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# STUDIES REGARDING YIELD POTENTIAL OF SOME GARDEN PEAS ACCESSIONS SOWN IN DIFFERENT DECADES

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***Abstract***

*Pisum sativum also known as garden peas is one of the major food legumes that can grow in different regions, and it ranks the fourth in world food legume productions next to soybean, peanut, and dry bean. At Vegetable Research Development Station Buzau, a new breeding program of peas has started and 15 stable accessions were taken into study. The focus of the present study was to evaluated the yield potential and the best suited sown decade for 15 peas accessions. The crops were severely affected by excessive rainfall, (in May and June) which however, it was found that the accessions sown in the first decade had higher yields compared to the accessions in the second decade, both at green peas maturity and at physiological maturity. Thus, the lowest value for weight of 1000 grains was at A11 with 212.04 g, and the highest was obtained by A1 with 455.25g. In terms of yield potential, it was noted that A8 had the lowest value/sqm (102.01 g), and A10 was the accession with the highest weight/sqm (295.53 g), at physiological maturity. A9 was the earliest accession, followed by A1, and the latest accessions were A6 and A7.*

***Key words***: *expressiveness, Pisum sativum, phenotype.*

## INTRODUCTION

Soil, as a living environment of plants, is the main determinant factor of the flora in a certain area and affects both the condition of crop plants and weeds (Haliniarz et al., 2014). One of the most suitable legumes crop cold tolerant and frost resistance is garden peas (Nemecek et al., 2008).
The contribution of legumes, especially garden peas, is one of the key factors in ensuring soil fertility and in supporting the production of cereals in dry or developing areas (Jacobsen et al., 2012).
Peas are an annual plant specific to the cold season, with importance in human and animal nutrition (Mihailović and Mikić, 2010; Chețan et al., 2015). The root is pivoting, and on the young branches a large number of atmospheric nitrogen-fixing nodules grow following symbiosis with *Rhizobiu*m bacteria, thus contributing to the improvement of soil fertility (Bohlool et al., 1992; Cass et al., 1994; Singh et al., 2007; Tago et al., 2011; Matsumiya et al., 2013; Ferguson, 2013; Şimon et al., 2014). Also, the root system is characterized by a high capacity of absorption and solubilization of potassium and phosphorus (Muntean et al., 2008), from this reason it is a good precursor to other vegetable crops and is of particular importance in organic farming (Vînătoru et al., 2019).
In the current context characterized by important climate changes that may have adverse effects on agricultural crops, peas may become the most important legume for grains grown in Romania and in the European Union, due to its high adaptability, short vegetation period and high contents of proteins and energetic substances. In addition, grain peas can help ensure the biological balance of our planet, reduce pollution, improve soil fertility and reduce energy consumption caused by the production and use of chemical fertilizers (Chirilă, 1990).
For this reasons, Vegetable Research and Development Station (VRDS) Buzau has started an breeding program for this species (Barcanu et al., 2019; Gherase et al., 2021), in

order to obtain competitive varieties on the market, with resistance to abiotic stress caused by the constantly changing environment.

The vegetation period is a hereditary controlled trait, influenced by the climatic factors characteristic of the landforms and represents the necessary period from sprouting to harvest maturation. This property is relatively stable only for the area where the biological material was created. Without a well-developed ecological plasticity, the vegetation period registers significant deviations if a genotype is cultivated in other pedoclimatic conditions.

In the Official Catalogue of Species and Varieties of Cultivated Crops from Romania only 11 cultivars are registered. One of this, 'Getica' variety was registered by VRDS Buzau in 2005. In 2021, 3 varieties of garden peas were approved under the name 'Banat', 'Crișana' and 'Muntenia'.

The aim of the study was to evaluate the production potential at physiological maturity of fifteen pea accessions and to identify the most suitable sowing period.

## MATERIALS AND METHODS

The Breeding and Biodiversity Laboratory of VRDS Buzau has a valuable germplasm collection of *Pisum sativum.*

The study aimed the evaluation of fifteen accessions of garden bean noted A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11, A12, A13, A14 and A15. For control variant is was used Getica cultivar, A15. The studied accessions were sown in two decades to identify the optimal sowing period in order to obtain a higher yield and quality production.

The studies were made for two consecutive years (2020-2021). The quantitative and qualitative observations were made using descriptors by the International Union for the Protection of New Varieties of Plants (UPOV 2006, 2015). The maximum temperature, minimum temperature, rainfalls in the studied years and average multiannual temperatures and rainfall are shown in Table 1.

The seeds were sown manually and the -sowing scheme used was 14 cm between plants and 70 cm between rows. The first decade was sown on March $1^{st}$, and the second decade was sown on April $1^{st}$, on both years of study.

Table 1. Mean of temperature and rainfall during studied years and multiannual

| 2020 | March | April | May | June | July |
|---|---|---|---|---|---|
| Temp. max °C | 14.35 | 19.93 | 22.77 | 28.3 | 30.77 |
| Temp. min °C | 3.32 | 4.8 | 10.7 | 16.16 | 18.09 |
| Average °C | 8.83 | 12.36 | 16.73 | 22.23 | 24.43 |
| Rainfall mm | 29.3 | 6.9 | 102.5 | 78.1 | 75 |
| **2021** | **March** | **April** | **May** | **June** | **July** |
| Temp. max °C | 10.25 | 14.86 | 22.67 | 25.73 | 31.32 |
| Temp. min °C | 0.38 | 4.23 | 11.45 | 15.73 | 19.25 |
| Average °C | 5.53 | 9.55 | 17.06 | 20.73 | 25.29 |
| Rainfall mm | 85.42 | 81.56 | 80.05 | 218.09 | 23 |
| **Multian** | **March** | **April** | **May** | **June** | **July** |
| Average °C | 5.2 | 11.4 | 17.1 | 21 | 22.9 |
| Rainfall mm | 26.09 | 40.6 | 68.8 | 80.8 | 67.7 |

The experiments were organized in randomized block design. In order to establish the quality of seeds, the total titratable acidity, the dry matter and total soluble solids content were measured at harvest maturity. Total titratable acidity was determined using 5 g of ground seeds diluted in 25 mL of double distilled water. The titratable acidity of seeds was determined by titration with 0.1 N NaOH until pH reach 8.1. The dry matter content (DM) was determined with KERN DBS60-3 thermobalance. The total soluble solids (TSS) were measured with digital refractometer KERN OPTICS ORF 1RS Methods described by us in details in other research articles (Agapie et al., 2020).

The yield was related to the quantity of dried seeds, reached physiological maturity because the aim of the researches was to obtain seeds and also to identify the most suitable sowing period. For statistical analysis, ANOVA was used followed by Duncan test.

## RESULTS AND DISCUSSIONS

Throughout the vegetation period, phenological observations were made for both decades, on two years of study. In Table 2 and Table 3 are presented the phenological observation of year 2021. The phenological data of year 2020 were three to five days earlier than those in 2021 (data not shown).

The seed sown in the first decade sprouted faster than the those sown in the second decade This is due to higher temperatures in April which favoured better and faster germination.

But, from a qualitative point of view, the accessions have decreased production, as the plants have been more exposed to high temperatures in the summer months, knowing that peas are one of the plants that do not prefer high temperatures.

Therefore, we recommend sowing in February-March, as early as possible, when the weather allows. The vegetation period varied from semi-early varieties (A1, A5, A10), to semi-late varieties (A2, A3, A4, A8, L10, L11, L12, L15) and late varieties with a vegetation period of over 90 days (A6, A7, A13).

Table 2. Phenological observation of garden pea accessions - first decade

| Accession | Sowing date | Germination date | Flowering period | Emergence of the first flat pod | Harvest fresh pods | Harvest dry pods |
|---|---|---|---|---|---|---|
| A1 | 01.03 | 29.03-31.03 | 07.05-13.05 | 19.05 | 09.06 | 02.07 |
| A2 | 01.03 | 31.03-01.04 | 19.05-21.05 | 24.05 | 15.06 | 09.07 |
| A3 | 01.03 | 29.03-04.04 | 14.05-16.05 | 21.05 | 12.06 | 05.07 |
| A4 | 01.03 | 29.03-01.04 | 15.05-21.05 | 24.05 | 15.06 | 09.07 |
| A5 | 01.03 | 29.03-30.03 | 13.05-17.05 | 15.05 | 09.06 | 02.07 |
| A6 | 01.03 | 01.04-05.04 | 24.05-27.05 | 04.06 | 26.06 | 18.07 |
| A7 | 01.03 | 01.04-05.04 | 24.05-26.05 | 31.05 | 24.06 | 13.07 |
| A8 | 01.03 | 29.03-04.04 | 17.05-21.05 | 24.05 | 15.06 | 09.07 |
| A9 | 01.03 | 30.03-01.04 | 07.05-10.05 | 12.05 | 10.06 | 03.07 |
| A10 | 01.03 | 31.03-01.04 | 16.05-18.05 | 21.05 | 12.06 | 05.07 |
| A11 | 01.03 | 29.03-30.03 | 15.05-21.05 | 25.05 | 16.06 | 10.07 |
| A12 | 01.03 | 01.04-05.04 | 17.05-21.05 | 13.05 | 11.06 | 11.07 |
| A13 | 01.03 | 31.03-02.04 | 17.05-23.05 | 28.05 | 25.06 | 23.07 |
| A14 | 01.03 | 29.03-01.04 | 18.05-25.05 | 28.05 | 28.06 | 23.07 |
| A15 | 01.03 | 29.03-03.04 | 14.05-17.05 | 16.05 | 09.06 | 02.07 |

Table 3. Phenological observation of garden pea accessions - second decade

| Accession | Sowing date | Germination date | Flowering period | Emergence of the first flat pod | Harvest fresh pods | Harvest dry pods |
|---|---|---|---|---|---|---|
| A1 | 01.04 | 13.04-16.04 | 17.05-20.05 | 28.05 | 18.06 | 09.07 |
| A2 | 01.04 | 13.04-16.04 | 20.05-26.05 | 31.05 | 21.06 | 12.07 |
| A3 | 01.04 | 12.04-14.04 | 19.05-25.05 | 31.05 | 21.06 | 12.07 |
| A4 | 01.04 | 13.04-15.04 | 24.05-29.05 | 03.06 | 24.06 | 15.07 |
| A5 | 01.04 | 12.04-14.04 | 18.05-24.05 | 02.06 | 24.06 | 15.07 |
| A6 | 01.04 | 18.04-21.04 | 27.05-03.06 | 14.06 | 26.06 | 18.07 |
| A7 | 01.04 | 17.04-21.04 | 26.05-01.06 | 09.06 | 24.06 | 13.07 |
| A8 | 01.04 | 13.03-15.04 | 24.05-29.05 | 03.06 | 24.06 | 15.07 |
| A9 | 01.04 | 0.03-12.04 | 15.05-19.05 | 25.05 | 18.06 | 19.07 |
| A10 | 01.04 | 13.04-16.04 | 21.05-26.05 | 30.05 | 21.06 | 12.07 |
| A11 | 01.04 | 14.03-17.03 | 22.05-27.05 | 02.06 | 25.06 | 16.07 |
| A12 | 01.04 | 13.04-16.04 | 22.05-31.05 | 04.06 | 28.06 | 16.07 |
| A13 | 01.04 | 15.04-19.04 | 23.05-30.05 | 04.06 | 28.06 | 16.07 |
| A14 | 01.04 | 13.03-16.04 | 20.05-26.05 | 02.06 | 24.06 | 15.07 |
| A15 | 01.04 | 13.03-16.04 | 19.05-25.05 | 29.05 | 18.06 | 09.07 |

As we can see in Table 1, the year 2021 was atypical. Precipitation far exceeded the average of multiannual precipitation in previous years. In March the multiannual average was exceeded by 58.52 l/m$^2$, in April
the average was exceeded by 40.96 l/m$^2$, the average in May was exceeded by 11.25 l/m$^2$.

The highest amount of precipitation was recorded in June, 218.09 l/m$^2$, thus exceeding 137.29 l/m$^2$. Due to heavy rainfall, the production and quality of pea seeds have been significantly affected. Water stress is one of the most important factors that can affect the plant. Excess water causes root rot or can lead to mould on the foliar system.

At the same time, the appearance of *Erysiphe pisi* was reported and was present on all shoot system. The most prone to powdery mildew attack were A5 and A15 cultivars while A4, A7 and A13 cultivar were tolerant.

Tolerance means the ability of the plant to avoid crop losses, even if the symptoms of the disease are present. The accessions that showed resistance will be retained and studied in future improvement programs.
The TSS content varies between 8.78°Brix (A7) to 19.56°Brix (A10) (Figure 1).
For a pea variety to be considered a sweet pea, it must have at least 10°Brix. From our research, most all accessions studied had a high content in TSS.
The higher the acidity, the easier it is to control the microbial damage of processed products.

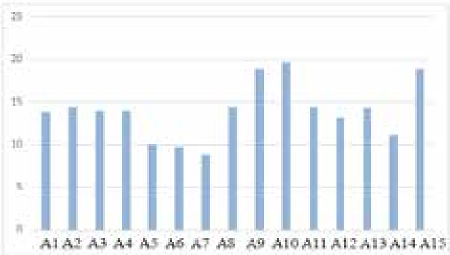


Figure 1. The mean soluble solids content (°Brix) of investigated *P. sativum* accessions

Pea crop is used mainly for industrialization. The percentage of titratable acidity varies between 0.79 g/l (A10) to 1.56 g/l (A9) (Figure 2). These values demonstrate the suitability of using the studied genotypes in the processed industry. The dry matter content varies from 21.18% (A11) to 36.84% (A3). Mostly acessions had the dry matter content exceeding 25% (Figure 3).

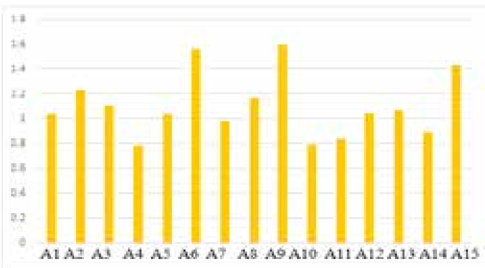


Figure 2. The mean titratable acidity content (g citric acid/100 mg vegetal product) of investigated *P. sativum* accessions

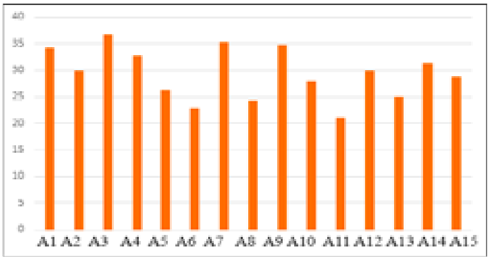


Figure 3. The mean dry matter content of investigated *P. sativum* accessions

The analysis of variance showed significant differences regarding the yield of seeds/plant (Figure 4), more accurate, in the first sowing decade A14 had the highest values (47.26g), while A6 had the smallest record with just 6.25 g/plant.
In the second sowing decade, the accessions behave differently, A4 had the highest values, with 29.19 g/plant, while A15 had 6.37 g/plant. A14 had a lower value with 26.85 g/plant less than in the second decade.
The accessions A7, A10, A13, A1, A3, A11 and A9 had similar values in both decades.
Concerning the yield of pods/plant (Figure 5),
A14 had the higher value in the first decade, with 126.58 g/plant, while A11 had just 16.23 g/plant. In the second decade, A4 had the higher value, 62.94 g, while A15 had just 14.78 g/plant.
A4 registered a decrease with 70.36 g in the second decade, while A14 recorded an increase with 40.65 g/plant in the second decade. Similar values between sowing decades were recorded by A 13, A10, A9, A6, A3, A11 and A1.

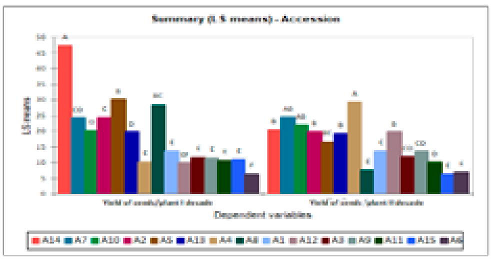

Figure 4. The mean Yield of seeds/plants (g) depending on the sowing decade

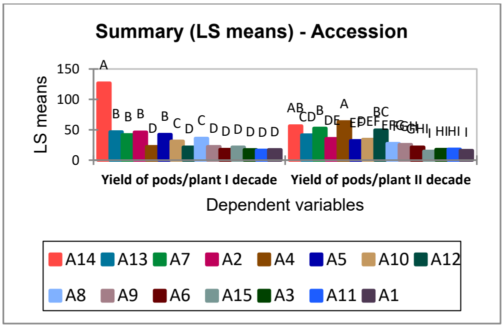


Figure 5. The mean yield of seeds/plants (g) depending on the sowing decade

Regarding the number of pods obtained per plant (Figure 6), it was observed that the number of pods per plant differed depending on the growing season, so it was found that accession A14 had 21 pods in the first epoch and in the second epoch the number was reduced to 7 pods/ plant.

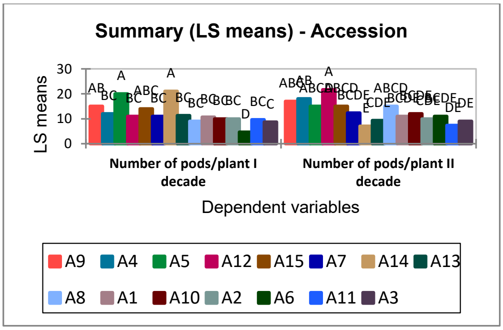


Figure 6. Number of pods/plants depending on the sowing decade

The number of pods per plant on accessions A1 and A2 did not differ according to the time of sowing, while accession A12, in the second epoch registered a higher number of pods per plant (25) compared to the first epoch (11).
These differences can be justified by the fact that each accession behaves differently depending on the growing conditions. Therefore, it is the breeder who decides the right accessions for his goals (Bos 2007).
The accessions A10, A13, A9, A1 and A3 have the highest yield of dry seeds per square meter with over 250 g/m$^2$, as shown in Table 4.
It should be noted that the same accessions had good results in the previous year regarding the seed production (Gherase et al., 2021). The accessions A4 and A11 had poor results compared to the previous year, as they were affected by excess rainfall. The accession A6 had lower production because it is a type of mange-tout pea, from which the young pods are harvested and consumed, while A8 had the lowest production, being attack more by pathogens. The yield was reduced because in May the accessions bloom, and the fruit setting rate was low.
Stages development of pea pods accession A1 can be found in (Figure 7).

Figure 7. Development stages of pea pods accession A1

Table 4. The Mean values of 1000 seeds mass and weight of dry seeds per square meter

| Accessions | A1 | A2 | A3 | A4 | A5 | A6 | A7 | A8 | A9 | A10 | A11 | A12 | A13 | A14 | A15 (CV) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mass of 1000 seeds (g) | 445.25 | 423.30 | 311.15 | 390.56 | 276.24 | 370.52 | 247.61 | 435.57 | 223.41 | 244.89 | 212.04 | 335.68 | 236.60 | 439.22 | 341.32 |
| Difference between control variant - CV (%) | **130.45** | 124.02 | 91.16 | 114.43 | 80.93 | 108.56 | 72.54 | 127.61 | 65.45 | 71.75 | **62.12** | 98.34 | 69.31 | 128.68 | 100 |
| Weight g/1 m$^2$ | 253.75 | 217.51 | 250.96 | 106.62 | 129.2 | 125.94 | 135.76 | 102.01 | 260.03 | 295.53 | 143.3 | 215.71 | 261.94 | 109.32 | 123.77 |
| Difference between control variant - CV (%) | 205.02 | 175.74 | 202.76 | 86.14 | 104.39 | 101.75 | 109.69 | **82.42** | 210.09 | **238.77** | 115.78 | 174.28 | 211.63 | 88.33 | 100 |

## CONCLUSIONS

The purpose of our study was to identify the most suitable sowing period. It was noticed that the accessions behave differently. For example, A10 had the highest yield/m$^2$, with over 295 g/m$^2$. In terms of yield of pods/plant A14 had the highest values in the first decade and in the second decade the yield registered a noticeable decrease. At the opposite pole, the A4 had the highest pod yield/plant in the second decade.
It was noticed that A1, A3, A10 and A13 behave similar in both decades. We could

conclude that the sowing period did not affect the growth stage.

Some accessions were selected for desirable agronomic characteristics and will be useful in the breeding program to obtain new genotypes adapted to the pedo-climatic conditions of Romania.

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