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Gouramanis G.

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The present status of rice diseases and their control in northern Greece

G. D. Gouraminis
National Agriculturural Research Foundation, Plant Protection Institute of Thessaloniki (Greece)

I – *Pyricularia oryzae* (Rice blast)

Abstract. The fungus *Pyricularia oryzae* is among the most well-known rice diseases. It severes in most of the humid rice-producing areas of the world. Rice grown under irrigation in areas of low relative humidity, as in N. Greece, are not affected by blast and conidia are not found below 88 percent relative humidity.
During a 4-year (1991–94) field evaluation of chemical methods for the control of rice blast *(Pyricularia oryzae Cav.),* we have studied the influence of environmental conditions, a very important factor of disease development.
In field experiment, the fungicides (carbendazim, pyroquilon, thiophanate methyl and chlobenthiazone) reduced leaf but not neck blast. On the contrary, tricyclazole was effective against neck blast.
In our area (N. Greece) the environmental conditions for blast development were favorable, particularly because the mean air temperature was between 21–28 °C and wind speed 0,7–1,6 m/sec. However, relative humidity (54–84%) was adverse to infection and disease development by the blast fungus *Pyricularia oryzae.*

Introduction

The discovery of several methods for control of rice blast disease (*Oryza sativa* L.) caused by heterothallic Ascomycete, Magnaporthe grisea Barr. (*anamorph, Pyricularia oryzae Cav.* or *Pyricularia grisea*) was the target for research in our country.

The disease was observed mainly in our area (N. Greece) and attacks the leaves, culms, branches of the panicle and the floral structures.

This study was necessary for the evaluation of chemical methods for the control of this disease in relation with the influence of environmental conditions.

Control of the disease was accomplished by using new fungicides as Fongoren, Beam and Oryzemate in relation with influence of enrironmental conditions (temperature, leaf wetness, relative humidity) for blast development.

1. Materials and methods

The experiment was carried outside, in Kalochori, on the farm of the Cereal Institute of Thessaloniki, during the 1991, 92, 93 and 1994 growing seasons. The rice variety "Rita", partially resistant to blast, was used in the study. Seeds were planted in soil with 18 cm row spacing at 110 kg seed/ha on 17–22 May. Fertilizer was applied at planting at a rate of 650 kg/ha of 20-10-10 (N-P_20_5-K_20). The herbicide propanil was applied at the recommended rate (3,5 kg active ingredient/ha) before the permanent flood. A complete randomized block design with ten treatments and four replications was also was used; the plot size was 5,3 m x 2,4 m. Five sprays were used with fungicides at 1000 litres/ha, three were applied up to leaf stage and the other two during panicle emergence.

In field experiment, the fungicides used were: Derosal (carbendazim), Fongoren (pyroquilon), Hinosan TCP (edifenphos), Kitazin P (iprobenfos), Bla-s (blasticidin), Chlobenthiazone, Beam (tricyclazole), Orysemate (probenazole) and Neotopsin (thiophanate-methyl).

We also studied the environmental conditions (temperature, leaf wetness, relative humidity and wind speed) and their influence on disease development.

2. Results and discussion

In field experiment, evaluation of fungicides in sprays agains *P. oryzae* in the same period are shown in *Tables 1* and *2*. The fungicide Derosal (carbendazim) in the dose of 1,5 lb/100 gallons gave satisfactory control with sprays commencing before the appearance of symproms. The results were better against leaf blast than neck infection as other researchers noted. Fongorer (pyroquilon), in the dose of 2 kg/ha, gave good results against leaf and neck blast while the Beam (tricyclazole) in 0,75 kg/ha effectively decreased neck blast with one or more applications followed by pyroquilon). The fungicides Hinosan (edifenphos) with 3,0 lb/100 gallons had moderate effectiveness while Kitazin (iprobenfos) and Bla-S (blasticidin) reduced leaf but not neck blast infection. Also the granular Chlobenthiazone in the dose of 30–40 kg/ha were better in leaf than neck infection while the oryzemate (probenazole) and Neotopsin (thiopharate-methyl) give a very good control against disease development.

Finally *Figures 1 to 5* present the averages of environmental conditions in our country (N. Greece) during the period 1991–94.

According to Choong-Hoe Kim *et al.*, the temperatures between 19 and 29° C particularly in the range 23–26° C, during more than 16 h when the relative humidity was above 90%, are considered to be highly favorable for blast development. The most favorable condition for blast development is a mean temperature between 23 and 26° C, 24 h of leaf wetness and 24 h of high relative humidity (above 90%).

Especially in N. Greece, the conditions for blast development were not favorable because average rainfall (0–85 mm) *(Figure 5)* and relative humidity (54–84%) *(Figure 4)* were most of the time adverse to infection and disease development by the blast fungus *Pyricularia oryzae.*

The adverse effect of relative humidity was not influenced by the favorable temperatures of the area (average temp.: 21–28° C; min.: 12°; max.: 34° C) *(Figures 1, 2)* and by the wind speed (0,5–1,7 m./sec.) *(Figure 3).*

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II – *Helminthosporium oryzae* (Brown spot or blight disease)

The disease appears at first as small, purplish brown spots, on the leaves and glumes. Later the spots grow larger and have a grey center and brown border. The fungus causes damage by infecting the seed directly, which then germinates poorly and produces weak seedlings, but primarily by attacking the leaves during the seedling stage either in the seed beds or in the field. In such infections the young foliage is severely damaged, the plants are weakened, and the yield drastically reduced.

Control of this disease is accomplished by using resistant varieties and fungicidal sprays with Brestan, Benlate+Manzate, Tersan LSR (maneb), Rovral, Mertect 340F+ Difolatan, Mertect 340F+Dithane M-45, Daconil 500, Derosal, and Prochloraz. They can be applied in the beginning from June (continuing at 1–2 week intervals for as long as necessary to get the disease under control).

Several systematic fungicides, such as imazalil, nuarimol, etaconazole and fenapanil, when applied as seed treatments with the irrigation water, give good control of the root rot and several of the other symptoms and are being tested for grower application.

III – *Rhizoctonia solani* (Sheath blight)

The sheath and culm blight of rice, one of it most serious diseases, different species of Rhizoctonia, cause large, irregular lesions that have a straw-colored center and a wide reddish-brown margin. Seedling and mature plants may become blighted under favorable conditions for the pathogen.

For most races of the fungus, the optimum temperature for infection is about l5–18 °C, but some races are most active at much higher temperatures (up to 35 °C). Disease is more severe in soils that are moderately wet than in those that are water logged or dry. Infection of young plants is most severe when plant growth is slow due to adverse environmental conditions (for the plant).

The greatest effort for controlling has gone into developing biological controls against Rhizoctonia. The disease is parasitized by several microorganisms, such as the fungi *Tricoderma spp.*, *Gliocladium Laetisaria* and several soil myxobacteria.

Of the many chemicals which have been tested against sheath blight, the most widely used and effective are: Rovral, Brestan, Daconil 500, Benlate and Bayleton Total.

Control of Rhizoctonia diseases, when the fungus is carried with the seed depends on the use of disease-free seed or seed treated with hot water and chemicals.

IV – *Fusarium moniliforme* (Foot rot)

The seedlings are first affected and become pale yellow or yellow green, and are thin and lanky. Also typical is a pink incrustation which forms at the base of the stem, and which consists of the causal fungus.

Control of this disease is accomplished by using resistant varieties and fungicidal sprays with Mertect 340F+Difolatan 4F, Mertect 340F+Dithane M45, Difolatan, Dithane M5, Prochloraz and Benlate. Also seed treatments with Maneb+Zineb, Mancozeb, TCMTB and Thiram give good results.

Biological control of Fusarium root and stem rots has been attempted with some success by incorporating organic materials such as barley straw, lettuce, and chitin in the soil, thus favoring the increase of several fungi and bacteria antagonistic to Fusarium, or by treating seeds or transplants with spores of fungal antagonists, mycorrhizal fungi, or antagonistic *Pseudomonas bacteria*.

V – Conclusion

The use of fungicides has greatly increased during the last years in our country. Although no resistance problem has been recorded yet in the field, there is obviously a risk of fungicide resistance in these fungal pathogens. Strategies for using fungicides with minimum risk have been developed jointly by the Plant Protection Institutes in Greece: a) Minimal numbers of applications, economical loss thresholds and other aids for spray decision, are available; b) Fungicides with multisite action should be preferred whenever possible; c) The choice of fungicides should depend on the diseases which are significantly present in the crop, unnecessary components should be avoided; d) Alternation of unisite fungicides of different resistance groups.

Biological control of pathogens, that is, the total or partial destruction of pathogen populations by other organisms, occurs routinely in nature. There are, for example, several diseases in which the pathogen cannot develop in certain areas either because the soil, called suppressive soils contains microorganisms antagonistic to the pathogen, or because the plant attacked by a pathogen has also been naturally inoculated, before or after the pathogen attack, with antagonistic microorganisms. Sometimes, the antagonistic microorganisms may consist of avirulent strains of the same pathogen that destroy or inhibit the development of the pathogen, as happens in hypovirulence and cross protection.

The mechanisms by which antagonistic microorganisms affect pathogen populations are not always clear, but they are generally attributed to one of four effects: 1) direct parasitism and death of the pathogen; 2) competition with the pathogen for food; 3) direct toxic effects on the pathogen by antibiotic substances released by the antagonist; and 4) indirect toxic effects on the pathogen by volatile substances, such as ethylene, released by the metabolic activities ot the antagonist.

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Table 1. Evaluation of fungicides in sprays against blast of rice in Northern Greece, 1991-94

Treatments and concentration	Rate of application	Leaves infection (%)* 1991	1992	1993	1994
Derosal WP (carbendazin 60%)	1,51 lb/100gal	17,3 ab**	19,7 ab	22,1 ab	18,2 a
Fongoren WP (pyroquilon)	2 kg/ha	9,8 a	8,8 a	24,3 ab	13,4 a
Hinosan TCP 35 WP (edifenphos 0,1%)	3,01 lb/100gal	35,5 bc	41,3 bcd	54,5 cd	42,7 bcd
Kitazin P (iprobenfos 0,1%)	750 g/ha	39,8 bcd	38,6 bc	47,8 bcd	53,9 cd
Bla - S (blasticidin)	100 μg/ml	34,1 bc	32,5 bc	35,1 abc	42,5 bcd
Chlobenthiazone	30-40 kg/ha	21,7 ab	26,1 abc	39,4 bc	20,2 ab
Beam (tricyclazole)	0,75 kg/ha	9,4 a	18,9 ab	11,2 a	8,8 a
Oryzemate (probenazole)	——	11,7 a	13,7 a	20,3 ab	12,0 a
Neotopsin WP (thiophanate-methyl 70%)	1,01 lb/100 gal	19,2 ab	34,2 bc	27,0 ab	36,3 bc
Unsprayed check	——	64,6 e	71,8 e	73,9 e	69,7 e

* Averages of four replications.
** Numbers in each column followed by same letter do not differ significantly from each other at P = 0,05 according to Duncan's multiple range test.

Table 2. Evaluation of fungicides in sprays against blast of rice in Northern Greece, 1991-94

Treatments and concentration	Rate of application	Necks infection (%)* 1991	1992	1993	1994
Derosal WP (carbendazin 60%)	1,51 lb/100gal	35,6 b**	23,2 b	30,6 bc	31,7 b
Fongoren WP (pyroquilon)	2 kg/ha	8,9 a	9,4 a	12,3 a	7,7 a
Hinosan TCP 35 WP (edifenphos 0,1%)	3,01 lb/100gal	39,2 bc	37,3 cd	39,7 cd	36,1 bc
Kitazin P (iprobenfos 0,1%)	750 g/ha	49,1 d	37,5 cd	49,1 de	46,4 cde
Bla - S (blasticidin)	100 μg/ml	40,8 bc	32,4 c	38,3 cd	41,2 cd
Chlobenthiazone	30-40 kg/ha	47,5 c	33,1 c	46,5 de	37,7 c
Beam (tricyclazole)	0,75 kg/ha	8,3 a	18,7 ab	10,2 a	8,6 a
Oryzemate (probenazole)	——	12,6 a	17,5 ab	23,4 ab	10,4 a
Neotopsin WP (thiophanate-methyl 70%)	1,01 lb/100 gal	39,8 bc	36,4 cd	42,3 cde	45,2 cde
Unsprayed check	——	71,3 e	77,3 e	69,2 f	70,1 f

* Averages of four replications.
** Numbers in each column followed by same letter do not differ significantly from each other at P = 0,05 according to Duncan's multiple range test.

Figure 1. Average temperatures of rice area in Northern Greece. 1991–1994

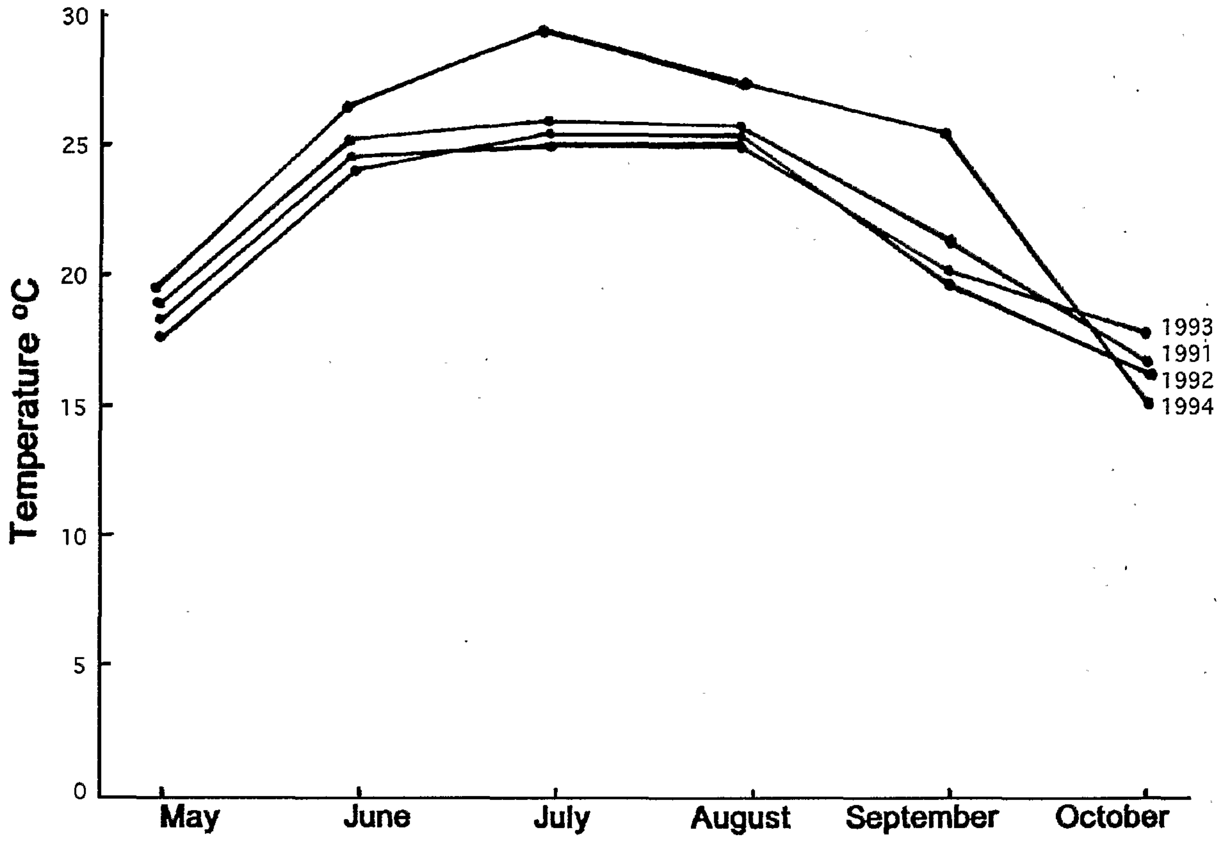

Figure 2. Average temperatures (min-max) of rice area in northern Greece. 1991–1994

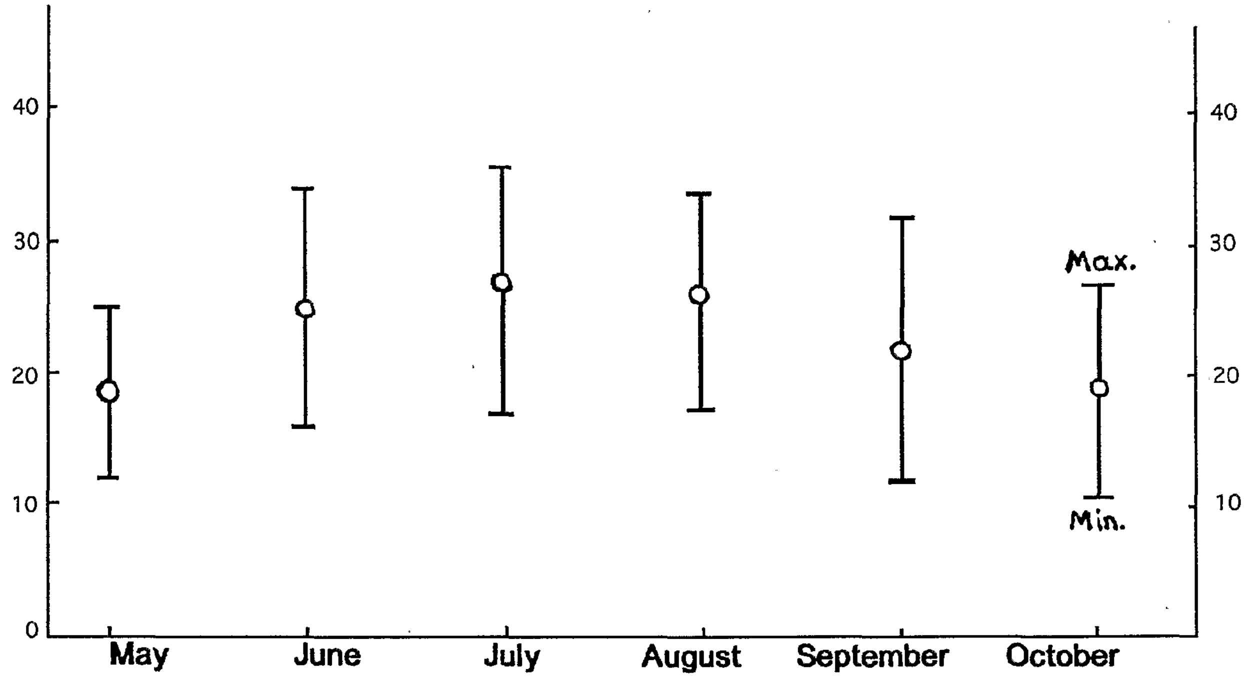

Figure 3. Average wind speed of rice area in northern Greece. 1991–1994

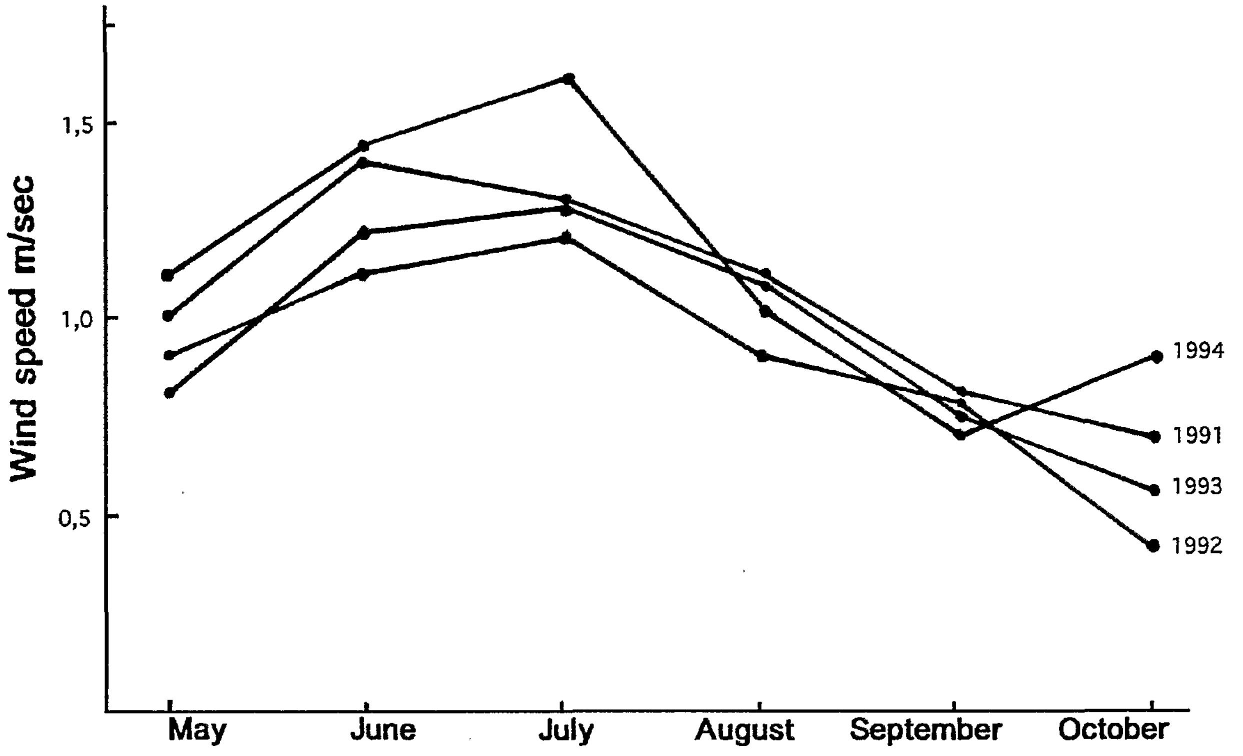

Figure 4. Average relative humidity of rice area in northern Greece. 1991–1994

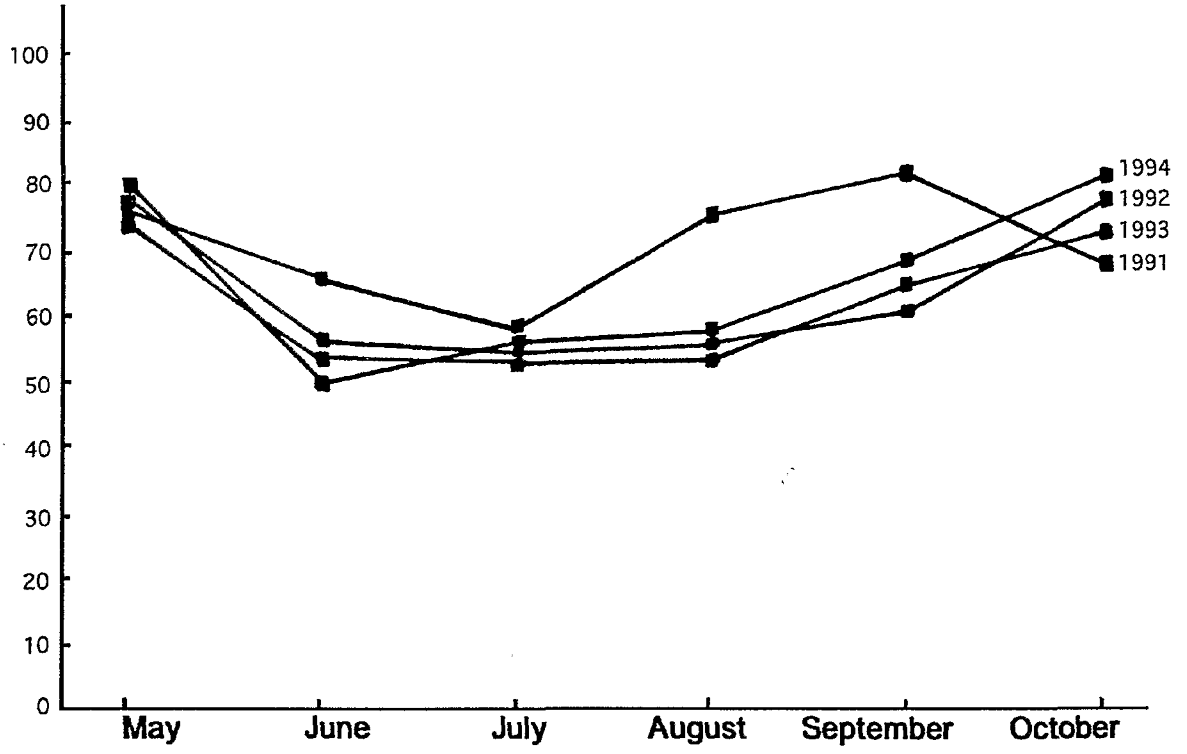

Figure 5. Average rainfall of rice area in northern Greece. 1991–1994