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Determination of Some Physical and Physiological Properties of Seeds of Different Grass Pea (*Lathyrus sativus* L.) Genotypes

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Abstract
Grass pea (*Lathyrus sativus*) is a naturally growing crop in Turkey and it is considered a valuable fodder resource to improve soil properties and livestock farming. This study was carried out in the laboratories of Bingol University between 2019-2020. In the study, some physical (shape-size, surface area, projection area, average arithmetic diameter, thousand grain weight) and physiological (germination rate and time) characteristics of the seeds belonging to twenty-four different genotypes of grass pea were determined, and the results were evaluated according to the randomized blocks experimental design with four repetitions. According to the data obtained, all grass pea genotypes have a short and oval seed structure, with an average length of 6.010 mm, average width of 5.369 mm, a surface area of 28.773 mm^2, a projection area of 25.830 mm^2, an arithmetic diameter of 5.690 mm and a thousand grain weight of 126.688 g. It was determined that all grass pea genotypes germinated at a rate of 85-100% within 0.508-0.538 days.

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1. Introduction

Grass pea (*Lathyrus*), which belongs to the *Vicieae* tribe of the legume family (*Fabaceae/Leguminosea*) is a large genus with 15 parts and 187 species or subspecies (Özdemir, 2016). It has 160 species, either annual or perennial (Plitmann et al., 1995). It is reported that there are 71 taxa belonging to approximately 61 species of grass pea in our country's flora (Özdemir, 2016), 18 of which have endemic properties.

Grass pea farming first started in the Balkans in the early Neolithic ages around 6000 BC, and it has been used as nutrition for people since then (Aslan, 2018), and it has been revealed in the archaeobotanical findings that this has encouraged the development of native legume varieties. In fact, according to these studies, this plant may be the first cultivated crop in Europe (Kislev, 1989). In addition, it is stated that the homeland of this crop could be the region between Asia, the Caucasus and the Caspian Sea and Northern India (Gençkan, 1983).

It is recognized and consumed as peas in many countries such as India, Bangladesh, Nepal, Iraq, Afghanistan and Eastern Europe. Despite its high protein content, its consumption should be limited due to β-ODAP, which is a neurotoxic compound (Sethi et al., 2021). It also has a neurotoxic effect due to substances such as ODAP (β-N-oxalyl-L-ά, β-diamoniopropionic acid) or β-N-oxalamio-L-alanine and β-oxalyl amino alanine (BOAA). Therefore, it is necessary to pay attention to its use (Urga et al., 1995; Kökten and Bakoğlu, 2011; Singh and Rao, 2013; Khandare et al., 2018; Bala et al., 2020) and usually, the production of varieties containing a proportionally smaller amount of this compound is preferred. Other than that, the grass pea is a rich legume containing 6.69% albumin, 1.5% prolamine, 13.3% globulin, 3.8% gluteline and 18.2-34.6% protein and minerals such as zinc, iron, calcium, phosphorus, magnesium and copper (Lambein et al., 2019; Buta et al., 2020; Sethi et al., 2021). It also contains 58% carbohydrates and 31% protein based on the dry weight of its seeds (Bala et al., 2020).

Grass pea is considered to be one of the important gene resources with its structure resistant to insects and pests which can survive in harsh climatic conditions (drought-excess rainfall) due to its highly developed adaptation ability (Hoque et al., 1996; Vaz Patto et al., 2006; Brunet et al., 2008). It can also be grown in regions with an annual rainfall of about 250 mm or less. Since it can be continued to be cultivated under the water, it can be preferred as the second product for alternation, especially in paddy farmlands (Kumar, 1997; Başaran et al., 2007). The leaf stems of the plant, which has a pile root structure, are quite long and wide-winged. Although its flowers are usually white, they can also be pink or bluish (Genckan, 1983). It needs a germination temperature of about 2-3°C, but as the temperature drops below 0°C, it can be damaged, however, it can be grown in loamy, moderately humid, and calcium rich soils (Özdemir, 2016).

The grass pea (*Lathyrus sativus* L.) shows a natural spread in our country (Ozdemir et al., 2020). This crop is commonly encountered in vegetation studies, especially in spontaneous pastures (Seydoşoğlu and Kökten, 2019). In general, *Lathyrus* species are used as green-dry grass, and feedstuff, grain feed for livestock around the world; it can also be grown as a green fertilizer to improve soil properties and as edible legumes and vegetables for human consumption (Özdemir et al., 2020). On the other hand, mixed plantation applications (*Leguminosae graminae*) are being practiced more and more in order to get the most yields from the unit area to meet the nutritional requirements for livestock. (Kökten, 1998) According to the

results obtained after the cultivation of mixtures created by mixing in different proportions, the rates that will provide the most benefit for livestock breeding are determined.

In the study, some physical (shape-size, surface area, projection area, average arithmetic diameter, thousand grain weight) and physiological (germination rate and time) characteristics of the seeds belonging to twenty-four different genotypes of grass pea were tried to be revealed. Thanks to these characteristics, it is aimed to prevent the problems that may be encountered during the machine planting of this crop. In addition, the sowing process is to be made by mixing with wheat seeds, it is aimed to match the seed sizes to each other and to be able to make the correct adjustments on the machine accordingly. On the other hand, it is aimed to help researchers by bringing together the inventories required for the cultivation of seeds with different genotypes.

2.Materials and Methods

This study was carried out in the laboratories belonging to Bingol University's Faculty of Agriculture, Biosystem Engineering Department, Field Crops Department and Food, Agriculture and Livestock Vocational School Crop and Livestock Production Department and Ege University's Faculty of Agriculture, Agricultural Machinery and Technologies Engineering departments between 2019 and 2020. In this study, some physical and physiological characteristics of seeds belonging to 24 different grass pea (*Lathyrus sativus* L.) genotypes were determined via the following methods.

The length (mm), width (mm) and thickness (mm) data, which are accepted as basic characteristics for each seed grain vary depending on climate, geography, soil properties (pH, salinity, drought, etc.) (Dumanoglu et al., 2021). Therefore, this data is required for the studies on seeds. According to the research, as stated by Yagcıoglu (2015), the seeds are examined according to their geometric characteristics (long-medium-short) and shapes (round-oval-long) (Table 1). According to the predetermined shape-size data of the seeds, the appropriate tools, machines and systems are selected for agricultural processes and infrastructure is created for cultivation studies in line with these methods.

In this study, the shape-size characteristics of seeds belonging to various grass pea genotypes were determined with a stereo microscope (Nikon SMZ 745T). 100 seeds from each genotype were sampled randomly and these seeds were examined separately (Dumanoğlu and Geren, 2020).

Table 1. Classification of seeds according to their geometric characteristics and shapes (Yagcıoğlu, 2015)

Seeds according to their geometric characteristics	Grain width/Grain length (b/a) (mm)	Seeds according to their shapes	Length (a), Width (b), Thickness (c) (mm)
Long	< 0.6	Round	$a \approx b \approx c$
Medium	0.6 – 0.7	Oval	$a/3 < b \approx c$
Short	> 0.7	Long	$c < b < a/3$

After determining the values of shape-size characteristics for each of the seeds belonging to twenty-four different grass pea genotypes, the following equations were used to determine the projection area (mm^2) and mean arithmetic diameter (mm) values of the seeds using this data (Mohsenin, 1970; Alayunt, 2000, Kara, 2012). The projection area is calculated in order to

equations the measured surface area values of the seeds over the seed length and width.

Projection area:

$A: (\pi * L * W)/4$ (1)

L : Seed length (mm)
W : Seed width (mm)
A: Projection area (mm^2)
π : 3.14

Mean Arithmetic Diameter:

$D: (L + W)/2$ (2)

D: Mean arithmetic diameter of the seed (mm)
L: Seed length (mm)
W: Seed width (mm)

After randomly sampling the seeds of twenty-four different grass pea genotypes examined in the study, thousands of grain weights were performed with three repetitions completed on Radwag AS 220.R2 analytical scale (with a sensitivity of 0.0001 g).

In the study, the germination time (days) and ratio (%) of seeds of twenty-four different grass pea (*Lathyrus sativus* L.) genotypes were tried to be determined. For this purpose, the seeds selected from random samples from each genotype were planted in Petri dishes under controlled conditions with four repetitions in 3 days (20-25°C, 60% humidity, dark environment,) in a MEMMERT brand incubator according to ISTA (2007) rules. Seeds were monitored daily.

2.1. Statistical analysis

In this study, some physical (shape-size, surface area, projection area, mean arithmetic diameter, thousand grain weight) and physiological (germination rate and time) characteristics of seeds belonging to twenty-four different grass pea genotypes were tried to be determined. The seeds were evaluated according to the randomized blocks experimental design with four repetitions and the data obtained were evaluated statistically using the SPSS V.22 software. First, the difference of seeds was determined at $p < 0.05$ level via a One-Way ANOVA test; and the values obtained were tested with TUKEY. The weights of a thousand grains belonging to genotypes were obtained from the dissertation prepared by Özdemir (2016) (analyzed with DUNCAN statistical method at $p < 0.01$ significance level).

3.Results and Discussion

In this study, seeds obtained from twenty-four different grass pea (*Lathyrus sativus* L.) genotypes were examined. According to the results obtained, it was determined that the physical characteristics difference between genotypes was statistically significant. In general, it was found that the average length values of genotypes were 6.010 mm, width values were 5.369 mm, surface area values were 28.773 mm^2, projection area values were 25.830 mm^2 and arithmetic diameter values were 5.690 mm. In addition, among all genotypes, Coloratus and Leucotetragonus obtained the highest values and the Ela genotype obtained the lowest values (Table 2).

The length, width and form of seeds belonging to different grass pea genotypes coincide with the characteristics (6-8 mm and 5 mm respectively) specified by Genckan (1983). The seed surface can be red, yellow gray-white or darker in color and spotted (white or black in color). According to the data obtained as a result of the study, it was found that all grass pea genotypes have a short and oval shape.

Table 2. Some physical characteristics of grass pea genotypes

No	Name of genotype	Length (mm)		Width (mm)		Surface area (mm^2)		Projection area (mm^2)		Mean Arithmetic Diameter (mm)	
		Avg.	Stdv.	Avg.	Stdv.	Avg.	Stdv.	Avg.	Stdv.	Avg.	Stdv.
1	452	6.637^{bcd}	0.717	5.940^{cd}	0.636	35.210^{cd}	6.480	31.126^{cd}	6.223	6.298^{cd}	0.648
2	481	6.912^{ab}	0.707	6.323^{ab}	0.642	36.701^{abc}	6.906	34.550^{ab}	6.431	6.618^{ab}	0.619
3	504	5.342^{ij}	0.587	4.836^{g}	0.561	23.157^{ijk}	4.814	20.456^{h}	4.314	5.089^{hı}	0.527
4	508	5.356^{ij}	0.698	4.673^{g}	0.572	22.443^{k}	5.042	19.864^{h}	4.681	5.014^{hı}	0.586
5	520	5.408^{ij}	0.629	4.789^{g}	0.551	22.342^{k}	4.922	20.477^{h}	4.305	5.099^{hı}	0.519
6	522	5.410^{ij}	0.678	4.760^{g}	0.702	23.010^{ijk}	5.794	20.482^{h}	5.633	5.085^{hı}	0.641
7	528	5.453^{ij}	0.664	4.877^{g}	0.501	24.016^{ijk}	5.127	21.061^{h}	4.480	5.165^{ı}	0.540
8	531	5.391^{ij}	0.519	4.843^{g}	0.544	23.480^{ijk}	4.605	20.644^{h}	3.928	5.117^{ı}	0.486
9	553	6.713^{bc}	0.763	6.050^{bc}	0.770	35.488^{bcd}	7.473	32.254^{bc}	7.548	6.381^{bc}	0.731
10	Adıyaman pop.	5.409^{ij}	0.663	4.865^{g}	0.513	23.092^{jk}	4.684	20.827^{h}	4.265	5.137^{ı}	0.532
11	**Colaratus**	**7.195^{a}**	0.865	**6.508^{a}**	0.706	**40.019^{a}**	7.834	**37.098^{a}**	7.834	**6.851^{a}**	0.729
12	**Ela**	**5.177^{j}**	0.684	**4.640^{g}**	0.621	**21.287^{k}**	5.516	**19.111^{h}**	4.842	**4.908^{j}**	0.614
13	Elazıg pop.	5.255^{ij}	0.587	4.659^{g}	0.458	21.280^{k}	4.151	19.348^{h}	3.707	4.957^{hı}	0.473
14	Eren	6.588^{bcd}	0.710	5.894^{cd}	0.634	33.856^{cde}	6.044	30.729^{cde}	6.191	6.241^{cd}	0.622
15	Gürbüz	6.091^{fg}	0.650	5.435^{ef}	0.640	28.805^{fgh}	5.308	26.221^{fg}	5.508	5.763^{efg}	0.589
16	Hat-1	6.519^{cde}	0.679	5.840^{cd}	0.691	33.174^{cdef}	5.560	30.170^{cde}	6.331	6.180^{cd}	0.646
17	Hat-6	5.895^{g}	0.558	5.239f	0.542	27.660^{ghı}	4.737	24.411^{g}	4.378	5.567^{fg}	0.506
18	Hat-12	6.368^{def}	0.608	5.675^{de}	0.512	31.989^{defg}	4.401	28.513^{ef}	4.724	6.021^{de}	0.502
19	Hat-17	5.969^{g}	0.641	5.223^{f}	0.560	27.212^{hıj}	5.437	24.639^{g}	4.749	5.596^{fg}	0.538
20	Hat-18	6.356^{def}	0.556	5.738^{de}	0.521	34.667^{cde}	4.688	28.775^{def}	4.626	6.047^{de}	0.488
21	Hat-19	6.188^{efg}	0.564	5.487^{ef}	0.551	30.562^{efgh}	5.281	26.818^{fg}	4.735	5.838^{ef}	0.511
22	İflis491	5.855^{gh}	0.613	5.215^{f}	0.606	27.412^{hıj}	5.259	24.135^{g}	4.822	5.535^{g}	0.542
23	Leucotetragonus	**7.206^{a}**	0.705	**6.474^{a}**	0.715	**39.930^{ab}**	6.743	**36.866^{a}**	6.871	**6.840^{a}**	0.638
24	Mardin pop.	5.536^{h}	0.641	4.883^{g}	0.606	23.769^{ijk}	5.086	21.347^{h}	4.818	5.210^{h}	0.588
	Avg.	**6.010**	**0.654**	**5.369**	**0.598**	**28.773**	**5.496**	**25.830**	**5.248**	**5.690**	**0.576**

When we examine the thousand grain weights (g) of seeds belonging to various grass pea genotypes (Table 3), it was determined that the lightest genotype belongs to the Elazig population (99.830 g) and the heaviest genotype belongs to Coloratusa (172.070 g) (Özdemir, 2016). Germination time (days) and germination percentages (%) of seeds belonging to twenty-four different grass pea genotypes were examined under controlled conditions according to ISTA (2007) rules. Although germination times were close to each other, the fastest germinated genotype was the Gürbüz variety (0.508 days), while the slowest germinating one was the Ela variety (0.536 days) (Table 3). On the other hand, when we examine the germination rates of seeds that hatch in almost half a day; it has been determined that all genotypes had over 85% germination ability, and almost all seeds (100%) were germinated (Table 3).

Table 3. Germination time / rate and one thousand grain weight of grass pea genotypes

No	Name of genotype	Thousand grain weight (g)	Germination Time (days)	Germination Rate (%)
1	452	143.970	0.517	100
2	481	137.170	0.512	100
3	504	111.170	0.531	99
4	508	103.130	0.518	96
5	520	110.700	0.513	100
6	522	103.170	0.517	96
7	528	107.000	0.512	100
8	531	117.730	0.517	100
9	553	132.630	0.515	87
10	Adıyaman pop.	114.300	0.511	96
11	**Coloratus**	**172.070**	**0.508**	94
12	**Ela**	105.530	**0.536**	100
13	Elazığ pop.	99.830	0.516	100
14	Eren	138.970	0.511	100
15	Gürbüz	127.930	0.510	100
16	Hat-1	139.900	0.518	100
17	Hat-6	121.630	0.532	100
18	Hat-12	146.200	0.517	100
19	Hat-17	129.210	0.523	100
20	Hat-18	143.130	0.523	99
21	Hat-19	135.400	0.520	99
22	İflis-491	126.330	0.523	100
23	Leucotetragonus	155.170	0.524	99
24	Mardin pop.	118.230	0.524	99

4.Conclusion

Grass pea (*Lathyrus sativus* L.) is a valuable herbal resource that has been cultivated since the early Neolithic ages around 6000 BC. In this study, seeds from twenty-four different genotypes of the grass pea crop, which were evaluated in different ways, were examined. The characteristics of seeds are used to prevent crop losses experienced especially during agricultural production (such as plantation, harvesting and product processing). The selection of the suitable sowing machine to be used in production or the settings of the sowing order in the existing sowing machine, the selection of the appropriate sieve during the separation of the seeds taken from the harvested plants, and the separation of the seeds according to their sizes during the product processing phase and the processing of the seeds according to the requirements are the main issues to be taken into consideration. In addition, since the seeds to be used must have a germination rate of approximately 70% and above in order for herbal products to provide economic returns to the producer, the climatic and environmental conditions differ according to the region where the product is grown, especially the length of days become important. Therefore, it is important to determine how long would it take for the seeds to hatch. On the other hand, seeds are evaluated according to their general characteristics in breeding studies, and such studies are diversified by taking

into account the conditions that are considered superior or weak.

In the study, some physical (shape-size, surface area, projection area, average arithmetic diameter, thousand grain weight) and physiological (germination rate and time) characteristics of the seeds belonging to twenty-four different genotypes of grass pea were tried to be revealed. It was revealed that the seeds belonging to twenty-four different grass pea genotypes generally have a short and oval seed structure, and the Coloratus and Leucotetragonus varieties stand out in terms of length, width, surface area, projection area, average arithmetic diameter values compared to other varieties. All grass pea genotypes are found to have an 85-100% germination rate, but the fastest germinating variety was Coloratus, and the slowest germinating one was the Ela variety. In terms of thousand grain weights, Coloratus and Leucotetragonus varieties were found to be the heaviest.

Declaration of Author Contributions

The authors declare that they have contributed equally to the article. All authors declare that they have seen/read and approved the final version of the article ready for publication.

Declaration of Conflicts of Interest

All authors declare that there is no conflict of interest related to this article.

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