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# NITROGEN IN RELATION TO THE DEVELOPMENT OF ROOT ROT OF BARLEY

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**Abstract**

Seedling mortality of barley caused by *Helminthosporium sativum* was highest in Hoagland's solution containing 0.25 times nitrogen of the normal solution. Seedling mortality gradually decreased as the level of nitrogen progressively increased from 0.25 to 4 times the nitrogen in the normal solution. Three sources of nitrogen viz., ammonium sulphate, urea and ammonium nitrate in quantities equivalent to potassium nitrate of the normal Hoagland's solution behaved in a similar manner with respect to the four levels of nitrogen. However, nitrogen source at 25, 50 and 75 lbs per acre did not significantly influence seedling mortality in the field experiment but the number of tillers, ears and yield of grain and straw increased with an increase in the level of nitrogen sources. Infesting seed with *H. sativum* significantly increased seedling mortality and reduced germination of seed, number of tillers, ears and yield of grain and straw, irrespective of the source of nitrogen used.

## Introduction

Root rot of barley caused by *Helminthosporium sativum* Pam., King, and Bakke has been investigated in many countries of the world. The salient features of these investigations have been reviewed (Christensen, 1922; Mitra & Bose, 1935; Mead, 1942; Dickson, 1956). However, nutrition in relation to the development of root rot of barley has not received adequate attention.

Mead (1942) reported that barley seedlings fertilized with ammonium sulphate were more severely infected with *H. sativum* but those that survived grew vigorously than unfertilized ones. Tabssam & Kausar (1966) showed that the intensity of root rot increased in unbalanced Hoagland's solution with low contents of nitrogen, phosphorus and potassium. The results reported in this paper summarises the influence of sources and levels of nitrogen on the development of root rot of barley.

## Materials and Methods

The relation of levels and sources of nitrogen on the development of root rot of

barley was studied in Hoagland's sand culture solutions in porcelain crocks and in a field experiment.

For sand culture experiment, sand was washed with distilled water and later disnifested with 40 per cent formalin solution to eliminate major elements of nutrition and soil organisms. The sand was later infested with cultures of *Helminthosporium sativum.* Seeds of barley infested with spore suspension of *H. sativum* were sown in procelain crock and covered with one inch of sand. Before infesting with *H. sativum,* the seeds were disinfested with 0.1 per cent mercuric chloride solution and washed with distilled water to eliminate seed borne fungi. The crocks were watered with Hoagland's solution adjusted to five levels of nitrogen (0.25, 0.5, 1, 2, and 4 times nitrogen of Normal Hoagland's solution) using ammonium sulphate, urea and ammonium nitrate in quantities equivalent to potassium nitrate of the normal Hoagland's solution. All other elements were kept at the level of normal solution.

The influence of three sources of nitrogen used at four levels on the development of root rot of barely was also studied in a field experiment laid out in a split-plot design with four replications. Ammonium sulphate, urea and ammonium nitrate at the rate of 0, 25, 50 and 75 lbs nitrogen per acre were used. The sources of nitrogen formed the main plots, whereas barley seed infested with *H. sativum* and disinfested seed formed the sub-plots. The levels of nitrogen formed plots within the sub-plots of infested and disinfested seed. The net experimental plot measured 18 feet by 5 feet with five rod rows of barley planted one foot apart.

Observations on germination of seed and seedling mortality from the sand culture experiment and those on germination of seed, seedling mortality, number of tillers and ears, and yield of grain and straw were subjected to analysis of variance.

## Results

*Sand culture experiment:*

F values for sources, levels of nitrogen and their interaction in respect of germination of seed were non-significant (Table 1). However, F value for levels of nitrogen in respect of seedling mortality was highly significant whereas that for sources and interaction between sources and levels of nitrogen was non-significant. This indicated that the three sources of nitrgen at five levels did not influence the germination of barley seed infested with *H. sativum.* However, different levels of nitrogen in Hoagland's solution influenced seedling mortality, irrespective of the source of nitrogen. Mortality in barley seedlings was highest in Hoagland's solution containing 0.25 times the nitrogen of the normal solution and decreased progressively to 4 times the nitrogen in the normal solution (Table 2). However, different sources of nitrogen comprising of ammonium sul-

**Table 1. F values for germination of seed and mortality of barley seedlings from seed infested with *Helminthosporium sativum* and grown in Hoagland's solution adjusted to varying levels of three nitrogen sources.**

| Variation due to | Degree of freedom | F values for Germination of seed | Seedling mortality |
|---|---|---|---|
| Sources of nitrogen | 2 | 0.46 NS | 0.65 NS |
| Levels of nitrogen sources | 4 | 0.17 NS | 6.2* |
| Interaction between sources and levels of nitrogen | 8 | 0.1 NS | 0.15 NS |
| Error | 30 | | |
| Total | 44 | | |

NS = non-significant * significant at 5% level

phate, urea and ammonium nitrate in quantities equivalent to potassium nitrate of the normal solution behaved in a similar manner with respect to the five leves of nitrogen.

*Field experiment:*

F values for infested seed in respect of germination of seed, seedling mortality, number of tillers and ears, and yield of grain and straw were significant, whereas those for sources of nitrogen in respect of these characters were non-significant. Similarly, F values for levels of nitrogen in respect of germination of seed and seedling mortality were non-significant, whereas those in respect of number of tillers and ears, and yield of grain and straw were significant (Table 3).

This indicated that infesting seed with *H. sativum* significantly increased seedling mortality and reduced germination of seed, number of tillers and ears, and yield of grain and straw (Table 4). However, three sources providing equivalent quantities of nitrogen did not differ among themselves significantly, in influencing these characters. This was true in the case of infested and disinfested seed, as the F values for the interaction between sources of nitrogen and infested seed for these characters were non-significant (Table 3). Similarly, three sources of nitrogen at four levels did not influence the germination of seed and seedling mortality, both in infested and disinfested seed, as the first and second order interactions between sources of nitrogen, rate of nitrogen and infested seed in respect of these characters were non-significant. However, the number of tillers and ears, and yield of grain and straw increased with an increase in the level of nitrogen

**Table 2. Seedling mortality caused by *Helminthosporium sativum* in barley seedlings grown in Hoagland's solution adjusted to varying levels of three nitrogen sources.**

| Levels of nitrogen in Hoagland's solution | Seedling mortality with nitrogen sources | | | |
|---|---|---|---|---|
| | Ammonium sulphate | Urea | Ammonium nitrate | Average |
| 0.25 N | 3.6 | 3.3 | 3.3 | 3.4a* |
| 0.50 N | 3.0 | 3.3 | 3.0 | 3.1a |
| 1.00 N | 2.6 | 2.6 | 3.0 | 2.7ab |
| 2.00 N | 2.0 | 2.3 | 2.0 | 2.1b |
| 4.00 N | 1.3 | 1.6 | 1.3 | 1.4bc |

Least significant difference for level of nitrogen was 0.99 and 1.34 at 5 and 1 per cent levels of significance respectively.

*Values sharing the same letter in a column do not differ significantly at 5 per cent level.

(Table 5). This was irrespective of sources of nitrogen and both for infested and unifested seed for number of tillers and ears, as the first and second order interactions between sources of nitrogen, rate of nitrogen and infested seed in respect of these characters were non-significant.

A differential response between sources and levels of nitrogen for infested seed was indicated by yield of grain, as the first order interactions between sources, levels of nitrogen and infested seed were significant. Similarly, a differential response between sources and levels of nitrogen, irrespective of infested seed was shown by the yield of straw as only the interaction between sources and levels of nitrogen for yield of straw was significant.

## Discussion

The results of sand culture experiment indicated that seedling mortality in barley decreased gradually as the concentration of nitrogen was progressively increased from 0.25 to 4 times the nitrogen in the Hoalgand's solution. These results are in conformity with the general conclusions of Tabassam & Kausar (1966), who observed higher mortality in barley seedlings grown in Hoalgland's solution containing low levels of nitrogen than the normal solution.

A high incidence of seedling mortality at low levels of nitrogen and reduction in

Table 3. F values for germination of seed, seedling mortality, number of tillers and ears, and yield of grain and straw of barley from seed infested with *Helminthosporium sativum* and grown in field fertilised with four levels of three nitrogen sources.

| Variation due to | Degree of freedom | F values for Germination of seed | Seedling mortality | Number of tillers | Number of ears | Grain | Yield of straw |
|---|---|---|---|---|---|---|---|
| Replications | 3 | | | | | | |
| Sources of nitrogen | 2 | 0.25 NS | 1.90 NS | 0.65 NS | 2.33 NS | 1.86 NS | 0.70 NS |
| Error (a) | 6 | | | | | | |
| Infested and disinfested seed | 1 | 136.81** | 261.43** | 30.12** | 46.71** | 569.14** | 46.66** |
| Sources of nitrogen x infested seed | 2 | 0.23 NS | 0.24 NS | 0.73 NS | 0.11 NS | 2.00 NS | 2.62 NS |
| Error (b) | 9 | | | | | | |
| Levels of nitrogen | 3 | 0.89 NS | 0.51 NS | 69.78** | 517.09** | 1622.97** | 1140.08** |
| Levels x sources of nitrogen | 6 | 0.36 NS | 0.54 NS | 0.66 NS | 0.62 NS | 7.80** | 4.95** |
| Levels of nitrogen x infested seed | 3 | 0.66 NS | 1.75 NS | 1.85 NS | 2.44 NS | 6.97 NS | 2.68 NS |
| Level x sources of nitrogen x infested seed | 6 | 0.50 NS | 0.49 NS | 0.76 NS | 0.48 NS | 0.88 NS | 1.20 NS |
| Error (c) | 54 | | | | | | |
| Total | 59 | | | | | | |

NS = non-significant ** = significant at 1% level

**Table 4. Effect of infesting barley seed with *Helminthosporium sativum* on the germination of seed, seedling mortality, number of tillers, ears and yield of grain and straw.**

| Treatment | Germination of seed | Seedling mortality | Number of tillers | Number of ears | Yield lbs/acre grain | Yield lbs/acre straw |
|---|---|---|---|---|---|---|
| Infested seed | 462.7a* | 44.2a | 2310.9a | 2143.9a | 1566.2a | 2911.0a |
| Disinfested seed | 508.3b | 17.7b | 270.2b | 2353.3b | 1795.8b | 3370.2b |
| Least significant difference at: | | | | | | |
| 5 percent | 8.45 | 3.66 | 99.86 | 20.28 | 0.26 | 0.74 |
| 1 percent | 12.14 | 5.26 | 143.47 | 29.14 | 0.38 | 1.06 |

*Values sharing the same letter in a column do not differ significantly at 5 per cent level.

mortality at high levels of nitrogen may be explained on the basis of host parasite competition for available nitrogen. At low levels of nitrogen, the growth of the host may be restricted and consequently the pathogen may dominate the host resulting in high seedling mortality. On the contrary, at high levels of nitrogen, the host may grow vigorously and may be in a better position to compete with the pathogen with the result that seedling mortality is reduced.

**Table 5. Effect of levels of nitrogen on the member of tillers, ears and yield of grain and straw of barley.**

| Levels of nitrogen (lbs N/acre) | Number of tillers | Number of ears | Yield (lbs/acre) grain | Yield (lbs/acre) straw |
|---|---|---|---|---|
| 0 | 1908.0a* | 1781.5a | 1,139.8a | 2,181.2a |
| 25 | 2216.5b | 2085.7b | 1,418.6b | 2,714.2b |
| 50 | 2476.9c | 2297.8c | 1,730.2c | 3,148.8c |
| 75 | 2809.5d | 2549.5d | 2,074.6d | 3,755.6d |
| Least significant difference at: | | | | |
| 5 percent | 1229.84 | 12.79 | 0.34 | 0.67 |
| 1 percent | 173.66 | 17.2 | 0.46 | 0.91 |

*Values preceding different letters in a column differ significantly at 5 and 1 per cent levels of sifniciance.

The results of field experiment indicated that ammonium sulphate, urea and ammonium nitrate at 25, 50 and 75 lbs nitrogen per acre significantly increased the number of tillers, ear, and yield of grain and straw. However, these sources of nitrogen at these rates did not significantly increase or decrease seedling mortality caused by the root rot pathogen. It may be concluded that these fertilizers applied to barley at these rates can enhance grain yield and are not likely to favour the development of seedling mortality caused by root rot.

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