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Araştırma Makalesi

Evaluation of Emergence of Seeds of Some Edible Flowers Using Different Parameters

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Keywords

Edible flower, Emergence index, Emergence time

Abstract: In the study, the emergence power of 4 different edible flower seeds was determined using different parameters. It has been observed that final emergence percentage alone is not sufficient to express the emergence characteristics of the seed. When evaluated in terms of final emergence percentage, while calendula, red nasturtium and yellow nasturtium seeds had similar seed emergence, electric flower seeds had less emergence compared to the others. Considering the average emergence time, it was determined that nasturtium seeds emerged faster and more homogeneously compared to calendula and electric flower. In the study, germination index, emergence rate coefficient, emergence rate index values were calculated and it was determined that red and yellow nasturtium had better seed emergence in terms of these values compared to calendula and electric flower. As a result of the study, it was determined that final germination or emergence percentage alone was not sufficient to define the germination characteristics of seeds, and that determining at least one of the parameters such as germination index, emergence rate coefficient or emergence rate index in addition to the final emergence percentage would provide more reliable results.

Farklı Parametreler Kullanılarak Bazı Yenilebilir Çiçeklere Ait Tohumların Çıkış Oranlarının Değerlendirilmesi

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Anahtar Kelimeler

Yenilebilir Çiçek, Çıkış İndeksi,

Öz: Çalışmada, 4 farklı yenilebilir çiçek tohumlarının çıkış gücü farklı parametreler kullanılarak belirlenmiştir. Tek başına tohum çıkış oranının tohumun çıkış özelliklerini ifade etmede yeterli olmadığı görülmüştür. Çıkış oranı değerlendirildiğinde kalendula, kırmızı Latin ve sarı Latin çiçeği tohumlarında benzer oranda tohum çıkışının olduğu, elektrik çiçeği tohumlarında ise diğerlerine kıyasla daha az çıkış olmuştur. Ortalama çıkış süresi dikkate alındığında ise kalendula ve elektrik çiçeğine kıyasla Latin çiçeği tohumlarının daha hızlı ve daha homojen bir çıkış yaptığı belirlenmiştir. Çalışmada ayrıca çimlenme indeksi, çıkış hızı katsayısı, çıkış

Çıkış Süresi

oranı indeksi değerleri hesaplanmış ve bu değerler bakımından kalendula ve elektrik çiçeğine kıyasla kırmızı ve sarı Latin çiçeğinde daha iyi bir tohum çıkışının olduğu tespit edilmiştir. Çalışma sonucunda, tohum çimlenme veya tohum çıkışını tespit etmeye yönelik çalışmalarda tek başına çimlenme veya çıkış oranının yeterli olmadığı, son çıkış oranı yanında çimlenme indeksi, çıkış hızı katsayısı veya çıkış oranı indeksi gibi parametrelerden en az birisinin de belirlenmesinin daha güvenilir sonuçlar vereceği belirlenmiştir.

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1. Introduction

In many countries of the world, traditional dishes, desserts, and salads have been made using edible flowers for a long time (Fernandes et al., 2020). Nowadays, consumers search for new tastes, their longing for their previous lifestyles or the increase in awareness about the health benefits of the bioactive compounds contained in edible flowers have made edible flowers more popular. The increase in the number of cookbooks and culinary magazines containing recipes using edible flowers clearly shows that the interest in these plants is increasing (Rop et al., 2012). Additionally, some organic or gourmet markets have started selling fresh edible flowers in small packages, increasing consumer interest in this new trend. Again, in some restaurants, chefs have started to use edible flowers to add different tastes and colors to their dishes, drinks, or desserts (Fernandes et al., 2020).

Increasing interest in edible flowers has also led to an increase in the number of scientific articles published on these products. Although many scientific articles have been published on edible flowers, the majority of these articles discuss the health benefits and nutritional content of flowers. There are almost no studies on the cultivation techniques of these products. Since edible flowers are mostly grown with seeds, this study aimed to determine the emergence status of the seeds of some edible flowers.

Seed germination or emergence rate and speed affect cultural processes such as determining planting time, fertilization, ripening time of the product, and harvesting. It is suggested that high germination rate and seed strength provide an advantage to the plant in terms of stress resistance. (Kader and Jutzi 2002). In addition, the dynamics of the germination process, such as time, speed, homogeneity, and synchronization of germination, are indicators of the ecology in which any plant species will develop better (Scott et al., 1984; Ranal and Santana, 2006).

Many studies have been conducted on germination, which is an important stage of the plant life cycle. In most of these studies, it has been emphasized that only the final germination percentage will not be sufficient and it is also necessary to determine the germination velocity. Since simple approaches such as the final germination percentage make it difficult to evaluate the seed germination, more complex indices and coefficients have been used in scientific studies (Kader and Jutzi 2001, 2002; Grundy et al., 2000; Kader, 2005; Al-Ansari and Ksiksi, 2016; Fernandes et al., 2020).

In the seeds of higher plants, the term germination refers to the emergence of a root or shoot from the seed coat, while seed emergence means the shoot becomes visible above the soil surface. In studies conducted to determine the germination status of plant seeds, germination or emergence rate or both are used. In this study, seed emergence characteristics of four different edible flower species were determined with the help of some coefficients and indices developed to measure germination or emergence rate.

2. Material and Method

The experiment was carried out in an unheated greenhouse belonging to Tokat Gaziosmanpaşa University Research and Application Center. The study was carried out using four types of flower seeds, including yellow nasturtium (*Tropaeolum majus* L.), red nasturtium (*Tropaeolum majus* L.), calendula (*Calendula officinalis*), and electric flower (*Spilanthes oleracea*), which are frequently used among edible flowers. The seeds used in the study were obtained from a company that specifically produces organic edible flower seeds in the Netherlands.

The experiment was set up according to the random plot design with 3 replications and 100 seeds in each replication. At the end of the experiment, the data was analyzed (checking whether it met the necessary assumptions for variance analysis). Whether the differences between the treatments means were significant or not was determined by the Duncan Multiple Comparison Test.

The seeds were planted in viols filled with peat on April 14, 2022, without any pre-treatment. Viols in which seeds were planted were watered regularly to keep them constantly moist. Daily checks were made and the emerging plants were counted and recorded. The following parameters were calculated using the data obtained at the end of the experiment.

Final emercence percentage (FEP):

$$\mathrm{FEP}(\%) = \frac{\text{Total number of seeds emerged}}{\text{Number of seeds planted}}\, x100$$

Mean emergence time (MET): The formula developed by Orchard (1977) was used to calculate the mean germination time.

$$\mathrm{MET(day)} = \frac{\sum \mathrm{f.n}}{\sum \mathrm{f}}$$

where: f=n. Percentage of seeds emerging per day.

Emergence Index (EI): The formula developed by Bench Arnold et al. (1991) for the germination index was modified and used as follows.

EI= (g . n1) + ((g-1). n2) + ... (1 x ng)

Emergence index; The number of seeds hatched each day is multiplied by different weight scores. The highest score is given to the seeds produced on the first day, and the scores gradually decrease. The lowest score is given to the seeds produced on the last day.

In the formula, g = the time in days from seed sowing to the last seed emergence, n1, n2… ng = 1, 2 and g respectively. percentage of seeds hatched per day.

Emergence Rate Coefficient (ERC): According to Jones and Sanders (1987), it was calculated as follows.

$$\mathrm{ERC} = \frac{(\sum Ni).100}{\sum (Ni.Ti)}$$

Ni=i. Number of seeds released per day, Ti = from seed sowing i. passes day by day

Emergence Rate Index (ERI): Based on Kader (2005).

ERI (%/gün)=N1/1 + N2/2 + …….+ NX/X

N1 = Number of seeds hatched on the first day.

N2 = Number of seeds hatched on the second day.
Nx=X. number of seeds hatched per day

Emergence rate index; Indicator of the exit percentage for each day in my checkout process.

First Emergence Day (FED): The day on which the first seed emergence event occurred

Last Emergence Day (LED): The day on which the last seed emergence event occurred

Emergence Period (EP): The time in days between the first emergence and the last emergence.

3.3. Results and discussion

The emergence percentage of seeds depending on time is given in Figure 1. As can be seen from the figure, nasturtium seeds started to emerge earlier. The first emergence was observed on the 8th day in yellow nasturtium and on the 10th day in Red nasturtium. Compared to nasturtiums, calendula, and electric flower seeds started to emerge later. The seed emergence rate in all four edible flower species showed a steady increase over time. Red and yellow nasturtiums started to emerge at almost the same time and reached similar emergence rates at the end of the germination period. Although calendula seeds started to emerge relatively late, they reached the highest emergence rate with faster germination.

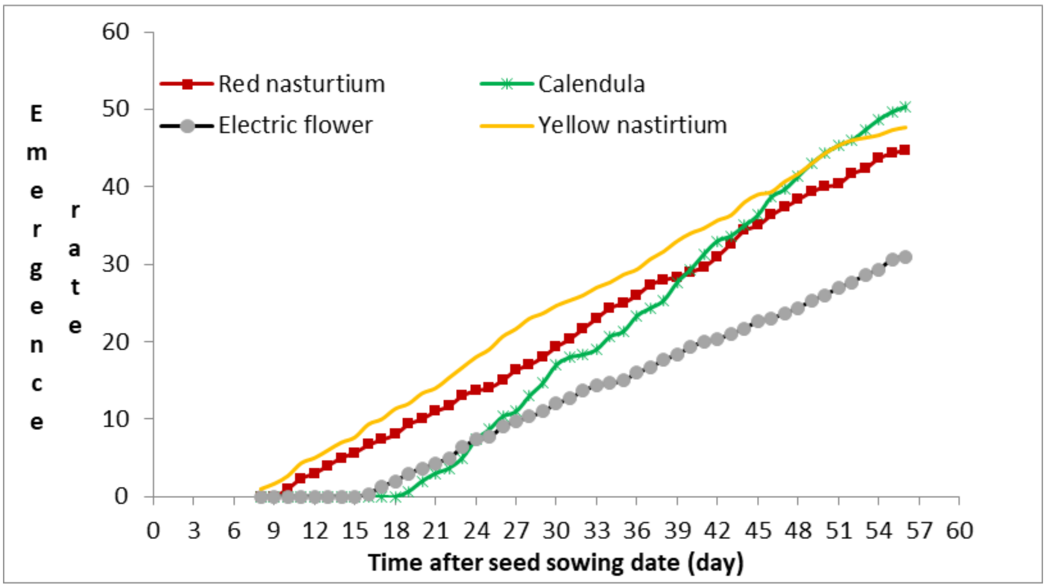

Figure 1: Time-dependent seed emergence rates of edible flower seeds.

Different formulas have been developed by researchers to measure the germination and emergence success of seeds. Some of these formules were used in this study. When the final emergence percentage (FEP) were compared, it was seen that electric flower seeds had a lower emergence percentage compared to other species. While 50.3% of calendula seeds reached the soil surface, this rate was found to be 31.3% in electric flower seeds. Yellow and red nasturtiums had an FEP of 48.0% and 45%, respectively. Mean emergence time (MET) is calculated in days, and a low MET value indicates a high emergence velocity. As a result of the evaluation made in this respect, it was seen that the emergence velocity of red and yellow nasturtiums, which have lower MET values, compared to calendula and electric flower, was higher. When the emergence index (EI) values reflecting emergence velocity rate and emergence rate, are compared, the highest value was obtained from yellow nasturtium and the lowest EI was obtained from electric flower. This result shows that when emergence rate and velocity are evaluated together, the best emergence is in yellow nasturtium seeds and the poorest emergence is in electric flower seeds. Emergence rate coefficient (ERC), another measure of seed emergence, increases as the number of seeds emerged increases and the time required for emergence decreases. This value reveals that yellow and red nasturtium seeds emerged better than calendula and electric flower seeds. Emergence rate and emergence velocity in seeds are also expressed by the emergence rate index (ERI). High ERI value indicates high and rapid emergence. In terms of this value, the best emergence was found in yellow nasturtium seeds and the weakest emergence was found in electric flower seeds. Compared to calendula and electric flower, yellow nasturtium and red nasturtiums started to emerge earlier. The first seed emerge was observed on the 8th day after sowing in yellow nasturtiums and approximately on the 10th day in red nasturtiums. This period was up to 16 days in electric flower and 20 days in calendula. No seed emergence was observed after the 56th day in any of the seeds of the four flowers examined in the study. The period between the date of the first seed emergence and the date of the last seed emergence is expressed as emergence period (EP). This period lasted 44 and 46 days for red nasturtiums and yellow nasturtiums, respectively. EP took approximately 38 days in electric flower seeds and 36 days in calendula seeds.

Table 1: Germination data of flowers

Flower species	**FEP (%)**	**MET (day)**	**EI**	**ERC**	**ERI (%/day)**	**FED (day)**	**LED (gün)**	**EP (day)**
Calendula	50.3 a	38.4 a	971.3 b	2.6 b	1.4 b	20.3 a	56.7 a	36.3 b
Electric	31.3 b	36.9 a	646.3 c	2.7 b	1.0 c	18.0 a	56.3 a	38.3 b
Yellow Nas.	48.0 a	31.7 b	1214.3 a	3.2 a	1.9 a	10.0 b	56.0 a	46.0 a
Red Nas.	45.0 a	33.9 b	1042.7 ab	3.0 a	1.6 b	12.3 b	56.3 a	44.0 a

*: Differences between means marked with the same letter are not significant (p<0.05).

(FEP: Final emercence percentage, MET: Mean emergence time, EI: Emergence index, ERC: Emergence rate coefficient, ERI: Emergence rate index, FED: First emergence day, LED: Last emergence day, EP: Emergence period)

There are no sufficient studies in the literature on the emergence rate of seeds of edible flowers. In very few studies, evaluations were generally made only by taking into account the final emergence percentage. For example, Ruiz De Clavijo (2005) and Joly et al. (2013), in their study where they examined the effects of different applications on the germination and emergence rates of calendula seeds, reported that the germination rates were high (70-95%) and the emergence rates were similar to the value obtained in this study. Molina et al. (2018) reported that the germination rate of nasturtium seeds could be increased with different applications, and found the emergence percentage in the control application to be around 45%. Fakava (1992) reported that the emergence percentage of nasturtium (*Tropaeolum majus* Linn.) varies between 11% and 63% depending on the time of seed collection and sowing frequency. Similar emergence percentages were obtained in this study.

No study has been found in the literature on the emergence of electric flower seeds. Honorio et al. (2011) examined the germination rate of electric flower seeds and reported that the germination rate varied between 50.9% and 69.5% depending on the medium used. In this study, the emergence percentage was measured and the emergence percentage of electric flower seeds was found to be 31.3%. In studies on seed performance, the emergence rate is generally lower than the germination rate, since the root tip coming out of the seed coat is referred to as germination and the plant rising to the soil surface is referred to as emergence. From this perspective, it can be said that the emergence percentage obtained from this study is not too low compared to the value obtained by Honório et al (2011). The results obtained reveal that it is not always appropriate to express the germination or emergence characteristics of seeds with the final emergence percentage alone. While there was no significant difference between calendula and nasturtiums in the evaluation made by taking into account the FEP, MET values showed that seed emergence in nasturtiums is faster. The MEP is a value that shows the output speed, and the lower this value is, the higher the output speed

(Kader, 2005). A similar situation can be said for EI, ERC, and ERI values, which express both emergence velocity and emergence output rate. These values mean that seed emergence is better in nasturtium plants. It has been seen that the coefficients and indices except the FEP are compatible with each other. While nasturtium seeds emerged earlier, the last seed emergence was completed almost on the same day in each four edible flower seeds. This caused the seed emergence period in calendula and electric flowers to be shorter than in nasturtium flowers. Similarly, in her study using hypothetical data, Kader (2005) emphasized that the final germination rate alone does not provide sufficient information about other germination dynamics such as germination speed and germination uniformity in seeds.

This study provides useful information about the germination abilities of some edible flower seeds, for which there is limited information in the literature, for those considering growing these plants. In addition, it has been seen once again that the final germination percentage is not sufficient to express the seed germination ability, and the final germination percentage alone does not provide information about the germination rate of the seeds. It has been determined that using one of the MEP, EI, ERC or ERI in addition to the final germination percentage to measure seed performance will provide more reliable results.

In this study using four different edible flower seeds, it was observed that the highest germination rate belonged to the calendula flower, with a rate of 50.3%. It was determined that the rate, which was 48% and 45% in yellow and red nasturtiums, respectively, was 31.3% in electric flower. Considering that there is not enough information about edible flowers, whose use is increasing day by day, it is thought that this study will be an effective literature for future studies. This study will serve as an incentive to conduct studies that will increase the germination rates of edible flower seeds.

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