5	3	4	3	2	7	7	3
9	6	4	6	6	3	6	3	3	4	7	7	3
9	5	5	4	5	4	6	5	3	3	6	6	3
9	5	5	5	5	3	6	3	3	3	7	6	2
9	4	4	5	4	5	4	5	2	3	6	5	2
9	7	6	4	7	6	4	6	3	3	7	7	1
9	4	3	5	5	3	6	2	2	3	7	6	4
9	7	7	4	7	5	6	7	3	5	6	5	2
9	5	5	5	6	6	5	4	2	3	7	6	3
9	6	5	6	6	5	6	5	4	4	6	6	3
9	6	6	5	6	6	5	6	2	3	7	7	4
9	5	5	4	5	3	6	4	2	4	7	6	3
9	6	6	4	7	5	6	5	3	5	7	6	3
9	5	5	4	6	6	5	5	2	2	7	6	3
9	4	4	5	6	4	6	7	2	4	6	5	3
9	5	5	3	6	6	5	4	1	2	7	7	3

Appendix 4

GC analysis of fatty acids and aroma in cucumber

Sample	(E,Z)-2,6-Nonadienal		(E)-2-Nonenal		Dekanal		(E,Z)-2,6-Nonadienal (ppm)	(E)-2-Nonenal (ppm)
	Ret time	*Area*	*Ret time*	*Area*	*Ret time*	*Area*		
1: Cadence 10/3	21,964	328154	22,552	300328	24,754	27246	6,15	2,44
2: Cadence 10/3	21,891	170155	22,469	121519	24,747	10884	7,87	2,65
3: Cadence 10/3	21,962	549711	22,559	514642	24,746	40486	6,97	2,75
4: Cadence 21/4	21,983	630340	22,587	621007	24,750	72348	4,48	1,85
5: Cadence 21/4	21,908	212660	22,498	211167	24,746	14827	7,26	3,21
6: Cadence 21/4	21,953	465547	22,552	464454	24,747	36043	6,62	2,80
7: Quatro	21,967	505023	22,545	373036	24,749	39525	6,56	2,07
8: Quatro	21,939	373341	22,521	289211	24,747	31223	6,11	2,05
9: Quatro	21,884	202157	22,463	135491	24,741	17985	5,69	1,77
10: E23C.2201	21,943	408212	22,533	374431	24,747	58050	3,60	1,41
11: E23C.2201	21,980	551892	22,577	512582	24,751	96196	2,95	1,15
12: E23C.2201	21,931	256367	22,517	226690	24,750	39793	3,28	1,28
13: Incas	21,922	261654	22,514	250655	24,748	38888	3,42	1,44
14: Incas	21,953	439686	22,546	412601	24,749	59559	3,78	1,51
15: Incas	21,900	163310	22,484	147624	24,748	29289	2,80	1,17
16: SV4097CV	21,930	282579	22,497	165063	24,749	53406	2,69	0,71
17: SV4097CV	21,893	149495	22,466	78320	24,747	33269	2,25	0,59
18: SV4097CV	21,894	219390	22,464	109436	24,745	49455	2,25	0,53
1A: Cadence 10/3	21,969	226079	22,549	170737	24,762	12237	9,37	3,20
1B: Cadence 10/3	21,946	307184	22,529	251079	24,753	23106	6,78	2,42
1C: Cadence 10/3	21,931	222448	22,518	203484	24,752	20613	5,47	2,23
1D: Cadence 10/3	21,967	372632	22,564	363278	24,755	26880	7,09	2,96

Sample	(E,Z)-2,6-Nonadienal/(E)-2-Nonenal	Linoleic		Linolenic		Heneicosanoic		Linolenic	Linoleic
		Ret time	*Area*	*Ret time*	*Area*	*Ret time*	*Area*	*mg/100g FW*	*mg/100gFW*
1: Cadence 10/3	1,40	10,376	218878	10,955	273123	12,289	468833	12,71	9,08
2: Cadence 10/3	1,76	10,293	258597	10,890	419707	12,246	590148	16,06	9,14
3: Cadence 10/3	1,54	10,172	214557	10,789	301866	12,180	431370	13,76	8,95
4: Cadence 21/4	1,37	10,170	206035	10,786	251050	12,180	429291	11,12	8,13
5: Cadence 21/4	1,30	10,172	229906	10,788	263151	12,183	470492	12,27	9,47
6: Cadence 21/4	1,37	10,172	229410	10,787	267743	12,188	604593	8,46	6,19
7: Quatro	1,62	10,171	194927	10,788	279814	12,186	521477	13,01	8,05
8: Quatro	1,60	10,171	231136	10,788	328396	12,188	602221	12,86	8,06
9: Quatro	1,58	10,170	187820	10,787	257873	12,188	549577	11,97	7,59
10: E23C.2201	1,36	10,171	261737	10,787	315141	12,185	561691	10,64	7,83
11: E23C.2201	1,26	10,174	343456	10,789	383382	12,190	658629	12,32	9,79
12: E23C.2201	1,25	10,170	183194	10,784	197877	12,180	397982	10,26	8,23
13: Incas	0,99	10,178	229575	10,789	190927	12,186	430936	8,40	8,49
14: Incas	1,15	10,173	281296	10,787	280206	12,187	548978	8,90	7,74
15: Incas	1,03	10,173	278012	10,786	250642	12,182	461130	10,54	10,18
16: SV4097CV	1,46	10,173	307026	10,792	418424	12,185	482058	20,65	14,14
17: SV4097CV	1,48	10,174	311185	10,793	430507	12,186	482352	19,90	13,47
18: SV4097CV	1,43	10,174	294573	10,791	397549	12,181	417075	20,85	14,54
1A: Cadence 10/3	1,54	10,165	127628	10,782	181554	12,171	245765	12,56	8,13
1B: Cadence 10/3	1,50	10,166	179438	10,782	244825	12,175	361430	12,10	8,08
1C: Cadence 10/3	1,40	10,167	183518	10,783	231411	12,177	369245	12,90	9,21
1D: Cadence 10/3	1,37	10,169	202595	10,785	238616	12,185	526655	9,51	6,93

Sample	Linolenic/Linoleic
1: Cadence 10/3	0,15
2: Cadence 10/3	0,19
3: Cadence 10/3	0,17
4: Cadence 21/4	0,17
5: Cadence 21/4	0,14
6: Cadence 21/4	0,22
7: Quatro	0,20
8: Quatro	0,20
9: Quatro	0,21
10: E23C.2201	0,17
11: E23C.2201	0,13
12: E23C.2201	0,15
13: Incas	0,12
14: Incas	0,15
15: Incas	0,10
16: SV4097CV	0,10
17: SV4097CV	0,11
18: SV4097CV	0,10
1A: Cadence 10/3	0,19
1B: Cadence 10/3	0,19
1C: Cadence 10/3	0,15
1D: Cadence 10/3	0,20

Appendix 5

Standard curves for fatty acids and aroma

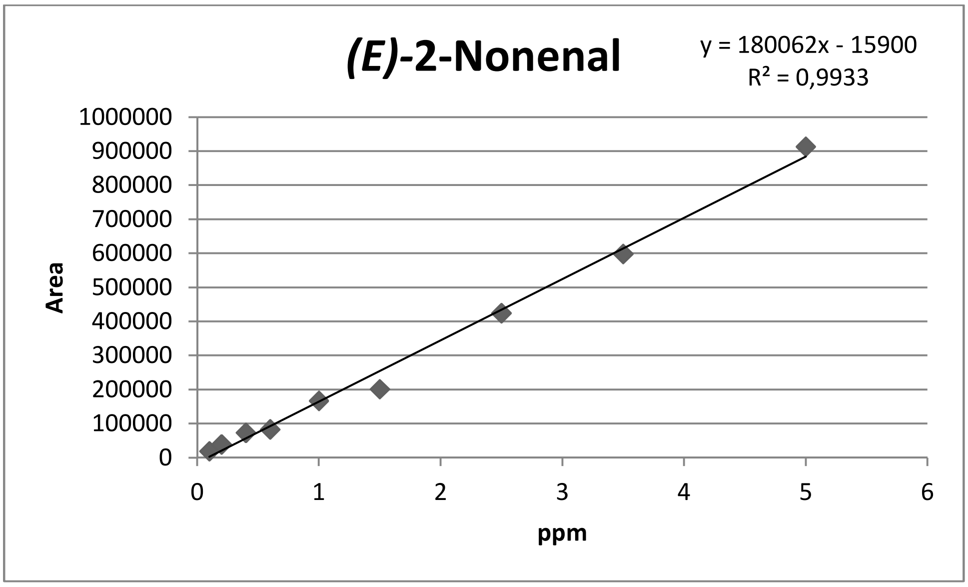
All solutions analysed in GC to determine standard curve for aromas (Table A5.1) and all solutions analysed in GC to determine standard curve for fatty acids (Table A5.2). Marked in yellow are results actually used in standard curves on the next pages.

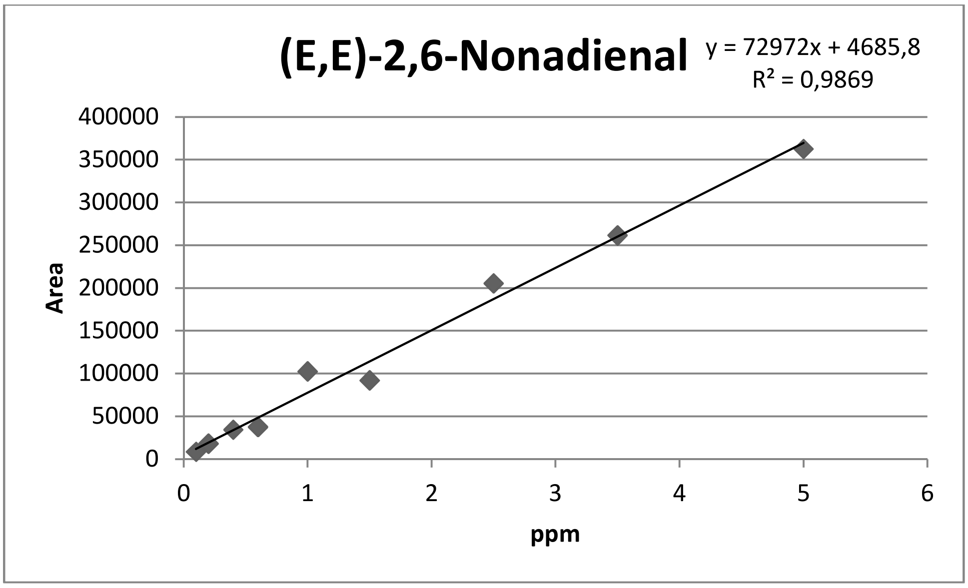
Table A5.1: Analyses in GC used to determine standard curve for aromas. Marked in yellow are results actually used in standard curves on the next pages.

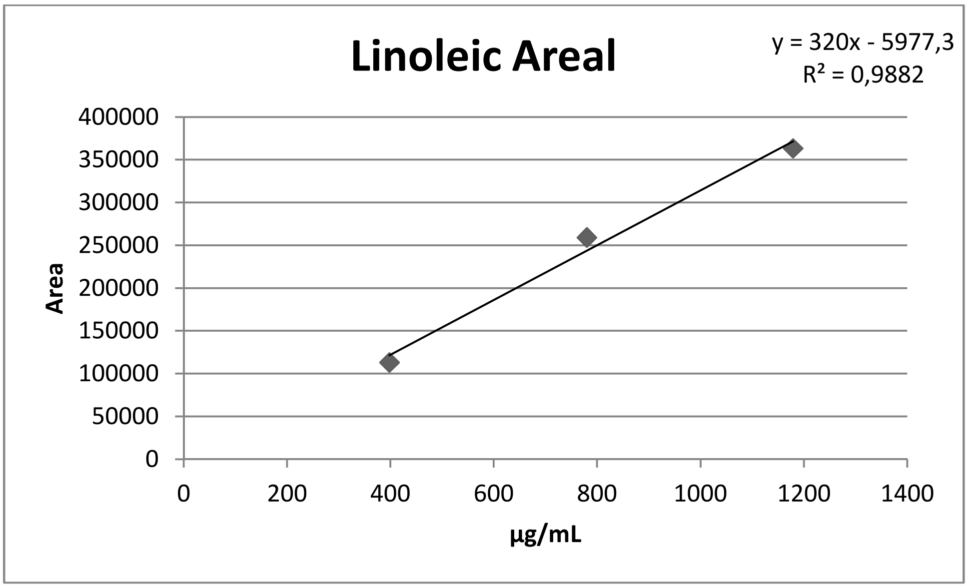
	(*E,E*)-2,6-nonadienal		**(*E*)-2-nonenal**		**Dekanal**	
Sample	**ppm**	**Area**	**ppm**	**Area**	**ppm**	**Area**
1B	0,1	8503	0,1	19248	0,1	75747
2B	0,2	18026	0,2	39547	0,2	147322
3B	0,4	34331	0,4	73598	0,4	267092
4B	0,6	37531	0,6	83399	0,6	347861
5B	1	102424	1	167061	1	646342
6B	1,5	91949	1,5	201495	1,5	789861
7B	2,5	205366	2,5	424993	2,5	1610399
8B	3,5	261491	3,5	598842	3,5	1885687
9B	5	362544	5	913630	5	2876977

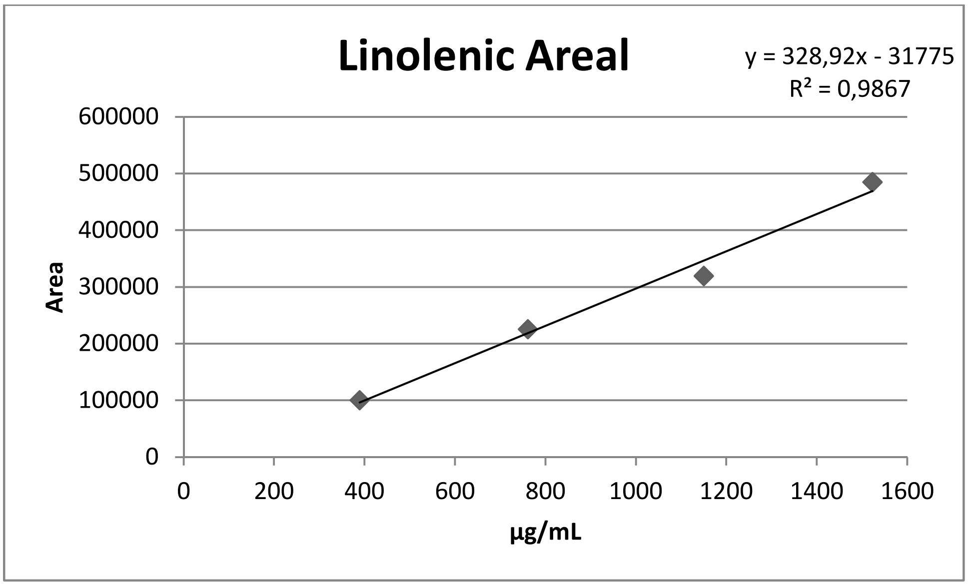
Table A5.2: Analyses in GC used to determine standard curve for fatty acids. Marked in yellow are results actually used in standard curves on the next pages.

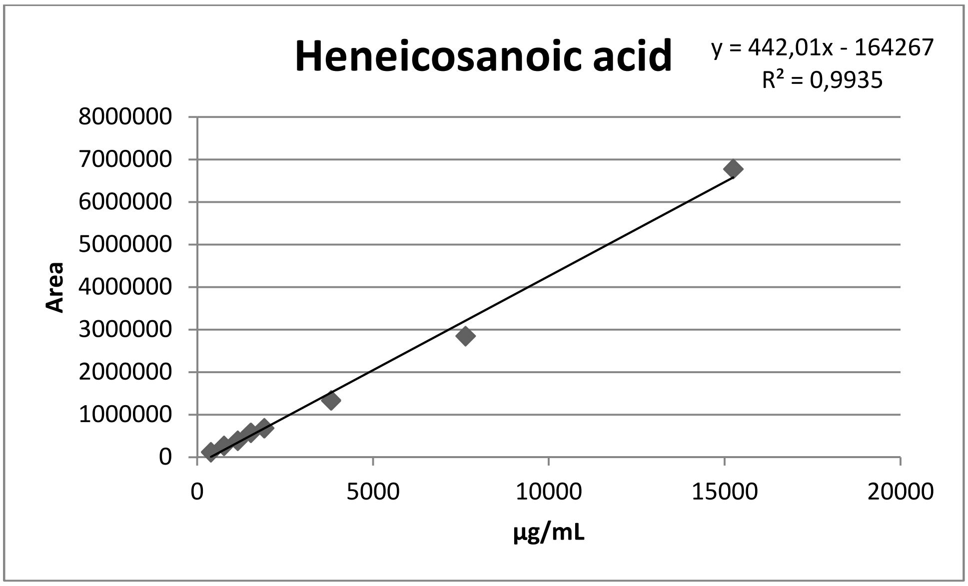
	Linoleic		**Linolenic**		**Heneicosanoic**	
Sample	**µg/mL**	**Areal**	**µg/mL**	**Areal**	**µg/mL**	**Areal**
1A	398	113331	389	100338	389	120705
2A	780	259379	761	225555	761	271576
3A	1179	363592	1150	319478	1150	390519
4A	1560	554993	1523	484986	1523	576287
5A	1959	662500	1905	579838	1905	685228
6A	3901	1291221	3807	1129129	3807	1337401
7A	7819	2766996	7630	2421831	7630	2850017
8A	15621	6600014	15244	5779548	15244	6779265


(E)-2-Nonenal
y = 180062x - 15900
R² = 0,9933
Area
ppm
1000000
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
0
1
2
3
4
5
6


(E,E)-2,6-Nonadienal
y = 72972x + 4685,8
R² = 0,9869
Area
ppm
400000
350000
300000
250000
200000
150000
100000
50000
0
0
1
2
3
4
5
6


Linoleic Areal
y = 320x - 5977,3
R² = 0,9882
Area
400000
350000
300000
250000
200000
150000
100000
50000
0
0
200
400
600
800
1000
1200
1400
µg/mL


Linolenic Areal
y = 328,92x - 31775
R² = 0,9867
Area
600000
500000
400000
300000
200000
100000
0
0
200
400
600
800
1000
1200
1400
1600
µg/mL


Heneicosanoic acid
y = 442,01x - 164267
R² = 0,9935
Area
8000000
7000000
6000000
5000000
4000000
3000000
2000000
1000000
0
0
5000
10000
15000
20000
µg/mL