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Düzce İlinde Doğal Olarak Bulunan Ceviz Genotipleri Arasındaki Morfolojik Farklılıkların Değerlendirilmesi

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ÖZ

Düzce ilinde tohumdan yetişen ceviz ağaçlarından oluşan populasyon içerisinden ceviz genotiplerini seçmek amacıyla gerçekleştirilen çalışmada 86 ağaçtan meyve örneği alınmış ve önemli meyve özellikleri incelenmiştir. Çalışmada elde edilen datalar tartılı derecelendirme ile değerlendirilmiştir. Araştırma sonucunda 5 ceviz genotipi ümitvar olarak seçilmiştir. Seçilen genotiplerde meyve ağırlığı 12.08 g (81.DZC.36)-15.47 g (81.DZC.11), iç ağırlığı 6.09 g (81.DZC.70)-8.44 g (81.DZC.42), iç oranı %41.41 (81.DZC.11)-%59.01 (81.DZC.42) ve kabuk kalınlığı 1.03 mm (81.DZC.42)-2.28 mm (81.DZC.11) arasında değişmiş; kabuk rengi tiplerin tamamında esmer, iç rengi ise bir tipte (81.DZC.83) kahverengi, diğer tiplerde koyu sarı olarak belirlenmiştir. Seçilen tiplerin tamamı %100 oranında dolu ve sağlam iç vermiştir.

Anahtar kelimeler: Ceviz, morfoloji, seleksiyon, Düzce

Assessment of Morphological Variances in Naturally Occurring Walnut Genotypes within Duzce Province

ABSTRACT

In this study, carried out to select walnut types from the population of seedling walnut trees in Duzce province, fruit samples were collected form 86 trees, then significant fruit properties were evaluated. The data regarding tested characteristics were evaluated by the modified weighed ranked method. According to results, 5 walnut types were selected as promising. In the selected types, fruit weights were measured as 12.08 g (81.DZC.36)-15.47 g (81.DZC.11), kernel weight as 6.09 g (81.DZC.70)-8.44 g (81.DZC.42), kernel ratio as %41.41 (81.DZC.11)-%59.01 (81.DZC.42) and shell thickness as 1.03 mm (81.DZC.42) - 2.28 mm (81.DZC.11). Shell color was determined as dark in all types, while inner color was amber in one type, other types were light amber. The selected types were in a good condition for full and sound interior ratio. Six types gave 100% full and sound inner.

Key words: Walnut, morphology, selection, Duzce

INTRODUCTION

Walnuts are hard-shelled fruits and an important source of nutrition for humans. The walnut population in Turkey is quite large due to its long years of seed cultivation. This population of walnuts, which possesses very different walnut gene resources, constitutes an important source for selection studies.

The global production of walnut is 3 500 172 tons. Among the major walnut-producing countries, China, the United States of America, Iran, and Turkey produced 1 100 000 t, 657 710 t, 386 976 t, and 325 000 t of shelled walnuts, respectively (Anonymous, 2021). Among all hard-shelled fruits, walnut production is the highest after

hazelnut in Turkey. The production of walnut has increased over the years. The number of walnut trees increased from 3 280,000 in 1970 to 27 573 082 in 2022, and walnut production increased from 103 000 tons to 335 000 tons (Anonymous, 2022). Walnut cultivation is performed in all agricultural regions. Besides the production of walnut on trees grown from seeds, the number of closed walnut gardens has increased. Covered gardens were established with foreign varieties of walnuts due to their late leafing characteristics, along with the local varieties determined and registered through selection studies. Selection studies were conducted in different regions of Turkey (Ateş, 2018; Başak, 2019; Özcan, 2019; Gerçekcioğlu et al., 2019; Oruç, 2020; Çeri, 2021; Mestav, 2022). These studies determined the walnut genetic resources in the country, and some of these genotypes were registered and grown commercially. We conducted a study in Düzce province to select high-quality walnut types adapted to the region. Around 316 tons of walnut is produced on 46 729 trees in Düzce province (29 084 fruiting trees and 17 645 non-fruiting trees) (Anonymous, 2022). Walnut trees are mostly found isolated, in hazelnut gardens, and as border trees. The number of closed gardens is quite low.

In this study, we evaluated the gene potential of walnut in Düzce province. We found superior walnut genotypes, indicating that the genetic resources of our country need to be protected.

MATERIALS AND METHODS

The study was conducted in the districts and villages of Düzce province between 2017 and 2019. The study area was located between 40° to 42° N and 30° to 33° E in the Western Black Sea Region. Düzce shares its borders with Sakarya in the west, Bolu in the east and south, and Zonguldak in the northeast (Figure 1).

Figure 1. A map of the Duzce province (Anonymous, 2023)

The province has an area of 2 492 km² and an altitude of 150 m. The Kardüz Plateau in the Elmacık Mountains is the highest point of the province, with an elevation of 1 830 m. Approximately 50% of the surface area of Düzce province is covered by forests, 30% of the area is used for agriculture, and 20% of the area comprises non-agricultural lands. Most of the agricultural areas of the province have hazelnut gardens. Maize, paddy, and wheat are also cultivated. Seed walnut populations are also found in the natural flora, and they are denser in higher areas (Anonymous, 2023). More than 500 walnut trees were analyzed in the study area. Fruit samples were collected from 86 walnut trees based on the information obtained from the Provincial Directorate of Agriculture, interviews with growers, and selection criteria. The trees from which fruit samples were collected were numbered starting from 81.DZC.01. Walnut samples were separated from the green shells after harvesting and dried at room temperature. The samples were then kept in an oven at 25 °C for 24 h to ensure standardized drying. Before performing physical evaluations, the moisture content of the walnuts was determined. The characteristics of the fruits, such as fruit size, fruit weight and internal weight, fruit shape (shape index), skin color, internal color, internal ratio, full and intact internal ratio, skin thickness, and empty fruit ratio, were determined from the samples (Ünver et al., 2015; Ateş, 2018; Çeri, 2021; Mestav, 2022).

RESULTS AND DISCUSSION

In the first year of the three-year study (2017), fruit samples were collected from 48 trees during the harvest period by searching different districts and villages of Düzce province. The physical characteristics of 10 randomly selected fruits from each genotype were analyzed. From the values obtained, 10 genotypes with a fruit weight above 12 g were selected for re-sampling. The characteristics of the fruits of 10 selected genotypes are presented in Table 1.

As the trees numbered 81.DZC.12 and 81.DZC.31 among the genotypes selected in the first year were cut down, samples could not be collected from these trees in the following years. In 2018, fruit samples were

collected from 46 trees; eight genotypes were characterized in the first year, and 38 walnut trees were sampled for the first time from villages that could not be visited in the first year. Their physical properties were determined, and seven genotypes were selected for re-sampling as a result of the screening conducted based on the fruit weight. The characteristics of the fruits of eight genotypes selected in the first year and seven genotypes selected in the second year are presented in Table 2. The fruit samples were collected from 15 genotypes (eight genotypes in the first year and seven genotypes in the second year) selected in the third year of the study (2019), and the examined fruit characteristics are presented in Table 3. Among the selected types, the mean of the nut weight, kernel ratio, kernel color, and shell thickness values recorded between 2017 and 2019 was calculated, and the results were evaluated according to the "weighted ranked method" (Ünver et al., 2015; Ateş, 2018; Özcan, 2019). The criteria, classes, scores of the classes, and the relative scores determined are presented in Table 4. The "weighted ranked" score of the genotypes examined was between 414 and 186, and five genotypes with a score of 282 and above were accepted as promising (Table 5). The average values of the fruit characteristics of the walnut genotypes that were considered to be promising are presented in Table 6.

Table 1. The characteristics of the fruits of the selected genotypes in 2017

No	Selection number	Nut length	Nut wideness	Nut height	Nut weight	Kernel weight	Kernel ratio	Shell thickness	Shape index
1	81.DZC.08	36.30	28.70	31.18	12.03	4.88	40.59	2.02	1.21
2	81.DZC.11	37.05	30.93	32.60	13.24	5.40	40.75	2.26	1.17
3	81.DZC.12	35.54	32.91	32.87	12.40	5.79	46.68	1.91	1.08
4	81.DZC.20	36.85	29.72	34.96	12.66	5.21	41.13	1.75	1.14
5	81.DZC.31	39.67	30.45	32.51	14.83	4.14	27.92	2.27	1.26
6	81.DZC.36	38.97	32.09	35.42	12.08	6.38	52.84	1.20	1.15
7	81.DZC.39	38.65	31.79	35.61	12.98	7.20	55.49	1.18	1.15
8	81.DZC.43	44.84	32.84	35.23	13.67	7.42	54.24	1.26	1.32
9	81.DZC.44	33.46	34.51	33.03	12.24	5.84	47.71	1.66	0.99
10	81.DZC.48	47.05	30.11	31.48	12.44	5.42	43.57	1.74	1.53

Table 1. The characteristics of the fruits of the selected genotypes in 2017 (continued)

No	Selection number	Fruit shape	Fruit size	Shell color	Kernel color	Blank fruit	Kernel fullness	Shell texture
1	81.DZC.08	Rounded	Extra	Medium	Light amber	0	100	Smooth
2	81.DZC.11	Rounded	Extra	Dark	Amber	0	100	Medium
3	81.DZC.12	Rounded	Extra	Medium	Light amber	0	100	Medium
4	81.DZC.20	Rounded	Extra	Medium	Light amber	0	100	Medium
5	81.DZC.31	Ovate	Extra	Dark	Light amber	0	100	Medium
6	81.DZC.36	Rounded	Extra	Medium	Light amber	0	100	Medium
7	81.DZC.39	Rounded	Extra	Medium	Light amber	0	100	Medium
8	81.DZC.42	Ovate	Extra	Medium	Light amber	0	100	Medium
9	81.DZC.43	Rounded	Extra	Medium	Light amber	0	100	Medium
10	81.DZC.47	Ovate	Extra	Dark	Light amber	0	100	Medium

Table 2. The characteristics of the fruits of the selected genotypes in 2017 and 2018

No	Selection number	Nut length	Nut wideness	Nut height	Nut weight	Kernel weight	Kernel ratio	Shell thickness	Shape index
1	81.DZC.08	35.16	29.15	31.12	13.31	5.52	41.50	1.99	1.17
2	81.DZC.11	39.61	34.03	34.87	16.96	7.04	41.50	2.20	1.15
3	81.DZC.20	37.45	31.18	33.16	12.41	5.01	40.37	1.93	1.16
4	81.DZC.36	38.43	31.92	34.81	11.21	6.51	58.08	1.03	1.15
5	81.DZC.39	35.72	27.58	28.10	10.80	4.46	41.31	1.40	1.28
6	81.DZC.42	45.24	33.44	35.67	13.97	8.28	59.26	0.96	1.31
7	81.DZC.43	32.26	33.74	32.78	12.34	6.00	48.61	1.69	0.97
8	81.DZC.47	43.60	27.92	28.82	9.90	4.14	41.81	1.70	1.54
9	81.DZC.51	36.89	30.32	33.27	12.66	5.10	41.00	2.22	1.16
10	81.DZC.60	40.89	30.36	33.05	12.90	5.87	45.29	1.76	1.29
11	81.DZC.70	36.18	32.46	36.35	13.57	6.25	45.61	1.93	1.05
12	81.DZC.74	42.32	31.91	34.48	11.87	5.75	48.38	1.51	1.27
13	81.DZC.75	37.96	33.04	36.04	13.60	6.45	47.40	1.77	1.10
14	81.DZC.80	41.65	31.85	34.40	12.36	6.15	49.62	1.45	1.26
15	81.DZC.83	40.86	31.70	33.23	13.37	6.85	51.25	1.47	1.26

Table 2. The characteristics of the fruits of the selected genotypes in 2017 and 2018 (continued)

No	Selection number	Fruit shape	Fruit size	Shell color	Kernel color	Blank fruit	Kernel fullness	Shell texture
1	81.DZC.08	Rounded	Extra	Medium	Light amber	0	100	Smooth
2	81.DZC.11	Rounded	Extra	Medium	Light amber	0	100	Medium
3	81.DZC.20	Rounded	Extra	Medium	Light amber	0	100	Medium
4	81.DZC.36	Rounded	Extra	Medium	Light amber	0	100	Medium
5	81.DZC.39	Ovate	Extra	Dark	Light amber	0	100	Medium
6	81.DZC.42	Ovate	Extra	Medium	Light amber	0	100	Medium
7	81.DZC.43	Rounded	Extra	Medium	Light amber	0	100	Medium
8	81.DZC.47	Ovate	Extra	Dark	Light amber	0	100	Medium
9	81.DZC.51	Rounded	Extra	Medium	Light amber	0	100	Medium
10	81.DZC.60	Ovate	Extra	Medium	Light amber	0	100	Medium
11	81.DZC.70	Rounded	Extra	Medium	Light amber	0	100	Medium
12	81.DZC.74	Ovate	Extra	Medium	Light amber	0	100	Medium
13	81.DZC.75	Rounded	Extra	Medium	Light amber	0	100	Medium
14	81.DZC.80	Ovate	Extra	Medium	Amber	0	100	Medium
15	81.DZC.83	Ovate	Extra	Medium	Amber	0	100	Medium

Among the selected genotypes, nut weight varied between 12.08-15.47 g, kernel weight varied between 6.09-8.44 g, the kernel ratio was 41.41-59.01% and shell thickness was 1.03-2.28 mm. In one genotype of walnut, the nut weight was above 15.00 g, in all of the selected walnut genotypes, the kernel weight was above 6.00 g and in three genotypes, the kernel ratio was above 50.00%. Various selection studies investigated the characteristics of the fruits of walnut. For example, İpek et al. (2019) reported a nut weight of 8.70-14.34 g, a kernel weight of 4.52-7.27 g and a kernel ratio of 40.15-63.21%. Başak (2019) reported that the nut weight ranged from 7.90-5.52 g, the kernel weight ranged from 4.15-7.55 g and the kernel ratio ranged from 45.25- 56.12%, respectively. Rezaei et al. (2018) reported that the nut weight, kernel weight and kernel ratio were 5.35-21.31 g, 2.49-11.15 g and 37.27-66.29%. Demir et al. (2019) reported that the nut weight ranged from 12.35-20.88 g, the kernel weight ranged from 6.25-8.97 g and the kernel ratio ranged from 36.67-52.90%. Varol et al. (2020) showed that the nut weight ranged from 10.14-4.98 g, the kernel weight ranged from 5.01-8.08 g and the kernel ratio ranged from 41.58-60.20%. Kırışık et al. (2021) reported that the nut weight ranged between 8.95-3.04 g, the kernel weight ranged between 4.87-6.53 g and the kernel ratio ranged between 43.70-65.09%. Mestav (2022) showed that the nut weight ranged between 12.75-7.85 g, the kernel

weight ranged between 6.59-8.83 g and the kernel ratio ranged between 45.50-52.91%. The values of nut weight, kernel weight and kernel ratio obtained in our study were similar to those obtained by Demir et al. (2019), Varol et al. (2020) and Mestav (2022). Shell thickness, which is an important selection criterion, was determined by Demir et al. (2019) 0.85-1.85 mm, Gerçekcioğlu et al. (2019) 0.97-1.47 mm, Özcan (2019) 1.9-3.3 mm, Öztürk and Öztürk (2019) 1.30-3.51 mm, Kazankaya et al. (2017) 1.18–2.82 mm and Şener Saka (2019) 0.95–2.10 mm. The shell thickness values of the promising genotypes of the Düzce region reported in this study were similar to those reported in other studies.

Table 3. The characteristics of the fruits in 2019 of the genotypes selected in 2017 and 2018

No	Selection number	Nut length	Nut wideness	Nut height	Nut weight	Kernel weight	Kernel ratio	Shell thickness	Shape index
1	81.DZC.08	35.00	29.76	31.91	13.27	6.01	45.31	2.06	1.14
2	81.DZC.11	38.10	33.51	35.22	16.22	6.81	41.99	2.37	1.11
3	81.DZC.20	40.52	30.23	35.16	12.45	5.46	43.86	1.89	1.24
4	81.DZC.36	39.04	34.85	36.98	12.96	7.17	55.33	1.05	1.09
5	81.DZC.39	36.91	28.22	29.41	11.94	5.03	42.09	1.34	1.28
6	81.DZC.42	47.47	34.68	38.75	14.65	8.61	58.76	1.11	1.29
7	81.DZC.43	33.86	34.59	33.70	12.78	6.63	51.84	1.64	0.99
8	81.DZC.47	44.21	28.62	30.13	10.89	4.67	42.33	1.73	1.50
9	81.DZC.51	35.14	28.53	31.12	12.33	4.39	35.58	2.13	1.18
10	81.DZC.60	39.09	29.02	31.43	12.42	6.32	50.85	1.78	1.29
11	81.DZC.70	37.22	31.79	34.65	12.77	5.92	46.34	1.97	1.12
12	81.DZC.74	39.53	30.67	33.28	11.81	5.85	49.52	1.48	1.24
13	81.DZC.75	35.24	31.38	32.76	11.62	5.98	51.47	1.83	1.10
14	81.DZC.80	38.93	30.54	34.88	12.56	6.58	52.40	1.44	1.19
15	81.DZC.83	40.45	31.98	32.68	12.76	6.30	49.37	1.53	1.25

Table 3. The characteristics of the fruits in 2019 of the genotypes selected in 2017 and 2018 (continued)

No	Selection number	Fruit shape	Fruit size	Shell color	Kernel color	Blank fruit	Kernel fullness	Shell texture
1	81.DZC.08	Rounded	Extra	Medium	Light amber	0	100	Smooth
2	81.DZC.11	Rounded	Extra	Medium	Light amber	0	100	Medium
3	81.DZC.20	Rounded	Extra	Medium	Light amber	0	100	Medium
4	81.DZC.36	Rounded	Extra	Medium	Light amber	0	100	Medium
5	81.DZC.39	Rounded	Extra	Dark	Light amber	0	100	Medium
6	81.DZC.42	Ovate	Extra	Medium	Light amber	0	100	Medium
7	81.DZC.43	Rounded	Extra	Medium	Light amber	0	100	Medium
8	81.DZC.47	Ovate	Extra	Dark	Light amber	0	100	Medium
9	81.DZC.51	Rounded	Extra	Medium	Light amber	0	100	Medium
10	81.DZC.60	Ovate	Extra	Medium	Light amber	0	100	Medium
11	81.DZC.70	Rounded	Extra	Medium	Light amber	0	100	Medium
12	81.DZC.74	Rounded	Extra	Medium	Light amber	0	100	Medium
13	81.DZC.75	Rounded	Extra	Medium	Light amber	0	100	Medium
14	81.DZC.80	Rounded	Extra	Medium	Amber	0	100	Medium
15	81.DZC.83	Ovate	Extra	Medium	Amber	0	100	Medium

Table 4. The criteria of walnut quality based on the weighted ranked method and the classes created by these types; their scores and relative scores were determined according to these criteria

Fruit characteristics	Points relative (%)	Category	Point
Nut weight	32	11.08–11.96	1
		11.97–12.85	2
		12.86–13.74	3
		13.75–14.63	4
		14.64–15.52	5
Kernel ratio	32	38.29–42.12	1
		42.13–45.96	2
		45.97–49.80	3
		49.81–53.64	4
		53.65–57.48	5
Kernel color	27	Light	5
		Amber	3
		Dark	1
Shell thickness	9	1.09–1.33	5
		1.34–1.58	4
		1.59–1.83	3
		1.84–2.08	2
		2.09–2.33	1

Table 5. The scores of the walnut types according to the weighted ranked method

No	Selection number	Nut weight	Kernel ratio	Shell color	Shell thickness	Total
1	81.DZC.42	128	160	81	45	414
2	81.DZC.36	64	160	81	45	350
3	81.DZC.70	96	96	81	18	291
4	81.DZC.83	96	128	27	36	287
5	81.DZC.11	160	32	81	9	282
6	81.DZC.43	64	96	81	27	268
7	81.DZC.60	64	96	81	27	268
8	81.DZC.75	64	96	81	27	268
9	81.DZC.08	96	64	81	18	259
10	81.DZC.80	64	128	27	36	255
11	81.DZC.39	32	96	81	45	254
12	81.DZC.74	32	96	81	36	245
13	81.DZC.47	32	64	81	27	204
14	81.DZC.20	64	32	81	18	195
15	81.DZC.51	64	32	81	9	186

Table 6. The characteristics of the fruits of the selected individuals (mean of three years)

No	Selection number	Nut weight	Kernel weight	Kernel ratio	Nut length	Nut wideness	Nut height	Fruit size	Shell texture
1	81.DZC.42	14.31	8.44	59.01	46.36	34.06	37.21	Extra	Medium
2	81.DZC.36	12.08	6.69	55.42	38.81	32.95	35.73	Extra	Medium
3	81.DZC.70	13.17	6.09	45.98	36.70	32.12	35.50	Extra	Medium
4	81.DZC.83	13.06	6.57	50.31	40.66	31.84	32.95	Extra	Medium
5	81.DZC.11	15.47	6.41	41.41	38.26	32.83	35.22	Extra	Medium

Table 6. The characteristics of the fruits of the selected individuals (mean of three years) (continued)

No	Selection number	Fruit shape	Shape index	Shell thickness	Shell color	Kernel color	Blank fruit	Kernel fullness
1	81.DZC.42	Ovate	1.30	1.03	Medium	Light amber	0	100
2	81.DZC.36	Rounded	1.13	1.09	Medium	Light amber	0	100
3	81.DZC.70	Rounded	1.09	1.95	Medium	Light amber	0	100
4	81.DZC.83	Ovate	1.25	1.50	Medium	Amber	0	100
5	81.DZC.11	Rounded	1.14	2.28	Medium	Light amber	0	100

We measured the fruit size of the genotypes found to be promising. Nut length was between 36.70 - 46.36 mm, nut wideness was 31.84-34.06 mm and nut height was 32.95-37.21 mm in the selected genotypes. Şener Saka (2019) determined nut length 37.7-47.7 mm, nut wideness 30.4-37.5 mm and nut height 30.3-37.5 mm. Ateş (2018) determined nut length 29.95-41.36 mm, nut width 27.37-38.93 mm and nut height 27.73-40.33 mm. Öztürk and Öztürk (2019) determined nut length, nut width and nut height as 27.85-55.52 mm, 24.02-31.07 mm and 23.43-28.84 mm. Varol et al. (2020) determined nut length 31.93-38.78 mm, nut width 29.49-36.65 mm and nut height 29.80-34.58 mm. When the size of the fruits of the selected promising genotypes from the Düzce region was compared to the values obtained in other studies, we found that the selected genotypes had lower values for nut length, whereas the values of nut width and nut height were higher. Fruit shape was ovate in types 81.DZC.42 and 81.DZC.83 and round in the other types. The selected types were all in the extra class. In the studies conducted by Göksüncükgil (2017), Kırışık et al. (2021) and Varol et al. (2020) fruit size was reported as extra size. The shell color of the genotypes was medium, and the kernel color was amber in one genotype (81.DZC.83) and light amber in the other genotypes. All genotypes gave 100% kernel fullness and the shell texture was medium. In the selection studies, the shell color was light for four of the genotypes investigated by Göksüncükgil (2017), medium for four genotypes, and dark for two genotypes; Gerçekçioğlu et al. (2019) reported that seven genotypes had a light shell color and four genotypes had a medium shell color; Güller (2020) reported that 48.27% of genotypes had a light shell color, 31.03% of genotypes had a medium color and 20.68% of genotypes had a dark color; Çeri (2021) determined that five genotypes had a very light shell color, three genotypes had a light color and one genotype had a dark color. Kernel color was found to be light in seven genotypes, light amber in three genotypes and amber in one genotype by Gerçekçioğlu et al. (2019). Güller (2020) found that kernel color was light in 55.17% of genotypes, light amber in 37.93% of genotypes and amber in 6.89% of genotypes; Kırışık et al. (2021) reported that the kernel color was light in seven genotypes and amber in three genotypes; Çeri (2021) reported that the kernel color was light in eight genotypes and amber in one genotype. In walnuts, light kernel color and full and solid inner ratio are economically important criteria. Promising walnut genotypes in the Düzce province include medium and light amber shell color and kernel color, but they are in good condition in terms of kernel fullness.

CONCLUSION and RECOMMENDATIONS

Based on the selection study conducted in the Düzce province, the natural walnut population of the region was examined, and important genotypes were identified in terms of fruit characteristics. Thus, we added new genotypes to the rich walnut gene resource of our country. To evaluate the selected genotypes in walnut cultivation, adaptation studies should be conducted in different regions, and the morphological and pomological characteristics of the walnut should be compared with local and foreign walnut varieties in the established gardens. To advance our findings, the walnut genotypes selected from the Düzce region need to be evaluated for cultivation.

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