Influence of Nutrition on the Development of Root Rot of Barley

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The influence of nutrition on the development of root rot of barley was studied in pot and field experiments.

In pot experiments, the intensity of root rot increased when the concentration of nutrient solution was either increased or decreased from the normal Hoagland's solution. Root rot development increased and the vigour of plants decreased in unbalanced nutrient solutions containing low concentration of nitrogen, phosphorus and potassium.

The results of the field experiment indicated that ammonium sulphate, superphosphate and potassium sulphate alone and in combination at their recommended rates of application did not enhance the germination of barley seed and failed to reduce the mortality of seedlings. However, fertilizers significantly increased the number of tillers, ears and yield of grain. The four fertilizers, ammonium sulphate, complete fertilizer, superphosphate and potassium sulphate ranked in that order for their efficacy.

INTRODUCTION

Root rot incited by *Helminthosporium sativum* is a major disease of barley in almost all the barley growing countries of the world (Christensen, 1922, 1953; Dickson, 1956). The disease is of common occurrence more or less every year in the barley producing areas of West Pakistan; the prevalence and losses caused vary with season, locality, and variety of the crop.

Root rot of barley has been the subject of a number of investigations in many countries of the world (Christensen, 1922; Mitra and Bose, 1935; Mead, 1942; Dickson, 1956). However, the influence of nutrition in relation to the development of root rot of barley is yet incompletely understood. Mead (1942) showed that the application of ammonium sulphate to barley seeds infested with *H. sativum* caused an insignificant reduction in emergence due to increased pre-emergence blight. Fertilized seedlings were more severely infected, but those that survived grew more vigorously than unfertilized ones. The present paper reports a study of the influence of nutrition on the development of root rot of barley.

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EXPERIMENTAL PROCEDURE AND RESULTS

The influence of nutrition on the development of root rot of barley was studied in pot and field experiments.

Pot Experiment

The effect of nutrition on the development of root rot of barley was studied in Crocks. Sand for the experiment was thoroughly washed with distilled water and disinfested with formalin solution (40 per cent commercial) and was then transferred to the disinfested Crocks. Barley seeds of Punjab type 5 disinfested with 0.1 per cent mercuric chloride solution was infested with a concentrated spore suspension of *H. sativum*. In each of the 24 Crocks, 10 seeds of the variety thus infested were planted. The original barley seed treated with 0.1 per cent mercuric chloride solution and planted in the disinfested sand, served as untreated check. The experiment was run in triplicate.

The basal nutrient solution (1H) was Hoagland's solution (Ferry and Ward, 1959). The concentration and balance of salts of the nutrient solution was varied according to the method employed by Walker and Gallegly (1949) and Walker and Hooker (1945). The salt concentration of the basal solution was reduced to one half (0.5H) and one fourth (0.25H) and increased two times and four times that of the normal solution. In the unbalanced solutions, basal nutrient solution (1H) was also used as the base. Low nitrogen, low phosphorus and low potassium solutions were prepared by decreasing the amounts of the respective ions to that found in the 0.25H solution. All other necessary elements were kept at the 1H level and none of the elements varied were lacking completely. The nutrient solution was applied by the Carboy method so that the sand was moderately saturated with the nutrient solution.

Observations on germination of seeds and seedling mortality were recorded and are presented in Table 1. Germination of seeds infested with *H. sativum* was significantly lower than that of the disinfested seeds. However, variation in the concentration of Hoagland's solution did not have significant effect on the germination of seeds infested with *H. sativum*. The rate of mortality of seedlings from infested seeds generally increased with an increase or decrease in the concentration of nutrient solution. In unbalanced nutrient solutions containing low levels of nitrogen, phosphorus and potassium, the seedling mortality was higher than in the normal solution. In unbalanced solutions containing low levels of nitrogen, phosphorus and potassium, the plants were less vigorous as compared to the plants in the normal solution.

Field experiment

The effect of application of four fertilizers on the incidence of root rot of barley was studied with Punjab barley type 5 in the field. The experiment

was laid out in a split-plot design with four replications. Fertilizers formed the main plots, while infested and disinfested seeds of the variety formed the sub-plots within the main plots of fertilizers. The fertilizers included in the test and the rate of their application were as follows: ammonium sulphate, (200 lbs. per acre); superphosphate, (200 lbs. per acre), and potassium sulphate (80 lbs. per acre) alone and in mixture. Unfertilized plots constituted the check.

Barley seeds were disinfested with 0.1 per cent mercuric chloride solution and were later infested artificially with a concentrated spore suspension of *H. sativum*. Original seed disinfested with mercuric chloride solution served as

TABLE 1. *Effect of various levels of Hoagland's solution on barley seed Punjab type 5 disinfested and infested with H. sativum in pots.*

Concentrations of nutrient solution	Per cent Germination		Per cent Seedling Mortality	
	Infested seeds	Disinfested seeds	Infested seeds	Disinfested seeds
0.25H ..	73.3	80.0	54.5	1.6
0.5H ...	73.3	86.6	40.9	0
1H ...	76.6	86.6	26.5	0
2H ..	76.6	86.6	34.7	0
4H ..	76.6	86.6	39.1	0
Low nitrogen ..	70.0	83.3	42.8	1.6
Low phosphorus ...	73.3	86.6	40.9	0
Low potassium ..	73.3	80.0	40.9	0

check. Each plot consisted of four rows of the variety, 36 feet long and one foot apart.

The seed rate of the barley variety used was 28 seers per acre which was kept uniform in all treatments. The data on germination, mortality, tillering, earing and yield of grain so obtained were subjected to analysis of variance and F values in respect of the five characters computed are presented in Table 2.

Germination

The emergence of barley seeds infested with *H. sativum* and from disinfested check as a result of the application of four fertilizers is summarised in Table 3. F value for infestation was highly significant, whereas that for interaction of fertilizers and infestation was non-significant, indicating that the response of infested seeds with respect to the application of all the fertilizers was similar. F value for fertilizers was non-significant, showing that none of

the fertilizers was helpful in enhancing germination of seed (Table 2). The emergence of infested seeds was significantly lower than that of the disinfested seeds.

Seedling mortality

F value for infestation was highly significant, whereas that for the fertilizers and for the interaction of fertilizers and infestation was non-significant (Table 2). This indicated that the application of fertilizers did not reduce the mortality of seedlings due to *H. sativum* significantly. However, the seedling mortality was lower in seedlings from disinfested seed as compared to those from infested seed (Table 3).

Tillering and Earing

F value in respect of tillering and earing for fertilizers and infestation was significant, whereas that for interaction between fertilizers and infestation was non-significant (Table 2), showing that behaviour of all fertilizers in respect of

TABLE 2. *F values of emergence, mortality, tillering, earing and yield of grains of barley seed infested with H. sativum and sown in plots fertilized with four fertilizers.*

Sources of Variation	Degrees of freedom	F value				
		Germination	Mortality	Tillering	Earing	Yield
Replications	.. 3					
Fertilizers (F)	.. 4	0.022	0.071	4.79*	5.02*	3.75*
Error (i)	.. 12					
Infestation (I)	.. 1	276.96**	33.2**	128.45**	654.8**	147.44**
F×I	.. 4	0.042	0.004	0.088	1.58	2.77
Error (ii)	.. 15					
Total	.. 39					

* Significant at 5 per cent level.
** Significant at 1 per cent level.

infested and disinfested seeds was similar. The number of tillers and ears produced from disinfested seed and seeds infested with *H. sativum* and sown in plots treated with four fertilizers are summarised in Table 3. The application of fertilizers significantly enhanced the number of tillers and ears. The four fertilizers, ammonium sulphate, complete fertilizer, superphosphate and potassium sulphate ranked in that order for their efficacy.

TABLE 3. *Effect of application of fertilizers on emergence, mortality, tillering, earing and grain yield of barley Punjab type 5 from seeds disinfested and infested with H. sativum.*

Fertilizers	Per cent Emergence		Per cent Mortality		Tillers per plot		Ears per plot		Yield (mds.)* per acre	
	Infested seeds	Disinfested seeds	Infested seeds	Disinfested seeds	Infested seeds	Disinfested seeds	Infested seeds	Disinfested seeds	Infested seeds	Disinfested seeds
Ammonium sulphate ..	67.7	74.8	14.1	2.3	4012.5	5038.7	3027.5	4054.7	20.25	29.5
Superphosphate ..	67.3	73.9	14.7	2.9	3997.0	5002.5	3012.0	4018.5	17.25	26.25
Potassium sulphate ..	67.0	74.1	14.9	3.0	3995.2	4998.7	3010.2	4014.7	17.13	26.01
Complete fertilizer ..	67.2	74.3	14.5	2.7	4004.5	5007.7	3019.5	4023.7	18.75	27.75
Check ..	66.9	73.7	15.4	3.5	3951.0	4871.5	2963.5	3887.5	15.75	21.00

*The least significant difference for fertilizers was 1.7 and 2.2 at 5 and 1 per cent levels of significance respectively, whereas for infestation it was 4.5 and 6.0 for these two levels respectively.

The least significant difference for infestation at 5 and 1 per cent levels for emergence, mortality, tillers and ears was 0.95 and 1.32, 1.57 and 2.34, 61.3 and 86.2, and 58.4 and 84.8, respectively.

Yield of grain

F values for fertilizers and infestation were significant. However, F value for interaction between fertilizers and infestation was non-significant, indicating that the behaviour of all the fertilizers in respect of infested and disinfested seeds was similar (Table 2).

The grain yield from disinfested seeds and those infested with *H. sativum* in plots fertilized with four fertilizers is summarised in Table 3. The yield of grain produced by infested and disinfested seeds was significantly higher in fertilized than in unfertilized plots. The effectiveness of the four fertilizers, ammonium sulphate, complete fertilizer, superphosphate, and potassium sulphate was indicated in that order. The yield of grain from seeds infested with *H. sativum* was significantly lower than from disinfested seeds.

DISCUSSION

The influence of nutrition on the development of root rot of barley has been investigated in pot and field experiments. A disease may be considered an interaction of the pathogen and the host as influenced by the environment including nutrition. Thus, an understanding of the influence of nutrition on the development of a disease involves an analysis of the influence of nutrition on the development of both the pathogen and the host.

In pot experiments, the severity of root rot increased with an increase or decrease in the concentration of the normal Hoagland's solution. The severity of the disease increased in unbalanced nutrient solutions containing low concentration of nitrogen, phosphorus and potassium. In the field experiments, the application of fertilizers did not enhance the germination of barley seed, nor did it reduce seedlings mortality. Fertilizer application enhanced tillering, earing and yield of grain. According to Alov (1944), excessive application of nitrogen to barley reduced production of grain and straw. The results of the present study may be partially explained on the basis of host-parasite competition for available nutrition. However, the results are by no means conclusive and indicate the need for further studies to gain a better understanding of the influence of nutrition on the development of root rot in barley.

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