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3878: GIBBERELLA FUJIKUROI (SAWADA) WOLLENWEBER, ANAMORF  
FUSARIUM MONILIFORME SHELDON, CAUSER OF BAKANAE DISEASE ON RICE  
IN THE REPUBLIC OF MACEDONIJA





# GIBBERELLA FUJIKUROI (SAWADA) WOLLENWEBER, ANAMORF FUSARIUM MONILIFORME SHELTON, CAUSER OF BAKANAE DISEASE ON RICE IN THE REPUBLIC OF MACEDONIA



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## Abstract

In August, 2006 symptoms of "bakanae disease" are observed for the first time in the rice fields of the locality "Vinje stone" in the area of Kicari. During 2007, 2008 and 2009, symptomatic plant material is collected from ten different fields in the regions of Štip, Kumanovo and Vinica. The research focused on disease dissemination, biological and physiological properties as well as on the epidemiology of the fungus. Laboratory investigations showed the presence of several pathogens – *Fusarium griseum* Sacc., *Sterium ochroleucum* Cati., and *Cochliobolus mycelium* (D. & Harkn.) Shoemaker ex Gerd. During this period a biotrophic stage of the fungus *Gibberella fujikuroi* (Sawada) Wollenweber is described for the first time in Republic of Macedonia. Clavate and produce hyaline ascospores, ellipsoid with 1–3 septa and 14–18 x 4.5–5 µm. In 2006 bakanae disease of rice was

present with an intensity of 20% but in 2008 the intensity was much higher around 40%. The presence of the anamorphic stage *Fusarium moniliforme* Sheldon, is confirmed on the basis of its morphological characteristics. It is firstly observed on the variety "San Andrea" without significant consequences for the yield production. Microscopic observation shows the presence of hyaline macroconidia, oblong, 5–9 x 1.5–2 µm without or with one septa. Macroconidia are hyaline, long tapered to the ends, slightly curved produced in acervuli with 7–9 septa, and dimensions 25–52 x 2.5–3.5 µm. Several fungicides are tested in field conditions for their effectiveness. The research show that trifluralin, propiconazole and prothioconazole are the most effective in our conditions.

**Key words:** *Oryza sativa*, *Gibberella fujikuroi*, bakanae, *Fusarium moniliforme*

## SYMPTOMS OF "BAKANAIE" DISEASE IN THE RICE FIELDS IN THE REPUBLIC OF MACEDONIA



Natural infection (infected field, left) and no infected, right



Symptoms of "bakanae" disease on rice plants



Symptoms of "bakanae" disease on rice plants



Enlarged view of rice plant



Natural infection



Symptoms on panicles



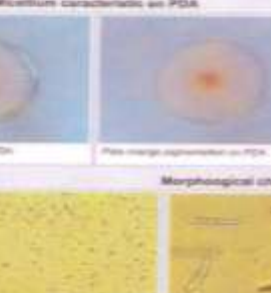
Whole panicle growth of mycelium on lower parts of diseased plants



Mycelium on rice stems



White primary mycelium on PDA



Pink and orange mycelium on PDA



Pink and orange mycelium on PDA

## Mycelium characteristic on PDA

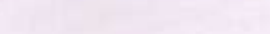
The mycelium on PDA is at, powdered whitish in color. The pigment in medium is orange to pale red. Microscopic observation shows the presence of hyaline, elliptical ascospores (10–18 x 4–5 µm, 1–3 septa), hyaline, oval to clavate, single-celled macroconidia (5–9 x 1.5–2 µm) without, and hyaline, slightly curved macroconidia (25–52 x 2.5–3.5 µm) with a foot-shaped basal cell and 3–9 septa.

## Morphological characteristics



Macroconidia

Macroconidia



Microconidia

Microconidia



Artificial inoculation



White primary mycelium on PDA



Pink and orange mycelium on PDA

## Reinoculation

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3878: GIBBERELLA FUJIKUROI (SAWADA) WOLLENWEBER, ANAMORF FUSARIUM MONILIFORME SHELTON,  
CAUSER OF BAKANAE DISEASE ON RICE IN THE REPUBLIC OF MACEDONIA

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### Abstract

In August, 2006 symptoms of "bakanae disease" are observed for the first time in the rice fields of the locality "White stone" in the area of Kocani. During 2007, 2008 and 2009, symptomatic plant material is collected from ten different fields in the regions of Shtip, Kocani and Vinica. The research focused on disease dissemination, biological and physiological properties as well as on the epidemiology of the fungus. Laboratory investigations showed the presence of several pathogens – *Pyricularia grisea* Sacc., *Sclerotium orizae* Catt., and *Cochliobolus miyabeanus* (Ito & Kurib.) Drechsler ex Dastur. During this period a teleomorphic stage of the fungus *Gibberella fujikuroi* (Sawada) Wollenweber is described for the first time in Republic of Macedonia. Clavate asci produce hyaline ascospores, ellipsoid with 1-3 septa and 14-16 x 4.5 – 5 µm. In 2006 bakanae disease at rice was present with an intensity of 20% but in 2009 the intensity was much higher around 40%. The presence of the anamorphic stage *Fusarium moniliforme* Sheldon is confirmed on the base of its morphological characteristics. It is firstly observed on the variety "San Andrea" without significant consequences for the yield production. Microscopic observation shows the presence of hyaline microconidia, oblong, 5-9 x 1.5 - 2 µm without or with one septa. Macroconidia are hyaline, long tapered to the ends, slightly curved produced in acervuli with 3-5 septa, and dimensions 25-52 x 2.5 x 3.5 µm. Several fungicides are tested in field conditions for their effectiveness. The research show that triflumizole, propiconazole and prochloraz are the most effective in our conditions.

**Key words:** *Oriza sativa*, *Gibberella fujikuroi*, bakanae, *Fusarium moniliforme*.

### Introduction

Rice in the Republic of Macedonia is cultivated in the area of around 3500ha, in several regions: Kocani, Vinica, Karbinci, Negotino, Cusinovo and Shtip. Almost 40% of the total production is concentrate in the region of Kocani with the yield more than 5000 kg/ha. Several years ago, since 2005, "bakanae disease" symptoms are observed for the first time in Republic of Macedonia. The first occurrence was in the rice fields of "white stone" in the area of Kocani. The disease progressed very quickly, so in 2007 it was present in every region where the rice is grown. Several other plant pathogens are also observed causing decays of rice yield: *Pyricularia grisea* Sacc., *Sclerotium orizae* Catt., and *Cochliobolus miyabeanus* (Ito & Kurib.) Drechsler ex Dastur.

### Materials and methods

Symptomatic plants are collected from the field and bring in to the laboratory for investigation. The isolation of the fungus is done on Czapek-Dox medium, modified (Nelson et al., 1983) and for conidia formation Bilay's medium modified by Joffe is used (Joffe, 1963, cit. Booth, 1971a). The fungus is grown at 25°C and day and night stimulation for seven days. After monospore isolation the identification is done by their morphological characteristics (John F. et al., 2006; Jelena T. Levic, 2008). The pathogenicity is investigated according to Chi et al., 1964, for that purpose the fungus is grown on PCA (potato carrot agar). Several fungicides are tested for suppressing the "bakanae" disease in field condition.

### Results

Seedlings with bakanae emerge rapidly, remain tender and are significantly taller than non-infected plants. Heavily infected seed lots may produce both, stunted and elongated seedlings. Older infected plants show tall tillers with pale-green flag leaves well above the canopy of the healthy crop. Infected plants produce only few tillers and leaves dry up before maturity. In some cases, diseased plants survive until maturity, but are sterile and produce no or empty panicles. White powdery growth of mycelia may be visible on lower parts of diseased plants. The panicles of healthy plants may be contaminated by spores and turn pink due to growth and sporulation of the fungus on hulls or kernels.

The mycelium on PSA is air, powdered whitish in color. The pigment in medium is orange to pale red. Microscopic observation show the presence of hyaline, elliptical ascospores (10 – 18 x 4 - 6 µm, 1 – 3 septa), hyaline, oval to clavate, single-celled microconidia (5-9 x 1.5 - 2 µm) in chains, and hyaline, slightly curved macroconidia (25-52 x 2.5 x 3.5 µm) with a foot-shaped basal cell and 3 – 5 septa. Treatments with fungicides show that the most effective are strobilurins like triflumizole, propiconazole and prochloraz.

### Conclusion

*G. fujikuroi* in Republic of Macedonia is introduced by seed. The first observation was in 2006 (Karov et al., 2009) when the intensity was low almost 4-5%. But the intensity of the disease increase every year due to the absence of fungicide treatment in field and the most important due to the absence of seed treatment. Since then, the intensity of the disease is increased at almost 30%. Airborne ascospores contaminate the panicle from heading to maturity, especially in rainy periods. The production of conidia and perithecia on diseased culms coincides with flowering and maturation. The pathogen may be also soil-borne, it can survive in the soil as thick-walled hyphae or macroconidia.

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3879: WEED SPECIES FOUND IN RICE FIELDS IN  
THE REPUBLIC OF MACEDONIA



# 3879: WEED SPECIES FOUND IN RICE FIELDS IN THE REPUBLIC OF MACEDONIA

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## Abstract

Rice (*Oryza sativa*) in Macedonia is cultivated at around 4 000 ha with a yield of approximately 6 000 kg/ha. It is mainly produced in the region of Kocani, and the most cultivated varieties are "San Andrea" and "Monticel" from Italy, type "Japonica".

Many weed species exist in the fields of rice which decrease the yield and the quality of rice. Most spread species are from the family Cyperaceae (*Scirpus maritimus*, *Scirpus mucronatus*, *Cyperus difformis* and *Cyperus rotundus*). *Echinochloa crus-galli* from the family Poaceae and *Heteranthera limosa* from the family Pontederiaceae. Less common weed species are *Potamogeton natans*, *Butomus umbellatus*, *Potamogeton distinctus* (Karov I. et al., 2001) and *Leersia oryzoides*. Other present weed species belong to *Ammanium* sp., *Rotala* sp. and *Lemna* sp.

In June 2007 in the area of Kocani the presence of new species *Heteranthera reniformis* Ruiz & Pavon is observed for the first time between the village Cesinovo and village Spancevo, on an area of 600 ha, occupying 10 - 15% of the field. From then onwards, the variety has been present in the rice fields, every year. In 2009 the presence of *Heteranthera reniformis* is observed in the region of Shtip and Negotino, with much higher intensity of around 40%. This is a first report for the presence of *Heteranthera reniformis* Ruiz & Pavon in the Republic of Macedonia.

**Key words:** *Oryza sativa*, weed, *Heteranthera reniformis*, Cyperaceae spp.

## Introduction

Republic of Macedonia is a country located in the central Balkan peninsula in Southeastern Europe with a total area of 25,713 km<sup>2</sup>. It is bordered by Kosovo to the northwest, Serbia to the north, Bulgaria to the east, Greece to the south and Albania to the west. The country enjoys mediterranean and continental climate due to its specific natural and geographical characteristics. Around 560,000 ha are arable land, from which 4 000 ha (0.7%) are yielded with rice, grown on small paddy fields, mostly in the region of Kocani. The main objective of this study is to represent the variety of weed species present in the rice paddies in Macedonia. I. Karov, in 1979 describe the presence of *Echinochloa crus-galli*, *Cynodon dactylon* and *Leersia oryzoides* in rice paddies as hosts of the fungus *Cochliobolus sativus*. This was the first published data about the presence of some weed species in rice paddies in Macedonia. Since then, Karov have identified the presence of *Heteranthera limosa*, *Potamogeton natans*, *Potamogeton distinctus*, *Butomus umbellatus* and *Leersia oryzoides* (Karov I. et al., 2001). In 2007, the same author, notice the presence of several new weed species. They were identified as *Heteranthera reniformis* and *Rotala* spp. This is the first report about the presence of *Heteranthera reniformis* in Macedonia.

## Materials and methods

Weed species collected from the rice paddies are, immediately herbarized, and photographed in the field and in the laboratory. Endemic and rare plants are sent in the National Museum of Republic of Macedonia. Characteristic parts from the weed plants are, photographed under the stereo microscope.

The determination was made on conventional methods using key determinant.

## Results

The investigation of rice paddies shows a great diversity of the weed flora. The most common are, species from the family Cyperaceae: *Scirpus maritimus*, *Scirpus mucronatus* L., *Cyperus difformis* and *Cyperus rotundus*. They can be found in the 70% of the rice fields. The most serious weed problem in rice growing areas is caused by the species *Echinochloa crus-galli* (L.) Beauv., from the family Poaceae. This species called Barnyard grass have steam up to 1m high, and it is very difficult to distinguish from young rice, because it is not noticeable until seed heads appear above the growing rice crop. Very common species is *Heteranthera limosa* (family Pontederiaceae), too. This species is present with white and blue flower. The flowering stage is observed in August, mostly around 11 am. This stage is very short and lasts between 30 min. - 1 hour.

Ten years ago, rice growers have problems with *Potamogeton natans*, *Potamogeton distinctus* and *Butomus umbellatus* that could be found in the area of Kocani, (Karov I. et al., 2001) but last year (2010) these species were found with much lower intensity. *Leersia oryzoides* (L.) Sw. known as "Rice Cut-grass" (family Poaceae), can be found almost in every region with different intensity. In some paddies the highest intensity

observed is almost 30%. In 2010 this weed caused the biggest problem from all present weed species.

The new species observed in rice paddies in Macedonia is *Heteranthera reniformis* Ruiz & Pavon. This weed was observed for the first time in 2007 on an area of 600 ha between the village Cesinovo and the village Spancevo. The intensity was estimated of around 10 - 15%. In 2009 the presence of *Heteranthera reniformis* is observed in other rice growing regions like Shtip and Negotino, but now the intensity was very much higher of around 40%. The adult plant is 20 - 30 cm in high. Leaves have kidney shape which are rounded and deeply cleft at the base. The raceme is usually 2-3 flowered. Flowers are with 6 tepals white in colour, united at base and forming a tube 6 to 10 mm, free in the other parts, lanceolate, sharply pointed; at anthesis, 2 outer tepals bend in towards the tube, the third bends outwards; 3 stamens, 2 small with yellow anther, the third longer with grey-blue anther. The fruit is capsule with many seeds.

The same year our attention was attracted by the appearance of other two new weed species. According to our investigations this weed belongs to *Rotala* spp. from the family Lythraceae and *Lindernia* spp. from the family Scrophulariaceae.

**Table 1.** Species list of Macedonian rice weeds

Taxon	Family	Common name	Origin	Current distribution in Macedonia
<i>Scirpus maritimus</i>	Cyperaceae	Alkali Bulrush		Widespread
<i>Scirpus mucronatus</i>	Cyperaceae	Ricefield bulrush	Euroasia	Widespread
<i>Cyperus difformis</i>	Cyperaceae	Smallflower umbrella	Asia	Widespread
<i>Cyperus rotundus</i>	Cyperaceae	Nut grass		Widespread
<i>Echinochloa crus-galli</i>	Poaceae	Barnyard grass	Euroasia	Widespread
<i>Heteranthera limosa</i>	Pontederiaceae	Ducksalad	Neotropics	Kochani (Ceshinovo, Ciflik)
<i>Potamogeton natans</i>	Potamogetonaceae	Floating-leaf pondweed	Asia	Kochani
<i>Potamogeton distinctus</i>	Potamogetonaceae	Roundleaf pondweed	Asia	Kochani
<i>Butomus umbellatus</i>	Butomaceae	Flowering rush grass	Eurasia	Kochani
<i>Leersia oryzoides</i>	Gramineae	Rice Cut-grass		Widespread
<i>Heteranthera reniformis</i>	Pontederiaceae	Mud plantains	Neotropics	Kochani
<i>Rotala</i> spp.	Lythraceae	-	-	Kochani
<i>Lindernia</i> spp.	Scrophulariaceae	-	-	Kochani

## Conclusion

Weed species present in rice paddies have received little attention from botanist in Republic of Macedonia. The investigation show that, in the rice fields in Macedonia can be found many weed species, decreasing the quality and yield of rice. Many of them are introduced in the country by the seed, mostly from Italy. Some weed species like *Cyperus difformis*, *Echinochloa crus-galli*, *Potamogeton natans* and *Potamogeton distinctus* are among the most cosmopolitan weeds of rice.

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