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SHORT COMMUNICATION

ROLE OF NUTRIENTS IN INDUCING RUST RESISTANCE IN SOYBEAN

HEMA MORAB, R.V. KOTI*, M.B. CHETTI, P.V.PATIL AND A.S. NALINI

Department of Crop Physiology, College of Agriculture, Dharwad
University of Agricultural Sciences, Dharwad - 580 005

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A field experiment was conducted at University of Agricultural Sciences, Dharwad, during *kharif* 2000 and 2001 to study the role of nutrients in inducing resistance against the incidence of rust in soybean. Results revealed that among different nutrients, Manganese sulphate ($MnSO_4$) and boric acid (H_3BO_3)treatments recorded lower PDI (per cent disease index) of 33.7 and 45.7 respectively as compared to control (89.6). The seed yield due to $MnSO_4$ and fungicide treatment did not differ significantly. In general, the phenol content and peroxidase activity increased from 45 to 65 days after sowing (DAS) for all the treatments, except due to the foliar application of $MnSO_4$ (0.3%) and fungicide, thereby indicating the operation of different mechanisms of disease control in $MnSO_4$. Considering the effect of $MnSO_4$, both in terms of yield advantage and environmental friendly, it is suggested to replace traditional fungicide application with $MnSo_4$.

Key words : **Nutrients, rust resistance, soybean.**

Yield reduction in soybean is attrributed to several biotic and abiotic stresses and diseases are the important biotic stresses causing considerable loss in seed yield. One hundred pathogens are known to affect soybean, of which rust caused by *Phakopsora pachyrthizi Syd.* is the most important, causing up to 70% yield reduction (Ogle *et al.* 1979). In 1994, it appeared in epiphytotic form in different soybean growing areas and caused substantial losses particularly in parts of Karnataka, Maharashtra and Madhya Pradesh (Anahosur *et al.* 1995). Rust is effectively controlled by systemic fungicides such as hexaconazole and propiconozole and improve the seed yield (Patil and Anahosur 1998). The use of systemic fungicides on crop plants is not only expensive but also has harmful effects on non target N_2 fixing bacteria in the soil, besides leading to environmental pollution and health hazards to mankind (Kalam and Mukarjee 2001).

Susceptibility of a crop plant could be due to imbalanced mineral nutrition. The alternative environmental friendly method of control of diseases through balanced mineral nutrition and developing host plant resistance through metabolic defense mechanism is utmost important. Keeping this in view, field investigations were carried out during *kharif* 2000 and 2001 to find out the role of nutrients (micro and secondary) in disease resistance in soybean.

The experiment consisted of genotype JS-335 (susceptible to rust) and nine foliar spray treatments comprising of control (unsprayed), fungicide (Hexaconazole, 0.1%), $MnSO_4$ (0.3%), $FeSO_4$ (0.5%), $ZnSO_4$ (0.2%), H_3BO_3 (0.2%), $CuSO_4$ (0.2%), elemental sulphur (0.1%) and $MgSO_4$ (0.5%) laid out in a randomized block design with three replications. Recommended dose of fertilizers was added prior to sowing and seeds were sown after inoculating the seeds with *Rhizobium* culture. The treatments were imposed twice at 35 and 50 days after sowing (DAS) and the inoculation for rust disease incidence was done at 45 DAS since, the rust did not appear naturally. Five plants per treatments at random were scored for rust severity at 75 DAS following 0-9 scale of Mayee and Datar (1986) and per cent disease index (PDI) was calculated using the formula of Wheeler (1969).

Corresponding authors : e-mail : rvkoti@rediffmail.com

The phenol content and the peroxidase activity were estimated in the fresh leaves at 45 and 65 DAS following the methods of Sadasivam and Manikam (1991) and Mahadevan and Sridhar (1986), respectively.

Data on effect of nutrients on per cent disease index (PDI) of rust, seed yield, phenol content and peroxidase activity in soybean genotypes JS-335 is presented in Table 1. The incidence of rust disease was noticed when the crop was sprayed with the inoculum (*Phakopsora pachyrhizi Syd*) and it was maximum at physiological maturity. Small grayish or brown coloured lesions appeared on the lower surface of leaves, which further spread to the upper leaves affecting the normal growth and development of the plant. Unsprayed control plants had the maximum PDI of 89.6 and the application of Hexaconazole had the least PDI of 7.5 and recorded significantly higher (26.67 kg/ha) seed yield over other treatments. There was approximately 42 per cent decrease in the yield due to rest incidence. Ogle *et al.* (1979) found similar reduction in seed yield due to rust.

Hexaconazole is a protectant and eradicant systemic fungicide belonging to the class of triazols which, along wth pathogenicity on target pathogen, *Phakopsora pachyrhizi Syd,* has inhibitory effect on some beneficial soil bacteria, thereby affecting the soil fertility and further causing environmental pollution.

The application of sulphur, magnesium, iron, zinc, boron, copper and manganese also controlled the incidence of disease with PDI ranging from 33.7 to 75.7 as compared to the control indicating that foliar applied nutrients offered resistance for the invasion of the rust pathogen. Among the micronutrients, maximum resistance was noticed with the foliar application of manganese with a PDI of 33.7 and seed yield of 24.88 kg ha^{-1}, which was on par with fungicide spray. The higher response due to manganese may be attributed to its lower availability.

Graham *et al.* (1991) reported that more than hundred diseases in different crops can be controlled by micronutrients and further mentioned that managanese

Table 1. Effect of nutrients on per cent disease index (PDI) of rust, seed yield, phenol content and peroxidase activity in soybean genotype JS-335.

Treatments	Per cent disease index (PDI)	Seed yield (q ha^{-1})	Phenol content ($mg\ g^{-1}$ frw)		Peroxidase activity ($\Delta OD\ mg^{-1}$ protein min^{-1})	
			45 DAS	65 DAS	45 DAS	65 DAS
Control (unsprayed)	89.6(71.19)	15.48	1.100	1.254	0.099	0.134
Fungicide (Hexaconazole)	7.5(15.89)	26.67	1.278	1.154	0.095	0.145
Manganese sulphate @ 0.3%	33.7(35.49)	24.88	1.334	1.178	1.124	0.113
Ferrous sulphate @ 0.2%	79.9(63.36)	17.41	1.131	1.286	0.117	0.196
Zinc sulphate @ 0.2%	69.6(56.54)	18.37	1.014	1.378	0.105	0.184
Boric acid @ 0.2%	45.7(42.53)	22.54	1.131	1.305	0.094	0.136
Copper culphate @ 0.2%	71.5(57.73)	17.59	1.407	1.068	0.091	0.192
Elemental sulphur @ 0.1%	75.7(60.47)	17.96	1.122	1.210	0.199	0.177
Magnesium sulphate @ 0.5%	71.5(57.73)	18.70	1.431	1.304	0.12	0.191
Mean	**60.5(51.06)**	**19.96**	**1.216**	**1.237**	**0.106**	**0.163**
S.Em±	1.84	0.83	0.034	0.023	0.019	0.007
CD at 5%	5.52	2.49	0.102	0.069	NS	0.003

DAS=Days after sowing

NS= Non significant

Note: Figure in parenthesis indicate arc sine value alone controls about 50 diseases of different crops. Kaur *et al.* (1979) also reported that susceptible variety of rice to brown spot disease offered more reistance than the resistant varieties by the application of 5 and 10 ppm of manganese. In the present study also, Mn was superior over other micronutrients, and next best micronutrient was boric acid. Similarly Basundrui *et al.* (1994) controlled the rhizopus fruit rot of brinjal using boric acid.

Phenolic compounds have been shown to have antimicrobial activity and is often assumed that, their main role in plants is to act as protective compounds against disease causing agents such as fungi, bacteria and viruses. The phenolic content increased from 45 DAS (1.216 mg g^{-1} fr. wt.) to 65 DAS (1.237 mg g^{-1} fr.wt.). The increase in phenolic content coincided with an increase in the degree of infestation of rust.Friend (1979) observed an increase in the phenolic content during infestation which acts as toxic to pathogens.

Treatments differed significantly and the maximum phenolic content was noticed in $ZnSO_4$ with higher disease reaction (69.6). The phenol content is not necessarily be associated with the disease reistance (Wakimoto *et al.*, 1959). Whereas, boron application has more phenols with lower infestation of disease (43.7). Thus, foliar application of boron appears to synthesize and regulate its metabolism. Similar results were reported by Marschner (1985) for both fungi and insects.

The peroxidase enzyme generally catalyses a redox reaction between hydrogen peroxide (H_2O_2) as an electron acceptor and many kinds of substrates (phenolic substances, aromatic amines, ascorbic acid, cytochrome C, $NADH_2$ etc.). One of the functions ascribed to peroxidase in the cell walls is lignin formation (Stafford 1965). Peroxidase activity in the present investigation increased from 45-65 DAS along with an increase in the severity of disease. Arora and Bajaj (1985) were also of the same opinion as far as increase in the activity of peroxidase with the infection of *Rhizoctonia solani* in mungbean. Peroxidase activity was significantly higher due to the application of $FeSO_4$, $CuSO_4$, $MgSO_4$ and $ZnSO_4$ along with higher incidence of disease. However, the activity of peroxidase was lower with the application $MnSO_4$ and fungicide. It is further evident in the present investigations that the application of $MnSO_4$ neither increased the phenolic content nor the peroxidase activity from 45 to 65 DAS, instead both decreased but controlled the rust severity besides maintaining the seed yield which was on par with fungicide treatment. Similarly, Rengel *et al.* (1994) reported that manganese fertilization did not significantly influence the rate of phenolic accumulation but, reduced the radial penetration by hyphe of *Gaemannomyoes gramminis* var tritici in wheat.

From this, it is clear that Mn is involved in at least two steps in the biosynthetic pathways leading to lignin systhesis by utilizing phenols and resisting the invasion of pathogens. Its deficiency can increase susceptibility to pathogen invasion (Graham 1983).

It is thus inferred that the susceptibility of soybean to rust may be due to the deficiency of nutrients in the plant or the inefficiency on the part of the genotype to take up the nutrients from the soils, particularly the Mn and B. The present practice of controlling rust using hexaconazole, which is deterimental to other beneficial organisms, hazardous to human health can safely be replaced by the foliar application of $MnSO_4$ @ 0.3% twice at 35 and 45 DAS without compromising the seed yield.

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