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# RICE BLAST INFECTION AS AFFECTED BY NITROGEN, PHOSPHORUS, POTASSIUM AND ZINC FERTILIZERS APPLICATION SOLELY OR INCOMBINATIONS ON GIZA 176 IN EGYPT.

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## ABSTRACT

An experiment was carried out at the experimental of farm of Rice Research and Training Center, Sakha (RRTC) in 1997, and 1998 rice growing seasons on the susceptible rice cultivar Giza 176. A split plot design was carried out to study the effect of nitrogen fertilizer rates either alone or in combination with P, K and Zn on rice blast disease. Three nitrogen rates were used as main treatments i.e. 0, 40 and 80 Kg N/fed. While eight treatments as combination between P, K and Zn were used as sub treatments. The obtained incombination results from both seasons 1997 and 1998 showed that severity of blast infection on leaves and Panicles increased by increasing nitrogen rates. The blast infection decreased under high nitrogen level by adding phosphorous alone or incombination with potassium and zinc, as compared with high nitrogen level alone. The lowest blast infection either on leaves or panicles as well as the highest grain yield were obtained under the balance of P, K and Zn (15-24-10 Kg / fed.) with the recommended nitrogen rate (40KgN/fed).

Total nitrogen content significantly increased in plant tissues from 1.16 to 1.55 % as the increasing of nitrogen doses from zero up to 80 Kg N /fed. with no application of P, K and Zn. A little increasing was observed between P content in plant tissues come from plants grown in treated plots by Phosphorus application than the other untreated plots. Plant height, number of tillers / hill, number of leaves / hill and leaf area increased by the increasing nitrogen rates from zero up to 80 kg / fed. The largest numbers for each character were obtained under 15, 24 and 10 Kg /fed. For (P, K and Zn) respectively, compared with the same treatment of nitrogen rate.
**Keywords:** rice, blast, nitrogen, phosphorus, potassium, zinc, Giza 176

## INTRODUCTION

Nitrogen is one of the essential inputs needed to increase yields in rice. Ammonium-N is the main and most stable inorganic N source under flooded conditions Gupta and Otoole (1986). The most serious disease of rice is blast, caused by *Pyricularia grisea* sacc. (Rossman *et al* 1990). Blast severity increase when N is applied or when the rate of N application is increased, while the split application of N is recommended to increase the efficiency of N fertilization in rice and to reduce N losses and blast infection (Gupta and Otoole, 1986, Amin and venkatavao 1979 and Bernaux 1981).

Ou (1985) and Long *et al.* (1996) reported that, in the many experiments over a long period have shown that a high nitrogen supply always induces heavy incidence of blast regardless of phosphorus or potassium supply. In addition, a large potassium supply reduce the disease in plants receiving high nitrogen. Early experiments in Japan showed that an ample supply of potassium reduces infection and the supply of large amounts of potassium was recommended as a control measure. Also, experiments later, however, showed that while an ample supply of potassium sometimes reduces infection it generally causes an increase in the disease. Phosphorus availability for rice in paddy soil varies depends on soil – water regimes (Kirk *et al.*, 1990, Willett 1991, and Salegue *et al.*, 1996). Changes in Ph and Eh caused by Wet-dry soil conditions also influence the availability of P because they control the P sorption characteristics of soil, Krairapanand *et al.* (1993). Sangar and Singh (1998) found that, the mean disease incidence increased with increasing nitrogen level whereas disease decreased with increasing potash application. In phosphate deficient soil, however, experiments shcwed that large amounts of phosphate reduced the severity of the disease to some extent (Okamoto, 1950). Under conditions in which phosphate is deficient to the point that plant growth is retarded or inhibited, the supply of phosphate reduces the disease to a low level-until normal growth occurs, Kozaka (1965). Sakho and Takamori (1958) demonstrated that application of potassium alone increased the disease, which was reduced by adding magnesium and phosphorus. However, Prabhu *et al.* (1999) found that panicle blast severity decreased with increasing rates of potassium in the absence of nitrogen. A significant response to K fertilization was not obtained at 60 Kg/ha of nitrogen in relation to panicle blast severity. Maintaining high yields requires fairly close adherence to the cptimum balance in nutrient concentration (Munson 1982). Potassium molebdate increased percentage of leaves with symptoms. Phosphorus reduced this percentage and the lesions / leaf. Mineral nutrition did not affect the mean size of lesions. A bdel Hak *et al.* (1973) indicate that phosphorus reduced incidence of blast, the diseased increased with high doses of $(NH_4)$ But no clear cut effect being observed with $K_2So_4$. A positive correlation between the levels of nitrogen fertilization and consequently increase in total nitrogen of the host plant and severity of infection was found (Shatla *et al.*, 1979). Kim (1986) reported that, Phosphorus and Potassium have relatively little effect on blast development as compared to nitrogen.

## MATERIALS AND METHODS

An experiment was carried out at the experimental farm of Rice Research and Training Center, Sakha (RRTC) in 1997, and 1998 rice growing seasons, to study the effect of nitrogen fertilizer rates alone or in combination with phosphorus. (P), Potassium (K), and Zinc sulfate (Zn) on rice blast disease. A split plot design with four replicates was conducted. The main treatments were allocated for the three nitrogen rates i.e. 0, 40 and 80 kg N/fed., while sub treatments as eight of P, K and Zn applied alone or combinations were used as in Table(1)

Phosphorus, Potassium and half dose of nitrogen (Urea 46.5%) were applied and incorporated in the dry soil before transplanting and the Second half of nitrogen fertilizer was applied at maximum tillering stage (30 D.A.T), Zinc sulfate was applied after water leveling and before transplanting. The plot size was 2x5m. thirty day-old seedlings of the cultivar Giza 176 was transplanted in rows with three plants / hill.

**Table (1): Fertilizer treatments of Phosphorous (P), Potassium (K) and Zinc (Zn) in terms of Kg / feddan alone or combined together under three nitrogen rates assigned to study their effect on rice blast.**

| No. | Sub-treatment | | |
|---|---|---|---|
| | Phosphorus | Potassium | Zinc |
| 1 | 0 | 0 | 0 |
| 2 | 0 | 24 | 0 |
| 3 | 0 | 0 | 10 |
| 4 | 0 | 24 | 10 |
| 5 | 15 | 0 | 0 |
| 6 | 15 | 24 | 0 |
| 7 | 15 | 0 | 10 |
| 8 | 15 | 24 | 10 |

**Estimation of blast infection:**

Samples of rice leaves were taken four times with 15-day intervals, beginning from thirty days after transplanting. Each sample consisted of one hundred leaves randomly collected to determine leaf blast infection. Percentage of the infected leaves was calculated, while severity of infection was estimated by counting the total number of type (4) blast lesions/100 leaves. Neck rot infection was estimated by collecting one hundred panicles from each plot. The severity of neck rot infection was calculated by using the formula adopted by (Townsend and Huberger 1943).

**Plant chemical analysis:**

Total nitrogen content was determined by the orange-G dye calorimetric method, according to (Hafez and Mikkelson, 1981).

Spectronic Milton Roy Model (1201) was used for phosphorus analysis using (Witanabe and Olsen 1965).

**Plant Sampling:**

Plant samples (leaves and stems) were randomly taken, in the maximum tillering stage five guarded hills from the third row of each plot were cut, leaving the first three hills in this row. The plants were washed and transferred to the laboratory. The leaves were separated from the stems and weighed.

Leaf area index was estimated for ten leaves taken at random. Both leaves and stems samples were cut into small pieces then, put into a paper bag and dried in an oven at 60-80$^0$c for 48 hours. The samples were then ground to pass through a 20-mesh screen in stainless steel Wiley mill.

**Statistical analysis:**

All the collected data were subjected to statistical analysis following the standard methods by Gomez and Gomez (1976), using IRRISTAT and M. STAT computer program. Data were presented in tables.

**Grain yield:**

Two rows from each side of the plots were discarded to avoid the border effect, the remaining rows were harvested. The weight of the grain yield was recorded on the base of 18% moisture content at the harvest, then adjusted to 14%.

## RESULTS AND DISCUSSION

The effect of nitrogen rates on leaf severity of blast infection, data in Table (2) show that, the severity of leaf blast enhanced by the increasing of nitrogen rate from zero up to 80 Kg N/fed. regardless of potassium, Phosphorus and zinc application. Highly significant differences were found between zero, 40or 80 Kg N/ fed. with 12.42, 38.26 and 46.15 lesions / 100 leaves respectively.

**Table (2): Effect of nitrogen rates in combination with P, K and Zn on leaf blast infection severity on Giza 176 cultivar as an average of two seasons 1997 and 1998.**

| Treatments | | | | Leaf infection severity | | | |
|---|---|---|---|---|---|---|---|
| No. | P | K | Zn | O N | 40 N | 80 N | Sub- Mean |
| 1 | 0 | 0 | 0 | 18.45 | 45.83 | 60.35 | 41.54 |
| 2 | 0 | 24 | 0 | 11.13 | 40.25 | 50.33 | 33.90 |
| 3 | 0 | 0 | 10 | 12.31 | 38.35 | 48.18 | 32.95 |
| 4 | 0 | 24 | 10 | 13.55 | 38.17 | 47.15 | 32.95 |
| 5 | 15 | 0 | 0 | 11.74 | 39.69 | 42.40 | 31.28 |
| 6 | 15 | 24 | 0 | 10.85 | 33.43 | 39.68 | 27.98 |
| 7 | 15 | 0 | 10 | 10.90 | 36.65 | 40.92 | 29.49 |
| 8 | 15 | 24 | 10 | 10.43 | 33.71 | 40.19 f | 28.11 |
| Main – Mean | | | | 12.42 | 38.26 | 46.15 | 32.27 |

**L. S. D 5% Main = 10.26**
**Sub = 2.8**
**Inter. = 4.40**

Concerning the effect of Phosphorus (P), Potassium (K) and Zinc (Zn) regardless of nitrogen, data indicated that, the greatest number of leaf severity was obtained under zero for all elements with 41.54 lesion / 100 leaves. Adding each of elements (P, K or Zn with 15, 24, 10 kg / fed. respectively) separately or incombination decreased the leaf severity, ranging from 27.98 to 33.90 lesions / 100 leaves. Phosphorus application either alone or incombination with other elements gave the highest effect on reducing leaf severity as compared with K and Zn. The low number of leaf severity was obtained under balance of all fertilizer elements at the rate of (15, 24 and 10 kg /fed.) from P, K and Zn respectively, as compared with the rest of treatments for the three elements either under low or high nitrogen doses, these results seemed to be in the same line with those of (Abd El- Wahab *et al.*, 1993).

The same trend was obtained on panicle infection. Data in Table (3) show that, the severity of panicle infection was significantly increased by the increase of nitrogen dose regardless of the rest of elements (P, K or Zn). The severity of infection was 10.27, 14.38 and 18.40% with zero, 40 and 80 Kg N/fed respectively. The high infection severity of panicle was obtained under zero elements P, K and Zn regardless of nitrogen doses as 19.64%, while the low infection severity was obtained under the combination of P, K and Zn (15, 24 and 10 Kg each /fed.) with 12.34%. The panicle severity was decreased under P application either combined with K or Zn especially under 40 or 80 Kg nitrogen /fed. These results are agree with those adopted by (Atkins, 1974 and Kim, 1986), who reported that, nitrogen was the most influential single element affecting blast development. High nitrogen levels always increase blast susceptibility regardless of availability of Phosphorus or Potassium. Amin and Venkatarao (1979) reported that, the maximum leaf blast was found on HR 12 susceptible rice variety at a high level of nitrogen (150 Kg /ha) when applied as a basal dose, also the maximum neck blast was developed on the moderate resistant Ratna and HR 12 at high level of nitrogen (150 Kg /ha). Sangar and Singh (1998) found that, the mean disease incidence increased with increasing nitrogen level whereas disease decreased with increasing potash application. Kozaka, (1965) and Kim, (1986) reported that phosphorus and Potassium have relatively little effect on blast development as compared to nitrogen and Silica. Adding Phosphorus to Phosphorus deficient plants can reduce the disease until plants grow normally, but further application beyond that point caused an increase in the disease. Also, increasing the level of potassium generally increased blast, but the effect of potassium is complicated owing to its interrelationship with nitrogen. In addition, Application of potassium in Potassium – rich soil increased the disease when nitrogen levels were high. Adding potassium to Potassium- deficient soil caused an increase in disease at the first growth period, but reduced disease thereafter.

**Table (3): Effect of nitrogen rates in combination with P, K and Zn on panicle severity on Giza 176 cultivar as an average of two seasons 1997 and 1998.**

| Treatments | | | | Panicle infection severity | | | |
|---|---|---|---|---|---|---|---|
| No. | P | K | Zn | O N | 40 N | 80 N | Sub- Mean |
| 1 | 0 | 0 | 0 | 14.96 | 20.54 | 23.43 | 19.64 |
| 2 | 0 | 24 | 0 | 9.18 | 14.45 | 18.80 | 14.14 |
| 3 | 0 | 0 | 10 | 10.33 | 15.44 | 18.16 | 14.64 |
| 4 | 0 | 24 | 10 | 10.13 | 13.10 | 18.82 | 14.02 |
| 5 | 15 | 0 | 0 | 9.18 | 14.01 | 19.49 | 14.23 |
| 6 | 15 | 24 | 0 | 8.95 | 11.96 | 16.21 | 12.37 |
| 7 | 15 | 0 | 10 | 10.21 | 13.68 | 16.44 | 13.44 |
| 8 | 15 | 24 | 10 | 9.25 | 11.90 | 15.86 | 12.34 |
| Main - Mean | | | | 10.27 | 14.38 | 18.40 | 14.35 |

**L.S.D 5% Main = 3.224**
**Sub = 1.420**
**Inter. = 2.230**

Results of rice plant tissue analysis for nitrogen is presented in Table (4). Total nitrogen content increased in plant tissues as the increasing of nitrogen doses from zero up to 80 Kg N/fed. Total nitrogen content significantly increased in plant tissues from 1.16 to 1.55 % as the increasing of nitrogen doses from zero up to 80 Kg N /fed. with no application of P, K and Zn. While the increment of nitrogen content under the presence of recommended P, K and Zn (15, 24 and 10 Kg / fed. respectively) was not significant. It ranged from 1.45 under zero up to 1.55 % under 80 Kg /fed.. The gradual increase of nitrogen content with increase of nitrogen dose goes in parallel line with leaf and panicle infection. These results coincide with those of Kim (1986) who reported that, application with double dose of nitrogen in flooded plots caused a corresponding increase in nitrogen content in leaf tissues of two cultivars for early period after treatment.

**Table (4): Nitrogen contents in plant tissues as affected by fertilizer P, K and Zn either alone or combinations under different rates of nitrogen on Giza 176 cultivar.**

| Treatments | | | | Nitrogen contents (%) | | | Sub-mean |
|---|---|---|---|---|---|---|---|
| No. | P | K | Zn | O N | 40 N | 80 N | |
| 1 | 0 | 0 | 0 | 1.16 | 1.44 | 1.55 | 1.38 |
| 2 | 0 | 24 | 0 | 1.33 | 1.40 | 1.44 | 1.39 |
| 3 | 0 | 0 | 10 | 1.25 | 1.51 | 1.62 | 1.49 |
| 4 | 0 | 24 | 10 | 1.33 | 1.45 | 1.51 | 1.43 |
| 5 | 15 | 0 | 0 | 1.34 | 1.40 | 1.42 | 1.39 |
| 6 | 15 | 24 | 0 | 1.34 | 1.37 | 1.57 | 1.43 |
| 7 | 15 | 0 | 10 | 1.33 | 1.41 | 1.46 | 1.41 |
| 8 | 15 | 24 | 10 | 1.45 | 1.49 | 1.55 | 1.50 |
| Main - Mean | | | | 1.32 | 1.44 | 1.52 | |

**LSD 5% Mean : 0.17**
**Sub : 0.12**

Concerning the Phosphorus content in plant tissues, data in Table (5) show that. P content was increased by the increasing of N fertilizer from zero, 40 and 80 Kg N/fed. as 0.0090, 0.0100 and 0.0107% respectively and there is no significant differences between them.

A slight increasing was observed between P content in leaf tissues that comes from plants grown in treated plots by Phosphorus application than the other untreated plots but still no significant differences between treated and untreated. Abd El-wahab *et al.* (1993) reported that, nitrogen uptake by Giza 171 and Giza 181 was increased as N levels increased up to 144 and 192 Kg N/ha respectively. Insignificant increase in P uptake was obtained due to the application of P, K and Zn. However, a significant increase in P taken up by the two rice varieties was obtained when the different N levels applied to 144 kg N/ha.

**Table (5): Phosphorus contents in plant tissues as affected by fertilizer P, K and Zn either alone or incombinations under different rates of nitrogen on Giza 176 cultivar.**

| Treatments | | | | Phosphorous contents (%) | | | |
|---|---|---|---|---|---|---|---|
| No | P | K | Zn | O N | 40 N | 80 N | Sub- Mean |
| 1 | 0 | 0 | 0 | 0.0082 | 0.0097 | 0.0089 | 0.0089 |
| 2 | 0 | 24 | 0 | 0.0089 | 0.0098 | 0.0099 | 0.0095 |
| 3 | 0 | 0 | 10 | 0.0079 | 0.0098 | 0.0109 | 0.0095 |
| 4 | 0 | 24 | 10 | 0.0076 | 0.0090 | 0.0107 | 0.0092 |
| 5 | 15 | 0 | 0 | 0.0100 | 0.0105 | 0.0112 | 0.0105 |
| 6 | 15 | 24 | 0 | 0.0098 | 0.0104 | 0.0110 | 0.0104 |
| 7 | 15 | 0 | 10 | 0.0097 | 0.0100 | 0.0113 | 0.0103 |
| 8 | 15 | 24 | 10 | 0.0100 | 0.0108 | 0.0114 | 0.0107 |
| Main - Mean | | | | 0.0090 | 0.0100 | 0.0107 | |

Grain yield was increased by the increasing of nitrogen fertilizer as a main effect from zero to 40 Kg N/fed. with 3.53 to 4.19 t/fed (Table 6). While, grain yield was decreased again under 80 Kg N/fed with 4.11 ton /fed. regardless of the rest elements. On the other hand the grain yield was increased by the adding of P, K and Zn either separately or incombinations. The greatest grain yield was obtained with P, K and zn applied together (15-24- 10 Kg/fed) as 4.21 ton/fed. This results agree with those of *Hamissa et al.* (1996) who reported that, the yield was increased as the nitrogen level increased up to 60 Kg N/fed which is equivalent to 144 Kg N/ha, thereafter the yield was decreased at 80 kg N/fed which is equivalent to 192 Kg N/ha. However, the differences between 40 and 60 kg N/fed were very little. Also, Abd El- Wahab *et al.* (1993) mentioned that, the grain yield was significantly increased as nitrogen levels increased. The highest grain yield was obtained when nitrogen was applied at the rate of 144 Kg N/ha. Maintaining high yield requires fairly close adherence to optimum balance in nutrient concentrations.

**Table (6): Effect of nitrogen rates in combination with P, K and Zn on grain yield of Giza 176 rice cultivar as an average of two seasons, 1997 and 1998.**

| Treatments | | | | Grain yield (ton / fed.) | | | Sub- mean |
|---|---|---|---|---|---|---|---|
| No. | P | K | Zn | O N | 40 N | 80 N | |
| 1 | 0 | 0 | 0 | 3.17 | 3.54 | 3.94 | 3.55 |
| 2 | 0 | 24 | 0 | 3.43 | 4.06 | 3.84 | 3.78 |
| 3 | 0 | 0 | 10 | 3.45 | 3.86 | 4.03 | 3.78 |
| 4 | 0 | 24 | 10 | 3.51 | 4.23 | 4.10 | 3.94 |
| 5 | 15 | 0 | 0 | 3.52 | 4.58 | 4.15 4.36 | 4.08 |
| 6 | 15 | 24 | 0 | 3.85 | 4.30 | 4.21 | 4.17 4.05 |
| 7 | 15 | 0 | 10 | 3.63 | 4.32 | 4.28 | 4.21 |
| 8 | 15 | 24 | 10 | 3.69 | 4.65 | | |
| Main - Mean | | | | 3.53 | 4.19 | 4.11 | |

Concerning the effect of these nutritional applications on certain yield parameters, some characteristics of plant growth data presented in Table (7) indicated that, plant height, number of tillers / hill, number of leaves / hill and leaf area increased result as a function of increasing nitrogen rates from zero up to 80 kg / fed. But, without significant differences between 40 and 80 kg N/ fed. Also, all these characters increased under the application of (P, K and Zn) either separately or incombination compared with untreated treatments. The lowest numbers were obtained under zero (P, K and Zn) treatment with 66.2 cm (Plant Height), 21.5 tillers / hill 84.8 leaves/ hill and 13.8 $cm^2$ (leaf area). While the largest numbers were obtained under 15, 24 and 10 Kg /fed. (for P, K and Zn respectively) with 71.2 cm (plant height), 36.9 litters / hill, 155.6 leaves/ hill and 18.8 $cm^2$ (leaf area),(Table 8). Abd El-Wahab (1993) found that, plant height had an insignificant increase as nitrogen level increased up to 192 kg N/ha. However, number of tillers / $m^2$ was significantly increased as nitrogen level increased up to 144 kg/ ha. Also, no appreciable increase in the plant height due to the application of P, K and Zn, while number of tillers significantly increased. The increased of plant height, number of tillers / hill, number of leaves / hill and leaf area, under the high levels of fertilizers, all these characteristics may lead to an increase of leaf surface and plant canopy. These factors in addition to the higher levels of relative humidity would predispose the plants to the blast infection incidence.

**Table (7): Effect of nitrogen levels regardless of P, K and Zn on certain yield parameters.**

| Nitrogen rates Kg / fed. | Characteristics | | | |
|---|---|---|---|---|
| | Plant height / cm | No. of tillers / hill | No. of leaves / hill | Leaf area $cm^2$ |
| 0 | 57.0 | 23.3 | 89.2 | 13.1 |
| 40 | 72.1 | 31.9 | 140.8 | 18.9 |
| 80 | 74.4 | 34.3 | 153.5 | 20.1 |
| LSD 5 % | 3.5 | 3.85 | 32.03 | 2.61 |

**Table (8): Effect of Phosphorus, potassium and Zinc separately or incompination on certain yield parameters.**

| Treatments | | | | Characteristics | | | |
|---|---|---|---|---|---|---|---|
| No. | P | K | Zn | Plant height / cm | No. of tillers / hill | No. of leaves / hill | Leaf area $cm^2$ |
| 1 | 0 | 0 | 0 | 66.2 | 21.5 | 84.8 | 13.8 |
| 2 | 0 | 24 | 0 | 69.5 | 25.9 | 111.9 | 17.1 |
| 3 | 0 | 0 | 10 | 70.4 | 28.4 | 118.2 | 18.5 |
| 4 | 0 | 24 | 10 | 70.6 | 28.9 | 125.4 | 17.9 |
| 5 | 15 | 0 | 0 | 70.6 | 29.4 | 131.9 | 17.3 |
| 6 | 15 | 24 | 0 | 71.5 | 33.3 | 146.4 | 18.2 |
| 7 | 15 | 0 | 10 | 70.7 | 34.2 | 148.5 | 17.5 |
| 8 | 15 | 24 | 10 | 71.2 | 36.9 | 155.6 | 18.8 |
| LSD 5 % | | | | 2.99 | 2.07 | 11.67 | 1.64 |

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**تأثير معدلات من النيتروجين مع الفوسفور والبوتاسيوم والزنك علي الإصابة بمرض اللفحه في الأرز علي الصنف جيزة ١٧٦ تحت الظروف المصرية.**

ظريف حافظ عثمان و صلاح محمود الوحش و السيد علاء سعد بدر و محمد رشدي سحلي و عيسي أحمد سالم
قسم بحوث أمراض الأرز- معهد بحوث أمراض النباتات - مركز البحوث الزراعية.

تم إجراء هذه التجارب بالمزرعة البحثية لمحطة بحوث سخا الزراعية وذلك خلال موسمي ١٩٩٧،١٩٩٨. في قطع منشقة لدراسة تأثير معدلات مختلفة من التسميد النيتروجيني سواء كان منفردا أو مع الفوسفور والبوتاسيوم والزنك علي الإصابة بمرض اللفحه. كانت المعاملات الرئيسية ثلاثة معدلات من النيتروجين هى صفر، ٤٠، ٨٠ وحده أزوت للفدان. وثمان معاملات منشقة بالتبادل من الفوسفور والبوتاسيوم والزنك (١٥،٢٤،١٠ كجم/ ف) أو مجتمعة معا.

أظهرت النتائج خلال موسمي ١٩٩٨،١٩٩٧ أن شدة الإصابة بمرض اللفحه علي الأوراق والسنابل تزداد بزيادة معدل التسميد النيتروجينى. كما أن الإصابة بالمرض تقل تحت المستوي العالي من النتروجين عند إضافة الفوسفور سواء منفردا أو مع البوتاسيوم والزنك مقارنة بالمستوي العالي من النيتروجين بدون إضافة هذه العناصر.

أقل إصابة باللفحه علي الأوراق أو السنابل وأعلي محصول تم الحصول عليها عند استخدام معدلات متوازنه من عناصر الفوسفور والبوتاسيوم والزنك (١٥-٢٤-١٠ كجم / فدان) مع المعدل الموصي به من النيتروجين (٤٠ وحده أزوت للفدان)

لوحظ وجود زيادة معنوية في المحتوي النتروجين في أنسجة النبات من ١,١٦ إلى ١,٥٥% وذلك بزيادة التسميد الأزوتي من صفر إلى ٨٠ وحده أزوت في غياب العناصر الأخرى. كمالوحظ زيادة غير معنوية في محتوي الفوسفور بأنسجة النباتات المأخوذة من الاحواض التي عوملت بالفوسفور مقارنة بغير المعامل.

أما الصفات المورفولوجيه من طول النباتات - عدد الأفرع والأوراق في الجوره وكذلك المساحة الورقية فقد لوحظ أنها تزداد بزيادة التسميد النتروجين من صفر الي ٨٠ وحده أزوت للفدان. كما أن أعلي النتائج لهذه الصفات تم الحصول عليها تحت مستوي ١٥،٢٤، ١٠ من الفوسفور والبوتاسيوم والزنك بمقارنتها تحت نفس المعدل من النتروجين.