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Introducing Seed Material Selection Method for the Increase of Tomato Seed Yield and Quality

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ABSTRACT

The aim of the research was to identify the most efficient cluster level and crop harvesting period (day) for tomato seed production, as well as to find out which seed breeding options will ensure higher quality indicators. The study objects were mid-early ripening tomato variety "Anahit 351" and mid-ripening varieties "Lia" and "Eraz".

Experimental results showed that tomato seeds taken from the fruit of second cluster after 10 days of ripening have provided highest seed weight, high germinability and germination energy meanwhile ensuring high productivity.

Introduction

Proper organization of theoretically justified seed production is almost missing in some agricultural areas of the Republic of Armenia. Today, seed breeding often refers to physical, chemical, and biological stimulants that improve seed sowing quality and efficiency (Ryabchikova, 2018).

Taking into account the rapidly changing production-economic and market conditions in our Republic, the scientific investigations on consistent seed breeding management methods and on a number of other issues related to various agricultural crops, including tomatoes, are of utmost importance.

The share of vegetable croplands, particularly tomatoes, in the agrarian system of the Republic of Armenia has significantly increased in recent years. Tomato occupies 21 % of the total sown areas of vegetable crops (20 616 ha) (www.armstat.am).

Tomato is the most popular vegetable crop. It is endowed with high taste properties and is rich in vitamins (*A, B, C, PP*), organic acids (citric acid and malic acid) and mineral salts (*Ca, Na, Mg, Fe* and etc.). It is used fresh and processed (Zuev, et al., 2016).

We have set up a task to research and identify the most effective cluster number and the period (day) for harvesting tomato seed crops, as well as to reveal the options where the seed yield would demonstrate high quality indicators.

Materials and methods

The current research was carried out on the experimental farm of "Scientific Centre of Vegetable and Industrial Crops" within 2019-2020. The research objects were mid-early ripening tomato variety "Anahit 351" and mid-ripening varieties "Lia" and "Eraz".

Phenological observations and biometric measurements were conducted during the vegetation period. The weight of 1 tomato seed crop, seed number and weight per 1 fruit, as well as the weight of 1000 seeds and number of locales were determined according to the cluster level and harvesting time after tomato fruit maturation (Sichev, et al., 1991). Biochemical analysis of the plants was carried out. Dry matter content was determined through IGF-454B2M refractometer, while total sugars were determined through Bertrand's method and ascorbic acid – through the Moore method (Peterburgskiy, 1968, Yermakov, 1972).

The content of proteins, fats, starch and phosphorus in the seeds of studied tomato varieties were determined (Yermakov, 1972). Seed germination capacity and germination energy were determined according to GOST standards. The period corresponding to 75 % of germinated seeds was recorded as an indicator characterizing the germination process (Sichev, et al., 1991).

Per the determined seed crop harvesting time and identified cluster level, from each hundred plants of the studied varieties ten kilograms of seed fruit were taken, which were deseeded and dried out in the open air. The yield of obtained seeds was determined through weighing method in grams. The yield calculation was implemented by weighing the yield of each experimental bed. The total yield per each cluster level and per hectare was also calculated and the average weight of the fruit was determined (Methodology for State Variety Testing of Agricultural Crops, 2015).

The data retrieved as a result of the study were subjected to statistical analysis (Dospekhov, 1985).

Results and discussions

Investigations showed that the examined varieties differed in biomorphological indicators. Thus, average height of the tomato plant variety "Anahit 351" was 55.6 cm, and "Lia" variety exceeded "Anahit 351" by 4.4 cm, while "Eraz" variety, on the contrary, conceded by 9.9 cm. The varieties also differed in cluster and fruit number both on the main stem and throughout the whole plant. The best indicators were registered in "Anahit 351" (Table 1). As the data of the Table 1 indicate, the fruits of "Lia" variety are roundish, while those of "Anahit 351" are slightly flattened and in "Eraz" variety they are ellipsoid. The variety of "Anahit 351" was distinguished by the number of locales and seeds in the fruits.

Qualitative analyses of the fruits and seeds in the studied tomato varieties were performed on the 5th, 10th and 15th days after fruit maturation to find out the option with highest quality. The content of dry matter, total sugars, ascorbic acid and seed nutrients (proteins, fats, starch and total phosphorus) of the mentioned varieties was determined in the laboratory.

The results of biochemical analysis showed that in all studied varieties, both dry matter and ascorbic acid were higher in the second cluster of 10-day ripened fruits, and total sugars were higher in the third cluster of 15-day ripened fruits. The seeds taken from the second and third clusters of 10-day ripened fruits (Table 2) were the most prominent regarding the high content of nutrients.

Studies show that the quality of seeds obtained from different clusters of "Anahit 351", "Lia" and "Eraz" tomato varieties and harvested in different periods is also different.

Table 1. Biometric indicators of tomato varieties*

Varieties	Plant height, cm	The number of clusters, n		The number of fruits, n		Fruit index	Fruit weight, g	Number of locales in 1 fruit, n	Number of seeds in 1 fruit, n
		On the main stem	On the whole plant	On the main stem	On the whole plant				
Anahit 351	55.6	5.5	10.5	7.4	15.2	0.7	162	4-5	420
Lia	60.0	4.8	7.5	9.9	15.0	0.9	212	2-3	285
Eraz	45.7	5.3	9.9	8.2	17.3	2.1	72	2	150

*Composed by the authors.

Table 2. Biochemical indicators of fruits and seeds per options, 2019*

Varieties	Options, clusters/day	In fruits			Seed chemical composition per dry matter, %			
		Dry matter, %	Sugars, %	Vitamin C, mg/%	Protein	Fats	Starch	Total phosphorus
Anahit 351	2/5	6.0	3.0	18.4	26.25	26.30	2.95	0.880
	2/10	6.9	3.3	18.8	28.66	26.72	3.15	0.892
	2/15	6.8	3.3	18.6	26.35	26.01	2.75	0.867
	3/5	6.7	3.1	17.9	26.65	24.95	2.68	0.872
	3/10	6.8	3.2	18.2	27.86	26.90	3.25	0.884
	3/15	6.2	3.6	18.0	26.31	25.82	2.85	0.868
Lia	2/5	6.5	3.1	19.0	28.21	25.20	2.44	0.925
	2/10	7.0	3.3	19.5	29.75	26.78	2.78	0.975
	2/15	6.8	3.4	19.4	29.25	25.71	2.46	0.922
	3/5	6.2	2.8	18.9	28.24	25.35	2.11	0.927
	3/10	6.3	3.4	19.2	29.48	26.72	2.56	0.953
	3/15	6.0	3.7	18.7	29.05	26.01	2.12	0.950
Eraz	2/5	7.2	3.5	17.3	28.55	24.87	2.78	0.735
	2/10	7.5	3.8	18.1	30.14	25.65	3.37	0.828
	2/15	7.3	3.6	17.7	28.65	25.16	3.17	0.805
	3/5	7.1	3.4	17.5	29.02	25.11	3.13	0.749
	3/10	7.3	3.5	17.3	29.87	25.80	3.20	0.799
	3/15	6.8	3.9	17.0	28.11	25.00	3.09	0.740

*Composed by the authors.

As it can be seen from the data of introduced Figure, the seed weight per 1 fruit of "Anahit 351" variety is higher than that of "Lia" and "Eraz" varieties in 1.5 and 2.8 times respectively. At the same time, it should be noted that in all studied varieties, the highest seed weight was recorded in the second cluster of 10-day ripened fruits.

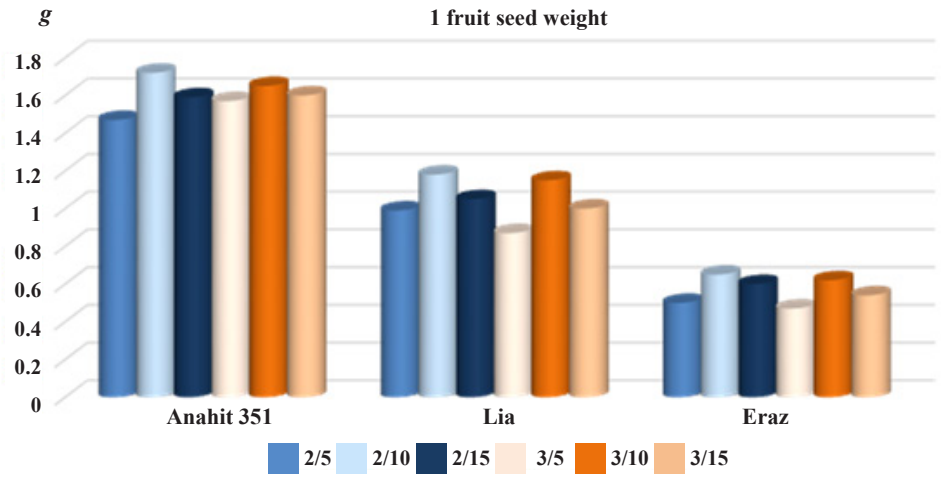

Figure. Weight of seeds in one fruit depending on cluster level and harvest period (*composed by the authors*).

Table 3. Seed germinability and germination energy of tomato varieties according to options in laboratory and field conditions*

Varieties	Options, clusters/days	In laboratory conditions		In field conditions	
		Germinability, %	Germination energy, %	Germinability, %	Germination energy, %
Anahit 351	2/5	94± 1.4	87± 3.2	92± 2.5	85± 2.4
	2/10	97± 1.1	90± 1.7	96± 1.8	89± 1.3
	2/15	95± 1.2	88± 1.3	94± 1.4	87± 2.5
	3/5	91± 2.4	85± 1.5	87± 3.5	82± 3.6
	3/10	93± 1.2	87± 2.4	94± 1.3	86± 1.2
	3/15	93± 1.4	85± 3.1	91± 3.2	83± 1.4
Lia	2/5	95± 1.5	90± 2.4	92± 4.2	85± 3.8
	2/10	97± 1.3	92± 1.1	95± 1.7	90± 1.7
	2/15	94± 1.4	86± 1.7	94± 2.6	83± 2.6
	3/5	93± 0.9	86± 2.1	92± 3.3	85± 2.1
	3/10	97± 3.1	88± 3.0	96± 1.5	88± 3.4
	3/15	97± 2.2	90± 2.8	95± 3.4	83± 3.8
Eraz	2/5	95± 1.5	89± 3.4	92± 1.7	85± 5.4
	2/10	98± 1.0	91± 1.5	95± 1.3	89± 1.8
	2/15	96± 2.4	90± 2.0	94± 1.4	87± 3.1
	3/5	96± 1.7	87± 1.8	93± 2.4	85± 2.7
	3/10	97± 2.5	92± 1.6	92± 1.3	84± 2.0
	3/15	94± 3.4	90± 2.5	92± 3.0	83± 2.5

*Composed by the authors.

To thoroughly assess the quality of tomato seeds, the seeds taken in 2019 (cluster/day) were sown in the following year per the same options. Seed germination capacity and germination energy were determined in laboratory and field conditions. Studies indicated that in contrast to open field conditions, seed germination capacity and energy were higher in laboratory conditions due to more favorable medium for seed germination. However, the field germination rate was also quite high in all 3 studied varieties (Table 3).

The results of phenological observations showed that the germinability and germination energy of the seeds taken from the second and third clusters of the the same options 10 days after ripening, were relatively higher than those in the seeds of 5 - and 15 – day ripened options in all mentioned varieties.

Sowing of the tomato seed varieties harvested in different time periods and from various clusters was implemented in 2020 per the mentioned options to disclose their efficiency.

Yield amount was calculated according to varieties and options per hundred plants, and seed yield rate was determined per 10 kg of seed material. It was found out that the seed materials harvested from the second cluster after 10 days of fruit ripening showed relatively higher productivity in all varieties. Thus, the yield capacity of "Anahit 351" variety made 851.7 c/ha; anyhow, high yield (846.3 c/ha) was also provided in the seeds harvested from the third cluster after 10 days of fruit maturation. The same pattern is observed for "Lia" and "Eraz" varieties. The yield capacity for "Lia" variety made 928.7 c/ha and 916.0 c/ha in respective options and for "Eraz" variety it was 796.6 c/ha and 785.0 c/ha respectively. This regularity is also true for seed yield indicators (Table 4).

Table 4. Tomato yield capacity and seed yield rate depending on fruit cluster level and harvest time, 2020*

Varieties	Options, cluster/day	Yield, c/ha	Seed yield from 10 kg seed crop
Anahit 351	2/5	835.3	30.5
	2/10	851.7	35.2
	2/15	843.7	32.0
	3/5	835.0	29.4
	3/10	846.3	31.9
	3/15	840.7	30.0
	$LSD_{0.95}$ -1.1 Ex% - 0.7		
Lia	2/5	905.0	19.9
	2/10	928.7	21.5
	2/15	896.0	20.4
	3/5	902.7	20.1
	3/10	916.0	21.2
	3/15	896.7	20.0
	$LSD_{0.95}$ - 3.1; Ex% - 1.1		
Eraz	2/5	740.3	8.1
	2/10	796.6	11.6
	2/15	764.0	10.4
	3/5	757.0	10.0
	3/10	785.0	11.0
	3/15	753.0	9.5
	$LSD_{0.95}$ - 3.9; Ex% - 0.9		

*Composed by the authors.

Conclusion

So, taking into account the aforementioned circumstances and the conducted analyses, it is worthwhile stating that when selecting seed materials, those from the second clusters after 10 days of fruit maturation are highly recommended. The mentioned option ensures highly productive seed material from the qualitative and quantitative aspects, the seeds of which provide higher yield capacity when sowing in the following year.

The seed material of the third cluster harvested after 10 days of fruit maturation can be also used as the second recommended option, since their seeds also provided higher yield capacity as compared to the other discussed options.

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