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Effect Of Nitrogen And Potassium On The Expression Of Sensitivity And Variety Resistance To Rice Yellow Mottle Virus

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Abstract

The law land soil of the AFRICARICE Research Station was removed, dried, crushed and rooted. The test was conducted in pots filled with this soil at a rate of 4.5 kg. The pots were fertilized with nitrogen in the form of urea at 4 levels 0, 40, 80 and 120 kg / ha and potash in the form of KCL at 4 levels 0, 20, 40 and 60 kg / ha. All pots received triple super phosphate at the rate of 60kg / ha. After pre-germination for 72 hours, the seeds were sown in the pots at the rate of two plants per pot. 21 days after sowing; the plants were inoculated from the leaves showing the symptoms of RYMV. The inoculum was prepared by grinding 60 g of rice yellow mottle virus infected leaves with 1000 ml of distilled water in a mortar washed with alcohol. The plants were inoculated manually by rubbing the leaves from the leaf base to the tip with fingers moistened with the inoculum. The susceptibility and resistance of plants were assessed based on the rate of reduction in height at maturity and the loss of production due to RYMV. The results showed that these two parameters measured vary according to the fertilizer level applied. Combinations of 80 kg of nitrogen associated with low level of potassium reduce the aggravating effects of the disease on plant growth and grain yield. Better management of fertilization could be an alternative to managing rice yellow mottle virus.

Keys words: *fertilization, RYMV, susceptibility, grain yield, urea, potash*

1. Introduction

Rice is the staple food of more than half of the world's population. It ranks second after corn, and is grown on nearly 150 Mha. In recent years, production has reached 654.1 Mt (Anonymous 1, 2009). Consumption increases by almost 2% per year, due to the rapid increase of the population. This increase is also made low because of biotic and abiotic constraints. The introduction of improved but sensitive varieties has led to the emergence of many viral, bacterial and fungal diseases. Among these diseases, that caused by rice yellow mottle virus (RYMV) appears to be the main phytopathogenic disease, under an irrigated ecosystem, in tropical humid zone and Sahelian zone. The disease was identified for the first time in 1966 in Kenya (Banwo, 2003). The losses caused by the disease are very important, especially in susceptible rice varieties inoculated early (Bakker, 1974). The disease is transmitted by insects of the genus Chrysomelidea (Onasanya et al., 2012). The virus colonizes all rice-growing ecosystems in Africa, with significant production losses (Onwughalu et al., 2011). Different serotypes and pathotypes (Amancho et al., 2009) have been identified. The control methods recommended against this pest involve the management of insect vectors, the elimination of alternative hosts, appropriate cultural practices and the use of resistant varieties. The search for varieties resistant to RYMV has been the focal point of the fight against the disease. Various varietal screening studies undertaken indicate that sources of resistance exist in the japonica group Oryza sativa and Oryza glaberrima (Thiemele et al. 2010). The species O. sativa has several varieties, which express variable responses to RYMV infection. Among these varieties, Gigante (O. sativa indica) offers high resistance, as does the variety Tog5681 (O. glaberrima). The study of the genetic determinism of Tog5681 and Gigante revealed the existence of a recessive gene responsible for this high resistance (Ndjiondjop et al., 1999). A major resistance gene, called Rymv1, has been identified in the Gigante variety (Albar et al., 2003); then, a second major gene, Rymv2, was identified (Thiemele et al., 2010). Some varieties of O. sativa express partial resistance to RYMV (Thottappilly and Rossel, 1993). However, there are no resistant varieties capable of substituting for sensitive varieties of agronomic interest, such as Bouaké189, grown in Côte d'Ivoire, and adapted to lowland rice cultivation. Farmers continue to exploit this sensitive variety, causing the spread of the disease. The limited knowledge of the epidemiology of RYMV would explain, in part, the reasons for the progression of the disease. Indeed, according to Huber and Haneklaus, (2007), plant diseases are the result of complex interactions between three major components consisting of the pathogen (Figure 1.1), the host plant and the environment. Variations of each of the factors in the system such as the appearance of different pathotypes of a pathogen, the physiological state of the host, and variations in the environment, in particular, the introduction of pesticides or mineral elements, can positively or negatively affect pathogenesis. These different variations of the system result in a reduction, an increase or an absence of effect on the incidence or severity of the diseases. In host interactions, cultural practices, including mineral nutrition N, P and K, are one of the means to reduce the severity of viral, bacterial and fungal diseases (Huber and Haneklauss, 2007). According to Huber and Haneklaus (2007), sufficient nutrient intake remains an essential component for the total expression of genetic resistance. According to these authors, it is possible to fight against certain diseases, in the absence of a resistance gene, if the mineral nutrition is sufficient. Mineral nutrition may, depending on the nature and / or doses of the fertilizer, orient the interaction, either in favor of the host or in favor of the pathogen. The interactions between nitrogen and other elements are well known (Katan, 2009). The nitrate form stimulates the absorption of potassium (K) favorable to the synthesis of nitrogenous organic compounds. On the other hand, the ammonium form may limit the use of K. The general concept formulated on N is its major role in increasing plant susceptibility to disease (Agrios, 1997). However, significant reductions in the incidence due to nitrogen fertilization have been reported (Katan, 2009). The curative effect of an application of K has been observed on bacterial diseases of rice (Hardter, 1997). According to Prabhu et al. (2007b), potassium deficiency predisposes.

Figure 1.1: Symptom induced by RYMV on the sensitive variety Bouaké 189

2. Material and methods

2.1 Plant material

The plant material consists of the rice variety Bouake 189 sensitive to yellow rice variegation virus.

2.2 Viral material

Viral material consists of yellow rice variegation virus isolate collected from rice fields near AFRICARICE research station

2.3. Methods

2.3.1 Soil sampling

The culture soil was collected during the rainy season, in a low-lying area of the AFRICARICE research station. It was kept out of the rain for 2 months. After drying in the open air, it was ground in a mortar, in order to obtain very fine particles. The root debris has been entirely removed. The set was mixed with the shovel to ensure a very homogeneous mixture. Each pot of 5 L was filled with this soil, at a rate of 4.5 kg / seal.

2.3.2 Soil fertilization

The different doses of N and K were weighed using a sensitive scale, type AG 245 Mettler Toledo. Potassium K (K2O) was supplied in the form of potassium chloride (KCl) in the form of bottom fertilizer, respectively. One third of the nitrogen (N) was fed in the form of urea titrated at 46% N, then the remaining two thirds were introduced at the panicle initiation, ie at 62 jas. Phosphorus P was supplied as a triple super phosphate (TSP) at the rate of 60 Kg P / ha in bottom manure in all pots.

2.3.3 Experimental device

The device used for the study of the effect of N and K on the development of the disease is a split plot with four repetitions (three replicates for the inoculated plots and the fourth for non-inoculated controls), where N is at the main plot, with four levels (N0, N40, N80 and N120) corresponding to 0, 40, 80 and 120 kg N / ha. The secondary parcel is made up of K with four levels, namely 0; 20; 40 and 60 Kg of K / ha. The experiment was conducted in 5L pots, to better control the different levels of fertilization. Each treatment consists of two pots, at a rate of two plants per pot, after pre-germination at 72 h. One of the pots was used to evaluate the production. The main plots were 50 cm apart and the repetitions 1 m (Figure 2.1).

Figure 2.1: Experimental device

2.3.4 Preparation of the inoculum and infection of the plants

The Bouake 189 variety, infected with the Bouaké isolate (figure 2.2), was used for the preparation of the inoculum by grinding with the mortar, infected leaves, at the rate of 100 g / l, with PBS buffer. The plants were infected at 21 days by mechanical friction of the last leaf unsheathed from the main tiller (Onasanya et al., 2004).

Figure 2.2: Multiplication of a RYMV isolate on the rice variety Bouaké 189 at the AfricaRice Research Station in M'bé

2.3.5 Measured parameters
The parameters measured were height growth and grain yield of healthy and diseased plants at maturity.

2.3.5.1 Average height of mature plants

The height of healthy and inoculated plants was measured at maturity, using a tape measure, from the neck to the tip of the panicle leaf. The reduction rate relative to the uninoculated control was calculated as follows.

$$TRH = [(HPS-HPM) \times 100] / HPS$$

TRH: Height reduction rate
HPS: Height of healthy rice plants
HPM: Height of diseased rice plants

2.3.5.2 Determination of the weight of the harvest

When the rice matured, all the clumps of each variety, depending on the treatment, were harvested, bagged, beaten and vaulted. The weight of the crop was determined and corrected at a moisture level of 14%. The rate of production reduction (TRP) was evaluated as follows:

$$TRP = [(PPS-PPM) \times 100] / PPS$$

PPS: Healthy rice plant grain production
PPM: Grain production of diseased rice plant

2.3.6 Statistical treatment of data

The statistical treatments are based on the analysis of variance, at the threshold of 5% confidence level of the rate of reduction of the height at the maturity and the production of grain with the software IRRISTAT, version 5.10**3.**

3. Results

3.1 Effect of Nitrogen and Potassium on the Growth of Infected Plants

The rate of reduction in height at plant maturity varies from 14% to 27% depending on the nitrogen and potassium dose (Figure 3.1). The lowest reduction rates were obtained in the 80 Kg N / ha combinations and the highest reduction rates were obtained in the 40 Kg N / ha combinations. Combinations of 120 kg N / ha show intermediate reduction rates

3.2 Effect of nitrogen and potassium on grain yield of healthy and infected plants

The grain yield of healthy and uninfected plants varies with the level of nitrogen and potassium (Figure 3.2). When the variety is healthy, the grain yield varies from 27 to 46 g / pot. The highest grain yield (46 g / pot) is obtained at 120 kg N / ha associated with 40kgK / ha. However the grain yield of infected plants remains lower (14 g / pot). In plants infected with RYMV, there is a significant reduction in grain yield that varies from 14 to 22g / pot depending on the dose of nitrogen and potassium. When grain production losses are expressed in terms of reduction rates (Figure 3.3), the impact of the virus is strongly influenced by the level of nitrogen and potassium. The lowest reduction rates (14%) are observed in the absence of nitrogen input but associated with a high potassium dose (60Kg / ha). As the nitrogen rate increases, the rate of reduction of production increases indicating an increase in the level of sensitivity of the plant compared to the control that has not received fertilizers. Production losses are estimated on average at 45% for the potassium combinations associated with 40 kg N / ha against 30% for the control without fertilizer. The highest reduction rate (47%) is observed for 120 kg N / ha associated with 40 kg K / ha. A reduction in the effects of the virus on the rate of reduction is observed for nitrogen doses of 80 kg N / ha associated with low doses of potassium.

In the absence of nitrogen, grain yield is lower in both healthy and RYMV infected plants.

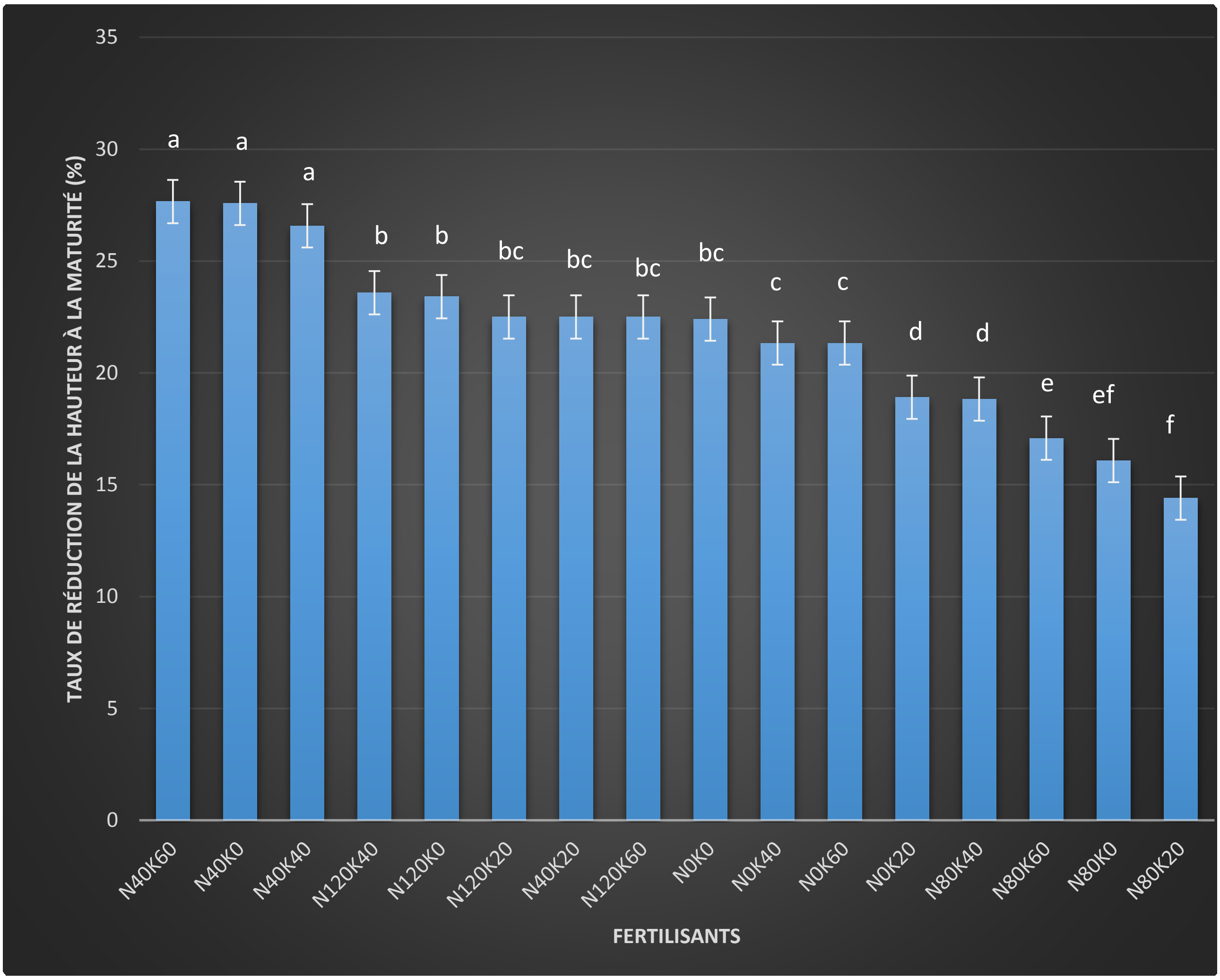

Figure 3.1: Effect of Nitrogen and Potassium Fertilization on Rate of Height Reduction of RYMV Infected Rice Plants

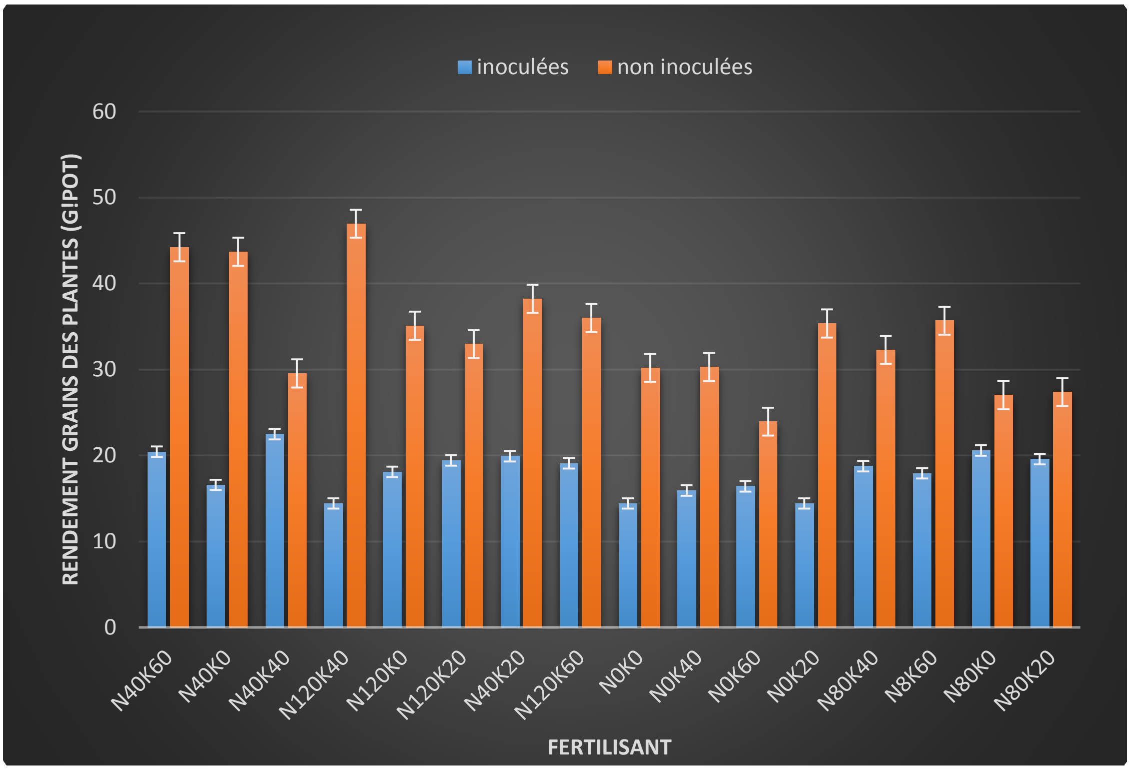

Figure 3.2: Effect of nitrogen and potassium fertilization on the grain yield of uninfected plants and those infected with RYMV

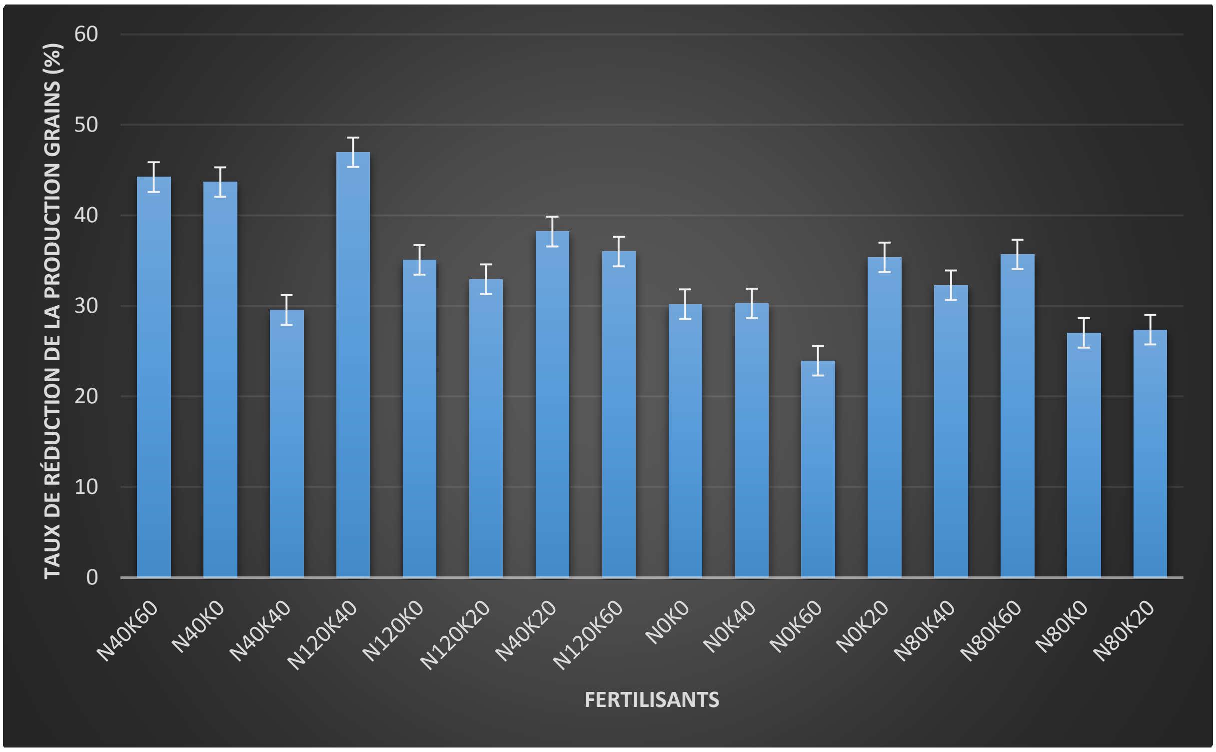

Figure 3.3: Rate of reduction of grain production according to fertilization level of nitrogen (N) and potassium (K)

4. Discussion

The use of mineral elements in crops helps to avoid stress on the plant, and to ensure a solid resistance to pathogens. These mineral elements must be handled to the advantage of the plant and to the disadvantage of the pathogen (Palti, 1997).

The rate of reduction in the height of rice plants and the loss of grain production are characteristic symptoms of RYMV (Zouzou et al., 2008). The susceptibility or resistance of rice cultivars to RYMV is also defined in relation to these parameters. Sensitivity is associated with a significant reduction in the height and grain yield of inoculated plants. Reduction rates of less than 5% are considered as resistant varieties, and those between 6 and 25% are considered as moderately resistant varieties, and then 26 to 75% as varieties of susceptible varieties.

The effects of N and K fertilization on plant height reduction and RYMV production losses depended on the level of each element. Thus, rates of height reduction ranged from 14 to 27% at maturity. These reduction rates indicated that the Bouaké 189 variety had variable sensitivity or resistance levels depending on nitrogen and potassium fertilization. The N80 combinations conferred greater resistance to the Bouake 189 rice variety compared to the reduction in height. On the other hand, the highest reduction rate of production was observed at 120 kgN / ha associated with 40 kg N / ha. According to Huber and Graham (2002) high doses of N increase, very often, the sensitivity of plants to pathogens. From the point of view of different authors (Marschner, 1995, Huber and Graham, 2002), high doses of N promote longevity of cells, ensure a high turnover of soluble sugars and low molecular weight compounds such as free amino acids. . These conditions are favorable to the development of obligate parasites such as viruses, to ensure their life cycle, but are unfavorable to the optional parasites, which need weaker plants, whose subsequent death will ensure their life. Generally, in plant viruses, the fertilizer doses favorable to the development of the plant are also favorable to the proliferation of the virus.

The response of inoculated plants was highly variable under nitrogen and potassium fertilization. According to Katan (2009), the effects of potassium on plant pathologies are strongly influenced by its interactions with other minerals. In the mineral nutrition of plants, potassium interacts with both phosphorus and nitrogen. Low doses of potassium affect the absorption of nitrate. The speed of nitrate nitrogen uptake depends on the adequate soil potassium dose. The antagonistic effect of low potassium levels on the decrease of resistance to RYMV is explained by a low absorption of nitrogen. Thus, the severity of rice blast in rice is low when the K / N ratio is high. On the other hand, a low K / N ratio increases the severity of the disease.

The rate of reduction in grain production has been influenced by mineral nutrition. It varied from 25 to 48% depending on the dose of N, and K applied. The effects of fertilization resulted in a decrease or increase in the effects of RYMV. Grain production losses were severely affected by RYMV when there was nitrogen deficiency. When the potassium dose is low, the resistance to RYMV decreases, in the presence of high doses of nitrogen. This tendency is systematically reversed at high doses of potassium.

Our work has shown that it is possible to modify the genetic resistance to RYMV of the sensitive variety Bouaké 189, under certain N-K combinations. In many parasitic host interactions, nitrogen, phosphorus and potassium have been shown to be a means of reducing the severity of viral, bacterial and fungal diseases (Marschner 1995, Huber and Graham 2002).

Mineral nutrition is essential for plant development and growth. It affects grain yield, acting on growth, morphology and, especially, chemical composition. It thus contributes to reducing or increasing resistance or tolerance to disease (Marschner 1995, Datnoff et al., 2007, Huber and Haneklaus 2007). These mineral elements form part of many molecules such as proteins, chlorophyll, amino acids and phenolic compounds, which are involved in the resistance or tolerance of plants to pathogens (Huber and Graham, 2002). The mineral nutrition of the host significantly affects viral diseases (Marschner, 1995).

5. Conclusion

Mineral nutrition N, and K affect the growth and production of the rice variety Bouake 189 infected with yellow rice variegation virus. The direction of the interactions is thus modified either in favor of the host or in favor of the RYMV. Thus a nitrogen intake of 120 Kg / ha associated with a low potassium intake increases the resistance of the variety and thus reduces the drastic effects of the disease on grain yield. A nitrogen intake of 80

Kg / ha associated with a low potassium intake increases the resistance of the susceptible variety by reducing the decline in yield. In the absence of nitrogen, a high dose of potassium reduces the effects of RYMV on grain production

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