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Research Article

Testing Some Varieties of Peas in the Southern Area of Romania

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Abstract

The pea, *Pisum sativum* L. *Family Papilionaceae*, is a leguminous, herbaceous plant native to Asia Minor and Central Asia. It was cultivated by the Greeks and Romans in antiquity and quickly spread throughout the world; it was brought to Romania in the 17th century. Pea has long been an important component of the human diet, providing an excellent source of protein, is characterized by high yielding ability, but at the same time significant variability of yield level. It also has a high protein content in seeds and the ability to bind atmospheric nitrogen, which is of both ecological and economic importance. Peas play also an important role in crop rotation and in the plant production systems being a good previous crop for cereals and chemicals are not used or only used to a limited extent and has recently received special attention for the improvement of new varieties. To establish the production potential and the ability to adapt to the climatic conditions of the area, in the period 2019, 2020, 2021, at Agricultural and Development Research Station Teleorman, was tested the behavior of 7 local and foreign pea varieties, by establishing a bifactorial experiment, in 3 repetitions, laid out according to the randomized block method, with plots having an area of 10 m^2, because the capability of the variety to adapt to growing conditions plays an important role in increasing the quantity and quality of crops production.

Keywords

Varieties, Peas, Climatic Conditions, Production, Herbicide

1. Introduction

Legumes for grains represent a primary and effective source of protein, being able to supplement or replace the protein content in human nutrition and animal feed.

PEAS, like other grain legumes, require low amounts of chemical nitrogen fertilizers, enriching the soil with appreciable amounts of atmospherically fixed nitrogen, under favorable climate conditions. Within the cultivation technology of this plant, the choice and use of the most valuable varieties are basic factors in obtaining large and as constant productions as possible.

Peas, as a valuable nutritious and cultivated plant [1], have recently received special attention for the improvement of new varieties [2]. They are increasingly adapted to any kind of environmental conditions. Thus, we want an increased production of grains, contents in active principles as high as possible [3], but also to increase its proportion in the structure of crops on a farm.

The capability of the variety to adapt to growing conditions plays an important role in increasing the quantity and quality of crops production [4].

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An important task of the breeders is to achieve a combination of resistance to abiotic and biotic stress factors [5], but the fundamental goal of pea breeders is to increase seed yield to maximize plant productivity and allow for more widespread use of pea in various agricultural production systems [6].

Pea (Pisum sativum L.) has long been an important component of the human diet, providing an excellent source of protein, is characterized by high yielding ability, but at the same time significant variability of yield level. It also has a high protein content in seeds and the ability to bind atmospheric nitrogen, which is of both ecological and economic importance. Peas play also an important role in crop rotation and in the plant production systems being a good previous crop for cereals and chemicals are not used or only used to a limited extent [7, 8].

A large part of the nitrogen requirement (42-78%) is obtained by peas from the atmosphere by means of symbiotic bacteria [9], and the rest is provided from the soil reserves, thus achieving a substantial reduction in the amount of fertilizers with N, applied to culture.

The environment acts on the absorption and translocation of nutrients, namely drought, positively influences the absorption of nitrogen, potassium, sulphur, magnesium and reduces the absorption and translocation of phosphorus and, to a lesser extent, manganese, iron [10]. The optimal nutrition of plants is achieved under the conditions of the existence of balanced ratios between macro and microelements. It is important to reduce the amount of fertilizers applied per hectare, because nodules with bacteria (Rhizobium leguminosarum) fixing atmospheric nitrogen in symbiosis with the plant develop on the young ramifications of the root. Peas make good use of phosphorus reserves in the soil, having a high capacity to solubilize phosphorus from more difficult-to-dissolve combinations. Peas were cultivated in 2008, on an area of 5.9 million hectares worldwide [11], the largest areas being cultivated in Canada (1.58 million hectares), China (0.91 million hectares), the Russian Federation (0.63 million hectares), the world average production being 1658 kg/ha, with 5993 kg/ha in Luxembourg, 4666 kg/ha in the Netherlands, 4528 kg/ha in France.

In Romania, at the level of 2008, 17,400 hectares were cultivated with peas. Due to the lack of market demand, the area under peas has gradually decreased recently. Research carried out in our country [12] and in France showed that high doses of nitrogen fertilizers inhibit the development of nodules, but the ability to fix nitrogen biologically is not affected, in the conditions of application of reduced amounts of nitrogen fertilizers. In the context of climate change, peas can be one of the field legumes that, in dry areas, due to the short vegetation period and the fact that it is sown earlier in the spring and makes better use of the moisture accumulated in the soil during the cold season, can represent an alternative to other legumes for grains. For germination, the optimal temperature is 4-5 ℃. With ideal conditions, the emergence takes place in 10-12 days. The optimal sowing time for peas is conditioned by the climatic conditions between March 1-15. Sow in rows, with a distance between rows of 15-20 cm, between plants/row of 5 cm. Sowing is done at a maximum depth of 4-5 cm, under the conditions of a well-prepared seed bed. The seed required for one hectare is 180 kg/ha.

2. Characteristics of Indigenous Varieties

RODICA, pea variety certified in 2017; the height of the plant varies between 42.0-84.0 cm, depending on the pedo-climatic conditions and the culture technology applied; the plant is of the afila type (leaflets transformed into tendrils) with indeterminate growth; TGW is 265-286 g; crude seed protein content is 21.6-26.2%; good resistance to falling; very good resistance to low temperatures in the seedling phase; good drought resistance; good resistance to diseases and pests; Agricultural and Development Research Station Teleorman [13].

TELMA, pea variety certified in 2017; the height of the plant varies between 54.0-82.0 cm, depending on the pedo-climatic conditions and the culture technology applied; the plant is of the afila type (leaflets transformed into tendrils) with indeterminate growth; TGW is 265-284 g; crude seed protein content is 21.2-25.8%; very good resistance to falling; very good resistance to low temperatures in the seedling phase; good drought resistance; good resistance to diseases and pests; Agricultural and Development Research Station Teleorman [13].

VEDEA, plant of normal type, with indeterminate growth, TGW is 260-280 g; crude protein content 26.5-28.5%; good resistance to drought, diseases and pests; recommended for all areas of culture in Romania. Agricultural and Development Research Station Teleorman [14].

NICOLETA, variety with indeterminate growth type; the plant is afila type, with leaflets transformed into strongly developed and branched tendrils with medium-sized stipules; TGW: 250-280 g; very good resistance to falling and shaking; good resistance to pea powdery mildew (Erysiphe polygoni), anthracnose (Ascochya pisi) and viruses; the protein content is 24.5-26%; I.N.C.D.A. Fundulea.

3. Characteristics of Foreign Varieties

SALAMANCA, a pea variety that has proven high production potential in most farms where it has been cultivated; very high resistance to falling and bending; afila-type variety, determinate growth, high yield potential, easy harvest; outstanding stability every year; SATEN UNION [15].

BELMONDO, variety adapted to drought conditions; peas of the afila type, with tall bearing and late maturity; winter resistance; lower plant height; resistance to falling; the best disease resistance; high TGW; high drop rate; PROBSTDORFER [16].

ASTRONAUTE, new afila pea variety with determined growth; high production capacity; high protein content; spring peas; TGW between 265-275 g. [17].

The research was carried out in Drăgănesti Vlașca, on a chernozeom-vertric type soil with good fertility (over 3.1% humus, clay content over 42% in the 0-24 cm horizon, pH > 5.9). The predecessor plant was wheat. Fertilization: Nitrolimestone 200 kg/ha. The sowing date was 19.03.2019, 26.02.2020 and 20.02.2021 respectively.

4. Results and Discussion

In terms of water, in 2019 peas benefited from 376.6 mm of precipitation over the total vegetation period, being 76.6 mm more than the crop's moisture requirements, but their distribution was unfavorable to the pea crop. Thus, in the first part of the vegetation period, precipitation was quantitatively higher than the multiannual average (+27.2 mm) in April, (+48.1 mm) in May and (+99.3 mm) in June. Excess moisture from April to June affected the growth and development of peas by suffocating the roots and reducing plant metabolism, which led to a significant decrease in grain production obtained in 2019 by all studied varieties [18].

In 2020, there were moderate excesses of precipitation in the months of May (7.8 mm) and June (11.6 mm), and in April a deficit of 21.8 mm, compared to the multi-year averages of the area (figure 1). In the month of July, it can be said that total drought has set in, only 2.8 mm of precipitation was recorded, precipitation being practically absent, the month's deficit being (58.6 mm).

The productions achieved in 2020, by the pea varieties, were less affected by the water deficit, from the first part of the vegetation period (April), and favored by the moderate surpluses of precipitation during the period of intense growth and formation of productivity elements May-June (figure 1).

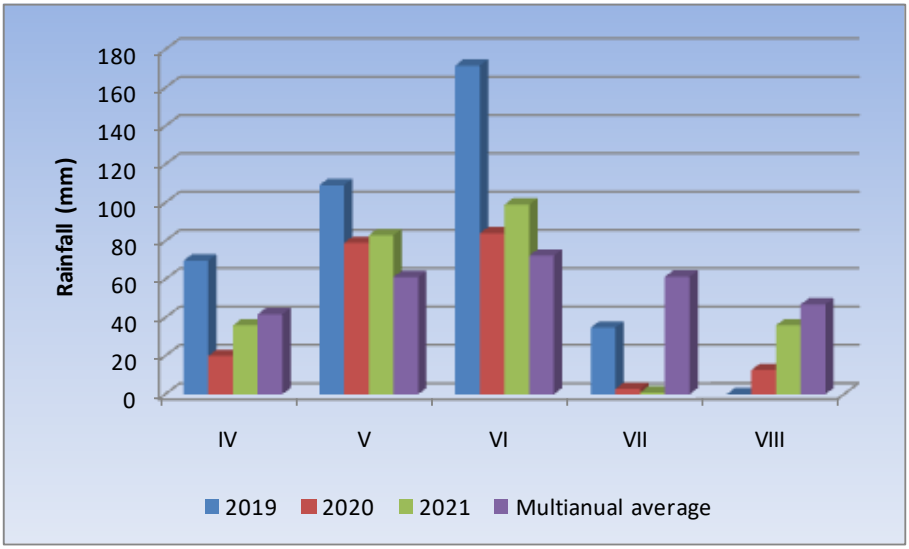

Figure 1. *Rainfall evolution ARDS Teleorman, 2019 - 2021.*

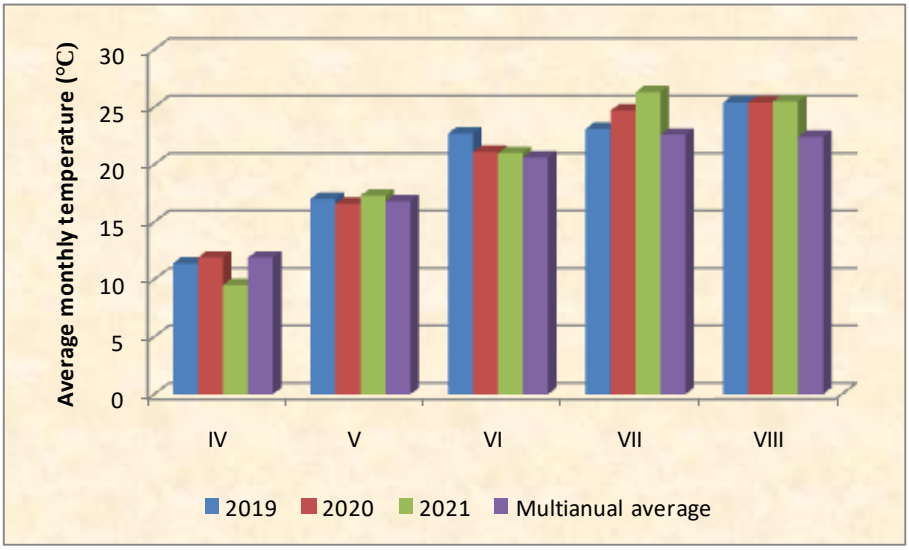

Figure 2. *Evolution of temperatures at ARDS Teleorman, 2019 - 2021.*

In 2021, there were positive precipitation deviations in the months of May (+21.8 mm) and June (26.4 mm. In April 2021, 36.0 mm of rain was recorded, 5.8 mm less compared to the multiannual average. In the months of May and June, the deviations were 21.8 mm and 26.4 mm respectively, determining a good growth and development of the pea plants. The most pronounced water deficit was recorded in the month of July - 59.9 mm.

In the climatic conditions of the years 2019-2021, in the area of influence of Agricultural and Development Research Station Teleorman, the productions obtained by the 7 pea varieties were below the production capacity (2019) and close to the productive potential in 2020. Large positive temperature deviation monthly averages of 3.7 ℃, compared to the multi-year average, were recorded in July of 2021, a favorable year for the pea crop.

In order to highlight the importance of the experimental factors (variety and year of experimentation), the statistical analysis of the 7 pea varieties was carried out in the formation of the crop. The calculation and interpretation of production results was based on the analysis of variance of bifactorial experiments arranged in randomized blocks [19].

The experimental factors were: Factor A – variety with 7 graduations (a1= Telma; a2= Rodica; a3= Nicoleta; a4=Vedea; a5= Salamanca; a6= Astronaut; a7= Belmondo; Factor B – year of experimentation with 3 graduations (b1=2019; b2=2020; b3=2021).

Analyzing the variance table of the bifactorial experience (7 varieties × 3 years) we observe the very significant influence of the variety and the year of experimentation (climatic conditions), also the interaction of the variety x the year of experimentation is very significant for the pea production obtained (table 1).

Table 1. *Analysis of variance (ANOVA) for production at bifactorial experience genotype x year of experimentation.*

Source of variance	Sum of square (SS)	Degree of freedom (DF)	Mean square s ²	Test F
Total	38127436	62		
Repetition	7031.0	2		
Years	21538328	2	10769164	1728.81***
Variety	13105872	6	2184312	350.65***
Year X variety interaction	3227034.9	12	268919,6	43.17***

The variety influences the pea production obtained, on average over the years of experimentation, very significant increases in production of 606 kg/ha were obtained with the Astronaut variety and 602 kg/ha with the Salamanca variety, compared to the average of the experience (table 2), as well as the climatic conditions represents an essential factor in the realization of production.

From the point of view of the favorability of the agricultural year for the pea crop, the year 2021 stands out when very significant production increases of 825 kg/ha were obtained, compared to the average of experience (Table 3), (figure 1) in the three years of study.

Table 2. *The influence of the cultivar on the pea production, averaged over the years of experimentation, ARDS Teleorman.*

Variety	Yield (Kg/ha)	(%)	Difference ± Control	Significance
Telma	2015	82.80	-418	
Rodica	2374	97.56	-59	
Nicoleta	2443	100.42	10	
Vedea	1692	69.55	-741	
Salamanca	3035	124.72	602	***

Variety	Yield (Kg/ha)	(%)	Difference ± Control	Significance
Astronaut	3039	124.89	606	***
Belmondo	2435	100.06	1	
Average	2433	100	Control	

LSD 5%=49.20 kg/ha; LSD 1%= 65.76 kg/ha; LSD 0.1%=86.47 kg/ha *** significant at p< 0.05 and p< 0.01

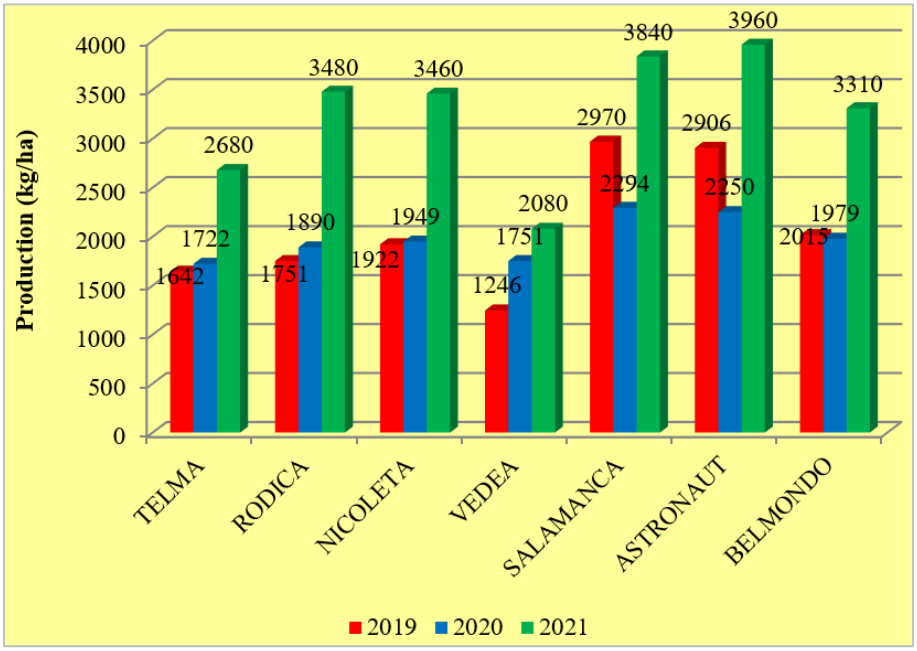

Figure 1. *Average production for the studied years 2019 – 2021.*

Table 3. *The influence of climatic conditions on pea production, averaged per variety, ARDS Teleorman.*

The year of study	Yield (Kg/ha)	(%)	Difference ± Control	Significance
2019	2064	84.85	-369	
2020	1976	81.23	-457	
2021	3259	133.92	*825*	***
Average	2433	100	Control	

LSD 5%=75.16 kg/ha; LSD 1%= 100.46 kg/ha; LSD 0,1%=132.08 kg/ha

The analysis of variance (ANOVA) for hectoliter mass at the bifactorial experience genotype x year of experimentation shows us the distinctly significant influence of the variety and highly significant of the year of experimentation (climatic conditions), and the interaction of variety x year of experimentation is insignificant for the hectoliter mass of pea varieties studied (table 4).

Table 4. *Analysis of variance (ANOVA) for hectoliter mass at bifactorial experience genotype x year of experimentation.*

Source of variance	Sum of square (SS)	Degree of freedom (DF)	Mean square s ²	Test F
Total	259	62		
Repetition	3,6	2		
Years	23.6746	2	11.8373	16.82**
Variety	203.6841	6	33.94735	48.24***
Year X variety interaction	0.03873	12	0.003228	0.0046^{Ns}

Ns - not significant;

The variety also influences the hectoliter mass values, a very significant increase in hectoliter mass was obtained by the Nicoleta variety (1.96 kg/hl), a distinctly significant increase by the Rodica and Salamanca varieties (0.76 kg/hl), and by the Astronaut and Telma varieties significant of 0.56 kg/hl, respectively 0.46 kg/hl (table 5).

Table 5. *The influence of the variety on the hectoliter mass in peas, averaged over the years of experimentation, ARDS Teleorman.*

Variety	Hectoliter mass (kg/hl)	(%)	Difference ± Control	Significance
Telma	78.25	100.59	0.46	*
Rodica	78.55	100.97	0.76	**
Nicoleta	79.75	102.52	1.96	***
Vedea	73.65	94.67	-4.14	
Salamanca	78.55	100.97	0.76	**
Astronaut	78.35	100.72	0.56	*
Belmondo	77.45	99.56	-0.34	
Average	77.79	100.00	Control	

LSD 5%=0.52 kg/hl; LSD 1%= 0.70 kg/hl; LSD 0.1%=0.92 kg/hl

Climatic conditions during the study years did not have a major influence on the hectoliter mass values of the studied varieties (table 6).

Table 6. *The influence of climatic conditions on hectoliter mass in peas, on average per variety, ARDS Teleorman.*

Variety	Hectoliter mass (kg/hl)	(%)	Difference ± Control	Significance
2019	77.79	100.00	0.00	
2020	77.04	99.04	-0.75	
2021	78.54	100.96	0.75	
Average	77.79	100.00	Control	

Variety	Hectoliter mass (kg/hl)	(%)	Difference ± Control	Significance
LSD 5%=0,80 kg/hl; LSD 1%= 1,07 kg/hl; LSD 0,1%=1,40 kg/hl				

I apply the analysis of variance (ANOVA) for thousand grain weight to the bifactor experience genotype x year of experimentation, this shows us the distinctly significant influence of the variety and the highly significant influence of the year of experimentation (climatic conditions), and the interaction of variety x year of experimentation is insignificant for the thousand grain weight of the pea varieties studied (table 7).

Table 7. *Analysis of variance (ANOVA) for thousand grain weight at bifactorial experience genotype x year of experimentation.*

Source of variance	Sum of Square (SS)	Degree of freedom (DF)	Mean square s ²	Test F
Total	46294	62		
Repetition	67.2	2		
Years	259.5098	2	129.7549	14.62**
Variety	45611.83	6	7601.971	856.56***
Year x variety interaction	0.016825	12	0.001402	0.0002^{Ns}
Ns - not significant; * and *** significant at p< 0.05 and p< 0.01				

The variety influences the thousand grain weight values, the Telma (32.71 g), Belmondo (29.11 g), Rodica (13.91 g) and Astronaut (4.31 g) varieties obtained a very significant increase in the thousand grain weight (table 8).

Table 8. *The influence of the variety on the thousand grain weight in peas, averaged over the years of experimentation, ARDS Teleorman.*

Variety	Thousand grain weight (g)	(%)	Difference ± Control	Significance
Telma	241.70	115.65	+32.71	***
Rodica	222.90	106.66	+13.91	***
Nicoleta	201.70	96.51	-7.29	
Vedea	161.70	77.37	-47.29	
Salamanca	183.50	87.81	-25.49	
Astronaut	213.30	102.06	+4.31	***
Belmondo	238.10	113.93	+29.11	***
Average	208.99	100	Control	
LSD 5%=1.86 g; LSD 1%= 2.48 g; LSD 0.1%=3.26 g				

Figure 2. *Rodica variety.*

Figure 3. *NICOLETA variety.*

Figure 4. *VEDEA variety.*

Figure 5. *SALAMANCA variety.*

In order to achieve high productions of peas, it is necessary to protect the crop against diseases, pests and weeds.

Pest control requires treatment against aphids, thrips and the pea weevil (*Bruchus pisorum*) in the pods. The pathogens *Botrytis* cinerea and *Mycosphaell*e *sp*. must be controlled by fungicide treatment.

The problem weeds in the southern part of the country are: *Digitaria sanguinalis; Echinochloa crus-galli; Setaria spp.; Amaranthus retroflexus; Chenopodium album; Solanum nigrum; Hibiscus trionum; Polygonum convolvulus; Sinapis arvensis; Stellaria media; Veronica spp.; Xanthium italicum; Cirsium arvense; Convolvulus arvensis; Sonchus arvensis.*

In the fight against weeds, the most effective solution is the use of (Corum) herbicide (*bentazone* 480 g/l + *imazamox* 22.4 g/l), in a dose of 1.5 l/ha, divided into two periods of application: 0.75 l /ha, when the pea plants are 12-15 cm and the second stage, two weeks after the first application. It will be applied together with the DASH HC adjuvant in a dose of 0.25 – 0.3 liters per 100 liters of solution.

Some difficulties are encountered when harvesting peas, due to the staggered ripening of the pods (from the base to the tip of the stem), by shaking the grains and laying down the plants. The optimal harvesting time is when the plants have turned yellow, the leaves have dried, with a maximum humidity of 15-17%.

To prevent losses by shaking, it is recommended to harvest in a very short time through a single pass, with the combine adapted for the pea crop.

5. Conclusions

1) The pea productions, for the varieties in the experiment, according to the average of the three years, were: Astronaut (606 kg/ha), followed by Salamanca (602 kg/ha) and Nicoleta (10 kg/ha).
2) In the climatic conditions of the Agricultural and Development Research Station Teleorman, the Astronaut and Salamanca varieties gave the highest yields of 3960 kg/ha and 3840 kg/ha, respectively, in 2021, a favorable year from the point of view of the recorded climatic conditions.
3) Excess humidity from April to June in 2019 affected the growth and development of peas by suffocating the roots and destroying the plants, which led to a significant decrease in grain production obtained in all studied varieties.
4) Climatic conditions, especially precipitation, in excess, after the fallow ripening phenophase negatively influence obtaining high and constant productions in the pea crop.
5) In the area of influence of Agricultural and Development Research Station Teleorman, the climatic conditions can favor obtaining high and constant productions of the pea crop.
6) For the protection of the crop from weeds it is

recommended (Corum) herbicide (*bentazone* 480 g/l + *imazamox* 22.4 g/l), in a dose of 1.5 l/ha, divided into two periods of application: 0.75 l /ha, when the pea plants are 12-15 cm and the second stage, two weeks after the first application. It will be applied together with the DASH HC adjuvant in a dose of 0.25 – 0.3 liters per 100 liters of solution.

7) The studied genotypes are recommended to be cultivated in the study area, an area with difficult growing conditions (water deficit), due to their ability to adapt to climatic conditions.

Abbreviations

ARDS Teleorman	Agricultural and Development Research Station Teleorman
TWG	Thousand Grain Weight
I.N.C.D.A. Fundulea	National Agricultural Research and Development Institute Fundulea

Conflicts of Interest

The authors declare no conflicts of interest.

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