Al-Mukhtar Journal of Sciences **37 (4): 345-352, 2022**
ISSN: online 2617-2186 print 2617-2178
Journal Homepage https://omu.edu.ly/journals/index.php/mjsc/index
Doi: https://doi.org/10.54172/mjsc.v37i4.923

Production of High-Quality Tomato Seedlings in the Open Field Nurseries

Fatma A. H. Mohamed, Fayrouz A. A. Buojaylah*, and Alsunousi S. O. Masoud

Department of Horticulture, Faculty of Agriculture, Omar Al-Mukhtar University, Libya.

ARTICLE HISTORY

Received:
29 May 2022

Accepted:
04 October 2022

Keywords:
Planting distances;
Seed rates;
Quality;
Dry weight;
Density.

Abstract: The aim of the study is to produce tomatoes seedlings with good characteristics for summer and fall seedlings seasons in field nurseries by investigating three plant distances (10, 15, 20 cm), inaddition to scatteringand two levels of seed rate (100 and 150% of the recommended rates).The experiment was carried out using completely random plots using split plot designs in three replications, and the levels of each factor were randomly distributed within the plots withcultivation of two seedbeds. Planting tomato seedlings at a 20 cm distance can improve tomato seedlings' growth in open field nurseries. Finally, more researches are needed to determine the optimal seed rates as well as planting distances in open field nurseries production under Al-Jabal Al-Khader conditions.

إنتاج شتلات الطماطم عالية الجودة في مشاتل الحقول المفتوحة

الكلمات المفتاحية :
مسافات الزراعة؛
معدلات البذور؛
الجودة؛
الوزن الجاف؛
الكثافة.

المستخلص : تستهدف هذه الدراسة إنتاج شتلات طماطم ذات خصائص جيدة لموسمي الصيف والخريف في المشاتل الحقلية، عن طريق اختبار ثلاث مسافات نباتية (10، 15، 20 سم) فضلًا عن الزراعة بالنثر ومستويين من البذور بمعدل 100 و 150 ٪ من المعدلات الموصى بها في المشتل الميداني المفتوح. نُفِّذت التجربة باستخدام القطاعات العشوائية الكاملة، باستخدام تصميم القطع المنشقَّة بثلاث مكررات. وتشير نتائج هذه الدراسة إلى أن زراعة شتلات الطماطم على مسافة 20 سم يمكن أن يحسِّن نمو شتلات الطماطم في مشاتل الحقول المفتوحة في المنطقة، علاوة على ذلك تشير النتائج إلى أن معدلات البذور في مشاتل الحقول المفتوحة ليست حاسمة لإنتاج شتلات الطماطم في المنطقة. أخيرًا، هناك حاجة إلى مزيد من البحوث لتحديد معدلات البذور المُثلى ومسافات الزراعة المناسبة في إنتاج المشاتل المفتوحة تحت ظروف منطقة الجبل الأخضر.

INTRODUCTION

Tomatoes (*Solanumlycopersicum*) have grown to be one of the world's most popular and extensively cultivated vegetable. In terms of total yearly world output, tomato ranks as one of the essential vegetables recognized by the Food and Agriculture Organization (FAO). Tomatoes are a very important vegetable crop in terms of economics, and they are farmed in 175 nations (FAO, 2014).

Between 2000 and 2019, the global production of vegetables increased more quickly, rising by 65 percent. Tomatoes are the most abundant of the five major vegetable species, making up between 42 and 45 percent of the total over the time period, and tomatoes represented about 16 percent in 2019 (FAO, 2021). China is the world's greatest tomato grower, with 52 million tons, then India, and United States is the third-largest producer,

***Corresponding author**: Fayrouz A. A. Buojaylah: *fayrouz.buojaylah@omu.edu.ly*, Department of Horticulture, Faculty of Agriculture, Omar Al-Mukhtar University, Libya.

then Egypt, with 18, 14, and 8 million tons, respectively (FAO, 2014). Government revenue, smallholder farmers, and foreign exchange gains have all benefited from the horticultural sector of agriculture. Additionally, the sector contributes significantly to food security and is a critical supplier of raw materials for the industrial sector (Irungu, 2011).

Development of profitable tomatoes is a huge difficulty challenge all over the world. Tomatoes plants can be grown in the field directly through plug-mix sowing (Hayslip, 1974), or by transplanting (Hochmuth, 1988). Tomato seedlings have a better chance of surviving, establishing quicker, improving plant uniformity, and maturing sooner than immediately seeded plants (Weston & Zandstra, 1989). Depending on the available planting space, operational simplicity, and adaptability of the approach, seedlings may be raised in trays, beds, or seedboxes (Lin et al., 2015). However, even in new and modern trays, seedlings could root and branch into the tray, which leads to poor removal and extraction of the plug, in addition, it is difficult to keep the seed boxes or trays clean (Balliu et al., 2017). Brower (1963) explained a functional balance between roots and shoots as connected growth, in which changes in shoot growth rate are reflected in the roots and inversely, therefore, to prevent these difficulties, it is preferable to grow tomato seedlings on beds in a field nursery rather than utilizing containers like seed-boxes or trays to produce seedlings. Properly grown transplants have an impact on vegetable output. Successful vegetable cultivation depends heavily on healthy seedlings generated in an expert nursery, especially for transplanted crops like tomatoes (Lin et al., 2015). Transplants are considered good quality when they are free of disease and pest infections, have the potential to live in difficult settings after transplanting, have a good root system, and contain a leaf area without any visible problems (Weston & Zandstra, 1989). Air humidity, CO2, culture techniques, light, Temperature, water availability, all of which are directly impacted by the density of seedlings, which is represented in the number of seeds, including the planting space between rows, where fragile and weak seedlings may emerge as a result of shading and then have an impact on the quality of transplants (Brazaitytė et al., 2010; Juknys et al., 2011; Lin et al., 2015; Paul & Metzger, 2005).A vegetable nursery is a location or facility where immature vegetable seedlings are raised or handled until they are suitable for more permanent planting (Bharathi & Ravishankar, 2018; Hassan, 1991), demonstrates that field nurseries must be in a pest-free environment so that pests do not attack seedlings, which are then transported to the permanent field. To avoid any harm, insecticides must be applied to the nursery site. According to the degree of levelness of the terrain in the field, field nurseries are constructed in the shape of beds with an area of 1 x 1, 2 x 2, or 2 x 3 meters. Planting in lines is ideal, as long as the spacing between them is 15-20 cm and the seeds are planted at a depth of 1.5 to 2 cm. Although heavy soils are not advised for nurseries, they can be utilized if required by covering the seeds with a mixture of sand and gravel. In the other hand, to tackle the management issues that nursery farmers encounter, further study is needed.

Nurseries had received no training, and various technical issues were discovered, affecting their profitability as well as the quality of seedlings delivered to farmers. Because the majority of crop varieties were open-pollinated, farmers used to generate their own seedlings for transplanting at a reduced cost. To boost output, most commercial farmers are turning to intensive vegetable growing with high-yielding F1 hybrids. Because these hybrid seeds are so expensive, it's critical to turn each seed into a healthy seedling, which necessitates meticulous nursery care. In most progressing nations, vegetable seedling production is done by specialist farmers or companies (Bharathi & Ravishankar, 2018).

Seeding rate and plant density, based to (Yucel, 2013), are major factors impacting vegetable crop output and quality. Increased sowing rates, according to the same scientist, may improve agricultural competitiveness. Crop profitability, on the other hand, may or may not improve as a result of the high seed cost. However, there were no significant impacts of plant densities on pea plant height and other examined attributes, according to (Barary et al., 1996; Ibrahim et al., 2019). In Agadir, Morocco, a study was conducted where three separate plant densities of two processing tomato varieties (Heinz 1370 and Rio Grande) were examined over two seasons in sandy loam soil (Elattir, 2002). The spacing separated between single seed lines and between seed line clusters were 1.3 meters and 0.25 meters, respectively. Seedlings were reduced to one, two, or three plants per clump at the second true-leaf phase, resulting in plant densities of 30400, 60800, and 91200 plants.ha^{-1}, correspondingly. With increasing plant density, the number of clusters per m^2 grew dramatically, with no differences across varieties. The maximum plant density enhanced yield by 40% as compared to the control (30400 plants. ha-1), with no significant variation across cultivars. Under high plant density, the Rio Grande variety produced a significant early yield. When the plant density rose, the average fruit weight fell. Researches are currently intended to familiarize tomato producers with effective nursery management procedures for developing healthy tomato seedlings and to encourage the use of healthy seedling preparation strategies to improve tomato yields. So, the aim of this study is to produce tomatoes seedlings with good characteristics for summer and fall seedlings seasons in field nurseries by investigating three plant distances and two levels of seed rate in the field nursery at Omar Al-Mukhtar University, Al-Jabal Al-Khader, Libya.

MATERIALS AND METHODS

The study was conducted at the farm of the Department of Horticulture, Faculty of Agriculture, Omar Al-Mukhtar University, Al-Jabal Al-Khaderin 2016 to investigate the impact of seeding rates and planting distances and the interaction between them on germination, vegetative growth and quality of tomato cv. Rio Grande **(**Syngenta , Cairo, Egypt**)** seedlings. Two seed rates of 100 and 150% of the recommended rates were used as well as three planting distances (10, 15, 20 cm) between the lines in addition to the scattering treatment. The nursery site soil characteristics display in Table 1.

Table: (1). Soil characteristics and properties.

Measurements		
Particle Size distribution	Sand (%)	14.25
	Silt (%)	51.15
	Clay (%)	34.6
Organic Matter (%)		2.3
E.C (Mmhos/ cm)		1.36
Total Nitrogen (%)		0.21
Soil pH		7.87
CO_3^{--}%		1.35
P ppm		115

Data collected at the region of the Department of Horticulture, Faculty of Agriculture, Omar Al-Mukhtar University

Experimental Design: The experiment was carried out using completely random plots using split plot designs in three replications, where the main plots were assigned to the two seed rates (100 and 150% of the recommended rates), and the sub-plots to the coefficients of planting distances (10, 15, 20 cm) and addition to scattering. The levels of each factor were randomly distributed within the plots with cultivation of two seedbeds, so that each replicate included 8 factorial treatments (2 seeding rate * 4 planting distances).

Fieldwork: 3 beds with dimensions of 4x 1m are well-equipped, and the weight of the seeds needed for planting in 1 m was prepared and calculated, as well as the weight of the seeds needed for planting per square meter. Beds were planned according to the studied planting distances and were distributed randomly within the experimental units. Three lines were planted in each experimental unit, and after irrigation, the beds were covered with plastic strips until germination was complete. The service operations were carried out by irrigation and purification of weeds. The seedlings were also fertilized by spraying with urea solution (150 mg N/L).After 45 days of planting, samples were taken (5 seedlings always from the middle line).

Studied Traits: The response of the seedlings to the effect of the treatments under study was estimated on 5 seedlings that were randomly selected from the middle line of each treatment in the three replicates, then the following measurements were recorded as an average of five representatives: Fresh and dry weight for seedlings, leaves and stems, number of days for germination, number of leaves/ plant, seedlings height, and chlorophyll content. Total chlorophyll content of leaves (100 mg) was determined by extracting chlorophyll by acetone (80%) and quantified by absorption spectrometry using a tomographic analyzer at wavelengths (645, 653, 666) nm (Laval-Martin, 1979).

Data Analysis: JMP was used to examine all of the data (Version 11.0 for Windows; SAS Institute, Cary, NC). In all cases, Levene's test was used to determine homogeneity of variances, and the Shapiro-Wilk test was used to confirm normality (W> 0.80). By employing square root or log transformations, certain data were changed before analysis to fulfill the requirements of normality and equality of variance. The LSMeans Student's test was used to compare treatment means at 0.05.

RESULTS AND DISCUSSION

Fresh and dry weight of seedlings, leaves, and stems were not significantly affected by seed rates (100 and 150% of the recommended rates) investigated in this experiment (Table 2).The dry matter weight of seedlings was significantly higher for the scattering treatment than the other planting distances investigated in the current study. This outcome might have been caused by the enhanced seedling growth at the other broadening planting distances, which had relatively easy access to environmental resources such as water, light and essential minerals than those in a scattering population. This, in turn, probably led to higher water content and a lower accumulation of dry matter and may have been the cause of the observed results. From another angle, this finding can be supported by the hypothesis of dilution (Greenwood et al., 1990), where increasing planting spacing, resulted in higher water content and lower dry matter accumulation.

Number of days for germination was affected by seed rates as well as planting distances examined in the current study, where the treatment of scattering differed from the rest of the other treatments, as it achieved the least number of days for germination, as well as with 150% of the recommended rates (Figure 1). where the crowding of the seeds with each other in the scattering treatment enhances their cooperation with each other in raising the soil cover and increasing the speed of their germination more than the seeds that are less crowded in the other studied treatments, likewise, number of seeds can show considerable variation within germination, since increasing the number of seeds is often associated with the highest survival. This finding concurred with that of (Elattir, 2002) in which under high plant density, the Rio Grande variety produced a significant early yield, in other words, the maximum plant density enhanced yield by 40% as compared to the control, and thus, this finding may be an important consideration for developing a management plan and addressing the early tomato production issues at Al-Jabal Al-Khader area.

Table(:2). Mean fresh and dry weight for the tomato seedlings cv. Rio Grande, leaves and stems, under different seed rates and different planting distances were used as well as the scattering treatment.

			Seedling Weight[z]			
Weight (g)	Seed rate[y]	scattering	10 cm	15 cm	20 cm	average
	First rate	1.30 a[x]	1.32 a	1.02 a	0.96 b	1.04 A
Fresh	Second rate	1.00 a	1.04 a	1.10 a	1.09 a	1.06 A
	Average	1.15 A	1.18 A	1.06 A	1.03 A	NA
	First rate	0.30 a	0.25 a	0.29 ab	0.19 b	0.25 A
Dry	Second rate	0.35 a	0.29 ab	0.25 ab	0.31 a	0.30 A
	Average	0.33 A	0.27 B	0.27 B	0.25 AB	NA
LEAVES						
	Seed rate	scattering	10 cm	15 cm	20 cm	average
	First rate	0.74 a	0.77 a	0.68 a	0.91 a	0.77 A
Fresh	Second rate	0.92 a	0.54 b	0.86 a	0.54 b	0.72 A
	Average	0.83 A	0.65 B	0.76 A	0.72 A	NA
	First rate	0.24 a	0.17 ab	0.25 a	0.26 a	0.23 A
Dry	Second rate	0.25 a	0.26 a	0.14 b	0.23 a	0.22 A
	Average	7.10 A	0.23 A	0.20 A	0.25 A	NA
STEM						
	Seed rate	scattering	10 cm	15 cm	20 cm	average
	First rate	0.47 a	0.46 b	0.47 a	0.32 ab	0.33 A
Fresh	Second rate	0.32 ab	0.34 ab	0.18 b	0.19 ab	0.25A
	Average	0.40 A	0.20 B	0.33 A	0.26 AB	NA
	First rate	0.20 a	0.14 b	0.10 b	0.11 b	0.14 A
Dry	Second rate	0.10 b	0.10 b	0.12 b	0.14 b	0.12 A
	Average	0.16 A	0.12 A	0.11 A	0.12 A	NA

[z]All data were subjected to analysis of variance using ANOVA in JMP (version 11.0 for Windows; SAS Institute, Cary, NC).
[y]Seed rates are100% (First rate) and 150% (Second rate) of the recommended rates were used as well as three planting distances (10, 15, 20 cm) between the lines in addition to the scattering treatment (control).
[x]Means followed by the same letter within sampling date are not significantly different at $P<0.05$.

The main factor seed rates evaluated in this experiment had no significant effect on the total number of leaves per seedling (Figure2). However, it tended to be significantly different due to the planting distances tested in the current experiment, wherewith the 20 cm planting distance the total number of leaves per seedling was greater than the other distances investigated in this study. The greater number of leaves per seedling with 20 cm planting distance evaluated in the current experiment is likely owing to the plants in a wider spacing having easier access to environmental resources included water, light, and nutrients than those in a denser population (Berhane et al., 2016). There was no significant difference between seed rates as well

as planting distances tested in this research for seedlings height (cm) (Figure 3).

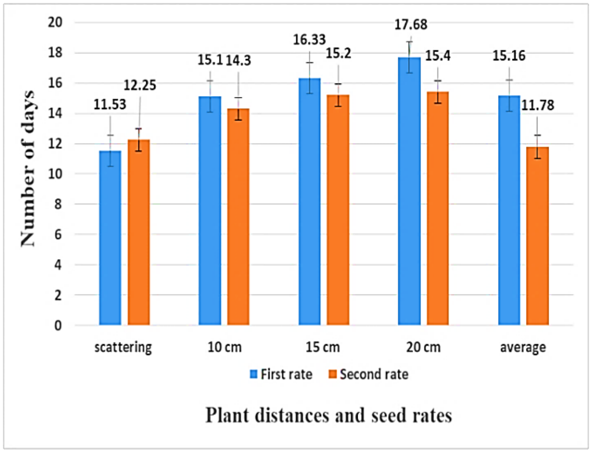

Figure: (1). Number of days for germination tomato seedlings cv. Rio Grande under different seed rates and different planting distances were used as well as the scattering treatment.

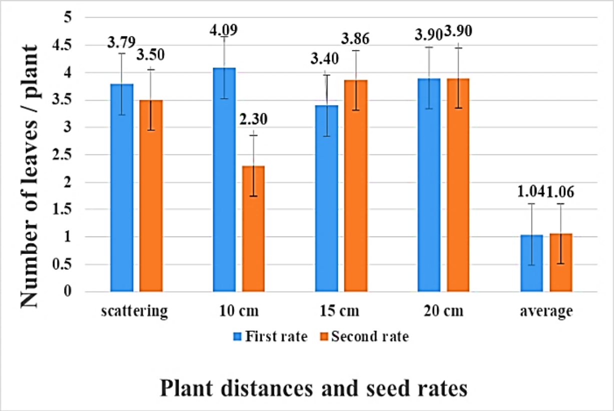

Figure: (2). Number of leaves per plant for tomato seedlings cv. Rio Grandeunder different seed rates and different planting distances were used as well as the scattering treatment.

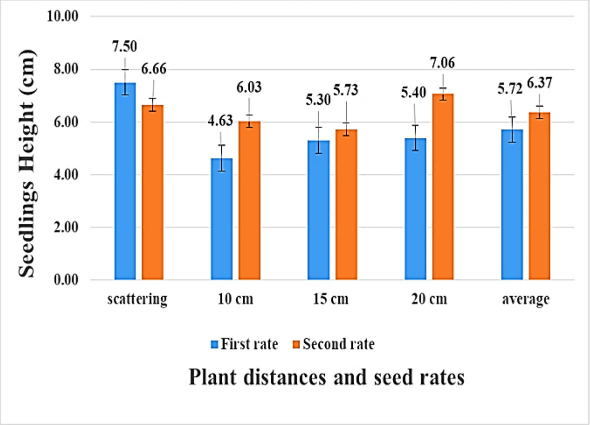

Figure: (3). Plant height for tomato seedlings cv. Rio Grande under different seed rates and different planting distances were used as well as the scattering treatment.

This finding is similar to (Barary et al., 1996; Ibrahim et al., 2019) that found there were no significant impacts of plant densities on pea plant height and other examined attributes. Chlorophyll content for tomato seedlings examined in this experiment was not significantly affected by seed rate treatment, but it was higher for 20 cm planting distance as compared to the other planting distances investigated in the current study (Figure 4). As previously explained is likely owing to the plants in a wider spacing having easier access to environmental and natural resources such as water, light, and nutrients than those with more population density (Berhane et al., 2016), suggesting that chlorophyll content analysis is a sensitive indicator of plant nutrient status, and maybe a useful and efficient tool to evaluate tomato seedlings nutrients status.

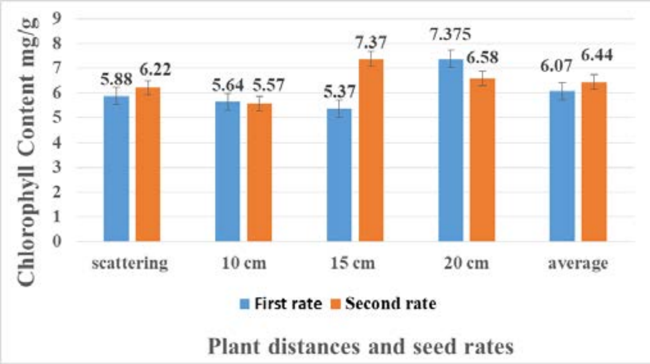

Figure: (4). Chlorophyll content for tomato seedlings cv. Rio Grandeunder different seed rates and different planting distances were used as well as the scattering treatment.

CONCLUSION

This result suggests that planting tomato seedlings at a 20 cm distance can improve tomato seedlings' growth in open field nurseries in the region by enhancing access to natural and environmental supplies including water, sunshine, and nutrition. This finding may be an important consideration for developing an annual management plan and addressing long-term issues for tomato seedlings production in open nurseries in Al-Jabal Al-Khader area. Further, results from the present study indicate that the seed rates in an open field nursery are not critical for tomato seedlings production in the region. As tomato is commonly grown in the whole world, and demand for tomato seedlings is increasing each year in Libya, more research is needed to determine the optimal seed rates as well as planting distances in open field nurseries production under Al-Jabal Al-Khader conditions.

ACKNOWLEDGEMENT

We owed a deep of gratitude to all those who helped us in this study to collect the information and data, particularly the faculty members in the Horticulture Department, Faculty of Agriculture, Omar Al-Mukhtar University, Al-Bayda, Libya, who always support us and provide the Professional guidance and suggestions.

Duality of interest: The authors declare that they have no duality of interest associated with this manuscript.

Author contributions: Fatma Mohamed conceived and designed the study, and supervised the fieldwork with support and help from Fayrouz Buojaylah and Alsunousi Masoud. Fayrouz Buojaylah took the lead in writing the manuscript in consultation with Fatma Mohamed and Alsunousi Masoud. Alsunousi Masoud performed the measurement and collected the data with support from Fayrouz Buojaylah and Fatma Mohamed. All the authors involved in this manuscript performed the laboratory work, data analysis, and approved the final version of the manuscript together.

Funding: This work was funded by Omar Al-Mukhtar University, Department of Horticulture, Al Bayda, Libya..

REFERENCES

Balliu, A., MarŠić, N., & Gruda, N. (2017). Seedling production. *Good Agricultural Practices for Greenhouse Vegetable Production in the South East European Countries—Principles for Sustainable Intensification of Smallholder Farms*, 189-206.

Barary, M., Mazaheri, D., & Banai, T. (1996). The effect of row and plant spacing on the growth and yield of chickpea (Cicer arietinum L.). *Aus J Exp Agric, 34*, 421-426.

Berhane, S., Hayelom, B., Gebremeskel, G., & Kasaye, A. (2016). Determination of planting spacing for improved yield and yield components of Dekoko (Pisum sativum var. abyssinicum) at Raya Valley, Northern Ethiopia. *African Journal of Plant Science, 10*(8), 157-161.

Bharathi, P., & Ravishankar, M. (2018). *Vegetable nursery and seedling management guide for South and Central India*.

Brazaitytė, A., Duchovskis, P., Urbonavičiūtė, A., Samuolienė, G., Jankauskienė, J., Sakalauskaitė, J., Šabajevienė, G., Sirtautas, R., & Novičkovas, A. (2010). The effect of light-emitting diodes lighting on the growth of tomato transplants. *Zemdirbyste-Agriculture, 97*(2), 89-98.

Elattir, H. (2002). Plant density effects on processing tomato grown in Morocco. VIII International Symposium on the Processing Tomato 613,

FAO, F. (2014). Food and agriculture organization of the United Nations. *Rome, URL: http://faostat. fao. org*.

FAO, F. (2021). Food and agriculture organization of the United Nations. *Rome, URL: http://faostat. fao. org*.

Greenwood, D., Lemaire, G., Gosse, G., Cruz, P., Draycott, A., & Neeteson, J. (1990). Decline in percentage N of C3 and C4 crops with increasing plant mass. *Annals of botany, 66*(4), 425-436.

Hassan, A. (1991). Fundamentals of plant breeding. Arabic chamber for publication and Distribution, Cairo, Egypt.

Hayslip, N. (1974). *A plug-mix'seeding method for field planting tomatoes* *and other small-seeded hill crops. Univ. of Fla., Fort Pierce ARC Mimeo Rep*.

Hochmuth, G. J. (1988). *Tomato production guide for Florida*.

Ibrahim, D. M., Mohamed, S. J., & Ahmed, S. M. (2019). Effects of plant density on seed yield and it's components of two pea (Pisum sativum L.) cultivars under rainfed condition in Sulaimani province. *Journal of Kerbala for Agricultural Sciences, 6*(1), 36-48.

Irungu, J. (2011). Contribution of horticulture to food security in Kenya. *Acta Horticulturae,* 911, 27–32.

Juknys, R., Duchovskis, P., Sliesaravičius, A., Šlepetys, J., Januškaitienė, I., Brazaitytė, A., Ramaškevičienė, A., Lazauskas, S., Dėdelienė, K., & Sakalauskaitė, J. (2011). Response of different agricultural plants to elevated CO2 and air temperature. *Žemdirbystė (Agriculture), 98*(3), 259-266.

Laval-Martin, D. (1979). Physiologie végétale, TP et TD, Danielle Laval-Martin, Paul Mazliak.

Lin, L., Luther, G. C., & Hanson, P. (2015). Raising healthy tomato seedlings. *AVRDC–The World Vegetable Center publication*, 15-795.

Paul, L. C., & Metzger, J. D. (2005). Impact of vermicompost on vegetable transplant quality. *HortScience, 40*(7), 2020-2023.

Weston, L. A., & Zandstra, B. H. (1989). Transplant age and N and P nutrition effects on growth and yield of tomatoes. *HortScience, 24*(1), 88-90.

Yucel, D. O. (2013). Impact of plant density on yield and yield components of pea (Pisum sativum ssp. sativum L.) cultivars. *Journal of Agricultural and Biological Science, 8*(2), 169-174.