



**SZENT ISTVÁN EGYETEM**

**Modelling of fruit ripening of tomato**

**PhD. Thesis**

Pék Zoltán

GÖDÖLLŐ

2004.

**Ph.D. School:** Plant Sciences

**Scientific Code:** 4. Agricultural Sciences

4.1. Agronomy and Horticulture

**Ph.D. Program:** Plant breeding, genetics and biotechnology

**Director:** Prof. Dr. Ferenc Virányi, Ph.D., DSc

SZIU Department of Plant Protection

**Scientific Secretary:** Dr. Gábor Gyulai, Ph.D., CSc

SZIU Department of Genetics and Plant Breeding

Tomato is one of the most remarkable vegetable cropped under greenhouses in Hungary. It was being produced more than 1000 ha in average of late years. The forced tomato production is also moderate, 100 000 t per year (MZGySzT, 1997; 1998; 1999; 2000; 2001; 2002; 2003).

The main period of tomato forcing is spring, when the price of fresh market tomato is the highest. Used varieties predominantly belong to indeterminate type and hybrids, with widespread resistance against pests. Tomato is growing mostly under older type plastic covered greenhouses, where climate control is more difficult, then in prevalent modern ones, with high valley and automatic control system.

Environmental requirements of indeterminate tomato are studying for many years, especially during winter and early spring season. Deficiency of natural light is one of the main limiting factors in Northern Temperate Zone during this period, because it is not possible to replace light economically.

Development and consecutive phenological stages of indeterminate tomato were being described by several simulation models, which try to predict response of tomato to changing environmental conditions in relation of some well known ecological factors. SIMULTOM (Sauviller et al., 2002), TOMSIM (Heuvelink et al., 2003), HORTISIM (Gijzen et al. 1998), TOMPOUSSE (Abreu et al., 2002) are adaptable models for indeterminate tomato.

This models can characterize indeterminate tomato plant from the beginning of the generative period, appearance of the first truss or the first anthesis, while this date is equal with planting out. Indeterminate tomato plants develop clusters continuously after every third leaf on the main shoot. Whereas flower and fruit initiation are continuous and some flowers or fruits compose a truss, there are flowering and fruiting trusses on each plant at the same time. Because of this, modelling of indeterminate tomato is the most difficult one of the vegetables.

Phenological stages of indeterminate tomato were observed during our trials and were converting to numerical data. We searched correlation between numerical data and environmental parameters. It was simple to justify close correlations between data and temperature, as usual in case of vegetables, and we got similar connection in relation of photosynthetically active radiation also. However, in modelling of fruit production we applied only parameters of temperature.

We have been recorded number of flowers and initiated fruits per truss, three times per week, during three years period of trials. The beginning and the end of flowering and efficiency of fruit set were also calculated from recorded data. Frequency of harvesting was the same as flowering in 2001, but weekly in 1999 and 2002. We collect data from 10 trusses of 60 plants, so we have characteristics of 600 trusses aggregate to calculate interrelations.

During the quantity determination of phenological stages, we searched parameters, which can characterize the rate of the indeterminate tomato development, irrespectively varieties. Analyses of the variances were made with measured and calculated characteristics of tomato, which is adequate to above mentioned criteria. Index or rate of the phenological stages, quantity changes of the plant in relation of time, was the best for characterizing tomato development. These indices demonstrate the development in relation daily or weekly.

Rate of the beginning of truss flowering (**fvk**) was the first calculated index, which suitable to describe the rate of up growth and estimate begin of flowering on each truss. Rate of flowering within truss (**fvb**), the second index, can characterize flowering process inside each truss. Fruit development rate (**bf**), can describe the course of individual fruit development. Rate of ripening (**e**) can calculate harvestable fruits within each truss. For all of the above mentioned indices, except the rate of ripening, we successfully found some temperature parameters, which have close correlation to them and fit well for changing of the quantity measurement of phenological characteristics.

All of the three indices have a linear and power connection with temperature regimes. Usually exponential and logistic curves are more correct then linear function, to describe vital process of vegetables. Correlations were closer and standard errors were smaller in calculations of power functions then linear ones. Accumulated temperature determined change of phenological stages more than 90% in average, by correlation coefficient, which means the closeness of

correlation, in case of first three indices. So we used functions derived from these correlations to calculate models.

After quantity determination of phenological stages, we created models, which can describe developmental process in relation of temperature. Models were named by Hungarian abbreviations of phenological indices (rate of the beginning of truss flowering - **fvk**; rate of flowering within truss - **fvb**; fruit development rate – **bf**; rate of ripening – **e**) and type of regression curve (linear – 1; power – 2) (beginning of truss flowering model: **fvk1**, **fvk2**; flowering within truss model: **fvb1**, **fvb2**; fruit development model: **bf1**, **bf2**; ripening model: **e**).

After creating models, we examined them by comparing with recorded data and foreigner tomato simulation model TOMPOUSSE carried out by Abreu et al., 2002. During the examination of models we got different degree of errors by each model. None of the model was able to characterize exactly the developmental process. But models on taking as a basis of power function were more adequate than models from linear correlations.

Quantity determination of phenology exhibited several interrelations. Rate of the beginning of truss flowering (**fvk**) is analogous truss appearance rate, which means number of macroscopically observed truss initiative per time interval, and used by index of development. Both indices result  $0.1\text{--}0.25 \text{ truss day}^{-1}$ , and temperature effect is  $0.008\text{--}0.015 \text{ truss day}^{-1} \text{ }^{\circ}\text{C}^{-1}$ . Model on taking as a basis of correlation ( $r^2=0.94$ ), derived from accumulated daily temperature between time interval of flowering consecutive trusses and rate of the beginning of truss flowering. Calculated model **fvk2** estimates not only the beginning of truss flowering, but informs about the growing rate of the indeterminate tomato.

Logistic function is the best fitting model to describe changing of accumulated number of flowers within the truss. Singly or accumulated application of logistic functions is difficult, so we used quotient of number of flowers and required time for flowering as index, named rate of flowering within truss to create model of flowering within truss (**fvb**). There are close correlation between rate of flowering within truss and accumulated daily temperature during the flowering period of truss. Power function gave the best regression curve ( $r^2=0.93$ ) same as previous index. Also there are correlation between index and photosynthetically active radiation (PAR), but closeness of connection was not so strong ( $r^2=0.78$ ) then with temperature.

Summarized fvk2 and fvb2 result model **fv2** (model tomato flowering) was more adequate after comparing with recorded data. Average daily temperature during the flowering period, average number of flowers per truss and number of trusses are the necessary input parameters of model fv2. Fv2 describes course daily and summarized number of flowers from input data. It is able to predict number of flowers per plant up to 10<sup>th</sup> truss at constant average daily temperature. Increasing of average daily temperature with  $1^{\circ}\text{C}$  could decrease total flowering time of first 10 trusses with 3-4 days between  $18\text{--}22^{\circ}\text{C}$ .

Fruit development rate (**bf**) responds similar effect to temperature then flowering, which characterize fruit development process. Temperature effect of  $0.001 \text{ fruit day}^{-1} \text{ }^{\circ}\text{C}^{-1}$  could increase the required time for fruit development. There are also two correlations between fruit development rate and accumulated average daily temperature, linear and power ones. Derived models of correlations were compared with recorded data. Whereas TOMPOUSSE also has a model to simulate of ripening, it is placed in comparison. Model **bf2** was the best to characterize fruit development and the beginning of ripening.

We tried to quantify fruit ripening from harvesting data. There was correlation between accumulated daily temperature of harvesting intervals and harvested fruits per unit area, but its closeness was weak ( $r^2=0.65$ ). We conclude, that fruit ripening is much more complex and controlled, than we could characterize by a single factor.

After modelling of phenology, we summarized and created models of crop dynamics (**td**), which can estimate the yield of the harvestable fruits per day.

We compared two models of crop dynamics, which was created in different ways. Model **td1** created by integration model fv2 (truss flowering) and model bf2 (fruit development). Crop dynamics model **td2** consist model bf2 (fruit development) and e (fruit ripening). Both models are

required date of first flowering, average daily temperature during the cropping season and number of trusses, as input parameters. Model td1 consist number of fruits per truss and average fruit weight of the fruits, and td2 consist average weight of trusses as additional input parameters.

After creating models, we examined them by comparison with recorded data. Model td2 did not describe fruit harvesting period adequately already in 1999, so we did not use it in further comparisons. But model td1 estimated the recorded data well, both of daily and accumulated yield in all of three experimental years.

Model td1 can predict not only the harvestable fruits, but it can describe increasing of the total weight of all different aged fruits per plant. Whereas model td1 uses only few input parameters, it was suitable to apply in practice under weakly controlled greenhouses in spring season.

## References

1. Abad, M. and Guardiola, J.L. (1986): Fruit-set and development in the tomato (*Lycopersicon esculentum* Mill.) grown under protected conditions during the cool season in the south-eastern coast region of Spain. The response to exogenous growth regulators. *Acta Horticulturae* 191, 123-132.
2. Abdelhafeez, A.T. and Verkerk, K. (1969): Effects of temperature and water regime on the emergence and yield of tomatoes. *Netherlands Journal of Agricultural Science* 17, 50-59.
3. Abreu, P., Meneses, J.F., and Gary, C. (2000): Tomousse, a model of yield prediction for tomato crops: calibration study for unheated plastic greenhouses. *Acta Horticulturae*, **519**: 141-150.
4. Adams P. (1986): Mineral nutrition In: Atherton, J.G. and Rudich, J. (eds) *The Tomato Crop. A scientific Basis for Improvement*. Chapman and Hall, London, pp. 281-334.
5. Adams, P. and Winsor, G.W. (1979): Nutrient uptake. Annual Report Glasshouse Crops Research Institute, Littlehampton, United Kingdom. 84-85.
6. Archbold, D.D., Dennis, F.G. Jr, and Fiore, J.A. (1982): Accumulation of  $^{14}\text{C}$ -labelled material from foliar-applied  $^{14}\text{C}$  sucrose by tomato ovaries during fruit set and initial development. *Journal of the American Society for Horticultural Science* 107, 19-23.
7. Atherton, J.G. and Harris, G.P. (1986): Flowering In: Atherton, J.G. and Rudich, J. (eds) *The Tomato Crop. A scientific Basis for Improvement*. Chapman and Hall, London, pp. 165-200.
8. Aung, L.H. (1979): Temperature regulation of growth and development of tomato during ontogeny. In: Cowell, R. (ed.) *Proceedings of the 1st International Symposium on Tropical Tomato*. Asian Vegetable Research and Development Center Publication no. 78-59, Shanhua, Taiwan, Republic of China, 79-93.
9. Bangerth, F. and Ho, L.C. (1984): Fruit position and fruit set sequence in a truss as factors determining final size of tomato fruits. *Annals of Botany* 53, 315-319.
10. Berry, S.Z. (1969): Germination response of the tomato at high temperature. *HortScience*, 4, 218-219.
11. Bertin, N. and Heuvelink, E. (1994): Dry matter production in a tomato crop: comparison of two simulation models. *Journal of Horticultural Science*, 68, 995-1011.
12. Biale, J.B. and Young, R.E. (1981): Respiration and ripening in fruits - retrospect and prospect. In: Friend, J. and Rhodes, M.J.C. (eds) *Recent Advances in the Biochemistry of Fruits and Vegetables*. Academic Press, London, pp. 1-39.
13. Binchy, A. and Morgan, J.V. (1970): Influence of light intensity and photoperiod on inflorescence initiation in tomatoes. *Irish Journal of Agricultural Research*, 9, 261-9.
14. Bohner, J., Hedden, P., Bora-Haber, E. and Bangerth, F. (1988): Identification and quantification of gibberellins in fruits of *Lycopersicon esculentum*, and their relationship to fruit size in *L. esculentum* and *L. pimpinellifolium*. *Physiologia Plantarum* 73, 348-353.

15. Broome, C.R., Terrell, E.E. and Reveal, J.L. (1983): Proposal to conserve *Lycopersicon esculentum* Miller as the scientific name of the tomato. *Report of the Tomato Genetics Cooperative*, **33**, 55-56.
16. Calvert, A. (1957): Effect of the early environment on the development of flowering in the tomato. I. Temperature. *Journal of Horticultural Science*, **32**, 9-17.
17. Calvert, A. (1959): Effect of the early environment on the development of flowering in tomato. II. Light and temperature interactions. *Journal of Horticultural Science*, **34**, 154-62.
18. Calvert, A. (1962): Critical phases of tomato plants. *The Grower*, **58**, 787-8.
19. Calvert, A. (1964a): The effects of air temperature on growth of young tomato plants in natural light conditions. *Journal of Horticultural Science*, **39**, 194-211.
20. Calvert, A. (1964b): Growth and flowering of the tomato in relation to natural light conditions. *Journal of Horticultural Science*, **39**, 182-193.
21. Calvert, A. (1965): Flower initiation and development in the tomato. *National Agricultural Advisory Service Quarterly Review* **70**, 79-88.
22. Charles, W.B. and Harris, R.E. (1972): Tomato fruit-set at high and low temperatures. *Canadian Journal of Plant Science* **52**, 497-506.
23. Cockshull, K.E., Graves, C.J. and Cave, C.R.J. (1992): The influence of shading on yield of glasshouse tomatoes. *Journal of Horticultural Science* **67**, 11-24.
24. Cockshull, K.E., Graves, C.J. and Cave, C.R.J. (1992): The influence of shading on yield of glasshouse tomatoes. *Journal of Horticultural Science* **67**, 11-24.
25. Codex Alimentarius Hungaricus 1-4-778/83 (1995): Magyar Élelmiszerkönyv Bizottság 10 p.
26. Cooper, A.J. (1960): The effects of the size, position and maturation period of inflorescences and fruits on abnormal pigmentation in the tomato variety Potentate. *Annals of Applied Biology* **48**, 230-235.
27. Cooper, A.J. (1964): The seasonal pattern of flowering glasshouse tomatoes. *Journal of Horticultural Science*, **39**, 111-119.
28. Csikai M., Glits M., Gyürós J., Kristóf L-né, Pénzes B., Terbe I., Túri I. és Zatykó F. (1993): Paradicsom In: Túri I. (szerk.) Zöldséghajtás, Mezőgazda Kiadó, Budapest, 194-220.
29. Cuartero, J., Costa, J. and Nuez, F. (1987): Problems of determining parthenocarpy in tomato plants. *Scientia Horticulturae* **32**, 9-15.
30. Davies, J.N. and Hobson, G.E. (1981): The constituents of tomato fruit - the influence of environment, nutrition, and genotype. CRC *Critical Reviews in Food Science and Nutrition* **15**, 205-280.
31. Davies, J.N. and Winsor, G.W. (1969): Tomato fruit quality. The composition of 'hollow' or 'boxy' tomato fruit. Annual Report of the Glasshouse Crops Research Institute for 1968. Littlehampton, UK, pp. 66-67.
32. de Candolle, A. (1855): *Geographie Botanique Raisonee*. Paris, Masson.
33. de Koning, A.N.M. (1994): Development and dry matter distribution in glasshouse tomato: a quantitative approach. *PhD Thesis Wageningen Agricultural University*, Wageningen, (1994.)
34. de Koning, A.N.M. (1996): Quantifying the responses to temperature of different plant processes involved in growth and development of glasshouse tomato. *Acta Horticulturae* **406**, 99-104.
35. de Koning, A.N.M. (2001): The effect of temperature, fruit load and salinity on development rate of tomato fruit. *Acta Horticulturae* **519**, 85-94.
36. de Zeeuw, D. (1954): The influence of the leaf on flowering. *Mededelingen van de Landbouwhogeschool te Wageningen* No. 54, 1-44.
37. De Ruiter Seeds (2004): <http://www.deruiterseeds.hu>
38. Dempsey, W.H. (1970): Effects of temperature on pollen germination and tube growth. Report of the Tomato Genetics Cooperative **20**, 15-16.
39. Descomps, S. and Deroche, M.E. (1973): Action de l'éclairement continu sur l'appareil photosynthétique de la tomate. *Physiologie végétale* **11**, 615-631.

40. Dieleman, J.A. and Heuvelink, E. 1992. Factors affecting the number of leaves preceding the first inflorescence in the tomato. *Journal of Horticultural Science*, 67, 1-10.
41. Dominguez, E., Cuartero, J. and Fernandez-Munoz, R. (2002): Reduced container volume increases tomato pollen fertility at low ambient temperatures. *Journal of the American Society for Horticultural Science*. 127, 32-37.
42. Egles, D. and Rollin, P. (1968): La photosensibilité des graines de tomate var. St. Pierre. *Comptes Rendus de l'Académie des Sciences - Series III - Sciences de la Vie*, 266, 1017-20.
43. Emery G.C. and Munger, H.M. (1970): Alteration of growth and flowering in tomatoes by the jointless genotype. *Journal of Heredity* 61, 51-53.
44. Esquinas-Alcazar, J.T. (1981): Genetic resources of tomatoes and wild relatives. International Board of Plant Genetic Resources Report. AGP: IBPGR, 80, 103.
45. FAO (2004): <http://faostat.fao.org/faostat/>
46. Farkas J. (1990): Milyen károkat okoz a hőingadozás, illetve a kedvezőtlenül magas vagy alacsony hőmérséklet? *Hajtatás, korai termesztés*, 2, 3-5.
47. Farkas J. (1994): Paradicsom. In: Balázs S. (szerk.) Zöldségtermesztők kézikönyve. Mezőgazda kiadó, Budapest. 195-225.
48. Feldmann, U. (1979): Wachstumskinetik. Matematische Modelle und Methoden zur Analyse Altersabhängiger, Populations-Kinetischer Prozesse, Medizinische Informatik und Statistik 11. Springer-Verlag, Berlin.
49. Feller C., Bleiholder H., Buhr L., Hack H., Hess M., Klose R., Meier U., Stauss R., van den Boom T. und WeberR E. (1995): Phänologische Entwicklungsstadien von Gemüsepflanzen: II. Fruchtgemüse und Hülsenfrüchte. *Nachrichtenblatt des Deutschen Pflanzenschutzdienstes* 47, 217-232.
50. Fernandez-Munoz, R. and Cuartero, J. (1991): Effects of temperature and irradiance on stigma exsertion, ovule viability and embryo development in tomato. *Journal of Horticultural Science* 66, 395-401.
51. Filius I. (1994): A zöldségtermesztés élettani alapjai. In: Balázs S. (szerk.) Zöldségtermesztők kézikönyve. Mezőgazda kiadó, Budapest. 36-94.
52. Fink, M. (1992): Wirkungen kurzfristiger Temperaturschwingungen auf das Pflanzenwachstum am Beispiel von Kohlrabi (*Brassica oleracea* convar. *acephala* var. *gongyloides* L.). PhD thesis, University of Hannover
53. Fernandez-Munoz, R., Gonzalez-Fernandez, J.J. and Cuartero, J. (1995): Variability of pollen tolerance to low temperatures in tomato and related wild species. *Journal of Horticultural Science*, 70, 41-49.
54. Frenz, F.W. (1968a): Die 'sensitive Phase' für die generative Entwicklung bei drei Tomatensorten ('Allround', 'Haubners Vollendung' and 'Hellfrucht Z1280'). *Gartenbauwissenschaft*, 33; 247-71.
55. Frenz, F.W. (1968b): Einflus einer 18-tagigen Anzucht mit verschiedenen Tag- und Nachttemperaturen auf die vegetative and generative Entwicklung von 7 Tomatensorten. *Gartenbauwissenschaft*, 33; 1-33.
56. Fryxell, P.A. (1954): Genetics of locule number. *Report of the Tomato Genetics Cooperative* 4, 10-11.
57. Fukumoto Y., Yokoyama K. and Kojima K. (1992): Effects of phosphate fertilizer application and water stress on yield and quality of fully ripe tomatoes. Bulletin of Research Institute of System Horticulture, Faculty of Agriculture, Kochi University, 25-31.
58. Fukushima Y. and Masui M. (1962): Effect of early environment on the flower formation in tomato. I. On night temperature and soil moisture. *Journal of the Japanese Society for Horticultural Science*, 31, 207-212.
59. Gary, C., Baille, A., Navarrete, M., Espanet, R., (1997): TOMPOUSSE, un modèle simplifié de prévision du rendement et du calibre de la tomate. In : A. Baille (ed.), Actes du Séminaire de l'AIP intersectorielle "Serres", INRA, Avignon, 100-109.

60. Gary, C., Tchamitchian, M., Bertin, N., Boulard, T., Baille, A., Charasse, L., Rebillard, A., Cardi, J.P. and Marcelis, L.F.M. (1998): SIMULSERRE: an education software simulating the greenhouse-crop systems. *Acta Horticulturae*. 456, 451-458.
61. George, W.L. Jr, Scott, J.W. and Splittstoesser, W.E. (1984): Parthenocarpy in tomato. *Horticultural Reviews* 6, 65-84.
62. Georghiou, K. and Kendrick, R.E. (1991): The germination characteristics of phytochrome-deficient aurea mutant tomato seeds. *Physiologia Plantarum*, 82, 127-133.
63. Gijzen, H., Heuvelink, E., Challa, H., Marcelis, L.F.M., Dayan, E., Cohen, S. and Fuchs, M. (1998): HORTISIM: a model for greenhouse crops and greenhouse climate. *Acta Horticulturae* 456, 441-450.
64. Goodall, D.W. (1937): Some preliminary observations on the position of the inflorescence in the tomato plant. *Annual Report of the Experimental Research Station Cheshunt*, 87-92.
65. Goodall, D.W. (1938): Further observations on factors affecting the position of the first inflorescence in the tomato. *Annual Report of the Experimental Research Station Cheshunt*, 73-8.
66. Gorter, C.J. (1949): The influence of 2,3,5-triiodobenzoic acid on the growing points of tomatoes. *Koninklijke Nederlandse Akademie voor Wetenschappen te Amsterdam*, 52, 1185-93.
67. Gould, W.A. (1983): Tomato production, processing quality evaluation. AVI Publishing Company, Westport, Connecticut, 550 pp.
68. Gray, J., Picton, S., Giovannoni, J.J. and Grierson, D. (1994): The use of transgenic and naturally occurring mutants to understand and manipulate tomato fruit ripening. *Plant, Cell and Environment* 17, 557-571.
69. Grierson, D. and Fray, R. (1994): Control of ripening in transgenic tomatoes. *Euphytica* 79, 251-263.
70. Grierson, D. and Kader, A.A. (1986): Fruit ripening and quality. In: Atherton, J.G. and Rudich, J. (eds) *The Tomato Crop. A Scientific Basis for Improvement*. Chapman & Hall, London, pp. 241-280.
71. Groot, S.P.C., Bruinsma J. and Karssen, C.M. (1987): The role of endogenous gibberellin in seed and fruit development of tomato: studies with a gibberellin-deficient mutant. *Physiologia Plantarum* 71, 184-190.
72. Guan, H.P. and Janes, H.W. (1991): Light regulation of sink metabolism in tomato fruit. II. Carbohydrate metabolizing enzymes. *Plant Physiology* 96, 922-927.
73. Hack H., Bleiholder H., Buhr L., Meier U., Schnock-Fricke U., Weber E. und Witzenberger A. (1992): Einheitliche Codierung der phänologischen Entwicklungsstadien mono- und dikotyler Pflanzen - Erweiterte BBCH-Skala, Allgemein -. *Nachrichtenblatt des Deutschen Pflanzenschutzdienstes* 44, 265-270.
74. Hayman, G. (1987): The hair-like cracking of last season. *Grower* 107, pp. 3-5.
75. Hazera Quality Seeds (2000): Paradicsomok részletes fajtaleírása. Flexil Kft. 2.
76. Helyes L.(1999): A paradicsom és termeszése. SYCA Szakkönyvszolgálat, Budapest, 233 pp.
77. Helyes L. (2000a): A paradicsom termelésének fejlődési irányai. *Gazdálkodás*, 3, 57-66.
78. Helyes L. (2000b): Milyen lesz a jövő paradicsoma? *Kertészet és Szőlészett*, 10, 10-11.
79. Helyes L. (1991): Paradicsomhajtatás. *Kertészet és Szőlészett*, 45, 7.
80. Helyes L. and Pék Z. (2001): The simultaneous effect of water supply and radiation on tomato flowering and setting. *Acta Horticulturae*, 542, 227-233.
81. Helyes L., Pék Z. (2000): Virágzásdinamika értékelése a paradicsom tavaszi hajtatásában. *Hajtatás, korai termesztés*, XXXI.évf. 4.sz. 20-23.
82. Helyes L., Pék Z. (1998): Hogyan virágzik a paradicsom összel? *Kertészet és Szőlészett*, 30, 6-7.
83. Helyes L., Szerdahelyi R., Pék Z. (2000): Appreciation of fruit set dynamics in autumn tomato forcing. *Acta Agronomica Óváriensis*, 2, 225-232.
84. Helyes L., Pék Z., Szerdahelyi R. (1998): Mikor köt a paradicsom? *Kertészet és Szőlészett*, 31, 6-7.
85. Helyes L., Szerdahelyi R., Pék Z. (1998): A kötődésdinamika értékelése a paradicsom őszi hajtatásában. *Kertgazdaság*, 2, 21-26.

86. Helyes L., Szerdahelyi R., Pék Z. (1998): Virágzásdinamika értékelése a paradicsom őszi hajtatásában. *Hajtatás, korai termesztsés*, XXIX. évf. 3.sz. 17-20.
87. Helyes L., Varga Gy. (1994): A hajtatás helytelen időzítésének hatása a paradicsomra. *Hajtatás, korai termesztsés*, XXV. évf. 4.sz. 24-27.p.
88. Heuvelink, E. (1995): Dry matter production in a tomato crop: measurements and simulation. *Annals of Botany*. 4, 369-379.
89. Heuvelink E. (1996): Tomato growth and yield: quantitative analysis and synthesis. *PhD Thesis* Wageningen Agricultural University, Wageningen.
90. Heuvelink, E., and Bertin, N. (1994): Dry matter partitioning in a tomato crop: comparison of two simulation models. *Journal of Horticultural Science*, 69, 885-903.
91. Heuvelink, E., Bakker, M., and Stanghellini, C. (2003): Salinity effects on fruit yield in vegetable crops: a simulation study. *Acta Horticulturae* 609, 133-140.
92. Ho, L.C. and Hewitt, J.D. (1986): Fruit development. In: Atherton, J.G. and Rudich, J. (eds) *The Tomato Crop. A Scientific Basis for Improvement*. Chapman and Hall, London, pp. 201-239.
93. Ho, L.C., Sjut, V. and Hoad, G.V. (1982): The effect of assimilate supply on fruit growth and hormone levels in tomato plants. *Plant Growth Regulation* 1, 155-171.
94. Hobson, G.E., Davies, J.N. and Winsor, G.W. (1977): Ripening disorders of tomato fruit. Growers' Bulletin No. 4. Glasshouse Crops Research Institute. Littlehampton, England.
95. Honma, S., Wittwer, S.H. and Phatak, S.C. (1963): Flowering and earliness in the tomato. Inheritance of associated characteristics. *Journal of Heredity*, 54, 212-8.
96. Horinka T. (1994): KEMIRA tápanyagutánpótlási technológiák. KEMIRA Kft. 388p.
97. Howlett, F.S. (1939): The modification of flower structure by environment in varieties of *Lycopersicon esculentum*. *Journal of Agricultural Research* 58, 79-117.
98. Hurd, R.G. (1973): Long-day effects on growth and flower initiation of tomato plants in low light; *Annals of Applied Biology*, 73, 221-8.
99. Hurd, R.G. and Cooper, A.J. (1967): Increasing flower number in single-truss tomatoes. *Journal of Horticultural Science*, 42, 181-8.
100. Hurd, R.G. and Cooper, A.J. (1970): The effect of early low temperature treatment on the yield of single-inflorescence tomatoes. *Journal of Horticultural Science*, 45, 19-27.
101. Hurd, R.G. and Thornley, J.H.M. (1974): An analysis of the growth of young tomato plants in water culture at different light integrals and CO<sub>2</sub> concentrations. I. Physiological aspects. *Annals of Botany* 38, 375-388.
102. Hurd, R.G., Gay A.P. and Mountifield, A.C. (1979): The effect of partial flower removal on the relation between root, shoot and fruit growth in the indeterminate tomato. *Annals of Applied Biology* 93, 77-89.
103. Hussey, G. (1963a): Growth and development in the young tomato. I. The effect of temperature and light intensity on growth of the shoot apex and leaf primordia. *Journal of Experimental Botany*, 14, 316-25.
104. Hussey, G. (1963b): Growth and development in the young tomato. II. The effect of defoliation on the development of the shoot apex. *Journal of Experimental Botany* 14, 326-333.
105. Iwahori, S. (1965): High temperature injuries in tomato. IV. Development of normal flower buds and morphological abnormalities of flower buds treated with high temperature. *Journal of the Japanese Society for Horticultural Science* 34, 33-41.
106. Iwahori, S. (1966): High temperature injuries in tomato. V. Fertilization and development of embryo with special reference to the abnormalities caused by high temperature. *Journal of the Japanese Society for Horticultural Science* 35, 379-386.
107. Iwahori, S. (1967): Auxin of tomato fruit at different stages of its development with a special reference to high temperature injuries. *Plant and Cell Physiology* 8, 15-22.
108. Janes, H.W. and McAvoy, R.J. (1991): Environmental control of a single-cluster greenhouse tomato crop. *HortTechnology* 1, 110-114.

109. Jaworski, C.A. and Valli, V.J. (1965): tomato seed germination and plant growth in relation to soil temperatures and phosphorus levels. *Proceedings of Florida State Horticultural Society 1964*, 77, 177-183.
110. Jones, J.W., Dayan, E., Keulen, H. van and Challa, H. (1989): Modeling tomato growth for optimizing greenhouse temperatures and carbon dioxide concentrations. *Acta-Horticulturae*. 248, 285-294.
111. Kader, A.A., Stevens, M.A., Albright-Holton, M., Morris, L.L. and Algazi, M. (1977): Effect of fruit ripeness when picked on flavour and composition in fresh market tomatoes. *Journal of the American Society for Horticultural Science*. 102, 724-731.
112. Kataoka K., Date S., Goto T. and Asahira T (1994): Reducing of tomato puffiness in auxin-induced parthenocarpic fruits by forchlorfenuron (1-(2-chloro-4-pyridyl)-3-phenylurea). *Journal of the Japanese Society for Horticultural Science*. 1, 61-66.
113. Kaul, M.L.H. (1991): Reproductive biology in tomato. In: Kalloo, G. (ed.) Genetic Improvement of Tomato. *Monographs on Theoretical and Applied Genetics*, Vol. 14. Springer-Verlag, Berlin, pp. 39-50.
114. Kedar, N. and Palevitch, D. (1968): Seed number, specific gravity and external appearance of hollow tomato fruits. *Journal of Horticultural Science* 43, 401-407.
115. Kedar, N. and Palevitch, D. (1970): Structural changes in hollow tomato fruits. *Israel Journal of Agricultural Research* 20, 87-90.
116. Kim, I.S. and Jeong, C.S. (1996): Effect of growth regulators on puffy-fruit, content of sugar and organic acid in tomato (*Lycopersicon esculentum* Mill.). *Journal of the Korean Society for Horticultural Science*. 2, 187-192.
117. Kinet, J.M. (1977a): Effect of light conditions on the development of the inflorescence in tomato. *Scientia Horticulturae* 6, 15-26.
118. Kinet, J.M. (1977b): Effect of defoliation and growth substances on the development of the inflorescence in tomato. *Scientia Horticulturae* 6, 27-35.
119. Kinet, J.M. (1989): Environmental and chemical controls of flower development. In: Lord, E. and Bernier, G. (eds) Plant Reproduction: from Floral Induction to Pollination. American Society of Plant Physiologists Symposium Series, Vol. 1, Rockville, MD, pp. 95-105.
120. Kinet, J.M. and Peet, M.M. (1997): Tomato In: Wien, H.C. (ed.) The Physiology of Vegetable Crops CAB International 207-258 pp.
121. Klapwijk, D. (1977): Waarnemingen inzake de positie van de eerste en tweede tros bij tomaten 1974-1977. *Proefstation voor de Groenten- en Fruitteelt onder Glas te Naaldwijk*. Intern verslag No. 41.
122. Klapwijk, D. (1986): Troshoogte in discussie: hogere eerste tros gelijkmatiger gewas. *De Tuinderij*, 66, 34-6.
123. Klapwijk, D. (1988): De software van tomaat: sturing van het groeipunt. *De Tuinderij*, 68, 14-7.
124. Koródi L. (2000): Paradicsom In: Balázs S. (szerk.) A zöldséghajtató kézikönyve. Mezőgazda Kiadó, Budapest, 244-285.
125. Koshioka M., Nishijima T., Yamazaki I.T., Liu Y., Nonaka M. and Mander, L.N. (1994): Analysis of gibberellins in growing fruits of *Lycopersicon esculentum* after pollination or treatment with 4-chlorophenoxyacetic acid. *Journal of Horticultural Science* 69, 171-179.
126. Kotowski, F. (1926): Chemical stimulants and germination of seed. *Proceedings of the American Society for Horticultural Science*, 23, 173-176.
127. Kovács F. (2000): Paradicsom In: Kristóf L.-né (szerk.) Leíró fajtajegyzék. Országos Mezőgazdasági Minősítő Intézet, Budapest, 55-89.
128. Kovács F. (2002): Paradicsom In: Füstös Zs. (szerk.) Leíró fajtajegyzék. Országos Mezőgazdasági Minősítő Intézet, Budapest, 53-114.
129. Kristóf L.-né, Fehér A., Fehér M., Kovács F., Köck O., Szani Sz. (2000): Szabadföldi támrendszeres paradicsom. In: Kristóf L.-né (szerk.) Államilag elismert zöldségfajták kísérleti eredményei. Országos Mezőgazdasági Minősítő Intézet, Budapest, 37-47.

130. Kristóf L.-né, Dimény J. és Borók I. (1996): Folytonnövő paradicsomfajták értékelése szabadföldi, karós termesztésben Kertgazdaság, 4, 74-79.
131. Krug, H. (1991): Gemüseproduktion, 2nd edn. Verlag Paul Pavey, Berlin
132. Krug, H. (1997): Environmental influences on development and yield. In: Wien, H.C. (ed.) *The Physiology of Vegetable Crops* CAB International 101-180 pp.
133. Kuo, C.G., Chen, H.M., Shen, B.J. and Chen, H.C. (1989): Relationship between hormonal levels in pistils and tomato fruit-set in hot and cool seasons. In: Green, S.K., Griggs, T.D. and McLean, B.T. (eds): *Tomato and Pepper Production in the Tropics*. Asian Vegetable Research Development Center Publication no. 89-317. Shanhua, Tainan, 138-149.
134. Lawrence, W.J.C. (1956): Growth and development of tomato. *Annual Report, John Innes Institute*, 32-37.
135. Levy, A., Rabinowitch, H.D. and Kedar, N. (1978): Morphological and physiological characters affecting flower drop and fruit set of tomatoes at high temperatures. *Euphytica* 27, 211-218.
136. Lewis, D. (1953): Some factors affecting flower production in the tomato. *Journal of Horticultural Science*, 28, 207-20.
137. Liebig, H.P. (1989): Die Quantifizierung der Pflanzlichen Stoffproduktion unter fluktuierenden Klimabedingungen. Habilitations thesis, University of Hannover
138. Lohar, D.P. and Peat, W.E. (1998): Floral characteristics of heat-tolerant and heat-sensitive tomato (*Lycopersicon esculentum* Mill.) cultivars at high temperature. *Scientia Horticulturae* 73 53-60.
139. Magyar Zöldség-Gyümölcs Terméktanács (1997): A zöldség és gyümölcs ágazat helyzete Magyarországon. MZGySzT, Budapest, 12-13.
140. Magyar Zöldség-Gyümölcs Terméktanács (1998): A zöldség és gyümölcs ágazat helyzete Magyarországon. MZGySzT, Budapest, 28-31.
141. Magyar Zöldség-Gyümölcs Terméktanács (1999): A zöldség és gyümölcs ágazat helyzete Magyarországon. MZGySzT, Budapest, 30-34.
142. Magyar Zöldség-Gyümölcs Terméktanács (2000): A zöldség és gyümölcs ágazat helyzete Magyarországon. MZGySzT, Budapest, 23-24.
143. Magyar Zöldség-Gyümölcs Terméktanács (2001): A zöldség és gyümölcs ágazat helyzete Magyarországon. MZGySzT, Budapest, 22-23.
144. Magyar Zöldség-Gyümölcs Szakmaközi Szervezet és Terméktanács (2002): A kertészeti ágazat helyzete Magyarországon. MZGySzT, Budapest, 24-25.
145. Magyar Zöldség-Gyümölcs Szakmaközi Szervezet és Terméktanács (2003): A zöldség-gyümölcs ágazat helyzete Magyarországon. MZGySzT, Budapest, 23-24.
146. Maher, M.J. (1976) Growth and nutrient content of a glasshouse tomato crop grown in peat. *Scientia Hortic.* 4, 23-6. p.
147. Mancinelli, A.L., Borthwick, H.A. and Hendricks, S.B. (1966): Phytochrome action in tomato seed germination. *Botanical Gazette*, 127, 1-5.
148. Mapelli, S., Frova, C., Torti, G. and Soressi, G.P. (1978): Relationship between set, development and activities of growth regulators in tomato fruits. *Plant and Cell Physiology* 19, 1281-1288.
149. Mapelli, S., Torti, G., Badino, M. and Soressi, G.P. (1979): Effects of GA<sub>4</sub> on flowering and fruit-set in a mutant of tomato. *HortScience* 14, 736-737.  
Markov V.M., Haev M.K. (1953): Ovosevodstvo. Szel'hozgiz. Moszkva, 567p.
150. McAvoy R.J., Janes, H.W., Godfriaux, B.L., Secks, M., Duchai, D. and Wittman, W.K. (1989): The effect of total available photosynthetic photon flux on single truss tomato growth and production. *Journal of Horticultural Science* 64, 331-338.
151. McAvoy, R.J. and Janes, H.W. (1989): Tomato plant photosynthetic activity as related to canopy age and tomato development. *Journal of the American Society for Horticultural Science* 114, 478-482.

152. McCollum, J.P. and Skok, J. (1960): Radiocarbon studies on the translocation of organic constituents into ripening tomato fruits. *Proceedings of the American Society for Horticultural Science* 75, 611-616.
153. Mertens, T.R. and Burdick, A.B. (1954): The morphology, anatomy and genetics of a stem fasciation in *Lycopersicon esculentum*. *American Journal of Botany*, 41, 726-732.
154. Milotay P. (1996): A paradicsomnemesítés útjai. *Kertgazdaság*, 2, 85-87.
155. Mobayen, R.G. (1980): Germination of citrus and tomato seeds in relation to temperature. *Journal of Horticultural Science*, 55, 291-297.
156. Monselise, S.P., Varga, A. and Bruinsma, J. (1978): Growth analysis of the tomato fruit, *Lycopersicon esculentum* Mill. *Annals of Botany* 42, 1245-1247.
157. Moore, E.L. and Thomas, W.O. (1952): Some effects of shading and para-chlorophenoxy acetic acid on fruitfulness of tomatoes. *Proceedings of the American Society for Horticultural Science* 60, 289-294.
158. Morgan, J.V., Dempsey, P.J. and Binchy, A. (1969): The influence of light, temperature, CO<sub>2</sub> concentration and compost on the development of tomato plants in growing rooms. *Acta Horticulturae*, 22, 164-80.
159. Muller, C.H. (1940): A revision of the genus *Lycopersicon*. United States Department of Agriculture Miscellaneous Publications, 328, 29.
160. Mutton, L., Patterson, B.D. and Nguyen, V.O. (1987): Two stages of pollen development are particularly sensitive to low temperatures. Report of the Tomato Genetics Cooperative 37, 56-57.
161. Nawata, E., Inden, H. and Asahira, T. (1985): Effects of CCC on the occurrence of tomato puffy fruits and the endogenous cytokinin activities. *Scientia Horticulturae* 26, 119-127.
162. Nickell, L.G. (1982): Plant Growth Regulators. Agricultural Uses. Springer-Verlag, New York. Heidelberg, Berlin 173 p.
163. Noto, G. and Malfa, G. La, (1986): Flowering of tomato in relation to pre-planting low temperatures. *Acta Horticulturae*, 191, 275-80.
164. Ohta K., Toyota K. and Hosoki T. (2002): Differences in flower-bud differentiation of malformed fruit in two tomato cultivars. *Horticultural Research Japan*, 2, 107-110.
165. Palevitch, D. and Kedar, N. (1968): Effect of fertilizer treatments and manure on hollowness of winter tomatoes. *Israel Journal of Agricultural Research* 18, 113-116.
166. Pearce, B.D., Grange, R.I. and Hardwick, K. (1993): The growth of young tomato fruit. I. Effects of temperature and irradiance on fruit grown in controlled environment. *Journal of Horticultural Science*, 68, 1-11.
167. Pék Z. (2000): Tavaszi hajtatott paradicsom kötődésének értékelése. *Kertgazdaság*, 2, 1-6.
168. Pék Z. and Helyes L. (2003): Relationship between flowering, fruit setting and environmental factors on consecutive clusters in greenhouse tomato (*Lycopersicon lycopersicum* (L) Karsten) *International Journal of Horticulture Science*, 3-4, 111-116.
169. Pék Z., Réti K., Helyes L. (2002): A környezeti tényezők hatása tavaszi hajtatott paradicsom fürtönkénti virágzására és termésképzésére. *Kertgazdaság*, 2, 9-16.
170. Pék Z. and Helyes L. (2002): Simultaneous appreciation of flowering and fruit setting dynamics in spring and autumn tomato forcing. *Bulletin of the Szent István University*, 21-27.
171. Pék Z. and Helyes L. (2000): Simultaneous appreciation of flowering and fruit setting dynamics in spring tomato forcing. *Abstract of Lippay János and Vas Károly Scientific Symposium*, Budapest, 588-589.
172. Pék Z. and Helyes L.: Effect of temperature to truss flowering rate of tomato *Journal of the Science of Food and Agriculture* (accepted in April, 2004).
173. Perry, K.B., Wu, Y., Sanders, D.C., Garrett, J.T., Decoteau, D.R., Nagata R.T., Dufault, R.J., Batal, K.D., Granberry, D.M. and McLaurin, W.J. (1997): Heat units to predict tomato harvest in southeast USA. *Agriculture and Forest Meteorology*, 84, 249-254.
174. Phatak, S. C., Wittwer, S. H. and Teubner, F. G. (1966): Top and root temperature effects on tomato flowering. *Proceedings of the American Society for Horticultural Science*, 88, 527-31.

175. Philouze, J. (1978): Comparaison des effets des gènes j et j-2 conditionnant le caractère 'jointless' chez la tornate et relations d'épitasis entre j et j-2 dans les lignées de même type variétal. *Annales de l'Amélioration des Plantes*, 28, 431-445.
176. Picken, A.J.F. (1984): A review of pollination and fruit set in the tomato (*Lycopersicon esculentum* Mill.). *Journal of Horticultural Science*, 59, 1-13.
177. Picken, A.J.F., Hurd, R.G. and Vince-Prue, D. (1985): *Lycopersicon esculentum*. In: Halevy, A.H. (ed.) CRC Handbook of Flowering, Vol. 3. CRC Press, Boca Raton, FL, pp. 330-346.
178. Picken, A.J.F., Stewart, K. and Klapwijk, D. (1986) Germination and vegetative development. In: Atherton, J.G. and Rudich, J. (eds) *The Tomato Crop. A Scientific Basis for Improvement*. Chapman and Hall, London, pp. 111-166.
179. Pogonyi Á., Pék Z. és Helyes L. (2004): Oltás hatása a paradicsom termésmennyiségré és minőségére tavaszi hajtatásban. *Kertgazdaság*, 1, 7-13.
180. Pressman, E., Peet, M.M. and Pharr, D.M. (2002): The effect of heat stress on tomato pollen characteristics is associated with changes in carbohydrate concentration in the developing anthers. *Annals of Botany*, 5, 631-636.
181. Rèaumur, R.A.F. de (1735): Observation du thermomètre faites à Paris pendant l'année 1735, comparées avec celles qui ont été faites sous la ligne, à l'Isle de France, à Alger et en quelques-unes de nos îles de l'Amérique. Mémoire d'Academie des Sciences, Paris.
182. Rick, C.M. (1976): Tomato (family Solanaceae), In: Simmonds, N.W. (ed.) *Evolution of Crop Plants*, Longman Publications, 268-273.
183. Rick, C.M. and Butler, L. (1956): Cytogenetics of the tomato. *Advances in Genetics* 8, 267-382.
184. Rick, C.M. and Dempsey, W.H. (1969): Position of the stigma in relation to fruit setting of the tomato. *Botanical Gazette* 130, 180-186.
185. Royal Sluis (1999): Fajtajegyzék, Seminis Hungária Kft.
186. Rudich, J., Zamski, E. and Regev, Y. (1977): Genotypic variation for sensitivity to high temperature in the tomato: pollination and fruit set. *Botanical Gazette* 138, 448-452.
187. Rylski, I., Aloni, B., Karni, L. and Zaidman, Z. (1994): Flowering, fruit set, fruit development and fruit quality under different environmental conditions in tomato and pepper crops. *Acta-Horticulturae*, 366, 45-55.
188. Rylski, I., (1979): Fruit set and development of seeded and seedless tomato fruits under diverse regimes of temperature and pollination. *Journal of the American Society for Horticultural Science*, 104: 835-838.
189. Saito, T., Konno, Y. and Ito, H. (1963): Studies on the growth and fruiting of tomato. IV. Effect of the early environment on the growth and fruiting 4. Fertility of bed soil, watering and spacing. *Journal of the Japanese Society for Horticultural Science*, 32, 186-96.
190. Salter, P.J. (1958): The effects of different water-regimes on the growth of plants under glass. IV. Vegetative growth and fruit development in the tomato. *Journal of Horticultural Science* 33, 1-12.
191. Sandoz Seeds (1996): Zöldségmag katalógus 1996-97, S&G Vetőmag Kft. 7.
192. Santa-Cruz, A. Martinez-Rodriguez, M.M., Bolarin, M.C., Cuartero, J. and Castilla, N. (2001): Response of plant yield and leaf ion contents to salinity in grafted tomato plants. *Acta Horticulturae*, 551, 413-417.
193. Sauser, B.J., Giacomelli, G.A., Janes, H.W. and Marcelis, L.F.M. (1998): Modelling the effects of air temperature perturbations for control of tomato plant development. *Acta Horticulturae*, 456, 87-92.
194. Sauviller, C., Baets, W., Pien, H. and Lemeur, R. (2002): Simultom: a diagnostic tool for greenhouse tomato production. *Acta Horticulturae* 593, 219-226.
195. Sawhney, V.K. (1983): The role of temperature and its relationship with gibberellic acid in the development of floral organs of tomato (*Lycopersicon esculentum*). *Canadian Journal of Botany* 61, 1258-1265.

196. Sawhney, V.K. and Dabbs, D. H. (1978): Gibberellic acid induced multilocular fruits in tomato and the role of locule number and seed number in fruit size. *Canadian Journal of Botany* 56, 2831-2835.
197. Smith, P.G. and Millet, A.H. (1964): Germinating and sprouting responses of the tomato at low temperature. *Journal of the American Society for Horticultural Science*, 84, 480-484.
198. Somos A., Helyes L. (1994): Zöldséghajtás, Egyetemi jegyzet ATE Gödöllő, 119 p.
199. Somos, A. (1971): A paradicsom. Akadémiai Kiadó, Budapest 408 p.
200. Sonneveld, C. (1985): Adaptation of fertilisation. *Tuinderij*, 64, 16-19.
201. Spitters, C.J.T., van Keulen, H. and van Kraalingen, D.W.G. (1989): A simple and universal crop growth simulator: SUCROS87. In: Rabbinge, R., Ward, S.A. and van Laar, H.H. (eds) Simulation and system management in crop protection. Simulation monographs. Pudoc, Wageningen, 147-181.
202. Stenvens, N. (1976): Growth, ripening and storage of tomato fruits. Sprenger Inst. Wageningen, Meded. 32, 2. p.
203. Stevens, M. A. and Rick, C. M. (1986): Genetics and breeding In: Atherton, J.G. and Rudich, J. (eds) The Tomato Crop. A scientific Basis for Improvement. Chapman and Hall, London, pp. 35-109.
204. Sugiyama, T., Iwahori, S. and Takahashi, K. (1966): Effect of high temperature on fruit setting of tomato under cover. *Acta Horticulturae* 4, 63-69.
205. Taylor, I.B. (1986): Biosystematics of the tomato In: Atherton, J.G. and Rudich, J. (eds) The Tomato Crop. A scientific Basis for Improvement. Chapman and Hall, London, pp. 1-34.
206. Tomato Genetics Cooperative (1983): Stocklist, *Report of the Tomato Genetics Cooperative*, 33, 18-33.
207. Thompson, P.A. (1974): Characterisation of the germination response to temperature of vegetable seeds. 1. Tomatoes. *Scientia Horticulturae*, 2, 35-54.
208. Thornley, J.H.M. (1987): Modelling flower initiation. In: Atherton, J.G. (ed.) Manipulation of flowering. Butterworth, London.
209. Toole, E.H. (1961): The effect of light and other variables on the control of seed germination. *Proceedings of International Seed Testing Association*, 26, 659-673.
210. Tripp, K.E., Peet, M.M., Pharr, D.M., Willits, D.H. and Nelson, P.V. (1991): CO<sub>2</sub> enhanced yield and foliar deformation among tomato genotypes in elevated CO<sub>2</sub> environments. *Plant Physiology* 96, 713-719.
211. Varga Gy. (1969): A hőmérséklet és a víz együttes hatása az uborka termésalakulására. Kandidátusi értekezés, Agrártudományi Egyetem, Gödöllő, 201 p.
212. Verkerk, K. (1957): The pollination of tomatoes. *Netherlands Journal of Agricultural Science* 5, 37-54.
213. Verkerk, K. (1964): Additional illumination before and temperature after planting of early tomatoes. *Netherlands Journal of Agricultural Science*, 12, 57-68.
214. Wada T., Ikeda H., Morimoto K., Furukawa H, and Abe K. (2001): Effects of minimum air temperatures at seedling stage on plant growth, yield, and fruit quality of tomatoes grown on a single-truss system. *Journal of the Japanese Society for Horticultural Science*, 2001, 6, 733-739.
215. Wagenvoort, W.A. and Bierhuizen, J.F. (1977): Some aspects of seed germination in vegetables. II. The effects of temperature fluctuation, depth of sowing, seed size and cultivar on heat sum and minimum temperature for germination. *Scientia Horticulturae*, 5, 259-270.
216. Watanabe, A., Beck, J., Rosebrock, H., Huang, J., Busse, U., Luib, M. and Schott, P. (1989): Biological activities of BAS 112W and BAS 113W on fruit-setting and fruit development in tomatoes. In: Green, S.K., Griggs, T.D. and McLean, B.T. (eds): Tomato and Pepper Production in the Tropics. Asian Vegetable Research Development Center Publication no. 89-317. Shanhua, Tainan, 174-183.

217. Winsor, G.W. (1966) A note on the rapid assessment of 'boxiness' in studies of fruit quality. Annual Report of the Glasshouse Crops Research Institute for 1965. Littlehampton, UK, pp. 124-127.
218. Winsor, G.W. (1968) Potassium and the quality of glasshouse crops. Potassium and the Quality of Agricultural Products. Proceedings of the 8th Congress of the International Potash Institute, Brussels, 1966, International Potash Institute, Berne, Switzerland, pp. 303-312.
219. Winsor, G.W. (1970) A long-term factorial study of the nutrition of greenhouse tomatoes. Fertilization of Protected Crops. Proceedings of the 6th Colloquium of the International Potash Institute, Florence 1968, International Potash Institute, Berne, Switzerland, pp. 269-281.
220. Wittwer S. H. and Aung, L.H. (1969): *Lycopersicon esculentum* Mill. In: Evans, L.T. (ed.) *The induction of flowering. Some case histories*. Macmillan, 409-423. pp.
221. Wittwer, S. H. (1963): Photoperiod and flowering in the tomato (*Lycopersicon esculentum* Mill.). *Proceedings of the American Society for Horticultural Science*, 83, 688-94.
222. Wittwer, S. H. and Teubner, F. G. (1956): Cold exposure of tomato seedlings and flower formation. *Journal of the American Society for Horticultural Science*, 67, 369-76.
223. Wittwer, S. H. and Teubner, F. G. (1957): The effects of temperature and nitrogen nutrition flower formation in the tomato. *American Journal of Botany*, 44, 125-8.
224. Wittwer, S.H. and Bukovac, M.J. (1962): Exogenous plant growth substances affecting floral initiation and fruit set. Proceedings Plant Science Symposium Camden 1962. Campbell Soup Co., Camden, New Jersey, pp. 65-83.
225. Wolf, S., Rudich, J., Marani, A. and Rekah, Y. (1986): Predicting harvest date of processing tomatoes by simulation model. *Journal of the American Society of Horticultural Science* 111, 11-16.
226. Yamaguchi M. (1983): World Vegetables AVI. Publishing Company 382 p.
227. Zatykó L. (1994): Paprika. In: Balázs S. (szerk.) Zöldségtermesztők kézikönyve. Mezőgazda kiadó, Budapest. 226-255.

