The incidence of rice diseases in Romanian climate conditions

Alionte G.

in

Chataigner J. (ed.).
Maladies du riz en région méditerranéenne et les possibilités d'amélioration de sa résistance

Montpellier : CIHEAM
Cahiers Options Méditerranéennes; n. 15(3)

1997
pages 7-18

The incidence of rice diseases in Romanian climate conditions

George Alionte
Research Institute for Cereals and Technical Plants, Fundulea Rice Laboratory, Bucharest (Romania)

Abstract. The present paper is a survey of the main achievements concerning the influence of climatic factors on some rice registered and new promising cultivars grown on different types of soil, crop rotation, fertilization and conditioning.

Starting with control fields, the whole plant breeding material has been studied for genetic resistance to the most important rice diseases, such as *Fusarium* spp., *Helminthosporium* spp. and *Pyricularia oryzae* Cav. The study revealed lines and cultivars remarkably resistant to these diseases, specially Cristal, Chirnogi, Oltenita, Speranta, Fundulea 24, Fundulea 29, Fundelea 30 and Fundelea 31.

Polizesti 28, a common cultivar, spreading over 65-70% of the area cultivated with rice, has been qualified as being the most sensible to diseases, specially to *Pyricularia oryzae* Cav. Consequently, The area cultivated with Polizesti 28 has been severely restricted.

Nitrogen fertilizers has a strong effect in decreasing resistance to *Pyricularia oryzae;* a basic element in soil condition of Romania for the complex prevention in rice is the addition at high rates of nitrogen, P. fertilizer.

Three to four years monoculture results in a high degree of pathogen attacks and a crop reduction of about 25-30%.

Very low temperatures during germination-sprouting period is favorable to a high frequency of *Fusarium* spp.

An excessive constant temperature during spike maturity period (July-September) has a favorable effect in reducing attacks by *Heminthosporium* spp. and *Pyricularia oryzae* Cav.

A great number of diseased seeds has been eliminated through our new conditioning system.

I – Introduction

It is well known that diseases, particularily blast caused by *Pyricularia oryzae* Cav., greatly damage the rice crop bringing about a crop reduction of more than 30% yearly.

The microclimate and the ecological complex created, strengthened by the maintenance of the crop on a same plot of land, correlated with unadequate agrotechnical means for tilling the soil favour saprophytes and pathogenic bodies evolution and multiplication, thus greatly impeding the rice crop technology.

Technical features describing the rice crop system and biotypes created by it tend to favour saprophytes and pathogenic agents' massive multiplication and spreading.

A primary infection can generate repeated secondary infections depending on species' sensitiveness, climatic conditions and technology applied, thus producing significant losses in yield. According to the plants' growth stage, temperatures, humidity, light and fertilization can generate physiological perturbation, thus contributing to sensitiveness to pathogenic agents' attack.

Under Romania's climate and soil conditions, the main diseases occuring within these last years, especially where the above mentioned data are not observed, is rice blast, caused by *Pyricularia oryzae* Cav. Therefore, as part of the improvement programme and in order to obtain resistant varieties, autochtonous and from abroad parents indicating a good resistance have been used, without knowing the nature of resistance (vertical or horizontal), and have led to the obtention of resistant and very productive species.

At the same time, when selecting rice seeds, the incompletely ripened and stunted (wrinkled and depreciated) seeds, vulnerable when conditoning, are pathogenic germs bearers and removing them at selection greatly improves seed quality (Raicu, Baciu, 1978).

II – Materials and methods

❑ The method used in order to promote disease attack was the administering of great doses of nitrogen (over 250 kg a.i./ha), applied one-sided and on densities of more than 1,200 g.s./s.m. Sowing has been accomplished by the beginning of June.

❑ Therefore, a number of 250 promising lines and varieties have been tested and selected.

Laboratory methods for identifying pathogenic agents (Raicu, Baciu, 1978)

1. *Gibberella Fujikuroi* (Saw.) Wollem (syn. *Fusarium moniliforme* Sheld.)
medium: blotting paper
temperature: 20°C
duration: 7 days

2. *Cochiobdus myabeanus* (Ito. and Kurib.) Drechs. Ex Dastur f.c. *Drechslera oryzae* (Breda de Haan) Subram And Jain syn. *Helminthosporium oryzae* Breda de Haan.
medium: blotting paper
temperature: 22°C
duration: 8 days
ultraviolet light/darkness cycle: 12/12 hrs

3. *Pyricularia oryzae* Cav.
medium: blotting paper
temperature: 20°C
duration: 7 days
light/darkness cycle: 12/12 hrs

❑ In the field of crop fertilization, agrotechnical experiments, among others, have been used for research concerning fertilizers' effect on main diseases such as: *Pyricularia oryzae* Cav., *Helminthosporium* spp. and *Fusarium* spp.

❑ Meteorological data have been gathered from local meteorological stations and correlated with data from the research centres.

III – Results

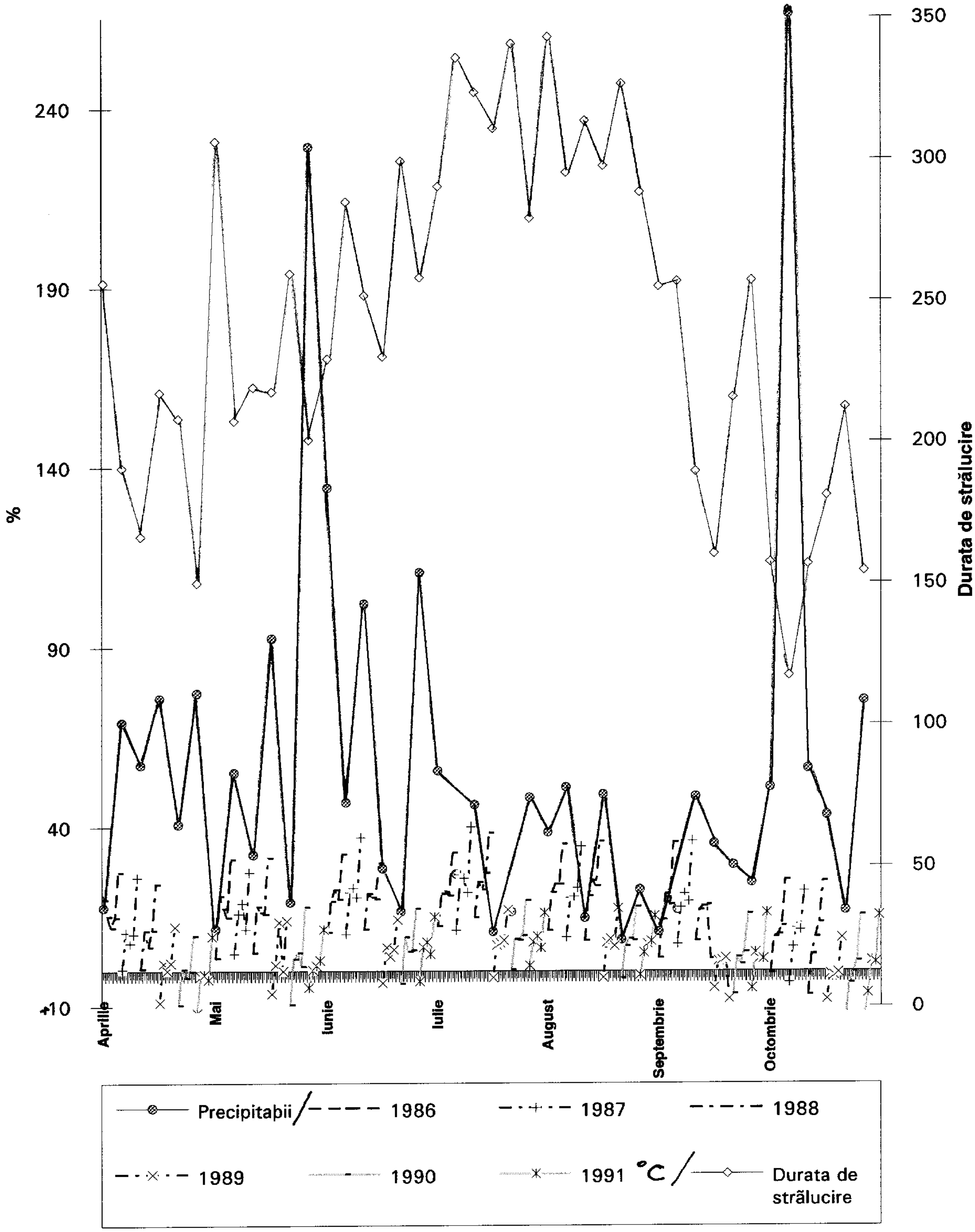
1. Climatic factors

Experimental results for 1986-1991 have proved that the climate's essential features in Romania are less favourable to rice diseases. The frequency and intensity of the attacks by the main rice diseases, *Fusarium* spp., *Heminthosporium oryzae* Breda de Haan (syn. Drechsler oryzae [Breda de Haan] Subram. and Jain), and *Pyricularia oryzae* Cav. have not created uncommon economic issues (see Figure 1).

The climatic conditions in Romania of the experimental years 1986, 1988, 1990, 1991 has been considered normal for the rice crop in all the cultivated areas, especially for the half-belated and half-precocious varieties, the overall resources in the vegetation period (May-September) being higher, in comparison with the normal value in the south of the Romanian Plain (34-39°C), as against the Western Plain (27°C) and the South Eastern Plain (30°C).

The sunny periods exceeded 1,400 hours, which favours the vegetative development of rice plants.

Figure 1. Climatic factors



Sowing rate has reached 80% within the optimum period. In May, better weather conditions with an air temperature of more than 15°C have allowed the sprouting of plants within an optimum period of 8-10 days, and tillering in favourable conditions; moreover, in May and during the first decade of June the temperature and insolation intensify plants' growth.

June with its changeable weather—alternations of short periods of diurnal thermic conditions (22°-30°C) and maximum temperatures of more than 37°C—contributes to slowing down the earing stage.

August, with its optimum air temperature, allows normal flowering and provides the required conditions for maturity. The end of August and September, with very low rainfall, higher air temperatures, and satisfactory luminosity, allows an intense ripening pace.

The 1986, 1988, 1990, and 1991 conditions allow to consider the phytosanitary state of the rice crop as good.

The attack by *Fusarium* spp. prevalent at the first vegetation stages have resulted from the low temperatures of the irrigation water and attacks by *Helminthosporium* spp. and *Pyricularia oryzae* have been prevented by the constant excessive temperatures of July and August.

In the experimental year 1987, the lowest spring temperatures for the last 4 decades has been recorded, with approximately 5°C below normal, i.e. 13°-16°C during the last days of April and frequent minimum temperatures below 10°C in the first decade of May. The adequate conditions for sowing have thus started after the first decade of May thus extending the vegetation period until the autumn.

The insolation in June (15°-39°C) accounted for the intensive growing pace, but the oscillating thermic conditions during the vegetation period (14°-40°C) have negatively altered the vegetation stage by delaying the tillering, by stopping the panicles' evolution and also by delaying the harvest.

Fusarium spp., due to low temperatures, appeared in the case of early sowing.

Owing to constant excessive temperatures during July and August, *Helminthosporium* spp. and *Pyricularia* attacks were less frequent.

During the experimental year 1989, with temperatures far below the required optimum (15°-16°C compared with 22°-25°C), the vegetation was late by 15-20 days, the flowering stage starting after August 15, when temperatures had reached an optimum level.

The cool September period with rainfall and low insolation has produced stunted (wrinkled and depreciated) grains, with reduced hectolitre mass). The favourable climatic conditions of the end of September and October allowing harvesting under normal conditions and within an optimum time .

Reduced temperatures following sowing have favoured *Fusarium* spp. attacks at the end of the vegetation stage. *Pyricularia oryzae* was located on the bottom leaves of plants and occurred in spots, and *Helminthosporium* spp. attacks prevailing in comparison with other pathogenic agents have showed a confined evolution due to temperatures registered in the middle of the vegetation stage.

2. Crop fertilization

On the basis of the analysis of experimental data for 6 years concerning fertilization with inorganic fertilizers, nitrogen and phosphorus (see Table 1), it has been ascertained that if to a fertilization level with a P.O. increasing doses of nitrogen (N 0-N 160), the percentage of pathogenic agents has relatively great values, with a slight increase in the case of maximum nitrogen doses, a significant diminution of the attack degree was registered, this value being maintained also by increasing the phosphorus dose from P 40 to P 120. The administering of P 40 together with any nitrogen dose leads to the decrease of pathogenic agents. Siginificant phenomena do not occur in case of balanced fertilizer doses.

3. The influence of precursory plants

Data from Table 3 show the influence of precursory plants on the attack degree of the main rice diseases, namely the importance of crop rotation for crop protection. The single-crop system during several years increases disease susceptibility and results in significant yield reduction, up to 30%.

4. Main pathogenic agents

With respect to the main pathogenic agents of the rice crop in Romania (see Table 4), data certify the linking of the microflora composition detected through laboratory methods with the same climatic conditions as in the sprouting-tillering stage, the floral panicles initiation stage, the flowering, the grains filling up and thorough maturation. Thus the pathogenic agents have occurred in the following ratios: 2.4%:8.6% for *Pyricularia oryzae*; 4.8%:18.0% for *Helminthosporium* spp.; and 1,4%:20% for *Fusarium* spp..

5. Varieties reaction

Research on varieties reaction depending on the vegetation stage and in case of the main rice diseases attacks (see Table 5) exemplifies once again the influence of climatic factors on their incidence at vegetation stage. From the meteorological data analysis (see Figure 1), it has been ascertained that throughout the vegetation stages of 1989, registered temperatures have been lower than the optimum. Thus, between May 1 and July 25, corresponding to germination-springing, tillering-straw elongation, a minus difference of 6°-9°C has occurred which has led to a delay in the vegetation stage of 15-20 days, mass rice flowering occurring after August 15. In September, at the rice filling up stage, a cool period, with rainfall and low insolation has led to a yield diminution with the appearance of stunted (wrinkled and depreciated) grains and lower hectolitre mass. The prevailing attack has been by *Helminthosporium* spp. at all the vegetation stages of the species analyzed.

Fusarium spp., present at floral panicles initiation had no economic issues. At that same stage, *Pyricularia oryzae* intensified its attack at full grain maturation.

The year 1990 has benefited from the sowing to springing stages from temperatures close to the multi-annual average favourable to plant growth and development. At the plant's development stage, the grain filling-up, full physiological maturation, temperatures have been higher than the multi-annual average, with relatively low air humidity.

Under these climatic conditions less favourable to disease attack and evolution, one has been able to identify specific pathogenic agents with an attack frequency value ranged between 2,9 and 4,8% for *Helminthosporium* spp., 0,3 to 6,2% for *Fusarium* spp. and 1,6 and 3,6% for *Pyricularia oryzae*. Under such circumstances and in comparison with 1989, the year 1990 may be considered as less favourable to disease appearance and evolution.

6. Seed conditioning

The experiments performed for emphasizing the influence of seed conditioning over the seed sanitary state (see Table 7), for the Krasnodar 424 and Ariana varieties, indicate that the *Fusarium* spp. ratio occurring in the combine bunker when receiving decreases significantly or even disappear at selecting and drying. When selecting, the incompletely ripened and stunted (wrinkled and depreciated) seeds are bearers of pathogenic bodies and their removal on selection leads to seed batch quality improvement.

7. Producing new resistant varieties

Research carried out has led to the selection of a considerable number of parents adaptable to the Romanian climatic and soil conditions (resistance to low temperatures at different vegetation stages, resistance to diseases and pests, lodging resistance, adaptability of mechanical harvesting, efficiency and of high quality). The material studied has allowed the obtention of new promising lines and varieties, with a good resistance to disease, among which 54 promising lines and varieties have been selected as being resistant to the main rice diseases in Romania (see Table 7).

IV – Conclusions

The present paper is a survey on the main achievements concerning the influence of climatic factors on some rice registered and new promising lines grown on different types of soil, crop rotation, fertilization and conditioning.

Starting with control fields, the whole plant breeding material has been studied for their genetic resistance to the most important rice diseases, such as *Fusarium* spp., *Helminthosporium* spp. and *Pyricularia oryzae* Cav. The study revealed lines and cultivars of remarkable value that are resistant to the above mentioned diseases, especially Cristal, Chirnogi, Oltenita, Speranta, F24, F29, F30, F31.

Polizesti 28, a common variety spread on 65-70% of the area cultivated with rice in our country, has been qualified as the most sensible to diseases, especially to *Pyricularia oryzae* Cav. Due to these results, the area cultivated with Polizesti 28 has been severely restricted.

Nitrogen fertilizer has a strong effect in decreasing resistance to *Pyricularia oryzae* Cav.

The addition of P fertilizers to high rates of nitrogen is an essential element in soil conditions in Romania for the complex prevention of rice diseases.

When using 3-4 years monoculture, a high degree of pathogenic attack has been registered with a crop reduction of about 25-30%.

A very low temperature during the germination-sprouting period is favourable to a high frequency of *Fusarium* spp.

A constantly excessive temperature during the spike-maturity period (July-September) had a favourable effect in reducing *Helminthosporium spp.* and *Pyricularia oryzae* Cav. attacks.

A great number of diseased seeds has been eliminated using our conditioning system.

Saprophytes and pathogenic agents identified in Romania

1. *Fusarium* spp. (Gibberella Fujikuroi - Saw. - Wollenw.) Syn. *Fusarium moniliforme* Sheld.
2. *Helminthosporium oryzae* Breda de Haan (syn. *Drechslera oryzae* - Breda de Haan - Subram. and Jain)
3. *Pyricularia oryzae* Br. & Cav.
4. *Curvularia lunata* (Wakker) Baedijn
5. *Drechslera sorghicola* (Lef. & Sherw.) Richardson & Fraser (syn. *Helminthosporium sorghicola* Lef. & Sherw.)
6. *Drechslera tetramera* (McKinney) Subram. & Jain
7. *Epicoccum purpurascens* Ehrenb. Ex Schlecht
8. *Cladesporium herbarum* (Pers.) Liink ex Fr.
9. *Alternaria* spp.
10. *Penicillium communae* Thorn
11. *Rhizopus nigricanus* Ehrenb. Ex Corda.
12. *Aspergillus flavris* Link ex Fr.
13. *Chaetomium globosum*. Kunze ex Fr.
14. *Sclerotinia sclerotiorum* (Lib.) De Bary
15. *Mucor* spp.

References

• **Bonman J. M.** (1992). Durable resistance to rice blast disease: environmental influences. *Euphytica* 63: 115-123.

• **Hearth M.C.** (1987). Evolution of plant resistance and susceptibility to fungal sunvalders. *Can. J. Plant Pathol.* 9: 389-397.

• **Kiyosawa S.** (1976). Methods for tests and analysis of blast resistance of rice varieties. *Oryza* 13: 1-32.

• — (1982). Genetics and epidemiological modelling of breakdown of plant diseases resistance. *Hun. Rev. Phytopathol.* 20: 444-448.

• — (1981). Breeding for disease resistance in crop plants and its basic studies. (33) *Agr. Hort.* 56: 485-488.

• **Moldenhamer K.A.K.** (1992). Inheritance of resistance race to mec. IB-49 and IC-17 of *Pyricularia grisea* rice blast. *Crop Sci*. 32: 584-588.

• **Neergaard G.** (1970). "Seed pathology of rice". Contrib. Danish Gov. Inst. of Seed pathology for Developing Countries, Copenhagen No. 2, 57-62.

• **Roumen E.C.** (1992). Effect of leaf age on components of partial resistance in rice to leaf blast. *Euphytica,* 63: 271-279, Kluwes Academic Publisher, printed in the Netherlands.

• **Raicu C., Baciu D.** (1978). *Seeds Pathology,* 208, Ceres Publishing House, Bucharest.

Annexe

Table 1. The mineral fertilizers influence in rice seed health (1986-1991)

Dose Kg/ha	***Fusarium* spp.**	***Curvularia lunata***	***Drechslera sorghicola***	***Drechslera tetramera***	***Bacterii***	***Alternaria* spp.**	***Aspergillus flavu***	***Chaetomium globosum***	***Penicillium communae***	***Rizopus nigricans***	***Sclerotinia sclerotiorum***
N_0P_0	13	-	-	3	1	56	1	1	3	4	-
N_0P_{40}	10	1	2	2	1	30	1	-	6	1	1
N_0P_{80}	6	-	-	3	2	45	-	1	7	1	-
N_0P_{120}	7	2	-	3	3	63	-	-	3	-	-
$N_{40}P_0$	10	1	-	4	5	33	5	-	2	1	-
$N_{40}P_{40}$	8	-	-	4	1	29	1	1	7	4	1
$N_{40}P_{80}$	5	1	-	2	3	45	-	-	5	6	-
$N_{40}P_{120}$	5	1	1	2	-	55	-	1	-	1	-
$N_{80}P_0$	13	-	-	6	3	48	1	3	5	-	3
$N_{80}P_{40}$	10	-	-	7	1	24	-	-	6	-	-
$N_{80}P_{80}$	6	-	-	7	1	40	-	-	10	2	-
$N_{80}P_{120}$	6	-	-	1	3	42	-	-	1	-	-
$N_{120}P_0$	15	-	-	4	2	45	2	1	5	-	1
$N_{120}P_{40}$	8	-	-	6	-	37	-	-	5	3	-
$N_{120}P_{80}$	5	1	-	4	1	40	-	-	3	2	-
$N_{120}P_{120}$	6	-	-	1	2	49	-	-	1	-	-
$N_{160}P_0$	15	-	-	9	1	44	-	2	6	1	1
$N_{160}P_{40}$	7	-	-	3	3	19	-	-	4	1	-
$N_{160}P_{80}$	5	1	1	1	1	50	-	-	2	1	-
$N_{160}P_{120}$	5	-	-	2	1	31	-	1	1	-	-

Table 2. The mineral and manure fertilizers influence in rice seed health (1986-1991)

Dose t/kg/ha	*Fusarium* spp.	*Drechslera tetramera*	*Curvularia lunata*	*Bacterii*	*Alternaria* spp.	*Epicoccum purpurascens*	*Cladosporium herbarum*	*Penicilium commune*	*Rhizopus nigricans*
0t M + N_0P_0	8	4	-	2	31	2	2	12	1
0t M + $N_{40}P_0$	8	4	-	2	43	-	3	4	-
0t M + $N_{40}P_{40}$	7	2	-	2	45	4	2	2	-
0t M+$N_{80}P_{80}$	4	2	-	2	30	-	-	2	2
20t M+N_0P_0	8	4	-	3	37	2	-	2	6
20t M+$N_{40}P_0$	8	2	-	2	34	2	-	-	2
20t M+$N_{40}P_{40}$	9	3	2	4	29	-	2	-	-
20t M+$N_{80}P_{80}$	8	5	-	-	30	2	3	-	2
40t M+N_0P_0	6	2	-	-	44	2	2	2	-
40t M+$N_{40}P_0$	11	3	-	2	31	-	2	-	-
40t M+$N_{40}P_{40}$	11	2	-	2	31	-	3	-	2
40t M+$N_{80}P_{80}$	11	2	-	-	26	2	6	-	-
60t M+N_0P_0	10	2	-	2	13	2	2	2	2
60t M+$N_{40}P_0$	12	4	-	2	30	2	2	20	-
60t M+$N_{40}P_{40}$	19	4	2	3	30	2	2	6	-
60t M+$N_{80}P_{80}$	37	2	-	-	26	2	4	-	-

Table 3. The crop rotation influence against degree of main pathogens attack in rice crop

Year	Rotation crop	% attack	Yield q/ha	Yield %
1986	Soybean	0.27	60.5	100.0
	Rice II	0.98	54.7	84.2
	Rice III	2.15	51.2	78.2
	Rice IV	4.82	45.0	69.2
1987	Soybean	0.59	55.8	100.0
	Rice II	1.35	51.3	91.9
	Rice III	2.74	47.9	85.8
	Rice IV	7.80	42.5	76.2
1988	Soybean	0.19	60.2	100.0
	Rice II	0.75	55.4	92.0
	Rice III	1.65	53.1	88.2
	Rice IV	5.65	49.1	81.9
1989	Soybean	0.27	57.8	100.0
	Rice II	0.85	53.2	92.0
	Rice III	1.10	49.8	86.2
	Rice IV	3.80	43.5	75.3
1990	Soybean	0.18	53.7	100.0
	Rice II	0.65	49.6	92.4
	Rice III	1.20	44.3	82.5
	Rice IV	2.75	39.6	73.7
1991	Soybean	0.24	56.2	100.0
	Rice II	0.84	50.3	90.4
	Rice III	1.60	47.2	83.9
	Rice IV	4.25	40.4	71.9

Table 3. ***Synthesis***

Year	Soybean	Yield (g/ha) Rice 2	Rice 3	Rice 4
1986	60.5	54.7	51.2	45.0
1987	55.8	51.3	47.9	42.5
1988	60.2	55.4	53.1	49.1
1989	57.2	53.2	49.8	43.5
1990	53 7	49.6	44.3	39.6
1991	56.2	50.8	47.2	40.4

Table 4. The main fungus species in rice fields from different parts of Romania

Year of check	*Fusarium* spp.	**Fungal species** (%) *Helminthosporium* spp.	*Pyricularia oryzae*
1986	3.0	5.0	6.0
1987	15.0	12.5	7.0
1988	13.0	10.0	5.0
1989	20.0	18.0	8.6
1990	6.2	4.8	3.6
1991	1.4	5.0	2.4

Table 5. The varietal vegetation stage reaction to the main diseases attack in rice, in different parts of Romania

Year of testing	Vegetation period	Variety = Polizesti & Locality	Attack frequency (%) *Fusarium* spp.	*Heimintho-sporium* spp.	*Pyricularia oryzae*
1989	Germination-tillering	Polizesti	-	15.4	-
		Chirnogi	-	11 .6	-
	Heading-flowering stage	Polizesti	9.3	18.9	3.5
		Banloc	6.4	12.6	2.1
	Ripening stage	Polizesti	5.9	18.3	3.9
		Giurgeni	4.6	17.2	11.6
	Maturated seed	Polizesti	3.9	18.6	10.3
1990	Germination-tillering stage	Polizesti	0.6	2.9	-
		Chirnogi	0.3	3.1	-
	Heading-flowering stage	Polizesti	1.9	3.0	-
		Banloc	1.4	3.3	-
	Ripening stage	Banloc	2.5	4.8	2.6
	Maturated seed	Polizesti	6.2	3.9	1.6
		Vladeni	6.0	3.4	1.9
		Vladeni	2.6	3.6	3.6

Table 6. Seed selection influence against seed health (BSE 13.5% H) (1986 - 1991)

	Variety	Ariana	Krasnodar 424
Combine	*Fusarium* spp.	12	16
	Drechslera tetramera	2	2
	Drechslera sorghicola	-	-
	Curvularla lunata	-	-
	Sclerotinia sclerotiorum	-	-
	Alternaria spp.	24	34
	Aspergillus flavus	-	4
	Cladosporium herbarum	16	-
	Penicilium communae	26	-
	Rhizopus nigricans	-	8
	Mucor mucedo	5	12
Reception	*Fusarium* spp.	8	6
	Drechslera tetramera	-	2
	Drechslera sorghicola	4	-
	Curvularia lunata	4	-
	Sclerotinia sclerotiorum	-	-
	Alternaria spp.	66	94
	Aspergillus flavus	20	-
	Cladosporium herbarum	6	-
	Penicillium communae	6	8
	Rhizopus nigricans	8	-
	Mucor mucedo	8	6
Cleaner	*Fusarium* spp.	-	8
	Drechslera tetramera	-	-
	Drechslera sorghicola	-	-
	Curvularia lunata	-	-
	Sclerotinia sclerotiorum	-	12
	Alternaria spp.	-	78
	Aspergillus flavus	-	4
	Cladosporium herbarum	-	-
	Penicillium communae	-	6
	Rhizopus nigricans	-	14
	Mucor mucedo	-	6
Selection	*Fusarium* spp.	4	-
	Drechslera tetramera	-	-
	Drechslera sorghicola	2	-
	Curvularia lunata	-	-
	Sclerotinia sclerotiorum	2	12
	Alternaria spp.	30	22
	Aspergillus flavus	8	6
	Cladosporium herbarum	-	-
	Penicillium communae	10	4
	Rhizopus nigricans	12	8
	Mucor mucedo	-	26
Dryer	*Fusarium* spp.	-	-
	Drechslera tetramera	-	-
	Drechslera sorghicola	-	-
	Curvularia lunata	2	-
	Sclerotinia sclerotiorum	-	-
	Alternaria spp.	48	-
	Aspergillus flavus	36	-
	Cladesporium herbarum	6	-
	Penicillium communae	6	-
	Rhizopus nigricans	8	-
	Mucor mucedo	14	-

Table 7. Varieties and new promising lines in breeding program for resistance to *Pyricularia oryzae* and *Helminthosporium oryzae*

Year of testing	Resistance	Variety / lines
1986	M.R.	Braila
	R	Coral, Bega, Timis, Partos 103/80, Partos 108/80, Partos 215/80, Partos 222/80, Partos 225/80, Partos 308/80, Topolea 58/76, Topolea 64/76, Topolea 66/76, Topolea 70/76, Topolea 88/76, Topolea 57/77.
1987	M.R.	F 15, F 16, F 17, F 18, F 19, F 38, P 228, Krasnodar 424, GMB x Kuban 9.
	R.	F 38M, F 7
1988	M.R.	L 7 Chirnogi, L 502/1, L 549, Fundulea 16, Fundulea 19, Fundulea 38, Fundulea 102/1, Fundulea 20, Krasnodar 424, Krasnodar 424 I, Cristal, Earlyrose x Krasnodar 424.
	R.	Cristal
1989	M.R.	Krasnodar 424 I, Ariana I, Timis 108 x Kr. 424, GMB x Kuban 9, Ringola x Cesariote, (Rizzoto x Cody) x Fugisaka 5, Ariana x Danublu, M 104.
	R.	Chirnogi
1990	R.	F 38M, Speranta, F 27, F 29, F 30, F 31,
1991	R.	Cristal, Oltenita, Chirnogi, F 22, F 23, F 24, F 25.

Table 8. Field check

Year	Variety	Source	**Fungal species** (%) *Fusarium* spp.	*Pyricularia oryzae*	*Helminth* spp.	*Epicoccum neg*	*Rhizoctonia solani*	*Alternaria* spp.	*Curvularia* spp.	*Cladosp.* spp.	*Penicillium* spp.	*Aspergillus* spp.
1986	Polizesti	Chirnogi	32	-	-	14	2	100	-	-	32	4
	Polizesti	Oltenita	40	2	6	20	12	88	-	12	18	10
	Polizesti I1	CPP Braila	24	-	1	8	-	100	1	18	22	4
	Polizesti I2	Giurgeni	12	-	4	10	-	100	-	-	40	4
	Sidef	Chirnogi	55	-	3	25	6	100	-	8	64	12
	Sidef	Piatra	42	1	6	14	6	100	1	4	18	-
	Sidef	Giurgeni	30	-	1	10	-	100	-	-	28	4
	Sidef elita	Oltenita	32	1	10	-	3	100	2	6	40	22
	Krasnodar 424	Piatra	46	2	4	14	8	75	3	6	20	5
1985		Oltenita	8	5	3							
		Giurgeni	7	7	5							
	Krasnodar 424	Vladeni	5	3	2							
		Dunareni	9	8	7							
		Alexandria	7	5	3							
	Bega	Banloc	3	-	-							
	Timis	Banloc	3	5	2							
	Diamant	Banloc	3	2	2							
	Coral	Banloc	3	3	3							

Table 9. Field check in different parts of Romania

Year	Pathogen	Variety	Attack frequency *Locality* Vladeni	Chirnogi	Banloc
		Polizesti	+	+	-
1989-		Sidef	+	+	-
1991	*Pyricularia oryzae*	Krasnodar 424	+	+	-
		Timis	-	+	+++
		Bega	-	+	+
		Polizesti	+	+	-
1989-		Sidef	+++	+	-
1991	*Helminth* spp.	Krasnodar 424	+ + +	+	-
		Timis	-	+	+
		Bega	-	+	+

+ weak infection
+ + moderate infection
+ + + strong infection