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Seedling Emergence of Romanian Tomato and Pepper Varieties

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Abstract

Nowadays, more than ever, people are turning to sustainable/ecological agriculture. Romanian local varieties with valuable traits can be used to develop novel organic improved varieties. Nine Romanian tomato (*Solanum lycopersicum* L.) varieties and seven pepper (*Capsicum annuum* L.) varieties were compared during seedling emergence in the growth chamber and greenhouse conditions. The aim of the present study is to observe the variation of emergence indicators, differences that can be correlated with genotype variation in ulterior genotyping research, with the final goal of using these results as a basis for genotype-assisted breeding programs.Several indicators such as percentage of emergence, mean emergence time, mean emergence rate, homogeneity and synchrony were calculated, and differences among varieties assessed by ANOVA.The present survey demonstrated significant differences in the emergence indicators studied, results that can be used in further genotyping studies.

Keywords: *Capsicum***,** emergence, germination, Romanian varieties, *Solanum*

Introduction

Healthy food is one of the main concerns of today's society (Coe et al., 2019), so people are turning to ecological labeled products for consume (Tobler et al., 2011). Therefore, researchers are looking to develop novel organic varieties with superior traits, based on consumer preferences (Rocha et al., 2013). In Romania, tomato is the most cultivated vegetable species (Zamfir et al., 2017). Organic tomatoes have high content of bioactive compounds, such as carotenoid and lycopen content (Bujor et al., 2019; Dobrin et al., 2019).

In present varieties, many times desirable traits come with the cost of less desirable traits such as low percentage of emergence (Foolad and Panthee, 2012). Khan et al. (2012) have identified 62 major Quantitative Trait Loci (QTLs) on 21 different positions for seed, seedlings, and root system architecture traits in a tomato.By correlating the differences in emergence indicators with the results of genotyping studies, breeder can select plants with multiple desirable traits in genotype-assisted breeding programs (Kim et al., 2016).

Following seeds germination, the seedlings have to penetrate the soil in order to reach light and be able to start photosynthesis (Briggs, 2016). Emergence is defined as the point in time when the seedlings stop to relay on the seed parental reserves and starts autotrophic nutrition by photosynthesis (Forcella et al., 2000). Seedlings emergence can be characterized using several indicators: percentage of emergence, mean emmergence time, homogeneity, mean emergence rate, uncertainty and sinchrony of emergence (Ranal et al., 2009). The percentage of emergence is based on a binary answer (emerged/not emerged). Mean emergence time represents the time spent by the seedling to emerge.

Homogeneity of emergence measures the seed variability in relation to the mean emergence time, and emergence synchrony and uncertainty are two indicators of emergence synchrony (Ranaland Santana, 2006).

In this survey, nine tomato varieties and seven pepper varieties were assesed during seedling emergence process in the growth chamber and in the greenhouse.

Materials and methods

Plant material

Tomato seeds from varieties Argeș 11, Argeș 20, Ștefănești 24 and Ștefănești 22 were received from I.N.C.D.B.H. Ștefănești-Argeș and tomato seeds from varieties Kristinica, Florina 44, Andrada, Buzău 1600, and Buzău 47 as well as pepper seeds from varieties

Decebal, Vladimir, Galben Superior, Splendens, Cosmin, Roial, and Cantemir were received from S.C.D.L. Buzău.

Sedling emergence measurements

Seeds were sown on Kekkila brown OPM 0.25W substrate in trays with 7x10 cells. Seedlings were considered emerged when the apical hook (Fig. 1A)was visible above the soil. Seedling emergence was counted once a day, and the process was considered finished when no new seedlings emerged for three days in a row.

In the growth chamber Memmert HPP 750 (Fig. 1B), the experiment was carried out at 80% humidity, constant temperature of 22˚C, and 14 hours day/10 hours night conditions. In the greenhouse (Fig. 1C), the experiment was carried out at natural light conditions, temperatureof 23-27°C daytime/17-18°C nighttime, and an average of 55% humidity. For each variety were used three replications, with 23 seeds in each replication. Physiological indicators associated with seedling elergencewere calculated following the procedure described in Ranal et al. (2009).

Results and discussions

Tomato seedling emergence

Nine tomato varieties were used compared for several physiological indicators of seedling emergence: percentage of emergence, mean emergence time, homogeneity, mean emergence rate, uncertainty of emergence and emergence synchrony (Fig. 2).

In the growth chamber, in the case of percentage of emergence, over 80%emergencewas observed for the Florina 44, Andrada and Buzau 47 vaieties, whereas the Argeș 11 variety displayed the lowest percentage of emergence (22.9%). The longest mean emergence time was observed for Ștefănești 24 variety (~13 days).

All the other varieties emerged between 5 and 7 days. In the case of homogeneity, expressed by the coeficient of variation of the emergence, there were no significant differences among the varieties studied at $P<0.05$, except for Florina 44, which had a value significantly higher than Andrada and Argeș 11 at $P<0.05$. Mean emergence rate varied significantly among the tomato varieties. The highest value for the emergence rate was observed for the Florina 44 (0.21 day^{-1}), whereas the lowest emergence rate was observed for Ștefănești 24 (0.07 day^{-1}). In the case of uncertainty of emergence, the highest value was observed for Ștefănești 24 variety (2.64 bit) and the lowest value for the Buzău 47 variety (1.11 bit). The highest synchrony value was detected for the Buzău 47 variety (0,58) whereas the lowest value was detected for the Ștefănești 24 variety (0.09).

In the greenhouse, over 80% emergence was observed for the Florina 44, Andrada, Buzau 47 and Ștefănești 22 varieties, whereas the Ștefănești 24 variety displayed the lowest percentage of emergence (34,4%).The longest mean emergence time was observed for Ștefănești 24 variety (~17 days). All the other varieties emerged between 8 and 10 days. In the case of homogeneity, expressed by the coeficient of variation of the emergence, there were no significant differences among the varieties studied at $P<0.05$. Mean emergence rate varied significantly among the tomato varieties. The lowest value for the emergence rate was observed for the Ștefănești 24 (0,06day^{-1}), whereas all the other varieties had values of 0.10-0.12 day^{-1}. In the case of uncertainty of emergence, the highest value was observed for Ștefănești 24 variety (2.51 bit) and the lowest value for the Florina 44 variety (0.23 bit). The highest synchrony value was detected for the Florina 44 variety (0,84) whereas the lowest value was detected for the Ștefănești 24 variety (0.07).

Pepper seedling emergence

Seven pepper varieties were used compared for several physiological indicators of seedling emergence: percentage of emergence, mean emergence time, homogeneity, mean emergence rate, uncertainty of emergence and emergence sinchrony (Fig. 3).

In the growth chamber, the highest percentage of emergence was observed for the varieties Galben Superior (89.9%), Splendens (78.8%) and Cosmin (92,8%), whereas the lowest percentage of emergence was observed for the Vladimir variety (10.00%).

The shortest mean emergencewas noted for the Roialvariety (~9 days), and the longest emergence time was noted for Decebal variety (~22 days). For the rest of the varieties, the mean emergence time values were between 12-17 days. The highest values for homogeneity were noted for Splendes (36.6) and Cantemir (36.9) varieties, whereas the lowest value was noted for the Vladimir (6.5) variety.

The highest mean emergence rate was observed for the Roial variety (0.11 day^{-1}), and the lowest emergence rate was observed for the Decebal variety (0.08 day^{-1}). The highest value for the uncertainty was observed for Cosmin variety (3.20 bit) and the lowest value for the Vladimir variety (0.92 bit). The highest sinchrony value was detected for the Vladimir variety (0.33) whereas the lowest value was detected for the Decebal and Cosmin varieties (0.08).

In the greenhouse, four varieties displayed over 90% percentage of emergence: Galben Superior (97.2%), Cosmin (94.3%), Roial (91.5%) andCantemir (92.9%). The lowest percentage of emergence was observed for Vladimir (12.9%). The shortest mean emergence was noted for the Roial variety (~10 days), and the longest emergence time was noted for Vladimir variety (~18 days) (Fig.4). For the rest of the varieties, the mean emergence time values were between 12-16 days.

The highest valuefor homogeneity was noted for Decebal (15.9) whereas the lowest value was noted for the Galben Superiorvariety (7.6). The highest mean emergence rate was

observed for the Roial variety (0.10 day^{-1}), and the lowest emergence rate was observed for the Vladimir variety (0.05 day^{-1}). The highest value for the uncertainty was observed for Decebal variety (2.66 bit) and the lowest value for the Vladimir variety (1.14 bit). The highest sinchrony value was detected for the Galben Superior variety (0.29) whereas the lowest value was detected for the Decebal variety (0.11). For both tomato and peppers, for most varieties, the values of indicators such as percentage of emergence, mean emergence time and sinchrony were higher in the greenhouse than in the growth chamber. These results may be due to the different temperature and humidity conditions (Weaver et al., 1988).

Conclusions

Significant differences in the seedling emergence indicators were observed among both the tomato and pepper varieties studied both in growth chamber and in greenhouse.

In the case of tomato, for most varieties the percentage of emergence was higher in the greenhouse as opposed to the growth chamber conditions, with the exception of Ștefănești 24 variety, that displayed a lower percentage of emergence in the greenhouse. A significant difference at was observed for Argeș 11 (22.9% growth chamber vs. 77.2% greenhouse) and Ștefănești 22 (48,6% growth chamber vs. 81,2% greenhouse).

For all varieties, the mean emergence time was longer in the greenhouse than in the growth chamber and the values of mean emergence rate were smaller in the greenhouse than in the growth chamber. Homogeneity and certainty values were similar or lower in the greenhouse as opposed to the growth chamber, whereas sinchrony values were similar or higher in the greenhouse compared to the growth chamber. Ștefănești 24 displayed the longest mean emergence time and lowest mean emergence rate, lowest sinchrony and highest uncertainty of emergence.

In the case of pepper, for most varieties, the values for the percentage of emergence, mean emergence time, and sinchrony were similar or higher in greenhouse as compared to growth chamber. On the other hand, the values for homogeneity, mean emergence rate and uncertainty were similar or lower in the greenhouse compared to the growth chamber. The exception is the variety Decebal, which had percentage of emergence, mean emergence time, and sinchronylower values and homogeneity, mean emergence rate and uncertainty higher values in the greenhouase as compared to the growth chamber. Among the pepper varieties studied, Vladimir showed the lowest values for percentage of emergence (10.0% growth chamber/12.9% greenhouse), homogeneity (6.5/13.7) and uncertainty of emergence (0.9/1.1).

Romanian consumers prefer to consume local tomato and pepper varieties, so breeding programs are delivering new varieties using local landraces that are well adapted to the local ecological conditions. For instance, one of the varieties of pepper from the present study was patended in 2015 from the 'CornulCaprei' landrace, which has been cultivated in Buzău region for more than 200 years (Tudor et al. 2019) and shows an improved yield compared to the original landrace. Also in the case of tomato, Kristinica, the first variety patented by the V.R.D.S Buzău for industry, the fruits have over 30 days shelf life (Vînătoru et al., 2016). Tomato germplasm colection at V.R.D.S. Buzău has over 1500 genotypes (Zamfir et al., 2017). In the future, further genotyping studies are needed to correlate the phenotyping traits studied in this survey with DNA sequence differences, in order to select plants with multiple superior traits in genotype-assisted breeding programs, with the final goal of creating novel ecological varieties of tomato and pepper, which will appeal to the Romanian consumers.

Acknowledgments

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Figure 1.A. Emerged seedling.B. Trays with seeds in the growth chamber. C. Trays with seedlings in the greenhouse

95x85mm (150 x 150 DPI)

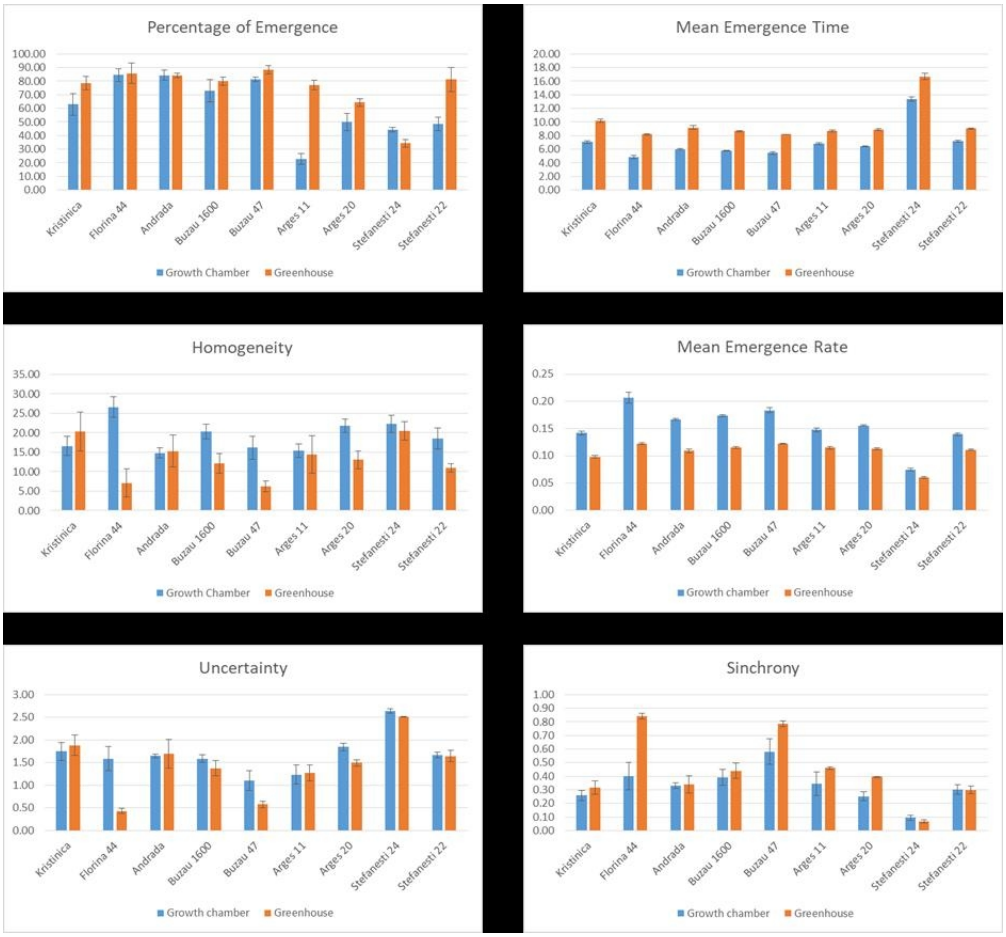

Figure 2. Seedling emergence indicators for the nine tomato varieties studied: Kristinica, Florina 44, Andrada, Buzău 1600, Buzău 47, Argeș11, Argeș 20, Ștefănești 24, Ștefănești 22. Error bars represent standard error on the mean.

158x147mm (150 x 150 DPI)

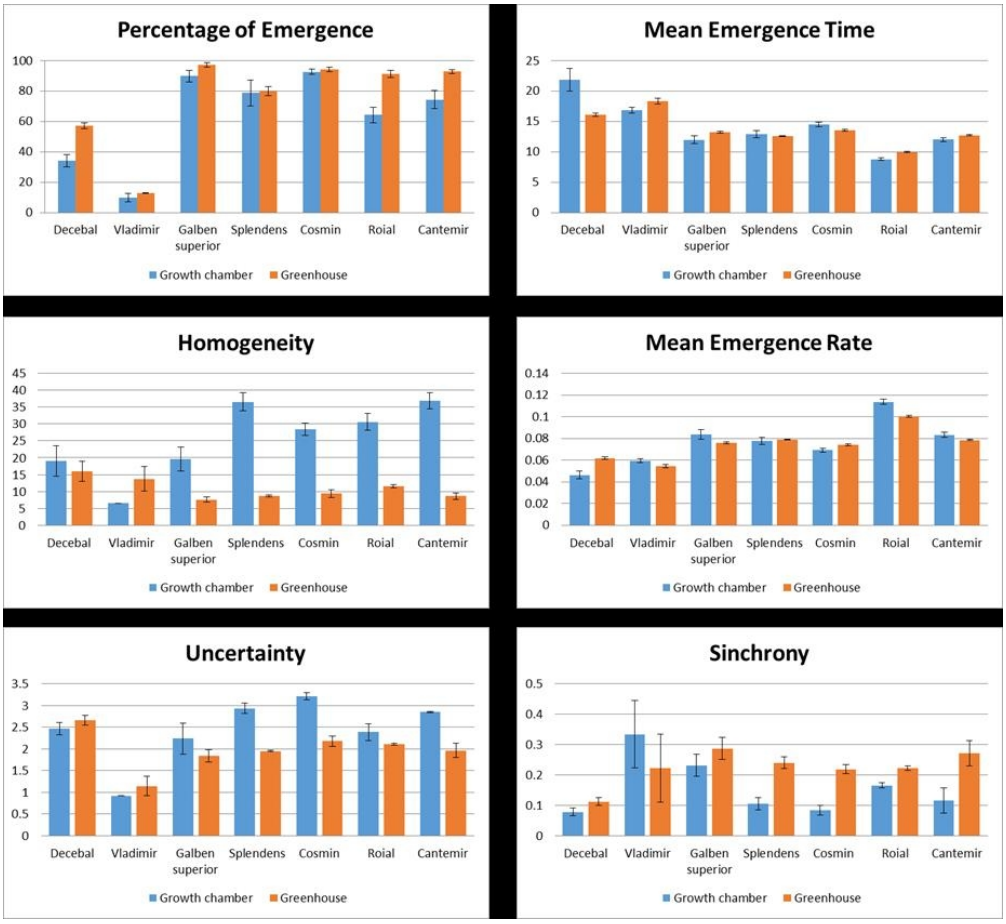

Figure 3. Seedling emergence indicators for the nine tomato varieties studied: Kristinica, Florina 44, Andrada, Buzău 1600, Buzău 47, Argeș11, Argeș 20, Ștefănești 24, Ștefănești 22. Error bars represent standard error on the mean.

156x143mm (150 x 150 DPI)

Figure.4 Seedling emergence after 14-18 days in the growth chamber and greenhouse.

138x69mm (150 x 150 DPI)