NARDI FUNDULEA, ROMANIA
www.incda-fundulea.ro

ROMANIAN AGRICULTURAL RESEARCH, NO. 39, 2022
First Online: November, 2021. DII 2067-5720 RAR 2022-83

POLIZEȘTI-19, A NEW RICE VARIETY CREATED IN THE PEDOCLIMATIC CONDITIONS IN SOUTHEASTERN ROMANIA

Ionel Ivan[1], Marcel Bularda[2*], Elena Ivan[1], Nicoleta Ungureanu[3*]

[1]Brăila Agricultural Research-Development Station, km 9 Viziru str., 810008 Brăila, Brăila County, Romania
[2]"Dunărea de Jos" University of Galați, 47 Domnească str., 800008 Galați, Galați County, Romania
[3]University Politehnica of Bucharest, Department of Biotechnical Systems, 313 Splaiul Independenței Blvd, 006042 Bucharest, Romania
[*]Corresponding authors. E-mail: marcelbularda@yahoo.com; nicoletaung@yahoo.com

ABSTRACT

Rice is an extremely important crop in the balance of agri-food products used by mankind. This crop feeds over 66% of the world's population and responds favorably to zonal cultivation conditions around the world. In Romania, rice is a perspective crop in the context of diversifying the agricultural production and of the need to find solutions to reduce import of agricultural products and to increase the country's food security. There are few crops such as rice, which can provide in optimal production conditions over 8-10 tons of good quality agricultural food product, usable in human food after relatively simple processing, or which allow to obtain a wide range of food products by industrialization. The creation of new varieties and hybrids through breeding activities is important for the fact that, in the economy of a crop, a new variety contributes to the increase of productivity by 5-10% compared to the varieties in the crop. In addition, the acclimatization is better and the behavior of new varieties against stressors is improved. Hence, plant breeding, including in rice crops, is the main method of progress and efficiency of agriculture and it must be further developed in Romania. This paper presents the new Polizești-19 rice variety, obtained at Brăila Agricultural Research-Development Station, located at the northern limit of rice cultivation in Romania.

Keywords: breeding, rice, Polizești-19 rice variety.

INTRODUCTION

Rice (*Orzya sativa* L.) is a semi-aquatic and extremely important crop, being cultivated under different climatic conditions.

Rice grows in flooded low-land conditions, occupying over 15% of the world's arable land. Compared to all other crops, rice is the greatest consumer of water (Zhang et al., 2020) and its cultivation also requires fertilization by nitrogen and phosphorous to increase crop yield (Paliwal et al., 1997; Peng et al., 2010; Matsunami et al., 2013; Ping et al., 2020; Sun et al., 2020; Bhuian et al., 2021). On the other hand, rice crops have been identified as predominant sources of greenhouse gas emissions like CH_4 and N_2O (Yan et al., 2009; Zou et al., 2009; Sun et al., 2020) due to the stagnant growing conditions in flooded low-lands (Kögel-Knabner et al., 2010).

At present, the agricultural activity is facing particular problems due to climate change, global population growth, freshwater shortages, issues which may also have implications for food security. In view of the aspects mentioned above, to ensure food security and environmental sustainability, rice producers must find the solutions to use less water and agro-chemicals, while still obtaining satisfactory rice yields.

Rice is the number one cereal in the world, being the staple food in Asia and Africa. Rice ranks the first place in terms of human consumption (is the main food source for half of the global population), second place in terms of production and third place in terms of cultivated areas, after wheat and corn. Rice has food importance, as well as industrial, cosmetic, medicinal, decorative, and even political importance. In 2020, the global rice production was 547.19 million tons and for 2021 it is estimated an increase of 2.17 million tons (USDA, 2020). It was estimated that 90% of rice production is achieved in

Received 1 September 2021; accepted 5 November 2021.

Asia (Nihad et al., 2021). The ranking by countries is the following: China (30%), India (24%), Bangladesh (7%), Indonesia (7%), Vietnam (5%) and Thailand (4%), and a total of 23% in many other countries with small shares in rice production (USDA, 2020). The production of rice has been increased by the development of new rice varieties and the improvement of crop establishment and crop management practices (Gan et al., 2017; Das et al., 2019; Iqbal et al., 2019; Xie et al., 2019; Ali et al., 2020; Singh et al., 2020; Zhang et al., 2021).

Rice yield is influenced by factors like water supply, salinity, flooding, soil fertility, planting density, reduction of genetic resources and other biotic stresses like pests (Phapumma et al., 2020; Panda and Barik, 2021; Fu et al., 2021). Like any other agricultural crop, rice can be attacked by diseases and pests. For example, in rice-producing countries, the yield can sometimes be reduced by 38-100% due to the tungro disease caused by rice tungro bacilliform virus and rice tungro spherical virus (Gour and Purohit, 2004).

The optimum temperature for the proper growth and reproduction of rice plants ranges between 24-29ºC. In the stage of reproductive development, rice plants are temperature sensitive (Shimono et al., 2007; Kilasi et al., 2018) and pollen development is inhibited below 17ºC, which ultimately leads to male sterility and severe yield reduction (Alemayehu et al., 2021). However, it should be noted that rice reacts better than other crops to increases of temperature and can usually achieve productivities of 10 t/ha. These qualities of rice will lead to an increase in the share of rice cultivation, an aspect that will be stimulated by future increased needs of cultivation, by expanding the cultivated surfaces in geographical areas that are currently less suitable. In order to adapt to climate change and to increase food security, measures are also required in the field of obtaining rice genotypes adapted to the new conditions (Kumar et al., 2021).

It is estimated that rice crops will extend beyond the current northern cultivation limit. Thus, rice is an increasingly important crop for the Romanian agriculture. Also, rice cultivation has an extremely dynamic evolution and shows visible efficiency trends through research and significant results obtained in the direction of diversification of the genetic base (there is conventional rice, Clearfield rice, GMO rice, hybrid rice, black rice, red rice, giant rice), as well as in the direction of improving the cultivation technology (rice cultivated with submersion irrigation, sprinkler irrigation, cultivation of irrigated rice in integrated system with fish farming etc.), aspects that must be known, deepened and developed as much as possible. Romania has a very good potential for rice cultivation because it has large flat areas, sufficient water sources and quite favorable soil and climatic conditions. The Danube River, with important water resources, offers competitive advantages to Romania over the countries with a tradition in the field (Spain and Italy), advantages that can lead to lower production costs. Rice could be considered the most resistant cereal in the future, due to its ecological plasticity that allows it to be cultivated beyond the limits of 50^{o} North latitude and 40^{o} South latitude, as well as due to its increased resistance to biotic and abiotic stressors compared to other crops.

MATERIAL AND METHODS

Rice breeding works were carried out within the sectorial project ADER 1.1.4. "*Creating rice lines with increased adaptability to climate change*". Breeding plays a special role in creating forms resistant to unfavorable climate and soil factors, which allows the expansion of plants in less favorable areas, as well as the development of forms resistant to disease and pest attack. By breeding the assortment of varieties, a better capitalization of the pedoclimatic conditions specific to each cultivation area can be obtained. At the same time, increasing the number of plant genotypes can ensure greater safety against the risks of calamity of more sensitive varieties. The existence of a fund of parental genetic material adapted to the rice areas is a premise for obtaining new creations with superior characteristics, in the field of rice cultivation.

The research aimed at combining the positive features and characteristics of varieties that have adaptability, increased productivity and high quality indices, in order to create new lines suitable for climate change. The direct hybridization method and the selection of the offspring were considered as the breeding method. The main activities carried out within the project represented the breeding stages included in the scheme used for rice breeding, starting from hybridization and applying repeated individual selection with the study of offspring. These activities were developed cyclically, for each hybrid combination, and consisted of a succession of choosing and selection works over the generations until the achievement of the established objectives. The scheme of rice breeding, used at the Experimental Center Polizești, is presented in Figure 1.

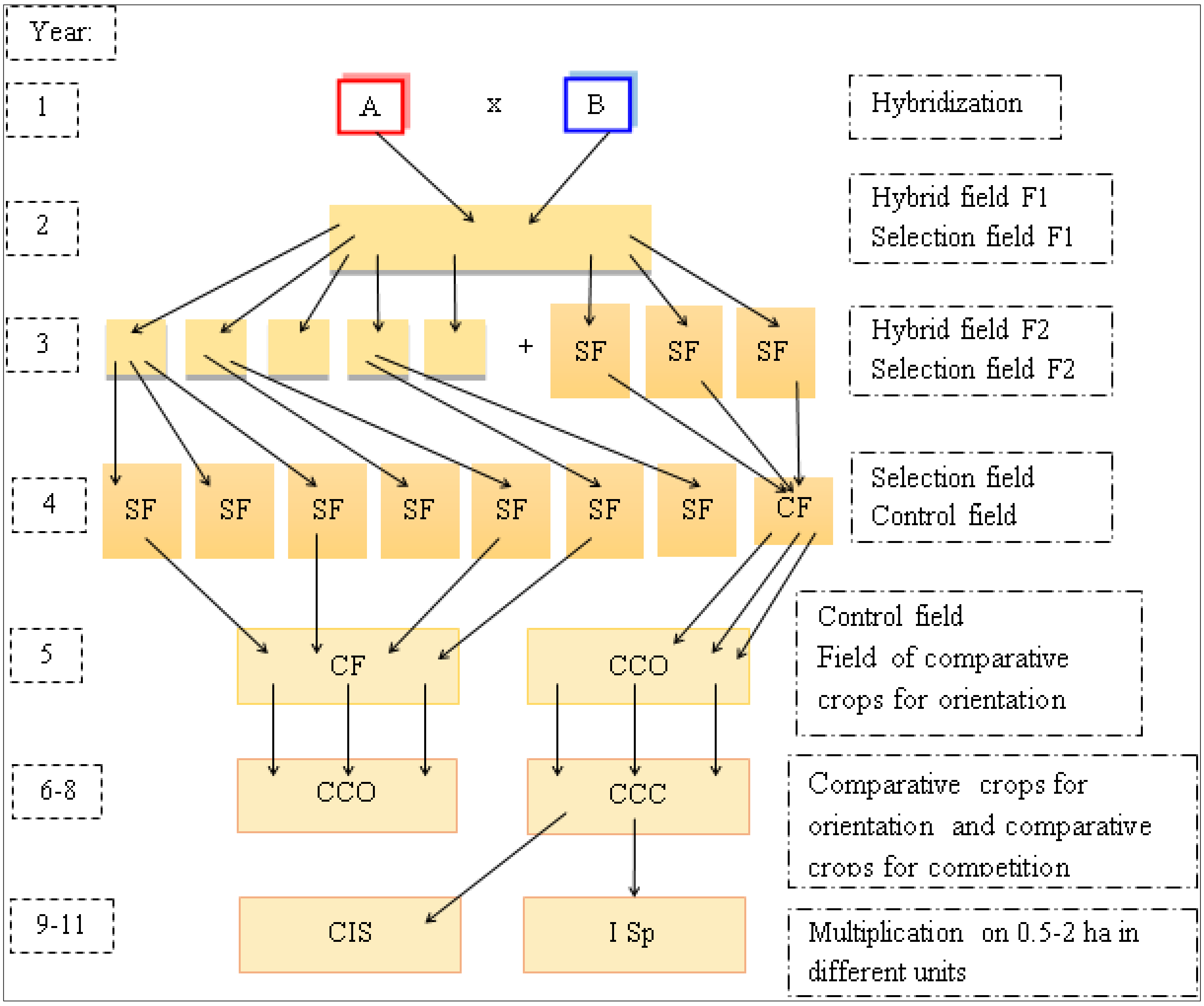

Figure 1. Rice breeding scheme used at the Experimental Center Polizești, starting from hybridization and applying repeated individual selection with the study of offsprings
A - mother; B - father; year 1 - hybridization field; year 2 - hybrid field (F1); year 3 - hybrid field (F1) and selection field (F2); year 4 - selection field and control field; year 5 - control field (CF) and field of comparative crops for orientation; years 6-8 - comparative crops for orientation (CCO) and comparative crops for competition (CCC); years 9-11 - testing, verification in the state network - special multiplications

To achieve disease resistance, the method that proved to be the most effective was used, namely the method of incorporating the genes by repeated hybridization (back-cross). In order to test the resistance to diseases, infections were made on the hybrids from the F2 and F3 generations, as well as on the lines from the first and second offspring.

The newly obtained plants were multiplied in the field. The experimental plots were located on specially arranged fields, divided into rectangular rice plots, with an area of 1-4 ha each, surrounded by dikes and provided with canals for irrigation water supply, and with canals for the water evacuation. The admission and evacuation of water from the plots was done through supply and drainage vents.

Specific breeding activities required appropriate working conditions and tools. Machinery, agricultural machinery and specific equipment necessary for the establishment, maintenance and harvesting of rice crop were used. A cultivation technology of new creations was applied that does not show differences from the current technology of rice cultivation recommended by Brăila Agricultural Research-Development Station.

Within the breeding activity and after the selection and multiplication of the elites, the rice line L-513/3 was obtained. The activities carried out within the selection scheme regarding the succession of the specific works of crossing the parental forms and of choosing during the generations of the offsprings with superior characteristics until reaching the characteristics that reflect the established objectives, are summarized in Table 1.

Table 1. Main activities carried out within the rice selection scheme

The work steps in the general scheme of rice offspring selection	Activities carried out
	Line-513/3
Collection of the biological material and study of its variability (year 0)	Starting with 2005, within the Experimental Center Polizești, fields were established with the collection of varieties, which included yearly over 100 varieties: Italian, Chinese, Turkish and local and newly created lines
Choice of parental forms	For the parental forms were chosen the varieties: Polizești-28 for the mother, respectively K01081 for the father
Creation of new biological material by hybridization (year 1)	The selected parental forms were crossed using appropriate instruments. A number of 25 grains were obtained
Obtaining hybrid plants (year 2)	From the grains obtained by combining the parental forms, grains harvested from the mother form, were obtained 18 hybrid plants
Application of selection in populations with existing or created variability (year 3)	In the F2 hybridization field, 30 lines were studied and retained
Selection of valuable hybrid combinations in order to stabilize the targeted characters (year 4)	In the F3 selection field, 12 lines were studied and retained
Study of the obtained lines and verification of the genetic potential (year 5)	In the F4 multiplication field, 6 lines were studied and retained
Obtaining and completing the populations that meet the cultivation conditions (years 6-8)	In field F5, 3 lines were studied and retained. In the control field, 3 lines were highlighted and retained Line L-513/3 was highlighted in the field with orientation crops
Multiplication of the newly created seed material (years 9-11)	Line L-513/3 was highlighted in the field with comparative cultures for competition In the CI multiplication field, was formed the seed nucleus by multiplying the seed material obtained from line L-513/3

Time table for obtaining the L-513/3 rice line

The synthetic time table for the development of L-513/3 line and the specification of the running of the testing steps for approval, under normal conditions, are shown in Table 2. It can be seen that, in order to have concrete results, to enter into the market, the breeding must be a continuous activity. Table 2 suggests the extent of an breeding process and gives a true picture of the need to sustain this activity over time.

Table 2. Time table for obtaining the L-513/3 rice line

	SCC	HF	HF-F1	HF-F2	SF-F3	CI-F4	CI-F5	CF	CCO	CCC	CI	ISTIS
2004												
2005												
2006	Selected parental forms: Polizești 28 (mother) and K01081 (father)											
2007		-25 hybrid seeds										
2008			-18 plants									
2009				-30 lines								
2010					-12 lines							
2011						-6 lines						
2012							-3 lines					
2013								-3 lines				
2014									-seed L-513/3			
2015										-seed L-513/3		
2016											-seed L-513/3	
2017												L-513/3
2018												L-513/3
2019												New variety Polizești-19

Out of the 25 combinations made in 2005, following the repeated selections of the hybrid plants, were remarked the offsprings that led to the obtaining of the L-513/3 line. This line passed the test organized by the State Institute for Variety Testing and Registration (ISTIS) Romania, obtaining the variety certification under the name of Polizești-19 which will be maintained and multiplied according to a conservative selection scheme.

Characterization of the L-513/3 rice line

The L-513/3 rice line was created at Brăila Agricultural Research-Development Station and was introduced in the approval procedure in 2017. In 2019, this line was certified as a variety (Certificate on the registration of the rice variety Polizești-19, no. 3022/ 15.04.2019, ISTIS Bucharest).

Morphological characteristics

The plants have a height of 75-85 cm. The panicle is generally 13.8-15.5 cm long and consists of an average of 8-9 grain-bearing branches. The average number of grains on the panicle is 77-105 pieces. The number of dried grains is low, of about 8-14%. The color of the panicle is yellow. The panicles have a semi-pendulous position with respect to the stem. Precocity is semitardive. The leaves have a length of 15-20 cm, with dark green aspect. The grain is of common type, yellow color, with MMB of 30-31.5 g, and hectoliter weight of 58-69 kg/hl.

Physiological characteristics

The Polizești-19 rice variety has a good resistance to lodging, and is weakly resistant to shaking. It is resistant to *Pyricularia oryzae* (the causal agent of the rice blast disease), medium resistant to *Fusarium* (which can cause contamination with mycotoxins that affect both human and animal health) and *Helminthosporium* (a fungus that causes brown spot disease in rice). The processing yield is 62-65%, which gives it a good quality of useful production.

Quality characteristics

The Polizești-19 rice variety falls into the group of rice varieties with medium grain and high processing yield 62.8-65.0%.

Production capacity

The Polizești-19 rice variety achieves, on average in recent years, a production of 8000-11000 kg/ha.

Synthesis of the main characteristics of the Polizești-19 rice variety

- is an intensive variety of small size (75-85 cm), very resistant to lodging;
- is a semi-late variety, which is sown in the optimal season (May 1st-10th), and has a vegetation period of 132-135 days;
- it requires 600 germinable kernels/m^2 for sowing, i.e. about 200-220 kg of seed/ha;
- the rice grain has an average length of 8 mm, a width of 4 mm and a thickness of 2 mm;
- the production capacity is between 8000-11000 kg/ha;
- is adapted to the pedoclimatic conditions in Romania and has specific culinary properties, respectively pleasant taste and fast cooking;
- compared to other rice varieties in the crop, it achieves constant productions and ensures increases by 11.5-18% higher at similar vegetation periods;
- is tolerant to cultivation on normal soils, as well as on soils affected by salting;
- is suitable for mechanized harvesting.

The synthesis of the climatic conditions developed during the experimentation period is presented in the Table 3.

Table 3. Climatic conditions developed during the experimentation period 2016-2018

Climatic elements		Monthly value during the agricultural year												Annual value
		IX	**X**	**XI**	**XII**	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	
Precipitation (mm)	***Multiannual value***	***32***	***30***	***33***	***36***	***28***	***27***	***26***	***35***	***48***	***62***	***46***	***39***	***442***
		2015				**2016**								
	Monthly average	35	87	89	2	44	6	58	26	46	85	2	48	528
	Deviations	+3	+57	+56	-34	+16	-21	+32	-9	-2	+23	-44	+9	+86
		2016				**2017**								
	Monthly average	29	127	57	3	22	40	14	73	31	107	125	2	630
	Deviations	-3	+97	+24	-33	-6	+13	-12	+38	-17	+45	+79	-37	+188
		2017				**2018**								
	Monthly average	6	79	40	38	16	79	38	6	23	54	81	0	460
	Deviations	-26	+49	+7	+2	-12	+52	+12	-29	-25	-8	+35	-39	+18
Temperature (°C)	***Multiannual value***	***17.3***	***11.5***	***5.6***	***0.6***	***-2.1***	***-0.2***	***4.7***	***11.2***	***16.7***	***20.9***	***22.9***	***22.1***	***10.9***
		2015				**2016**								
	Monthly average	20.0	11.1	7.5	2.6	-2.6	6.4	7.2	14.0	16.7	22.4	23.9	22.9	12.7
	Deviations	+2.7	-0.4	+1.9	+2.0	-0.5	+6.6	+2.5	+2.8	0	+1.5	+1.0	+0.8	+1.7
		2016				**2017**								
	Monthly average	18.8	10.1	5.4	-0.4	-5.1	0.6	8.2	10.1	16.6	22.0	22.7	23.2	11.0
	Deviations	+1.5	-1.4	-0.2	-1.0	-3.0	+0.8	+3.5	-1.1	-0.1	+1.1	+0.2	+1.1	+0.1
		2017				**2018**								
	Monthly average	19.1	11.5	7.1	3.3	0.4	0.9	2.9	14.9	19.3	22.5	22.8	24.2	12.4
	Deviations	+1.8	0	+1.5	+2.7	+2.5	+1.1	-1.8	+3.7	+2.6	+1.6	-0.1	+2.1	+1.5

RESULTS AND DISCUSSION

Regarding a series of biometric observations and measurements recorded by the rice line L-513/3, compared to a series of Romanian and foreign varieties and lines, these are presented in Table 4 and Table 5.

Table 4. Results obtained in the Field of microplots, with domestic and foreign rice varieties, at CE Polizeşti, Brăila County, during 2016-2018

Nr. crt.	Variety/line	Date of rise			Plant density (pl/mp)				Panicle density (pan/mp)				Release date flowering			Stem length (cm)			
		2016	2017	2018	2016	2017	2018	Average	2016	2017	2018	Average	2016	2017	2018	2016	2017	2018	Average
1	Polizești-28	11.06	26.05	27.05	440	327	346	**371**	606	430	480	**505**	15.08	11.08	04.08	85	70	72	**75**
2	L-22	11.06	26.05	27.05	412	336	324	**357**	532	404	516	**484**	18.08	10.08	07.08	95	98	74	**89**
3	L-87	11.06	26.05	27.05	428	296	336	**353**	540	412	532	**494**	18.08	13.08	09.08	105	90	89	**94**
4	L-102	11.06	26.05	27.05	452	290	344	**362**	586	420	520	**508**	16.08	08.08	07.08	106	85	82	**91**
5	**L-513/3**	**11.06**	**26.05**	**27.05**	**440**	**270**	**392**	**367**	**676**	**428**	**512**	**538**	**15.08**	**11.08**	**05.08**	**90**	**80**	**70**	**80**
6	Chokwang	11.06	26.05	27.05	460	272	356	**362**	632	356	508	**498**	26.08	22.08	18.08	78	63	62	**67**
7	Scirocco	11.06	26.05	27.05	440	242	312	**331**	350	348	520	**406**	22.08	19.08	10.08	73	65	68	**68**
8	Keope	11.06	26.05	27.05	404	232	332	**322**	448	328	504	**426**	25.08	18.08	11.08	80	68	72	**73**
9	Cirene	11.06	26.05	27.05	420	292	324	**345**	542	384	532	**486**	22.08	14.08	08.08	75	71	70	**72**
10	Ronaldo	11.06	26.05	27.05	344	212	312	**289**	314	425	544	**427**	23.08	19.08	10.08	73	65	59	**65**
11	Vasco	11.06	26.05	27.05	320	196	308	**274**	358	268	434	**353**	23.08	19.08	11.08	76	75	64	**71**
12	KM275	11.06	26.05	27.05	450	228	360	**346**	656	388	525	**523**	27.08	19.08	17.08	83	76	71	**76**
13	KM293	11.06	26.05	27.05	480	320	408	**402**	566	408	527	**500**	23.08	16.08	15.08	95	72	69	**78**
14	KM305	11.06	2605	27.05	424	324	404	**384**	780	420	530	**576**	23.08	17.08	18.08	86	69	78	**77**

Date of sowing: 2016-05.31; 2017-05.16; 2018-05.18.

Table 5. Results obtained in the Field of microplots, with domestic and foreign rice varieties, at CE Polizeşti, Brăila County, during 2016-2018

Nr. crt.	Variety/line	Panicle length (cm)				No. totally grain on the panic (no)				No. dry grain (no)				Percent of dry grain (%)				MMB (g)			
		2016	2017	2018	Average	2016	2017	2018	Average	2016	2017	2018	Average	2016	2017	2018	Average	2016	2017	2018	Average
1	Polizești-28	12.2	12.7	16.2	**13.7**	84.5	79.6	80.6	**81.5**	11.4	9.2	9.4	**10.0**	13.5	11.55	11.66	**12.23**	30.81	31.5	30	**30.7**
2	L-22	14.4	18.2	19.3	**17.3**	74.6	76.4	79.4	**76.8**	13.0	7.0	10.4	**10.1**	17.4	9.16	13.09	**13.21**	31.91	31.9	30.5	**31.4**
3	L-87	17.2	17.5	16.7	**17.1**	86.8	68.6	80.4	**78.6**	16.4	8.4	10.8	**11.8**	18.9	12.24	13.43	**14.85**	32.20	36.9	32	**33.7**
4	L-102	14.7	12.7	16.0	**14.4**	94.8	70.0	90.4	**85.0**	18.0	9.0	11.8	**12.9**	19.0	12.85	13.05	**14.96**	33.60	31.7	31.5	**32.2**
5	**L-513/3**	**16.1**	**15.4**	**17.0**	**16.1**	**93.4**	**82.8**	**85.0**	**87.0**	**18.0**	**10.0**	**13.2**	**13.7**	**19.2**	**12.07**	**15.52**	**15.59**	**32.40**	**33.8**	**30**	**32.0**
6	Chokwang	14.2	16.6	16.1	**15.6**	71.4	80.0	79.0	**76.8**	11.2	19.0	15.4	**15.2**	15.7	23.75	19.49	**19.64**	24.16	27.5	24	**25.2**
7	Scirocco	14.2	19.1	18.3	**17.2**	57.4	72.0	72.8	**67.4**	19.2	19.0	22.2	**20.1**	33.4	26.38	30.49	**30.09**	37.21	35.5	36	**36.2**
8	Keope	16.4	18.6	16.3	**17.1**	56.8	74.6	63.8	**65.0**	18.4	13.8	9.4	**13.8**	32.4	18.49	14.73	**21.87**	34.54	36.3	35	**35.2**
9	Cirene	15.3	19.5	16.6	**17.1**	46.8	72.4	70.2	**63.1**	15.8	12.8	12.2	**13.6**	33.7	17.67	17.37	**22.91**	40.03	40.5	35	**38.5**
10	Ronaldo	14.2	17.5	16.8	**16.1**	57.0	92.6	72.8	**74.1**	19.0	24.0	18.2	**20.4**	33.3	25.91	25.00	**28.07**	36.40	35.1	28	**33.1**
11	Vasco	13.6	18.0	17.7	**16.4**	49.2	89.4	83.2	**73.9**	18.2	12.0	35.0	**21.7**	37.0	13.42	42.06	**30.82**	37.50	38.0	39.2	**38.2**
12	KM275	15.0	18.5	16.1	**16.5**	68.2	82.0	75.6	**75.2**	17.2	22.6	9.0	**16.2**	25.2	27.56	11.90	**21.55**	26.11	27.7	26.5	**26.7**
13	KM293	13.4	17.4	14.5	**15.1**	53.4	66.8	65.4	**61.8**	11.4	10.4	10.0	**10.6**	21.3	15.56	15.29	**17.38**	25.74	26.3	26.8	**26.2**
14	KM305	13.7	14.1	15.2	**14.3**	69.2	63.2	71.8	**68.0**	13.8	10.0	8.4	**10.7**	19.9	15.82	11.69	**15.80**	25.42	26.9	24	**25.4**

The experimental tests performed during 2016-2018 within the Experimental Center Polizești showed that line L-513/3, in relation to the control variety Polizești-28 and other foreign varieties, had a better production by 9.07% compared to the control. The obtained results are presented in Table 6.

Table 6. Experimental results obtained at Experimental Center Polizeşti

Variety	Paddy rice (kg/ha)			Mean paddy rice (kg/ha)	Yield to processing (%)			Mean yield to processing (%)	Bleached rice (commercial product) (kg/ha)			Mean bleached rice (kg/ha)	Diference ± MT (%)
	2016	2017	2018		2016	2017	2018		2016	2017	2018		
Polizeşti-28	9590	9680	7286	8852	67.67	67.11	53.20	62.66	6489	6496	3876	5620	MT
L-22	6482	8950	7271	7568	66.93	64.86	55.03	62.27	4338	5805	4001	4715	83.89
L-87	7881	8880	7248	8003	70.79	68.63	51.50	63.64	5578	6094	3733	5135	91.37
L-102	9604	9820	8086	9170	64.81	67.37	56.25	65.00	6224	6616	4548	5973	106.28
L-513/3	9892	9890	8642	9474	65.74	66.63	58.28	64.55	6503	6590	5036	6130	109.07
Chokwang	7421	6210	6239	6623	42.24	57.76	65.50	55.16	3135	3587	4086	3602	64.09
Scirocco	6748	6500	6434	6561	45.21	70.17	50.05	55.14	3051	4561	3220	3611	64.25
Keope	5031	7833	7172	6679	64.98	58.90	39.35	54.41	3269	4614	2822	3568	63.48
Cirene	5801	7929	7031	6920	65.34	71.40	47.90	61.54	3790	5661	3368	4273	76.03
Ronaldo	6928	8883	6431	7414	65.12	65.11	54.00	61.41	4511	5784	3473	4589	81.65
Vasco	6527	4984	6773	6095	69.70	68.86	54.40	64.32	4549	3432	3685	3889	69.19
KM275	9271	6917	7689	7959	69.63	61.53	69.89	67.01	6455	4256	5374	5362	95.40
KM293	6778	5208	6717	6234	62.28	58.55	69.46	63.43	4221	3049	4666	3979	70.80
KM305	8442	5875	7232	7183	71.12	65.66	66.01	67.59	6022	3857	4774	4884	86.90

As it can be seen in Figure 2, the maximum paddy rice production of 9474 kg/ha was recorded for the L-513/3 line. In both cases, the lowest productivity was obtained in 2918. The rice line L-513/3 exceeded the control variety Polizeşti-28 by 662 kg/ha.

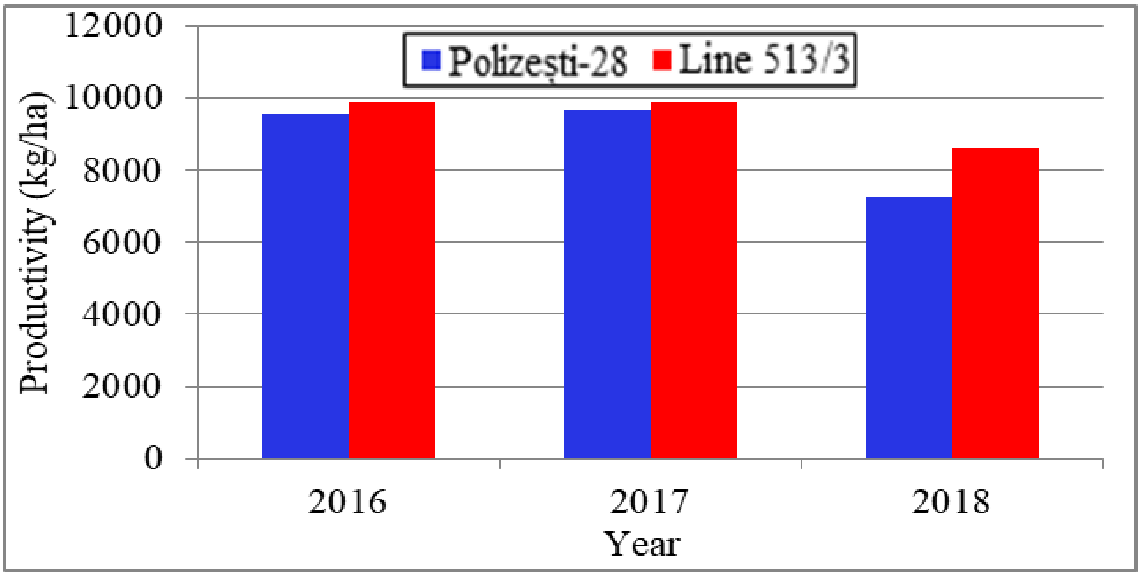

Figure 2. Productivity for paddy rice in case of Polizeşti-28 and Line-513/3

From Figure 3 it can be observed that the mean processing yields are also good, with an average value of 64.55% for the line L-513/3.

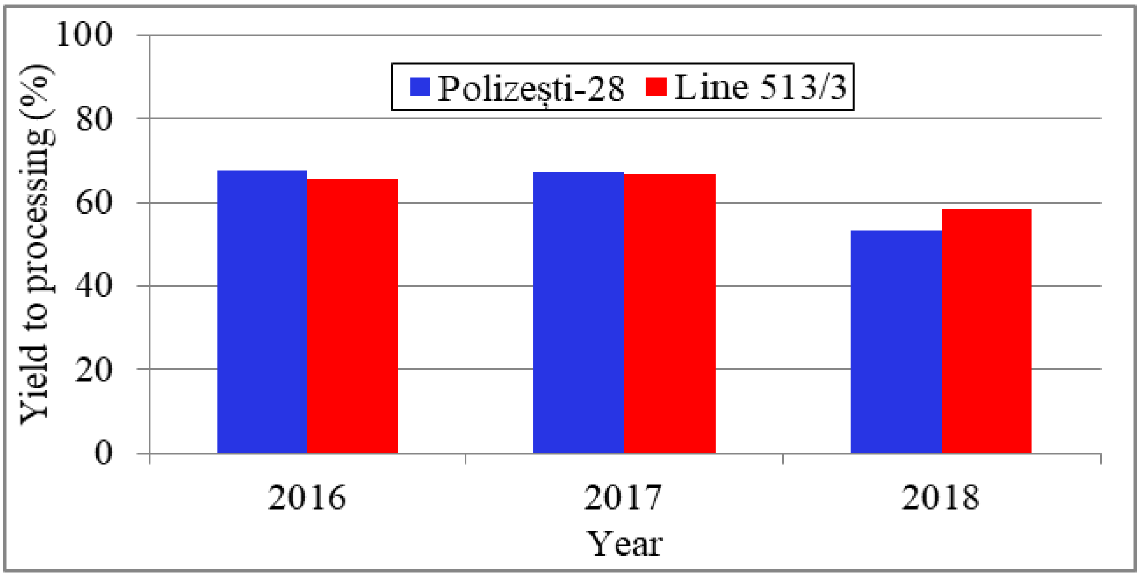

Figure 3. Yield to processing in case of Polizeşti-28 and Line-513/3

Figure 4 shows the variation of productivity related to the commercial bleached rice. The maximum production of bleached rice, of 6130 kg/ha, was obtained in case of line L-513/3.

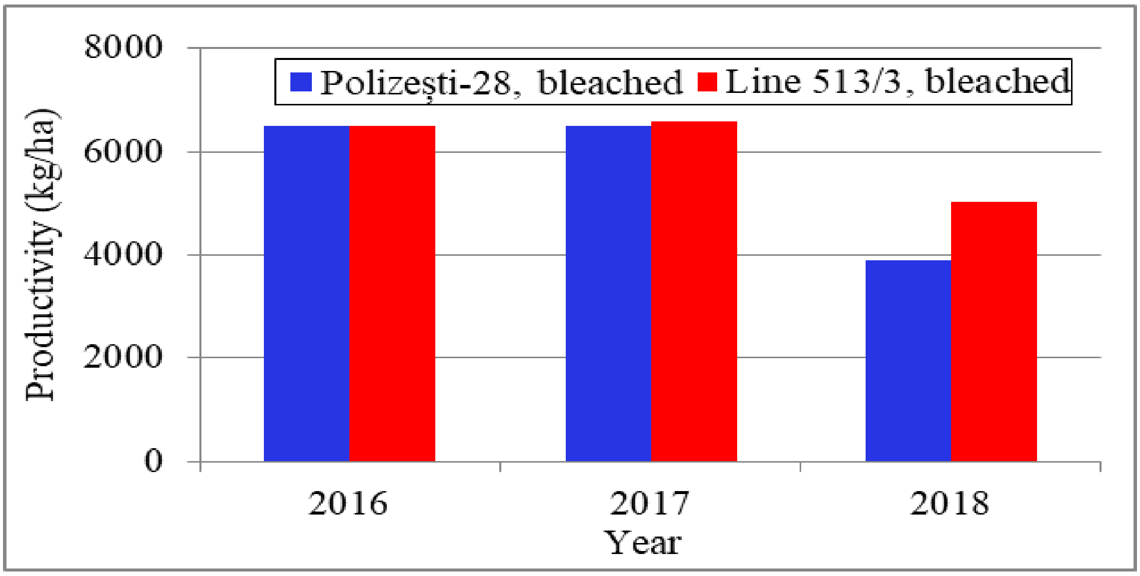

Figure 4. Productivity for bleached rice in case of Polizeşti-28 and Line-513/3

The L-513/3 line proved to be efficient in terms of productivity, stability and precocity, and exibited improved characteristics compared to the Polizeşti-28 variety.

CONCLUSIONS

The need to diversify agricultural production and achieve food security creates pressure on agriculture and human life in general, and research must find the solutions to mitigate the negative effects. Also, in the context of climate changes, it is estimated that the presence of rice will extend beyond the current northern cultivation limit.

Breeding plays a special role in creating forms resistant to unfavorable climatic and soil factors, which allows the expansion of rice in less favorable areas, and the development of forms resistant to disease and pest attack.

By improving the assortment of rice varieties, a better capitalization of the pedoclimatic conditions specific to each cultivation area can be obtained. At the same time, increasing the number of rice genotypes can ensure greater security against the risks of calamity of more sensitive varieties.

The determining factor of the increase of agricultural production was and is the variety (hybrid), respectively the genetic factor. From the perspective of food, industrial, medicinal and cosmetic importance, rice cultivation is considered one of the basic agricultural activities in the world hence, rice breeding also requires special attention. Achievements in this field bring a major economic effect in large production and can contribute to the social support of an entire area.

Rice-producing countries finance their rice-related research according to the share of this crop in the agricultural activities carried out, and according to the level of interest they have in the development of this activity.

In 2017, the L-513/3 rice line was introduced for testing at the State Institute for Variety Testing and Registration (ISTIS) Romania. L-513/3 is more efficient with regard to productivity, stability and precocity, and has improved characteristics compared to the Polizești-28 variety. In 2019, following the tests performed by ISTIS, line L-513/3 became a variety under the name Polizești-19.

REFERENCES

Alemayehu, H.A., Dumbuya, G., Hasan, M., Tadesse, T., Nakajyo, S., Fujioka, T., Abe, A., Matsunami, M., Shimono, H., 2021. *Genotypic variation in cold tolerance of 18 Ethiopian rice cultivars in relation to their reproductive morphology*. Field Crops Research, 262: 108042.

Ali, I., He, L., Ullah, S., Quan, Z., Wei, S., Iqbal, A., Munsif, F., Shah, T., Xuan, Y., Luo, Y., Li, T., 2020. *Biochar addition coupled with nitrogen fertilization impacts on soil quality, crop productivity, and nitrogen uptake under double-cropping system*. Food and Energy Security, 9: 208-228.

Bhuian, M.S.I., Rahman, A., Kim, G.W., Das, S., Kim, P.J., 2021. *Eco-friendly yield-scaled global warming potential assists to determine the right rate of nitrogen in rice system: a systematic literature review*. Environmental Pollution, 271: 116386.

Das, A., Layek, J., Ramkrushna, G.I., Rangappa, K., Lal, R., Ghosh, P.K., Choudhury, B.U., Mandal, S., Ngangon, B., Daj, U., Parkash, N., 2019. *Effects of tillage and rice residue management practices on lentil root architecture, productivity and soil properties in India's Lower Himalayas*. Soil and Tillage Research, 194: 104-313.

Fu, Y.Q., Zhong, X.H., Zeng, J.H., Liang, K.M., Pan, J.F., Xin, Y.F., Liu, Y.Z., Hu, X.Y., Peng, B.L., Chen, R.B., Hu, R., Huang, N.R., 2021. *Improving grain yield, nitrogen use efficiency and radiation use efficiency by dense planting, with delayed and reduced nitrogen application, in double cropping rice in South China*. Journal of Integrative Agriculture, 20(2): 565-580.

Gan, X., Zhou, L., Liu, B., Zhou, J., Li, Y., Shen, Z., Wu, Y., Wei, B., 2017. *Yield reduction and economic benefit of fertilizer reduction in rice with smash-ridging cultivation*. Hum. Agric. Sci., 11: 17-20.

Gour, H.N., and Purohit, S.D., 2004. *Annual review of plant pathology*. Scientific Publishers India, 2: 381-382.

Iqbal, A., He, L., Khan, A., Wei, S., Akhtar, K., Ali, I., Jiang, L., 2019. *Organic manure coupled with inorganic fertilizer: An approach for the sustainable production of rice by improving soil properties and nitrogen use efficiency*. Agronomy, 9(10): 651-671.

Kilasi, N.L., Singh, J., Vallejos, C.E., Ye, C.R., Jagadish, S.V.K., Kusolwa, P., Rathinasabapathi, B., 2018. *Heat stress tolerance in rice (Oryza sativa L.): identification of quantitative trait loci and candidate genes for seedling growth under heat stress*. Frontiers in Plant Science, 9: 1578.

Köogel-Knabner, I., Amelung, W., Cao, Z., Fiedler, S., Frenzel, P., Jahn, R., Kalbitzg, K., Köolbl, A., Schloter, M., 2010. *Biogeochemistry of paddy soils*. Geoderma, 157: 1-14.

Kumar, A., Raman, A., Yadav, S., Verulkar, S.B., Mandal, N.P., Singh, O.N., Swain, P., Ram, T., Badri, J., Dwivedi, J.L., Das, S.P., Singh, S.K., Singh, S.P., Kumar, S., Jain, A., Chandrababu, R., Robin, S., Shashidhar, H.E., Hittalmani, S., Satyanarayana, P., Venkateshwarlu, C., Ramayya, J., Naik, S., Nayak, S., Dar, M.H., Hossain, S.M., Henry, A., Piepho, H.P., 2021. *Genetic gain for rice yield in rainfed environments in India*. Field Crops Research, 260: 107977.

Matsunami, M., Matsunami, T., Kon, K., Ogawa, A., Kodama, I., Kokubun M., 2013. *Genotypic variation in nitrogen uptake during early growth among rice cultivars under different soil moisture regimes*. Plant Production Science, 16: 238-246.

Nihad, S.A.I., Manidas, A.C., Hasan, K., Hasan, A.I., Honey, O., Latif, M.A., 2021. *Genetic variability, heritability, genetic advance and phylogenetic relationship between rice tungro virus resistant and susceptible genotypes revealed by morphological traits and SSR markers*. Current Plant Biology, 25: 100194.

Paliwal, A.K., Singh, R.N., Singh, V.K., 1997. *Effect of nitrogen and phosphorus on yield and uptake of N, P and K by upland rice.* Advances in Plant Science, 10: 257-259.

Panda, D., and Barik, J., 2021. *Flooding tolerance in rice: focus on mechanisms and approaches*. Rice Science, 28(1): 43-57.

Peng, S., Buresh, R.J., Huang, J., Zhong, X., Zou, Y., Yang, J., Wang, G., Liu, Y., Tang, Q., Cui, K., Zhang, F., Dobermann, A., 2010. *Improving nitrogen fertilization in rice by site-specific N management. A review*. Agronomy for Sustainable Development, 30: 649-656.

Phapumma, A., Monkham, T., Chankaew, S., Kaewpradit, W., Harakotr, P., Sanitchon, J., 2020. *Characterization of indigenous upland rice varieties for high yield potential and grain quality characters under rainfed conditions in Thailand*. Annals of Agricultural Sciences, 65: 179-187.

Ping, L.I.A.O., Ros, M.B.H., Van Gestel, N., Yan-Ni, S., Jun, Z., Shan, H., Yong-Jung, Z, Zi-Ming, W., van Groenigen, K.J., 2020. *Liming reduces soil phosphorus availability but promotes yield and P uptake in a double rice cropping system.* Journal of Integrative Agriculture, 19(11): 2807-2814.

Shimono, H., Okada, M., Kanda, E., Arakawa, I., 2007. *Low temperature-induced sterility in rice: evidence for the effects of temperature before panicle initiation*. Field Crop Research, 101: 221-231.

Singh, M., Kumar, P., Kumar, V., Solanki, I.S., McDonald, A.J., Kumar, A., Poonia, S.P., Kumar, V., Ajay, A., Kumar, A., Singh, D.P., Singh, B., Singh, S., Malik, R.M., 2020. *Intercomparison of crop establishment methods for improving yield and profitability in the rice-wheat system of Eastern India*. Field Crop Research, 250: 107776.

Sun, H., Zhou, S., Zhang, J., Zhang, X., Wang, C., 2020. *Effects of controlled-release fertilizer on rice grain yield, nitrogen use efficiency, and greenhouse gas emissions in a paddy field with straw incorporation*. Field Crops Research, 253: 107814.

United States Department of Agriculture (USDA), Foreign Agricultural Services, 2020. *World rice production, consumption and stocks*. PSD Reports.

Xie, X., Shan, S., Wang, Y., Cao, F., Chen, J., Huang, M., Zou, Y., 2019. *Dense planting with reducing nitrogen rate increased grain yield and nitrogen use efficiency in two hybrid rice varieties across two light conditions*. Field Crops Research, 236: 24-32.

Yan, X., Akiyama, H., Yagi, K., Akimoto, H., 2009. *Global estimations of the inventory and mitigation potential of methane emissions from rice cultivation conducted using the 2006 Intergovernmental Panel on Climate Change Guidelines*. Global Biogeochemical Cycles, 23, GB2002.

Zhang, Y.J., Xu, J.N., Cheng, Y.D., Wang, C., Liu, G.S., Yang, J.C., 2020. *The effects of water and nitrogen on the roots and yield of upland and paddy rice*. Journal of Integrative Agriculture, 19(5): 1363-1374.

Zhang, Y., Huang, G., Zhang, S., Zhang, J., Gan, S., Cheng, M., Hu, J., Huang, L., Hu, F., 2021. *An innovated crop management scheme for perennial rice cropping system and its impacts on sustainable rice production*. European Journal of Agronomy, 122: 126186.

Zou, J., Huang, Y., Qin, Y., Liu, S., Shen, Q., Pan, G., Lu, Y., Liu, Q., 2009. *Changes in fertilizer-induced direct N_2O emissions from paddy fields during rice growing season in China between 1950 and 1990*. Global Change Biology, 15: 229-242.