UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF CUT CHRYSANTHEMUM (Chrysanthemum morifolium Ramat.) PRODUCTION IN SUBSTRATE CULTURE UNDER RESTRICTED ROOT VOLUME

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By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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DEVELOPMENT OF CUT CHRYSANTHEMUM (*Chrysanthemum morifolium* Ramat.) PRODUCTION IN SUBSTRATE CULTURE UNDER RESTRICTED ROOT VOLUME

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Chairman : Associate Professor Thohirah Lee Abdullah, PhD
Faculty : Agriculture

The effects of three different substrate volumes (34, 73, 140 cm^3) and three different substrates (coconut peat 100 %, burnt rice husk 100 % and coconut peat+burnt rice husk 50:50) grown at 64 plant/m^2 were investigated. Plant height and the total leaf area of chrysanthemums reduced significantly when substrate volume decreased regardless of substrate type but chrysanthemum grown in substrate volume of 140 cm^3 being produced at the highest plant height. Chrysanthemums grown in a substrate volume of 140 cm^3 had the largest root surface area. The relative water content and macro elements in leaves did not differ significantly between treatments. Chrysanthemums grown in restricted root volume had high proline levels throughout growth period. Root:shoot ratio did not differ between treatments. Plants grown in substrate volume of 140 ml showed the highest number of flower of 17.79 and flower diameter of 20.82 cm.

The effects of two substrate volumes (73 and 140 cm^3) and three irrigation frequencies (4, 6, 8 times/day) were investigated to determine a suitable irrigation frequency for the growth and flowering of cut chrysanthemum grown under restricted root volume. There was interaction between irrigation frequency and substrate volume on plant height of chrysanthemum. The tallest plant of 109.25 cm was obtained from chrysanthemum, grown at 140 cm^3 irrigated 6 times/day. Chrysanthemum irrigated 6 and 8 times/day had significantly higher phosphorus content in leaf than being irrigated 4 times/day. The total dry weight of chrysanthemum irrigated 6 and 8 times/day was higher than 4 times/day 32% and 23% consequently. Chrysanthemum_irrigated 8 times per day had the highest number of flower, indicated at 20.44. In conclusion, chrysanthemum grown in substrate volume of 140 cm^3 had better growth and flower quality than in 73 cm^3. The growth and flowering of chrysanthemum irrigated 6 and 8 times/day were better than 4 times/day.

The effects of two chrysanthemum varieties ('New White' and 'New Yellow') and three different plant densities (64, 81 and 99 plants/m^2) were investigated to determine a suitable plant density for the growth and flowering to determine financial possibility. For instance, the plant grown at 81 plants/m^2 had higher leaf area index than at 64 plants/m^2. The pedicel length of plant density of 99 plants/m^2 was longer than of 64 plant/m^2 18.33% and the stem fresh weight and total dry weight did not differ between three plant densities. Plant densities also did not significantly affect photosynthesis rate, transpiration rate, stomatal conductance, and Fv/Fm. Other than that, chrysanthemum grown at 99 plants/m^2 had the highest plant height but at the same time did not significantly differ from other two plant densities. Plant densities did not significantly affect the day of flowering, the number of flower, flower diameter, inflorescence diameter, flower color and vase life. These results indicated that under root restriction, chrysanthemum could be grown at high plant densities up to 99 plants/m^2. From the gross profit analysis, chrysanthemum 'New White' and 'New Yellow' grown at 81 plants/m^2 provided highest margin.

The last experiment investigated the growth and flowering, perception of growers, distributors and consumer and financial feasibility of chrysanthemum cultivated in the tray and the trough system. Furthermore, the growth and flowering of chrysanthemum produced in the tray system almost did not differ from the trough system. However, the yield of chrysanthemum produced in the trough system was higher than of the tray system significantly. Besides that, the quality of chrysanthemum produced in the tray and the trough system received very good scores from growers, distributors and consumers in almost all characteristics. From the gross profit analysis, the tray system had higher profit than the trough system but both of them were lower than that of soil-based system.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
Sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PERKEMBANGAN PENGELUARAN BUNGA KERATAN KEKWA (*Chrysanthemum morifolium* Ramat.) DALAM KULTUR SUBSTRAK DI BAWAH ISIPADU AKAR TERSEKAT

Oleh

TAWEESAK VIYACHAI

September 2015

Pengerusi : Profesor Madya Thohirah Lee Abdullah, PhD
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Kesan tiga isipadu media (34, 73, 140 cm^3) dan tiga jenis media berlainan (tanah gambut sabut kelapa 100%, sekam padi bakar 100% dan tanah gambut sabut kelapa 50:50) dengan kepadatan tanaman 64 pokok/m^2 telah dikaji. Ketinggian pokok dan jumlah luas permukaan daun kekwa berkurang dengan nyata apabila isipadu media berkurangan tanpa mengira jenis media tetapi kekwa yang ditanam dalam isipadu media 140 cm^3 mencatatkan tinggi pokok dan jumlah luas permukaan akar yang paling banyak. Kandungan air bandingan dan unsur makro pada daun tidak menunjukkan perbezaan yang nyata antara rawatan. Kekwa yang ditanam di bawah isipadu akar yang terhad mengandungi paras proline yang tinggi sepanjang tempoh pertumbuhan. Nisbah akar: pucuk tidak berbeza antara rawatan. Kekwa yang ditanam dalam isipadu media 140 cm^3 menghasilkan bilangan bunga (17.79 bunga) dan diameter bunga (20.82 cm) yang paling tinggi.

Kesan dua isipadu media (73 dan 140 cm^3) dan tiga kekerapan pengairan (4, 6, 8 kali/hari) telah dikaji untuk menentukan kekerapan pengairan yang sesuai untuk pertumbuhan dan pembungaan kekwa yang bertujuan untuk dijadikan bunga keratan yang ditanam di bawah isipadu akar yang terhad. Interaksi antara kekerapan pengairan dan isipadu media ke atas tinggi pokok kekwa telah diperhatikan. Kekwa yang paling tinggi (109.25 cm) telah diperoleh menggunakan isipadu media dan kekerapan pengairan 6 kali/ hari. Daun kekwa yang disiram 6 dan 8 kali/hari mengandungi paras fosforus yang nyata lebih tinggi berbanding dengan 4 kali/ hari. Jumlah berat kering kekwa yang disiram 6 dan 8 kali/ hari adalah lebih tinggi berbanding 4 kali/ hari 32% dan 23% masing-masing. Kekwa yang disiram 8 kali/hari menghasilkan bilangan bunga yang paling banyak (20.44 bunga). Kesimpulannya, kekwa yang ditanam dalam isipadu media 140 cm^3 menunjukkan pertumbuhan dan kualiti bunga yang lebih bagus berbanding

dengan isipadu media 73 cm^3. Kekwa yang disiram 6 dan 8 kali/hari menunjukkan pertumbuhan dan pembungaan yang lebih bagus berbanding dengan 4 kali/hari.

Kesan dua varieti kekwa ('New White' dan 'New Yellow') dan tiga kepadatan penanaman (64, 81 dan 99 pokok/m2) telah dikaji untuk menentukan kepadatan penanaman yang sesuai untuk pertumbuhan dan pembungaan kekwa dan juga untuk menentukan kebolehlaksanaan kewangan. Kekwa yang ditanam pada 81 pokok/ m^2 mencatatkan indeks luas daun yang lebih tinggi iaitu berbanding dengan kekwa yang ditanam pada 64 pokok/m^2. Kekwa yang ditanam pada kepadatan tanaman 99 pokok/ m^2 mencatatkan tangkai bunga 18.33% lebih tinggi berbanding dengan kepadatan tanaman 64 pokok/m^2. Berat basah batang dan jumlah berat kering tidak berbeza antara ketiga-tiga kepadatan tanaman tersebut. Kepadatan tanaman tidak mempengaruhi fotosintesis, transpirasi, kekonduksian stomata dan Fv/Fm. Kekwa yang ditanam pada 99 pokok/m^2 mencatatkan tinggi pokok yang paling banyak (61.28 cm) tetapi ianya tidak berbeza secara nyata daripada dua kepadatan tanaman lain yang dikaji. Kepadatan tanaman tidak mempengaruhi secara nyata hari pembungaan, bilangan bunga, diameter bunga, diameter kelompok bunga, warna bunga dan jangka hayat jambangan. Keputusan yang diperoleh menunjukkan bahawa di bawah pertumbuhan akar yang terhad, kekwa boleh ditanam pada kepadatan yang tinggi sehingga 99 pokok/m^2. Daripada analisa keuntungan bersih, kekwa 'New White' dan 'New Yellow' ditanam pada kepadatan 81 pokok/m^2 memberikan kepulangan yang paling tinggi.

Kajian yang terakhir mengkaji tentang pertumbuhan dan pembungaan, persepsi penanam, pengedar dan pembeli kekwa dan juga kebolehlaksanaan kewangan kekwa yang ditanam dalam sistem tray dan sistem palung. Pertumbuhan dan pembungaan kekwa dalam sistem tray hampir tidak berbeza daripada sistem palung, tetapi hasil kekwa yang ditanam dalam sistem palung adalah lebih tinggi secara nyata berbanding dengan sistem tray. Kualiti kekwa dalam hampir kesemua aspek yang dihasilkan melalui sistem tray dan sistem palung mendapat sambutan yang menggalakkan daripada penanam, pengedar dan pengguna. Melalui analisa keuntungan bersih, sistem tray berkeupayaan untuk menjana lebih banyak keuntungan berbanding sistem palung tetapi keuntungan yang dijana oleh kedua-dua sistem tersebut adalah lebih rendah berbanding sistem menggunakan media.

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I certify that a Thesis Examination Committee has met on 7 September 2015 to conduct the final examination of Taweesak Viyachai on his thesis entitled "Development of cut chrysanthemum (*Chrysanthemum morifolium* Ramat.) production in substrate culture under restricted root volume" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the degree of Doctor of Philosophy.

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%	Percentage
°C	Degree celsius
ANOVA	Analysis of variance
B	Boron
bar	Bar
C	Carbon
Ca	Calcium
Chl	Chlorophyll
cm	Centimeter
cm^2	Square centimeter
C/N	Carbon/Nitrogen
CRD	Completely Randomize Design
Cu	Copper
cv.	Cultivar
d	Day
e.g.	For example
EC	Electrical conductivity
et al.	And friends
etc.	et cetera
FAA	Formalin Acetic Acid
Fe	Iron
g	gram
h	Hour

K	Potassium
kPa	Kilopascal
l	Litre
LAI	Leaf Area Index
m	Meter
MARDI	Malaysian Agricultural Research and Development Insititue
m^2	Square meter
mg cm^{-2}	milligram per square centimeter
mg L^{-1}	Milligram per litre
Mg	Magnesium
ml	Milliliter
mol	Mole
µg	Microgram
µmol	Micromole
Mn	Manganese
MPa	Mega Paskal
Mo	Molybdenum
mS/cm	Milli-Siemens per centimeter
N	Nitrogen
nm	nanometre
ns	Not significant
p	Probability
P	Phosphorus
pb	Bulk density
pH	Measurement of Acidity/Alkalinity

RCBD	Randomized Complete Block Design
RM	Ringgit Malaysia
RWC	Relative Water Content
s	Second
SD	Standard deviation
USA	United States of America
Zn	Zinc

CHAPTER 1

INTRODUCTION

Chrysanthemum is a popular cut flower which is produced worldwide. The cultivation of cut chrysanthemum around the world is still mainly in soil (Blok and Vermeulen, 2012). Many flowers such as rose, gerbera, anthurium and cymbidium have changed to soilless cultivation (Erik *et al.* 2008). Several countries such as Holland and Israel have widely cultivated cut flower in soilless substrate for many years (Marta, 2001). Many countries such as Brazil, Canada, Europe, Morocco, Tanzania, USA and Colombia have used substrate culture for flower production to reduce the environmental problems from soil treatment by methyl bromide (Marta, 2012). Soilless culture system can improve the yield and quality of crop plants even in non- arable areas (Gruda, 2009).Soilless culture was a choice for flower production because it can avoid soil-borne pests and diseases that became hard to control. Soil problems such as soil degradation, soil contamination and poor soil structure were also difficult to manage in floriculture (Marta, 2007). Lim *et al*. (1998) reported that accumulation of nematodes and soil-born diseases were a problem for cut flower production which were produced in the same area continuously.

Chrysanthemum production in soilless culture system has been studied and developed for more than 30 years. In 1980, Van Os developed a nutrient film system for growing chrysanthemum. Production of chrysanthemum in nutrient film systems can increase yield up to 24 % when compared with soil culture (de Visser and Hendrix, 1986). Buwalda *et al*. (1994) reported that chrysanthemum grown in ebb and flow system had higher productivity than soil cultivation. Growing chrysanthemum also was tested in aeroponics system (de Kreij and Paternotte, 1999). Some systems showed disadvantages such as deep flow technique which produced shorter and weaker stem than soil (Sakamoto *et al*. 2001). However, chrysanthemums grown in solution system were prone to infection by *Pythium* (Liptay and TU, 2003). Even, the use of ultra violet treatment cannot decrease *Pythium* root rot (Liu *et al*. 2007). Chrysanthemums grown hydroponically had severe root rot problem and this inhibited chrysanthemum production in hydroponic systems (Sutton *et al*. 2006)

Substrate culture was another area of interest for producing chrysanthemum. Coarse grade peat can be use as a substrate for cultivate chrysanthemum all year round (Verhagen, 1993). High quality chrysanthemums can be produced with expanded clay, perlite, pumice and pumice mixed with peat in bag culture without any physiological disorder (Marlogio *et al.*1994). Wilson and Finlay (1995) reported that chrysanthemums can be produced in a sand-based system with higher stem length and heavier stem than soil grown without any sterilization for seven

crop cycles. Wrigth *et al*. (2008) found that pine tree substrate can be used for chrysanthemum production in a greenhouse as a peat-lite medium.

Even though, substrate cultures seem to be a possible way for growing chrysanthemums with less problems on root disease, but the disadvantage of this system was the high production cost due to high expense for replacing substrate (Buwalda *et al*. 1994). Blok and Vermeulen (2012) developed substrate systems for growing chrysanthemum such as a sand base system, peat base system and cassette base system to compare with soil grown. They found that all systems were unprofitable. Growing chrysanthemums with the optimum substrate may have the potential to obtain economic production and could be an alternative to solve soil degradation and soil-born diseases. However, the use of small container will increase root restricted condition experienced by the plants. Reduce rooting volume caused many physiological and morphological change (NeSmith and Duval, 1998). *Altering* amount in a *substrate* will *change* roof performance through influencing *plant growth* (Young *et al*. 2014). Beside, plants grown in small volume are very sensitive to the variation on the moisture and nutrient level in the root zone, which can affect growth performance and quality of plants (Xianfeng *et al*. 2010).

This study will conduct to investigate the growth and flowering of chrysanthemum under root restricted conditions in association with the financial analysis of chrysanthemum production in the developed system. The objectives of this study were:

1. To determine the effects of substrate types and substrate volumes on the growth and flowering of chrysanthemum.
2. To determine the effects of irrigation frequencies on the growth and flowering of chrysanthemum grown under restricted root volume.
3. To determine the effects of plant density on the growth and flowering of chrysanthemum grown under restricted root volume.
4. To survey the perception of growers, distributors and consumers on the flower quality of chrysanthemum grown under restricted root volume, and the economic possibility of chrysanthemum production.

REFERENCES

Abad, M., Noguera, P., Puchades, R., Maquieira, A. and Noguera, V. 2002. Physico-chemical and chemical properties of some coconut coir dusts for use as a peat substitute for containerised ornamental plants. *Bioresource Technology* 82(3): 241-245.

Ahirwar, M. K., Ahirwar, K., and Shukla, M. 2012. Effect of plant densities, nitrogen and phosphorus levels on growth, yield and quality of African marigold. *Annals of Plant and Soil Research* 14(2): 153-155.

Alberty, C. A., Pellett, H. M., and Taylor, D. H. 1984. Characterization of soil compaction at construction sites and woody plant response. *Journal of Environmental Horticulture 2*(2): 48-53.

Ali, H. I. 2005. *Effect of Rice straw compost and water regimes on growth performance of tomato (Lycopersicum Esculentum L.),* PhD thesis, Universiti Putra Malaysia.

Alvarez, L. R., and Beyl, C. 1993. Morphological effects of variable levels of root restriction on *on loring and red haven* peachs in different environments. *HortScience* 28(5): 556-556.

Aminifard, M.H., Aroiee, H., Karimpour, S. and Nemati, H. 2010. Growth and yield characteristics of paprika pepper (*Capsicum annum* L.) in response to plant density. *Asian Journal of Plant Science* 9(5): 276-280.

Aminifard, M.H., Arouiee, H., Ameri, A., and Fatemi. H. 2012. Effect of plant density and nitrogen fertilizer on growth, yield and fruit quality of sweet pepper (*Capsicum annum* L.). *African Journal of Agricultural Research* 7(6): 859-866.

Amjad, A. and Ahmad, I. 2012. Optimizing plant density, planting depth and postharvest preservatives for *Lilium longifolium*. *Journal of Ornamental and Horticultural Plants* 2(1): 13–20.

Aranjuelo, I., Tcherkez, G., Molero, G., Gilard, F., Avice, J. C. and Nogués, S. 2013. Concerted changes in N and C primary metabolism in alfalfa (Medicago sativa) under water restriction. *Journal of experimental botany*, *64*(4): 885-897.

Ariffin, D. 1993. Laboratory manual of soil samples. Kuala lumpur:Palm Oil Research Institute of Malaysia.

Arve, L. E., Torre, S., Olsen, J. E. and Tanino, K. K. 2011. Stomatal responses to drought stress and air humidity. In *Abiotic Stress in Plants - Mechanisms and Adaptations*, ed. A. Shanker, and B. Venkateswarlu, pp.267-280. Rijeka**:**Intech

Asiah, A., Mohd. Razi, I., Mohd. Khanif, Y., Marziah, M. and Shaharuddin, M. 2004. Physical and chemical properties of coconut coir dust and oil palm empty fruit bunch and the growth of hybrid heat tolerant cauliflower plant. *Pertanika Journal of Tropical Agricultural Science* 27(2): 121-133.

Atwell, B. J., Kriedemann, P. E., and Turnbull, C. G. 1999. *Plants in action: adaptation in nature, performance in cultivation*. pp 148-185. Macmillan Education AU.

Awang, Y., Shaharom, A. S., Mohamad, R. B. and Selamat, A. 2009. Chemical and physical characteristics of cocopeat-based media mixtures and their effects on the growth and development of *Celosia cristata*. *American Journal of Agricultural and Biological Sciences* 4(1): 63-71.

Aydinsakir, K., Tuzel, I. H., and Buyuktas, D. 2013. The effects of different irrigation levels on flowering and flower quality of carnation (*Dianthus caryophllus* L.) irrigated by drip irrigation. *African Journal of Biotechnology* 10(66): 14826-14835.

Baker, N. R., and Rosenqvist, E. 2004. Applications of chlorophyll fluorescence can improve crop production strategies: an examination of future possibilities. *Journal of experimental botany 55*(403): 1607-1621.

Barrie, M. and Nigel, S. 1978. Chrysanthemums year-round growing. pp. 10-49. Dorset:Blandford Press.

Bar-Tal, A. and Pressman, E. 1996. Root restriction and potassium and calcium solution concentrations affect dry-matter production, cation uptake, and blossom-end rot in greenhouse tomato. *Journal of the American Society for Horticultural Science* 121(4): 649-655.

Bar-Tal, A., Feigin, A., Sheinfeld, S., Rosenberg, R., Sternbaum, B., Rylski, I. and Pressman, E. 1995. Root restriction and N-NO_3 solution concentration effects on nutrient uptake, transpiration and dry matter production of tomato. *Scientia horticulturae* 63(3): 195-208.

Bar-Yosef, B. 2008. Fertigation management and crops response to solution recycling in semi-closed greenhouse. In *Soilless culture theory and practice,* ed. M.Raviv, and J.H.Lieth, pp. 343-424. Amsterdam:Elsevier.

Bates, L.S., Waldren, R.P. and Teare, I.D. 1973. Rapid determination of free proline for water-stress studies. *Plant and Soil* 39(1): 205-207.

Batt, P.j. and Lim, A.M.S. 1999. Consumer attitudes towards hydroponic produce in Western Australia. *Food Australia: Journal of CAFTA and AIFST* 51(11): 547-548.

Batt, P.J. and Pool, J. 2004. Consumer preference for cut flower in Western Australia. *Acta Horticulturae* 655: 81-88.

Becker, W.A., Behe, B.K., Johnson, J.L., Townsend, C.D. and Litzenberg, K.K. 1997. Consumer perception on service quality in the Texas retail floral industry. *HortScience* 32(2): 318-323.

Beckmann-Cavalcante, M. Z., Pivetta, K. F. L., Cavalcante, Í. H. L., Cavalcante, L. F., and Silva Júnior, J. V. D. 2013. Nutritional status of the potted chrysanthemum relative to electrical conductivity and salt leaching. *Revista Ciência Agronômica 44*(4): 782-789.

Behe, B.K. and Wolnick, D.J. 1991. Type of floral product purchased and demographic characteristics and floral knowledge of consumers. *HortScience* 26(4): 414-416.

Bellé, R. A., Rocha, E. K. D., Backes, F. A. A. L., Neuhaus, M., and Schwab, N. T. 2012. Safflower grown in different sowing dates and plant densities. *Ciência Rural* 42(12): 2145-2152.

Biernbaum, J. A. 1992. Root-zone management of greenhouse container-grown crops to control water and fertilizer use. *HortTechnology* 2(1): 127-132.

Björkman, O. and Demmig, B. 1987. Photon yield of O_2 evolution and chlorophyll fluorescence characteristics at 77 K among vascular plants of diverse origins. *Planta* 170(4): 489-504.

Blake, G.R. and Hartge, K.H.1986. Particle density. In *Methods of Soil Analysis Part 1 Physical and Mineralogical Methods 2nd editio*n, ed. A. Klute, P. 377-382 Widconsin:Soil Science Society of America, Inc.

Blanke, M. M. 2007. Regulatory mechanisms in source sink relationships in plants-a review. Acta Horticulturae 835:13-20.

Blok, C. and Vermeulen, T. 2012. Systems design methodology to develop chrysanthemum growing systems. *Acta Horticulturae* 927: 865-878.

Blok, C., Kreij, D. C., Baas, R., and Wever, G. 2008. Analytical methods used in soilless cultivation. In *Soilless culture theory and practice,* ed. M.Raviv, and J.H.Lieth, pp. 245-289. Amsterdam:Elsevier.

Blum, A. 2010. Plant breeding for water-limited environments. New York: Springer.

Bolques, A., Duke, E.R., Knox, G.W. and Hewitt, T. 2004. Consumer acceptance of an organically grown ornamental. In *Proceedings of the Florida State Horticultural Society* 117:326-328.

Boodia, N., Dursun, G., and Govinden-Soulange, J. 2011. Influence of soilless growing media, pot size and sieved media on the production of *'Hibiscus sabdariffa*' L. seedlings. *Australian Journal of Agricultural Engineering* 2(5): 147.

Botden, N. P. G., Terhürne, A. M. L. and HortiSolutions, B. V. 2007. Executive Flower Management", a unique quality performance management concept to regain trust and satisfaction of global flower consumers. In *Proceeding of the international symposium on fresh produce supply chain management,* ed. P. J. Batt and J. Cadilhon, pp. 291-303. Bangkok: FAO

Boyer, J.S. 1967. Leaf water potentials measured with a pressure chamber. *Plant Physiology* 42(1): 133-137.

Boyer, J.S. 1968. Relationship of water potential to growth of plant leaves. *Plant Physiology* 43:1056-1062

Brascamp, W. 1996. Evaluation and measurement of consumer preferences on outdoor ornamental plants, PhD. Thesis, Massey University

Bredmose, N. and Nielsen, J. 2004. Effects of thermoperiodicity and plant population density on stem and flower elongation, leaf development, and specific fresh weight in single stemmed rose (*Rosa hybrida* L.) plants. *Scientia Horticulturae* 100(1): 169-182.

Bredmose, N. B. 1998. Growth, flowering, and postharvest performance of single-stemmed rose (*Rosa hybrida* L.) plants in response to light quantum integral and plant population density. *Journal of the American Society for Horticultural Science* 123(4): 569-576.

Brouwer R. 1983. Functional equilibrium: sense or nonsense? *Netherlands Journal of Agricultural Science* 31: 335-48.

Bruria H, 1999. Osmoregulatory Role of Proline in Plants Exposed to Environmental Stresses. In *Handbook of Plant and Crop Stress, Second Edition*. ed, M. Pessarakli pp. 675–695. CRC Press

Budiartoa, K., Sulyo, Y., Dwi, S.N.E. and Maaswinkel, R.H.M. 2007. Effects of irrigation frequency and leaf detachment on chrysanthemum grown in two types of plastic house. *Indonesian Journal of Agricultural Science* 8(1): 39-42.

Bunt, A. C. and Powell, M. C. 1982. Carnation yield patterns: the effects of plant density and planting-date. *Scientia Horticulturae* 17(2): 177-186.

Burema, B.S., Buck-Sorlin, G.H., Damen, T., Vos, J., Heuvelink, E. and Marcelis, L.F.M. 2010. Cut-rose production in response to planting density in two contrasting cultivars. *Acta Horticulturae* 870:47-54.

Buwalda, F., Baas, R. and Van Weel, P. A. 1994. A soilless ebb-and-flow system for all-year-round chrysanthemums. *Acta Horticulturae* 361: 123-132.

Campbell, B., Mhlanga, S., Brown, W. and Lesschaeve, I. 2011. Producer Perception and Consumer Response: What Drives Poinsettia Purchases? Ontario. Vineland Research and Innovations Centre Inc.

Campostrini, E. and Yamanishi, O. K. 2001. Influence of mechanical root restriction on gas-exchange of four papaya genotypes. *Revista Brasileira de Fisiologia Vegetal 13*(2): 129-138.

Carmi, A. 1986. Effects of root zone volume and plant density on the vegetative and reproductive development of cotton. *Field Crops Research* 13: 25-32.

Carmi, A. 1995. Growth, water transport and transpiration in root-restricted plants of bean, and their relation to abscisic acid accumulation. *Plant Science* 107(1): 69-76.

Carvalho, S.M.P., Heuvelink, E. and Van Kooten, O. 2002. Effect of light intensity, plant density, and flower bud removal on the flower size and number in cut chrysanthemum. *Acta Horticulturae* 593: 33-38.

Carvalho, S. M. P. and Heuvelink, E. 2001. Influence of greenhouse climate and plant density on external quality of chrysanthemum (*Dendranthema grandiflorum* (Ramat.) Kitamura): first steps towards a quality model. *Journal of Horticultural Science and Biotechnology* 76(3): 249-258.

Carvalho, S.M.P., Heuvelink, E., Harbinson, J. and Van Kooten, O. 2006. Role of sink–source relationships in chrysanthemum flower size and total biomass production. *Physiologia Plantarum* 128(2): 263-273.

Carvalho, S.M.P. and Heuvelink, E. 2003. Effect of assimilate availability on flower characteristics and plant height of cut chrysanthemum:An integrated study. *Journal of Horticultural Science and Biotechnology* 78(5): 711–720.

Carvalho, S.M.P., Vrishali, B.D. and Heuvelink, E. 2003. Interactive Effects of duration of long-day period and plant density on external quality of cut chrysanthemum. *Acta Horticulturae* 624: 335-342.

Cathey, H. M. and Borthwick, H. A. 1957. Photoreversibility of floral initiation in chrysanthemum. *Botanical Gazette* 119(2): 71-76.

Cees, S. and Wim, V. 2009. Plant nutrition of greenhouse crops. Dordrecht:Springer.

Charles, L.B. 2008 .Nutritional properties of Agrocoir. Michigan:Horticultural Soils and Nutrition Consulting

Chavez, W., Di Benedetto, A., Civeira, G. and Lavado, R. 2008. Alternative soilless media for growing *Petunia hybrid* and *Impatiens wallerana* : Physical behavior, effect of fertilization and nitrate losses. *Bioresource Technology* 99 (17): 8082-8087.

Chen, Y. and Avnimelech, Y. 1986. The role of organic matter in modern agriculture. Dordvecht:Martinus Nijhoff Publishers.

Cheng L, Fuchigami LH, Breen PJ. 2000. Light absorption and partitioning in relation to nitrogen content in 'Fuji' apple leaves. *Journal of the American Society of Horticultural Science* 125:581–587.

Chern, W.S., Rickertsen, K., Tsuboi, N. and Fu, T. 2002. Consumer acceptance and willingness to pay for genetically modified vegetable oil and salmon: A multiple-country assessment. *AgBioForum* 5(3): 105-112.

Cho, Y. Y., Choi, K. Y., Lee, Y. B. and Son, J. E. 2012. Growth characteristics of sowthistle (*Ixeris dentata* Nakai.) under different levels of light intensity, electrical conductivity of nutrient solution, and planting density in a plant factory. *Horticulture, Environment, and Biotechnology* 53(5): 368-372.

Choi, J. H., Chung, G. C., Suh, S. R., Yu, J. A., Sung, J. H. and Choi, K. J. 1997. Suppression of calcium transport to shoots by root restriction in tomato plants. *Plant and Cell Physiology* 38(4): 495-498.

Christopher, T.B.S. and Jamal, T. 2006. Soil physics analysis volume 1. Selangor: Universiti Putra Malaysia Press.

Clark, D.C., Colquhoun, T.A. and Leonard, R.T. 2013. Identifying consumer preferences for essential elements of a flower product. Verginia:American Floral Endowment.

Claussen, W. 2005. Proline as a measure of stress in tomato plants. *Plant Science* 168(1): 241-248.

Coombs, J., Hall, D. O., Long, S. P. and Scurlock, J. M. O. 1987. Techniques in bioproductivity and photosynthesis, second edition. Oxford:Pergamon Press.

Dambre, P., Blindeman, L. and Van Labeke, M. C. 1998. Effect of planting density and harvesting method on rose flower production. *Acta Horticulturae* 513 : 129-136.

D'Angelo, G., Castelnuovo, M., Galli, A. and Valagussa, M. 1992. Relations between physical and chemical properties of the substrate and growth of some pot ornamentals. *International Symposium on Horticultural Substrates other than Soil in situ* 342: 313-324.

Das, K.K., Panda, D., Sarkar, R.K., Reddy, J.N. and Ismail, A.M. 2009. Submergence tolerance in relation to variable floodwater conditions in rice. *Environmental and Experimental Botany* 66(3): 425-434.

Dasgupta, S. and Dadlani, N.K. 2010. Expert consultation on floriculture development in Asia. Bangkok:FAO.

De Boon, H. 1990. A world perspective on more flowers for more people. *Floriculture Indiana* 4(2): 2-6.

De Kreij, C. and Paternotte, S.J. 1999. Root discoloration, growth and micro element uptake of chrysanthemum in aeroponics as affected by iron chelates and Pythium. *Acta Horticulturae* 481: 159-164.

De Kreij, C. and Van Leeuwen, G. J. L. 2001. Growth of pot plants treated coir dust as compared to peat. *Communications in Soil Science and Plant Analysis* 32(13-14): 2255-2265.

Department of Standards Malaysia. 2012. Fresh cut chrysanthemum – specification (First revision). Cyberjaya: Department of Standards Malaysia.

De Ronde, J. A., Van Der Mescht, A. and Steyn, H. S. F. 2000. Proline accumulation in response to drought and heat stress in cotton. *African Crop Science Journal* 8(1): 85-92.

De Visser, A. J. and Hendrix, A. T. M. 1987. Economic aspects of growing systems for year round chrysanthemums. *Acta Horticulturae* 197: 111-114.

Di Benedetto, A. H., and Klasman, R. 2004. The effect of plug cell volume on the post-transplant growth for *Impatiens walleriana* pot plant. *European Journal of Horticultural Science* 69(2): 82-86.

Dimitrios, S., Giorgio, G., Yuksel, T. and Nazim, G. 2013. Soilless culture. In *Good Agricultural Practicesfor greenhouse vegetable crops,* ed. W. Baudoin, R. Nono-Womdim, N. Lutaladio and A. Hodder, pp.303-354. Rome:FAO.

Dole, J. M. and Schnelle, M. A. 1993. A comparison of attitudes and practices among sectors of the Oklahoma floriculture industry. *HortTechnology* 3(3): 343-347.

Doorduin, J. C. 1989. Effects of CO2 and plant density on growth and yield of glasshouse grown freesias. *Acta Horticulturae 268*: 171-178.

Drüge, U. 1997. Proline level in leaves and yield of cuttings and flowers of chrysanthemum as influenced by different root zone conditions. *Scientia Horticulturae* 68(1): 171-180.

Dubik, S. P., Krizek, D. T. and Stimart, D. P. 1990. Influence of root zone restriction on mineral element concentration, water potential, chlorophyll concentration, and partitioning of assimilate in spreading euonymus (*E. Kiautschovica* Loes.'Sieboldiana'). *Journal of Plant Nutrition* 13(6): 677-699.

Dufault, R. J., Phillip, T. L. and Kelly, J. W. 1990. Nitrogen and potassium fertility and plant populations influence field production of gerbera. *HortScience 25*(12): 1599-1602.

Dwivedi, A. K. and Banerji, B. K. 2011. Chrysanthemum : An ocean of beauty. In *National Conference on Forest Biodiversity : Earth's Living Treasure*. p.119-124. Uttar Pradesh:Uttar Pradesh State Biodiversity Board.

Erik, V. O., Theo, H. G. and Lieth, J. H. 2008. Technical equipment in soilless production systems. In *Soilless Culture:Theory and Practice*, ed. M. Raviv, J. H. Lieth, pp.157-207. Amsterdam:Elsevier.

Evans, M. R., Konduru, S. and Stamps, R. H. 1996. Source variation in physical and chemical properties of coconut coir dust. *HortScience* 31(6): 965-967.

Fernandes, C. and Corá, J. E. 2004. Bulk density and relationship air/water of horticultural substrate. *Scientia Agricola* 61(4): 446-450.

Foyer, C. H., and Galtier, N. 1996. Source-sink interaction and communication in leaves. *Photoassimilate distribution in plants and crops. Source-sink relationships.* In Photoassimilate. Distribution in Plants and Crops: Source–Sink Relationships, ed. E., Zamski, and A.A., Schaffer, pp. 311–340. New York: Marcel Dekker.

Foyer, C. H., and Paul, M. J. 2001. Source–Sink Relationships. London:Nature Publishing group

Francescangeli, N., Sangiacomo, M. A. and Martí, H. 2006. Effects of plant density in broccoli on yield and radiation use efficiency. *Scientia Horticulturae* 110(2): 135-143.

Furuta, T. 1954. Photoperiod and flowering of *Chrysanthemum morifolium. Proceedings of the American Society for Horticultural Science* 63: 457–461.

Ghaziani, M. V. F., Berimavandi, A. R., Torkashvand, A. M., Hashemabadi, D. and Kaviani, B. 2012. Influence of plant density and irrigation method on the growth, flowering and quantity of essential oil of *Calendula officinalis* L. *Indian Journal of Fundamental and Applied Life Sciences* 2(2): 184-190.

Girapunthong, N. and Ward, R. W. 2002. Demand drivers for fresh-cut flowers and their Substitutes: An application of household expenditure allocation models, Doctoral dissertation, University of Florida.

Gisleröd, H.R. 1988. Effects of watering frequency on growth of cut chrysanthemums. *Acta Horticulturae* 221: 327-334.

Gitman, L. and Madura. 2001. Introduction to Finance. Massachusetts, Addison Wiley Inch.

Gizas, G. and Savvas, D. 2007. Particle size and hydraulic properties of pumice affect growth and yield of greenhouse crops in soilless culture. *HortScience* 42(5): 1274-1280.

Goreta, S., Batelja, K., & Perica, S. 2008. Growth of poinsettia as affected by cultivar, thinning, and pot size. *HortTechnology 18*(1): 122-129.

Goto, T. and Matsuno, T. 2002. Photosynthesis, evapotranspiratory and leaf morphological properties of chrysanthemum grown under root restriction as affected by fertigation frequency. *Journal of the Japanese Society for Horticultural* Science 71(2): 277-283.

Goto, T., Takaya, N., Yoshioka, N., Yoshida, Y., Kageyama, Y. and Konishi, K. 2001. Effects of water and nutrient stresses on reduction of vegetative growth in chrysanthemum grown under restricted root zone volume. *Journal of the Japanese Society for Horticultural Science* 70(6): 760-766.

Govedarica-Lucic, A., Perkovic, G., and Rahimic, A. 2014. Influence of substrate and cell volume of containers on the quality of basil. In Fifth International Scientific Agricultural Symposium, Agrosym 2014, Ed.Dusan Kovacevic. Jahorina, Bosnia and Herzegovina

Green, S. R., Picchioni, G. A., Murray, L. W., and Wall, M. M. 2010. Yield and Quality of Field-grown Celosia and Globe Amaranth Cut Flowers at Four Plant Densities. *HortTechnology 20*(3): 612-619.

Gruda, N. 2009. Do soilless culture systems have an influence on product quality of vegetables? *Journal of Applied Botany and Food Quality* 82: 141-147.

Grzesiak, M. T. 2009. Impact of soil compaction on root architecture, leaf water status, gas exchange and growth of maize and triticale seedlings. *Plant Root* 3: 10-16.

Guosheng, L., Dejuan, T., Fadi, C., Ya, S., Weimin, F., Zhiyong, G., Zhaolei, L. and Sumei, C. 2011. The anatomy and physiology of spray cut chrysanthemum pedicels, and expression of a caffeic acid 3-O-methyltransferase homologue. *Postharvest Biology and Technology* 60(3): 244-250.

Halevy, A.H. 1996. Rose. In Photoassimilate. Distribution in Plants and Crops: Source–Sink Relationships, ed. E., Zamski, and A.A., Schaffer, pp. 833–892. New York: Marcel Dekker.

Hall, J., Bhattarai, S. P., and Midmore, D. J. 2014. Effect of industrial hemp (*Cannabis sativa* L) planting density on weed suppression, crop growth, physiological responses, and fibre yield in the subtropics. *Renewable Bioresources* 2(1):1-7.

Hall, T.J., Dennis, J.H., Lopez, R.G. and Marshall, M.I. 2009. Factors affecting growers' willingness to adopt sustainable floriculture. *HortScience* 44(5): 1346-1351.

Hamir, N. A., Nor, L. M., Sulaiman, H. and Sandrang, A. K. 2008. The prospect of exporting Malaysian temperate cut flowers by sea shipment to Japan. *Economic and Technology Management Review* 3: 75-82.

Hanna, N. and Wozniak, A. 2013. Consumer behavior: An applied approach 4th edition. Iowa:Kendall Hunt Publishing.

Hansen, R. 1999. Chrysanthemums grown in hydroponics; toward development of a cost effective, automated production system. *Acta Horticulturae* 481: 297-304.

Hassall and Associates. 2001. Hydroponics as an agricultural production system. Canberra:Rural Industries Research and Development Corporation.

Hassan, S. A. and A. M, Asiah and Ramlan, Mohd Fauzi and A. K., Salbiah 2001. *Nitrogen fertilization influences flowering performance of lowland cut chrysanthemums.* In: *12th Malaysian Society of Plant Physiology Conference 2001*. Selangor:Malaysia.

Hattam, C. 2006. Adopting organic agriculture: an investigation using the theory of planned. Gold Coast: International Association of Agricultural Economics Conference.

Haver, D. and Schuch, U. 2001. Influence of root restriction and ethylene exposure on apicaldominance of petunia (*Petunia hybrida* Hort. Vilm.-Andr.). *Plant Growth Regulation* 35(2): 187-196.

Havis, J.R. and Hamilton, W.W. 1976. Physical properties of container media. Journal of Arboriculture 2(7):139-140.

Healy, W., and Klick, S. 1991. Controlling shoot elongation of potted alstroemeria. *Acta Horticulturae* 337: 25-30.

Henderson-Cole, J. C. and Davies, F. T. 1993. *Drought response of low* and *high maintenance landscape roses*. *Journal of Environment Horticulture* 11(2): 59–63.

Henry, A. 1996. Consumer behavior and marketing action 5th ed. Ohio:South-Western College Publishing..

Heuvelink, E., Marcelis, L. F. M., Bakker, M. J., and Van Der Ploeg, A. 2007. Use of crop growth models to evaluate physiological traits in genotypes of horticultural crops. *Frontis 21*: 221-231.

Hicklenton, P.R. 1983. Flowering, vegetative growth and mineral nutrition of pot chrysanthemums in sawdust and peat-life media. *Scientia Horticulturae,* 21(2): 189-197.

Hochmuth, R. C. and Hochmuth, G. J. 1993. Use of plastic in greenhouse vegetable production in the United States. *HortTechnology* 3(1): 20-27.

Hoffmann, C. and Jungk, A. 1995. Growth and phosphorus supply of sugar beet as affected by soil compaction and water tension. *Plant and Soil* 176(1): 15-25.

Howard, M.R. 2013. Hydroponic food production. Boca Raton:CRC press.

Huang, L. C. and Yeh, T. F. 2009. Floral consumption values for consumer groups with different purchase choices for flowers. *HortTechnology* 19(3): 563-571.

Huang, L.C. 2005. Floral product behaviors and their influences of floral purchase frequency. *Hortechnology* 15(4): 766-771.

Hudson, D. and Griffin, E. 2004. Market potential for “Mississippi Grown” cut Flowers. *Mississippi State university Bulletin* 1140: 1-9.

Huld, A. and Anderson, N.E. 1997. The influence of plant density and gradual shading on vegetative growth of Dendranthema. *Acta Horticulturae* 435: 209-218.

Hurley, M. B., Rowarth, J.S., Trought, M.C.T., Barnes, M.F. and Rowe, R.N. 1998. Variations in water availability and temperature in the root environment during root volume restriction studies. *New Zealand Journal of Crop and Horticultural Science* 26(2): 127-134.

HY Consultancy. 2010. Survey on flower retail in China. Kunming:NABSO.

Ichimura, K., Kawabata, Y., Kishimoto, M., Goto, R., and Yamada, K. 2002. Variation with the cultivar in the vase life of cut rose flowers. *Bulletin of the National Institute of Floriculture Science 2*: 9-2.

Ismail, M. R. and Noor, K. M. 1996. Growth, water relations and physiological processes of starfruit (*Averrhoa carambola* L.) plants under root growth restriction. *Scientia Horticulturae* 66(1): 51-58.

Ismail, M.R. and Davies, W.J. 1998. Root restriction affects leaf growth and stomatal response: the role of xylem sap ABA. *Scientia Horticulturae* 74(4): 257-268.

Jetphon, K. 2010. Consumers attitudes towards hydroponic vegetable in Mueang Chiang Mai District, Master Thesis, Chiang Mai University.

John, M. D. and Harold, F. W. 2005. Floriculture: principle and species, second edition. New Jersey:Prentice Hall.

Kafkafi, U. 2008. Functions of the root system. In *Soilless Culture: Theory and Practice,* ed. M.Raviv, and J.H.Lieth, pp. 13-40. Amsterdam:Elsevier.

Kagi, B.F. 1998. Vigour control in grapevines for wine production: The effects of root restriction on the vegetative growth, fruitfulness and fruit maturity of *Vitis vinifera* cv Cabernet sauvignon*,* Master Thesis, Lincoln University.

Kahar, A. and Mahmud, T.M.M. 2005. Growth, flowering and cut flower quality of spray chrysanthemum (*Chrysanthemum morifolium* Ramat) cv. V720 at different planting densities. *Journal of Tropical Agriculture and Food Science* 33(2): 177– 184.

Kahar, S. A., Mahmud, T. M. M., and Sakinah, S. 2005. Defoliation of chrysanthemum (*Chrysanthemum morifolium Ramat*) cv. Reagan Sunny for improved flowering and cut flower quality., *33*(2), 169-175.

Kai, K., Hiyashi, N., Shibane, T., Konishi, K. and Morita, M. 1995. Studies of algorithm for evaluating spray formation of cut chrysanthemum. *Environment Control in Biology* 33(4): 253-259.

Kang, M., Heuvelink, E., Carvalho, S. M., and de Reffye, P. 2012. A virtual plant that responds to the environment like a real one: the case for chrysanthemum. *New Phytologist*, *195*(2): 384-395.

Kapczyńska, A. 2013. Effect of plant spacing on the growth, flowering and bulb production of four lachenalia cultivars. *South African Journal of Botany* 88: 164-169.

Karni, L., Aloni, B., Bar-Tal, A., Moreshet, S., Keinan, M. and Yao, C. 2000. The effect of root restriction on the incidence of blossom-end rot in bell pepper (*Capsicum annuum* L.). *Journal of Horticultural Science and Biotechnology 75*(3): 364-369.

Katsoulas, N., Kittas, C., Dimokas, G. and Lykas, C. 2006. Effect of irrigation frequency on rose flower production and quality. *Biosystems Engineering* 93: 237-244.

Kazaz, S., Tekintaş, F. E., and Aşkın, M. A. 2011. Effects of different planting systems and densities on yield and quality in standard carnations. *Journal of Cell and Plant Sciences* 2(1): 19-23.

Kirkham, D. and W.L. Powers. 1972. Advanced soil physics. New York:Wiley-Interscience.

Khachatryan, H. and Choi, H. J. 2014. Factors affecting consumer preferences and demand for ornamental plants. Florida: University of Florida.

Khattak, A. M., Pearson, S. and Johnson, C. B. 2004. The effects of far red spectral filters and plant density on the growth and development of chrysanthemums. *Scientia Horticulturae* 102(3): 335-341.

Khedr, A. H. A., Abbas, M. A., Wahid, A. A. A., Quick, W. P. and Abogadallah, G. M. 2003. Proline induces the expression of salt□stress□esponsive proteins and may improve the adaptation of *Pancratium maritimum* L. to salt□stress. *Journal of Experimental Botany* 54(392): 2553-2562.

Kipp, J.A., Weber, W. and De Kreij, C. 2000. International substrate manual. Amsterdam: Elsevier.

Kostopoulou, P., Radoglou, K., Dini Papanastasi, O., and Adamidou, C. 2011. Effect of mini-plug container depth on root and shoot growth of four forest tree species during early developmental stages. *Turkish Journal of Agriculture and Forestry* 35(4): 379-390.

Krizek, D.T., Carmi, A., Mirecki, R.M., Snyder, F.W. and Bunce, J.A. 1985. Comparative effects of soil moisture stress and restricted root zone volume on morphogenetic and physiological responses of soybean *(Gylcine max* (L.) Merr.). *Journal of Experimental Botany* 36: 25-38.

Lugojan, C., and Ciulca, S. 2011. Evaluation of relative water content in winter wheat. *Journal of Horticulture, Forestry and Biotechnology* 15(2): 173-177.

Langton, F. A. 1992. Interrupted lighting of chrysanthemums: monitoring of average daily light integral as an aid to timing. *Scientia Horticulturae* 49: 147-57.

Langton, F.A., Benjamin, L.R. and Edmondson, R.N. 1999. The effects of crop density on plant growth and variability in cut-flower chrysanthemum (*Chrysanthemum morifolium* Ramat.). *Journal of Horticultural Science and Biotechnology* 74(4):493-501.

Latimer, J. G. 1991. Container size and shape influence growth and landscape performance of marigold seedlings. *HortScience* 26(2): 124-126.

Law-Ogbomo, K. E., and Ekunwe, P. A. 2010. Growth and herbage yield of *celosia argenta* as influence by plant density and NPK fertilization in degraded ultisol. *Tropical and Subtropical Agroecosystems 14*(1): 251-260.

Lee, J. H., Heuvelink, E. and Bakker, M. J. 2009. Interaction effects between light level and plant density on plant growth, development and external quality in year-around cut chrysanthemum. *Korean Journal of Horticultural Science and Technology* 27(3): 391-398.

Lee, J. H., Heuvelink, E. and Challa, H. 2002. Effects of planting date and plant density on crop growth of cut chrysanthemum. *Journal of Horticultural Science and Biotechnology* 77(2): 238-247.

Lee, S. Y., Kim, H. J. and Bae, J. H. 2010. Effect of planting density on growth and quality in hydroponics of *Sedum sarmentosum*. *Korean Journal of Horticultural Science and Technology* 28(4): 580-584

LEI Wageningen UR. 2014. CBI product factsheet:chrysanthemums in the UK market. Hague: CBI Ministry of Foreign Affair.

Lelia, S.K., Keith, C. and Judy, P. 2009. Soil pH for landscape plants. Mississippi:Mississippi State University Extension Service.

Lieth, J. H. and Burger, D.W. 1989. *Growth of chrysanthemum using an irrigation system controlled by soil moisture tension*. *Journal of the American Society for Horticultural Science* 114: 387-392.

Lieth, J.H. and Oki, L.R. 2008. Irrigation in soilless production. In *Soilless Culture :Theory and Practice,* ed. M.Raviv, and J.H.Lieth, pp. 117-156. Amsterdam:Elsevier.

Likert, R. 1932. A technique for measurement of attitudes. *Archives of physiology* 140: 1-55.

Lim, H. J., Mohd. R. M. S. and Nor, A. H. 1998. Cut flower production in Malaysia. In *Cut Flower Production in Asia,* ed. Food and Agriculture Organization, p33-44. Rome:FAO.

Lin, L., Li, W., Shao, J., Luo, W., Dai, J., Yin, X., Zhou, Y. and Zhao, C. 2011. Modelling the effects of soil water potential on growth and quality of cut chrysanthemum (*Chrysanthemum morifolium*). *Scientia Horticulturae* 130(1): 275-288.

Liu, A. and Latimer, J. G. 1995. Root cell volume in the planter flat affects watermelon seedling development and fruit yield. *HortScience* 30(2): 242-246.

Liu, A. and Latimer, J. G. 1995. Water relations and abscisic acid levels of watermelon as affected by rooting volume restriction. *Journal of Experimental Botany* 46: 1011-1015.

Liu, H. and Huang, G. 2009. Laboratory experiment on drip emitter clogging with fresh water and treated sewage effluent. *Agricultural Water Management*, 96(5): 745-756.

Liu, W., Sutton, J. C., Grodzinski, B., Kloepper, J. W. and Reddy, M. S. 2007. Biological control of *Pythium* root rot of chrysanthemum in small-scale hydroponic units. *Phytoparasitica* 35: 159-178.

Lucena, C. C. D., Siqueira, D. L. D., Martinez, H. E. P., and Cecon, P. R. 2012. Salt stress change chlorophyll fluorescence in mango. *Revista Brasileira de Fruticultura*, 34(4):1245-1255.

Lugojan, C. and Ciulca, S. 2011. Evaluation of relative water content in winter wheat. *Journal of Horticulture, Forestry and Biotechnology* 15(2): 173-177.

Luria, G., Weiss, D., Ziv, O., and Borochov, A. 2004. Effect of planting depth and density, leaf removal, cytokinin and gibberellic acid treatments on flowering and rhizome production in Zantedeschia aethiopica. Acta Horticulturae 673: 725-730.

Lyons, E. E. and Mully, T. W. 1992. Density effects of flowering phenology and mating potential in *Nicotiana alata*. *Oecologia* 91(1): 93-100.

Maboko, M.M. and Steyn, J.M. 2013. Effect of plant spacing on growth and yield of lettuce (*Lactuca sativa* L.) in a soilless production system. *South African Journal of Plant and Soil* 26(3): 195-198.

Maboko, M.M. and Du Plooy C.P. 2013. High-plant density planting of basil (*Ocimum basilicum*) during summer/fall growth season improves yield in a closed hydroponic system. *Acta Agriculturae Scandinavica* 63(8): 748-752

Marcelis, L. F. M. 1996. Sink strength as a determinant of dry matter partitioning in the whole plant. *Journal of Experimental Botany*, *47*(Special Issue): 1281-1291.

Maher, M., Prasad, M. and Raviv, M. *2008. Organic soilless media components*. In *Soilless Culture: Theory and Practice,* ed. M.Raviv, and J.H.Lieth, pp. 459-504. Amsterdam:Elsevier.

Mahtab, P., Fazlullah, S. and Pejman, M. 2013. Effect of planting time and density on morphological and physiology traits of *Achillea millefolium*. *Annals of Biological Research* 24(8): 183-186.

Marta, P. 2001. Floriculture and the environment: growing Flowers without Methyl Bromide. Nairobi:UNEP.

Marta, P. 2007. Soilless production of cut flowers continues to increase. *Floraculture International* 3: 14-16.

Marta, P. 2012. Soilless production of cut flowers continues to increase. *Floraculture International* 3: 14-16

Martin, C.A., Ingram, D.L. and Nell, T.A. 1991. Growth and photosynthesis of *Magnolia grandiflora* 'St. Mary' in response to constant and increased container volume. *Journal of the American* Society *for Horticultural Science* 116(3): 439-445.

Mataa, M. and Tominaga, S. 1998. Effects of root restriction on tree development in Ponkan mandarin (*Citrus reticulata* Blanco). *Journal of the American* Society *for Horticultural Science*, 123(4): 651-655.

Maxwell, K. and Johnson, G.N. 2000. Chlorophyll fluorescence-a practical guide. *Journal of Experimental Botany* 51: 659–68.

MacAdam, J. W. 2009. Structure and function of plants. Iowa:John Wiley and Sons.

McCall, W. W. 1980. The pH preference of plants. Manao: University of Hawaii

McCrum-Gardner, E. 2010. Sample size and power calculations made simple. *International Journal of Therapy and Rehabilitation* 17(1): 10.

McGuire, R. G. 1992. Reporting of objective color measurements. *HortScience* 27(12): 1254-1255.

Mellesse, B., Kassa, N., and Mohammed, A. 2013. Yield and quality of statice [*Limonium sinuatum* (L.) Mill.] as affected by cultivars and planting densities. *African Journal of Plant Science* 7(11): 528-537.

Merotto, A., and Mundstock, C. M. 1999. Wheat root growth as affected by soil strength. *Revista Brasileira de Ciência do Solo* 23: 197-202.

Michael Cohen Group. 2005. Consumer Attitudes and Behaviors about Floral Purchasing Study: Final Analysis. Virginia:Society of American Florists.

Minolta. 1994. *Precise color communication*: Color control from feeling to instrumentation. Osaka:Minolta.

Mohammad, R.M.S., Abdul, K.S., Syed A.R. and Ibrahim, O. 2003. Manual pengeluaran bunga kekwa keratan. Kuala Lumpur:MARDI

Morgan, J.V., Moustafa, A.T. and Groome, N. 1982. A technique for the production of spray chrysanthemums in a hydroponics system on raised benches. *Acta Horticulturae* 125:79-86.

Mugnai, S., Vernieri, P., Tognoni, F. and Serra, G. 2000. Container volume effects on morphology and physiology of tomato seedlings. *Acta Horticulturae* 516: 49-56.

Nardi, C., Bellé, R. A., Schmidt, C. M. and Toledo, K. D. A. 2001. Quality of chrysanthemum (*Dendranthema grandiflora* Tzevelev. cv. Snowdon) affected by plant density and plant date. *Ciência Rural* 31(6): 957-961.

Neil, O. A. 2007. Chrysanthemum: *Dendranthema x grandiflora* Tzvelv. In *Flower Breeding and Genetics*, ed. N.O. Anderson, pp. 389-437. Dordrecht:Sprinker.

Neilsen, G. H., Parchomchuk, P., Neilsen, D., Berard, R., and Hague, E. J. 1995. Leaf nutrition and soil nutrients are affected by irrigation frequency and method for NP-fertigated 'Gala' apple. *Journal of the American Society for Horticultural Science* 120(6): 971-976.

NeSmith, D. S. 1993. Influence of root restriction on two cultivars of summer squash (*Cucurbita pepo* L.). *Journal of Plant Nutrition* 16(3): 421-431.

NeSmith, D. S. and Duval, J. R. 1998. The effect of container size. *HortTechnology* 8(4): 495-498.

NeSmith, D. S., Bridges, D. C. and Barbour, J. C. 1992. Bell pepper responses to root restriction. *Journal of Plant Nutrition* 15(12): 2763-2776.

Nibber, J. 2013. Post-harvest product quality in the UK cut flower distribution, Master dissertation, University of Edinburgh.

Nishizawa, T. and Saito, K. 1998. Effects of rooting volume restriction on the growth and carbohydrate concentration in tomato plants. *Journal of the American Society for Horticultural Science*123 (4): 581-585.

Noguera, P., Abad, M., Puchades, R., Maquieira, A. and Noguera, V. 2003. Influence of particle size on physical and chemical properties of coconut coir dust as container medium. *Communications in Soil Science and Plant analysis* 34(3): 593-605.

Nolila, M.N. 2001. Consumer's perceptions, attitudes and willingness to pay towards chemical free produce: The case of vegetable, Master Thesis, Universiti Putra Malaysia.

Ouma, G.B. 2005. Root confinement and irrigation frequency affect growth of 'Rough lemon' (*Citrus limon*) seedlings. *Fruits* 60(3): 195-202.

Ouma, G. B. 2006. Growth responses of 'rough lemon (*Citrus limon* L.) rootstock seedlings to different container sizes and nitrogen levels. *Agricultura Tropica et Subtropica* 39(3)183-189.

Özzambak, M.E., Zeybekoğlu, E., Tuncay, O., Başer, S., Haspolat, G. and Olgun, A. 2009. A Survey on cut flower preferences and expectation. *Acta Horticulturae* 807: 771-776.

Panahandeh, J., Abdollahi, S., Kazemnia , H.D. and Mahna, N. 2012. Effect of plant density on root yield and leaf area in chichory (*Cichorium intybusl*). *Acta Horticulturae* 932: 427-430

Pardossi, A., Carmassi, G., Diara, C., Incrocci, L., Maggini, R. and Massa, D. 2011. Fertigation and substrate management in closed soilless culture. Pisa, University of Pisa

Pasquier, P., Anstett A. and Amiraux A. 1982. Effect of the rooting substrate on rooting, growth and flowering of *Chrysanthemum morifolium* Ramat. *Acta Horticulturae* 125: 37-46.

Paul, V. N. and William C. F. 1991. Physical analysis of rockwool slabs and effects of fiber orientation, irrigation frequency and propagation technique on chrysanthemum production. *Journal of Plant Nutrition* 14(8): 853-866.

Peterson, J. Hoyle, F. 2011. Soil organic carbon A Western Australian perspective. Western Australia:Government of Western Australia.

Peterson, T. A., Reinsel, M. D. and Krizek, D. T. 1991. Tomato (*Lycopersicon esculentum* Mill., cv.'Better Bush') plant response to root restriction. Alteration of plant morphology. *Journal of Experimental Botany* 42(10): 1233-1249.

Pezeshki, S.R. and Santos, M.I. 1998. Relationships among rhizosphere oxygen deficiency, root restriction, photosynthesis, and growth in baldcypress (*Taxodium distichum* L.) seedlings. *Photosynthethica* 35(3): 381-390.

Pires, R.C.D.M., Furlani, P.R., Ribeiro, R.V., Bodine Junior, D., Sakai, E., Lourenção, A.L. and Torre N.A. 2011. Irrigation frequency and substrate volume effects in the growth and yield of tomato plants under greenhouse conditions. *Scientia Agricola* 68: 400-405.

Pizano, M. 2002. Alternatives to methyl bromide for use in cut-flower production. In *Proceedings of International Conference on Alternatives to Methylbromide- The Remaining Challenges*, ed T. Batchelor, and J. Bolivar, pp. 233-237. Brussels:European Commission.

Poorter, H., Bühler, J., Van Dusschoten, D., Climent, J. and Postma, J. A. 2012. Pot size matters: A meta-analysis of the effects of rooting volume on plant growth. *Functional Plant Biology* 39(11): 839-850.

Posadas, B.C., Coker, C.H., Fain, G. and Knight, P.R. 2006. Consumer survey of selected garden chrysanthemum cultivars in Mississippi. *HortTechnology* 16(3): 539-543.

Powell, M.C. and Bunt, A.C. 1983. The effect of plant density and day-length on growth and development in the carnation. *Scientia Horticuiturae* 20(2): 193-202.

Puteri, E.M.W. 1999. The influences of water availability and vesiculararbuscular mycorrhizal (VAM) fungi on growth and physiological processes of tomato (*Lycopersicon Esculentum* Mill.) in soilless culture. Master Thesis, Universiti Putra Malaysia.

Quintero, M.F., González-Murillo, C.A., Florez, V.J. and Guzmán, J.M. 2009. Physical evaluation of four substrates for cut-rose crops. *Acta Horticulturae* 843: 349-358.

Quintero, M.F., Ortega, D., Valenzuela, J.L., and Guzmán, M. 2013. Variation of hydro-physical properties of burnt rice husk used for carnation crops: Improvement of fertigation criteria. *Scientia Horticulturae* 154: 82-87.

Rafiee, M. 2012. Effect of every other furrow irrigation and planting density on physiological traits in corn (*Zea mays* L.). *World Applied Sciences Journal* 17(2): 189-193.

Rahimi, A., Sayadi, F.and Dashti, H. 2013. Effects of water and nitrogen supply on growth, water-use efficiency and mucilage yield of isabgol (Plantago ovata Forsk). *Journal of Soil Science and Plant Nutrition* 13(2): 341-354.

Raosoft. 2004. Raosoft sample size calculator. Retrieve 1 August 2014 from http://www.raosoft.com/samplesize.html

Raviv, M. and Lieth, J. H. 2008. Significance of soilless culture in agriculture. In *Soilless Culture: Theory and Practice,* ed. M.Raviv, and J.H.Lieth, pp. 1-12. Amsterdam:Elsevier.

Raviv, M., Wallach, R., Silber, A. and Bar-Tal, A. 2002. Substrates and their analysis. In *Hydroponic Production of Vegetables and Ornamentals*. ed, D.Savvas and H. Passam, pp. 25-101. Athens:Embryo Publications.

Raviv, M., Wallach, R., Silber, A., Medina, S. and Krasnovsky, A. 1999. The effect of hydraulic characteristics of volcanic materials on yield of roses grown in soilless culture. *Journal of the American Society for Horticultural Science* 124(2): 205-209.

Reuter, D. and Robinson, J. B. 1986. Plant analysis: An interpretation manual. Melbourne: Inkata press

Rehm, G. and Schmitt, M. 2002. Potassium for crop production. Extension Service, University of Minnesota.: University of Minnesota.

Ritchie, G. A. 2006. Chlorophyll fluorescence: What is it and what do the numbers mean. *National Proceedings: Forest and Conservation Nursery Associations-2005*, 34-42.

Robbins, N.S. and Pharr, D.M. 1988. Effect of restricted root growth on carbohydrate metabolism and whole plant growth of *Cucumis sativus* L. *Plant Physiology* 87(2): 409-413.

Röber, R. and Hafez, M. 1982. *The influence of different water supply upon the growth of chrysanthemums*. *Acta Horticulturae* 125: 69-78.

Roberto, V. 2007. Reduction of irrigation water consumption in the Colombian Floriculture with the use of tensiometer. In *28th Annual International Irrigation Show2007*, ed. International Irrigation Association, pp. 842-846. Wisconsin:Omnipress.

Rodríguez-Delfín, A., Posadas, A., León-Velarde, C., Mares, V. and Quiroz, R. 2011. Effect of salt and water stress on the proline and total chlorophyll content and nutrients uptake on two sweet potato cultivars grown on soilless culture. *Acta Horticulturae* 947: 55-62.

Roháček, K., Soukupová, J. and Barták, M. 2008. Chlorophyll fluorescence: a wonderful tool to study plant physiology and plant stress. In *Plant cell compartments-selected topics,* ed. Benoît, S., pp. 41-104. Kerala:Research Signpost.

Ronchi, C. P., DaMatta, F. M., Batista, K. D., Moraes, G. A., Loureiro, M. E., and Ducatti, C. 2006. Growth and photosynthetic down-regulation in Coffea arabica in response to restricted root volume. *Functional Plant Biology* 33(11): 1013-1023.

Roychowdhury, N. 1989. Effect of plant spacing and growth regulators on growth and flower yield of gladiolus grown under polythene tunnel. *Acta Horticulturae* 246: 259–264.

Russo, V.W. 1991. Effect of fertilizer rate, application timing and plant spacing on yield and nutrient content of bell pepper. *Journal of Plant Nutrition* 14(10): 1047–1056.

Ryser, P., Gill, H.K., Byrne, C.J. 2011. Constraints of root response to waterlogging in *Alisma triviale*. *Plant and Soil* 343:247–260.

Sakamoto, Y., Watanabe, S. and Okano, K. 2001. Growth and quality of chrysanthemum (*Dendranthema grandiflora*) grown in wet sheet culture and deep flow technique. *Acta Horticulturae* 548: 459-468.

Samoilă, C. M. S. 2012. Preliminary study of flower market research through questionnaires. *Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca Horticulture* 69(2): 288-294.

Savvas, D., Gianquinto, G.P., Tüzel, Y. and Gruda, N., 2013. Soilless culture. In *Good agricultural practices for greenhouse vegetable crops. Principles for Mediterranean climate areas.* ed, W. Baudoin, R. Nono-Womdim, N. Lutaladio, , A. Hodder, N. Castilla, C. Leonardi, S. De Pascale, M. Qaryouti, R. Duffy, pp. 347-381. Rome: Food and Agriculture Organization of the United Nations.

Scagel, C. F., Bi, G., Fuchigami, L. H. and Regan, R. P. 2012. Irrigation frequency alters nutrient uptake in container-grown Rhododendron plants grown with different rates of nitrogen. *HortScience* 47(2): 189-197.

Scagel, C. F., Bi, G., Fuchigami, L. H., and Regan, R. P. 2011. Effects of irrigation frequency and nitrogen fertilizer rate on water stress, nitrogen uptake, and plant growth of container-grown Rhododendron. *HortScience* 46(12): 1598-1603.

Schimmenti, E., Asciuto, A., Galati, A. and Valenti, M. 2010. Consumers of flowers and ornamental plants: An exploratory survey in the Italian Mezzogiorno regions. *New Medit* 9: 36-46.

Schuch, U. K., Redak, R. A. and Bethke, J. A. 1998. Cultivar, fertilizer, and irrigation affect vegetative growth and susceptibility of chrysanthemum to western flower thrips. *Journal of the American Society for Horticultural Science* 123(4): 727-733.

Scoggins, H.L., Bailey, D.A. and Nelson, P.V. 2001. Development of the press extraction method for plug substrate analysis: quantitative relationships between solution extraction techniques. *HortScience* 36(5): 918-921.

Shabala, S., and Munns, R. 2012. Salinity stress: physiological constraints and adaptive mechanisms. In *Plant stress physiology*, ed. S. Shabala, pp. 59-93. Oxford:CABI.

Seyed, Y. S. L., Rouhollah, M., Mosharraf, M. H. and Ismail, M. M. R. 2012. Water stress in plants: Causes, effects and responses. In *Water stress*, ed. I. M. M. Rahman and H. Hasegawa, pp. 1-15. Rijeka:InTech.

Sharp, R. E. 1996. Regulation of plant growth responses to low soil water potentials. *HortScience* 31(1): 36-39.

Shi, K., Ding, X.T., Dong, D.K., Zhou, Y.H. and Yu, J.Q. 2008. Root restriction-induced limitation to photosynthesis in tomato (*Lycopersicon esculentum* Mill.) leaves. *Scientia Horticulturae* 117(3): 197-202.

Shinichi, K., Takashi, I., Mariko, S. and Atsushi, M. 2014. Consumer evaluation of plant factory produced vegetables. *Focusing on Modern Food Industry* 3(1): 1-9.

Silber, A. 2008. Chemical characteristics of soilless media. In *Soilless Culture: Theory and Practice,* ed. M.Raviv, and J.H.Lieth, pp. 210-224. Amsterdam:Elsevier.

Silber, A. and Bar-Tal, A. 2008. Nutrition of substrate-grown plants. In *Soilless Culture: Theory and Practice,* ed. M.Raviv, and J.H.Lieth, pp. 291-339. Amsterdam:Elsevier.

Silber, A., Xu, G., Levkovitch, I., Soriano, S., Bilu, A. and Wallach, R. 2003. High fertigation frequency: the effects on uptake of nutrients, water and plant growth. *Plant and soil* 253(2): 467-477.

Silva, E. E. D., Azevedo, P. H. S., Almeida, M. M. T. B., De-Polli, H., and Guerra, J. G. M. 2008. Influence of intercropping and irrigation frequencies in the leaf development and taro (Cocoyam) productivity under organic management. In *16th IFOAM Organic World Congress*, ed. D. Neuhoff, N. Halberg, T. Alfolfi, W. Lockeretz, A. Thommen, I.A. Rasmusssen, J. Hermansen, M. Vaarst, L. Lueck, F. Caporali, H.H. Jensen, P. Migliorini, and H. Willer. pp. 404-407. Modena:IFOAM

Silva, T. S., Braga, J. D., Silveira, L. M. D., and Sousa, R. P. D. 2013. Planting density and yield of cassava roots. *Revista Ciência Agronômica*, 44(2): 317-324.

Simpson, D. G. 1996. Nursery growing density and container volume affect nursery and field growth of Douglas-fir and Lodgepole pine seedlings. In *National Proceedings: Forest and Conservation Nursery Associations1994, ed.* D. Landis, and R.K.Dumroese, pp. 105-115. Virgina United State Department of Agriculture.

Siti, Z. S. 2006. Effects of root restriction and water stress on growth performance and physiological and biochemical responses of mango (*Mangiferra indica* cv.Chokanan), Master Thesis, Universiti Putra Malaysia.

Soffer, H., Burger, D.W. and Lieth, J.H. 1991. Plant growth and development of *Chrysanthemum* and *Ficus* in aero-hydroponics: response to low dissolved oxygen concentrations. *Scientia Horticulturae* 45: 287-294.

Stabler, L. B. and Martin, C. A. 2000. Irrigation regimens differentially affect growth and water use efficiency of two Southwest landscape plants. *Journal of Environmental Horticulture* 18(2): 66-70.

Stuart, N. W. 1943. Controlling time of blooming of chrysanthemums by the use of lights. *Proceeding of American Society for Horticultural Science* 42: 605-606.

Sun, J., Gu, J., Zeng, J., Han, S., Song, A., Chen, F.,Fang, W., Jiang, J. and Chen, S. 2013. Changes in leaf morphology, antioxidant activity and photosynthesis capacity in two different drought-tolerant cultivars of chrysanthemum during and after water stress. *Scientia Horticulturae* 161: 249-258.

Sutton, J. C., Sopher, C. R., Owen-Going, T. N., Liu, W., Grodzinski, B., Hall, J. C. and Benchimol, R. L. 2006. Etiology and epidemiology of *Pythium* root rot in hydroponic crops: Current knowledge and perspectives. *Summa Phytopathologica* 32(4): 307-321.

Szabados, L., and Savouré, A. 2010. Proline: A multifunctional amino acid. *Trends in Plant Science* 15(2): 89-97.

Ternesi, M., Andrade, A. P., Jorrin, J. and Benlloch, M. 1994. Root-shoot signalling in sunflower plants with confined root systems. *Plant and Soil* 166(1): 31-36.

Terra, S. B., Ferreira, A. A. F., Peil, R. M. N., Stumpf, E. R. T., Beckmann-Cavalcante, M. Z. and Cavalcante, Í. H. L. 2011. Alternative substrates for growth and production of potted chrysanthemum (cv. Funny). *Acta Scientiarum Agronomy* 33(3): 465-471.

Townend, J. and Dickinson, A. L. 1995. A comparison of rooting environments in containers of different sizes. *Plant and Soil* 175(1): 139-146.

Trelka, T. and Szczepaniak, S. 2009. Effect of substrate volume on the growth and flowering of '*Cyclamen persicum* Mill' 'Canto F1 Scarlet' from midi group. *Nauka Przyroda Technologie* 3(3): 1-6.

Trovato, M., Mattioli, R. and Costantino, P. 2008. Multiple roles of proline in plant stress tolerance and development. *Rendiconti Lincei 19*(4): 325-346.

Tsakalidis A. L., Mavrogiannopoulos, G.N., Passam, H.C., Savvas, D., Sideridis, A.B., and Yialouris, C.P. *2002. An integrated management information systems in hydroponics*. In *Proceeding of the Impact of ICT in Agriculture, Food and Environment,* ed. A.B. Sideridis and C.P. Yialouris, pp.556-564. Athen: Agricultural University of Athens.

Tsirogiannis, I., Katsoulas, N. and Kittas, C. 2010. Effect of irrigation scheduling on gerbera flower yield and quality*. HortScience* 45: 265-270.

Vaknin, Y., Dudai, N., Murkhovsky, L., Gelfandbein, L., Fischer, R., and Degani, A. 2009. Effects of pot size on leaf production and essential oil content and composition of *Eucalyptus citriodora* hook (Lemon-Scented Gum). *Journal of herbs, spices and medicinal plants 15*(2): 164-176.

Van der Werf, A. 1996. Growth analysis and Photoassimilate partitioning. In Photoassimilate. Distribution in Plants and Crops: Source–Sink Relationships, ed. E., Zamski, and A.A., Schaffer, pp. 1-20. New York: Marcel Dekker.

Van Iersel, M. 1997. Root restriction effects on growth and development of salvia (*Salvia splendens*). *HortScience* 32(7): 1186-1190.

Van Iersel M. 1999. Fertilizer concentration affects growth and nutrient composition of subirrigation pansies. *HortScience* 34: 660- 663.

Van Noordwijk, M. 1983. Functional interpretation of root densities in the field for nutrient and water Uptake. Haren:Instituut Voor Bodemvruchtbaarheid.

Van Os, E. A. 1980. Complete mechanization of the growing of cut chrysanthemums in nutrient film. In *Proceedings Fifth International Congress on Soilless Culture.* p. 187-196.

Van Os, E. A., Gieling, T. H. and Lieth, J. H. 2008. Technical equipment in soilless production systems. In *Soilless Culture: Theory and Practice,* ed. M.Raviv, and J.H.Lieth, pp. 157-207. Amsterdam:Elsevier.

Varela Milla, O., Rivera, E. B., Huang, W. J., Chien, C. and Wang, Y. M. 2013. Agronomic properties and characterization of rice husk and wood biochars and their effect on the growth of water spinach in a field test. *Journal of Soil Science and Plant Nutrition* 13(2): 251-266.

Verhagen, J.B.G.M. 1993. Peat as a substrate for year round chrysanthemum growing. *Acta Horticulturae* 342: 221-228.

Vetrivel, T., and Jawaharlal, M. 2014. Correlation and Path Analysis Studies in Chrysanthemum (*Dendranathema grandiflora* Tzelev.). *Trends in Biosciences*, *7*(15): 1941-1944.

Wallach, R. 2008. Physical characteristics of soilless media. In *Soilless Culture: Theory and Practice,* ed. M.Raviv, and J.H.Lieth, pp. 41-116. Amsterdam:Elsevier.

Wang, S., Okamoto, G., Ken, H. 1998. Effects of rooting-zone restriction on the changes in carbohydrates and nitrogenous compounds in 'Kyoho' grapevines during winter dormancy and early shoot growth. *Journal of the Japanese Society for Horticultural Science* 67:577-582.

Williams, K. A. and Nelson, P. V. 1996. Modifying a soilless root medium with aluminum influences phosphorus retention and chrysanthemum growth. *HortScience* 31(3): 381-384.

Williamson, J. G., Coston, D. C. and Cornell, J. A. 1992. Root restriction affects shoot development of peach in a high-density orchard. *Journal of the American Society for Horticultural Science* 117: 362-367.

Willits, D. H. and Peet, M. M. 1999. Using chlorophyll fluorescence to model leaf photosynthesis in greenhouse pepper and tomato. *Acta Horticulturae* 507: 311-317.

Wilson, D.P. and Finlay, A.R. 1995. Hydroponic system for the production of all year round chrysanthemum. *Acta Horticulturae* 40: 185-192.

Wilson, C., Hui, D., Nwaneri, E., Wang, J., Deng, Q., Duseja, D., and Tegegne, F. 2012. Effects of planting dates, densities, and varieties on ecophysiology of pigeonpea in the southeastern United States. *Agricultural Sciences* 3(2):147-152.

Wright, R. D., Grueber, K. L. and Leda, C. 1990. Medium nutrient extraction with the pour-through and saturated medium extract procedures for poinsettia. *HortScience* 25(6): 658-660.

Wright, R. D., Jackson, B. E., Browder, J. F. and Latimer, J. G. 2008. Growth of chrysanthemum in a pine tree substrate requires additional fertilizer. *HortTechnology* 18(1): 111-115.

Xianfeng, G., Rashied, K. and Chris, B. 2010. Substrate cultivation of chrysanthemum : evaluation of growth performance of chrysanthemum in 9 closed systems, fourth growing cycle. Bleiswijk:Wageningen UR Greenhouse Horticulture.

XiaoJie, M., JianFeng, D., WeiHong, L., QiFeng, D., YongShan, C., ChunJiang, Z., and XiaoJun, Q., KeXin, L. 2009. Quantifying the effects of nitrogen on dry matter partitioning of standard cut chrysanthemum'Shenma'in solar greenhouse. *Journal of Plant Ecology (Chinese Version)* 33(1): 108-117.

Xie z.s., Guo, X, and Cao, H. 2013. Effect of root restriction on vegetative growth and leaf anatomy of 'Kyoho' grapevines cultivar. *African Journal of Agricultural Research* 8(15): 1304-1309.

Xiuming, H. 1999. Effects of plant density on growth, yield, and quality of fresh-market sweet corn. *HortScience* 34(3):478-478.

Xu, G., Levkovitch, I., Soriano, S., Wallach, R. and Silber, A. 2004. Integrated effect of irrigation frequency and phosphorus level on lettuce:P uptake, root growth and yield. *Plant and Soil* 263(1): 297-309.

Yahya, A., Anieza S. S., Rosli, B. M. and Ahmad, S. 2009. Chemical and physical characteristics of cocopeat-based media mixtures and their effects on the growth and development of *Celosia cristata. American Journal of Agricultural and Biological Sciences* 4(1): 63-71.

Yahya, A., Safie, H. and Kahar, S.Ab. 1997. Properties of cocopeat-based growing media and their effects on two annual ornamentals. *Journal of Tropical Agriculture and Food Science* 25(2): 151-157.

Yang, Z., Hammer, G., Van Oosterom, E., Rochas, D., and Deifel K. 2010. Effects of pot size on growth of mazie and sorghum plants. In: B. George-Jaeggli, D.J. Jordan, eds. *1st Australian Summer Grains Conference*. Gold Coast, Australia: Grains Research and Development Corporation.

Yeh, D.M. and Chiang, H.H. 2001. Growth and flower initiation in hydrangea as affected by root restriction and defoliation. *Scientia Horticulturae* 91(1):123-132.

Yeung, E.C. and Saxena, P.K. 2005. Hostological Techniques. In *Protocol for Somatic Embryonesis in Woody Plant*, ed. S.M. Jani, and P.K. Gupta, p 517-537. Dordrecht:Springer.

Yin, D., Chen, S., Chen, F., Guan, Z. and Fang, W. 2009. Morphological and physiological responses of two chrysanthemum cultivars differing in their tolerance to waterlogging. *Environmental and Experimental Botany* 67(1): 87-93.

Yong, J.W., Letham, D.S., Wong, S.C. and Farquhar, G.D. 2010. Effects of root restriction on growth and associated cytokinin levels in cotton (*Gossypium hirsutum*). *Functional Plant Biology* 37(10): 974-984.

You, Z., Zhang, X., Chen, C., Ono, K., Hibino, H. and Koyama, S. 2013 Impact of Relevant Knowledge on Purchase Intention of Plant-factory-produced Plants. *Focusing on Modern Food Industry* 2(2): 63-69.

Young, T., Cameron, D. D., Sorrill, J., Edwards, T., and Phoenix, G. K. 2014. Importance of different components of green roof substrate on plant growth and physiological performance. *Urban Forestry and Urban Greening*, 13(3): 507-516.

Yu, X., Wang, B., Zhang, C., Xu, W., He, J., Zhu, L., and Wang, S. 2012. Effect of root restriction on nitrogen levels and glutamine synthetase activity in 'Kyoho'grapevines. *Scientia Horticulturae 137*: 156-163.

Yue, C. and Behe, B.K. 2008. Estimating U.S. consumers' choice of floral retail outlets. *HortScience* 43(3): 764-769.

Yuen, P. M. and Yau, P. Y. 1996. Nematode parasites on chrysanthemums in Peninsular Malaysia. *MARDI Research Journal* 24: 175-180.

Zainudin, M. 2005. Effects of root restriction on growth, flowering and water uptake of starfruit. *Journal of Tropical Agriculture and Food Science* 34(1): 27-36.

Zanin, G. and Sambo, P. 2006. Floating system production of *Liatris spicata* (L.) Willd. *HortScience* 41(4): 992-992.

Zeithaml, V. A. 1988. Consumer perceptions of price, quality, and value: A means-end model and synthesis of evidence. *The Journal of Marketing* 52(3): 2-22.

Zerche, S. 1997. Nitrigen uptake and total dry matter production of cut chrysanthemum (*Dendranthema grandiflorum* - Hybrids) in relation to shoot height and planting date. *Gartenbauwiss* 62(3): 119-128.

Zhu, L., Wang, S., Yang, T., Zhang, C., and Xu, W. 2006. Vine growth and nitrogen metabolism of 'Fujiminori'grapevines in response to root restriction. *Scientia horticulturae* 107(2): 143-149.