Effect of Biologic Stabilizers of Nitrogen and Chemical Fertilizers on Quantitative and Qualitative Characteristics of Rice

T. Sedghpour-Sabet, H.R. Doroodian and H. Besharati
1Department of Agronomy, Lahijan Branch, Islamic Azad University, Lahijan, Iran
2Department of Soil and Water Researches Institute of Iran, Iran

Abstract: To study the effects of reconciliation usage of some of nitrogen stabilizers (Azetobacter, Azospirillum and Azorhizobium), chemical fertilizer of urea, Zn (Zinc) and Fe (Iron)-EDDHA on the operation and operation components of rice, a split-factorial test in the framework of complete random block design was conducted with 3 replication in Bandar-Anzali (North of Iran) in 2011 crop year. In this test, nitrogen fertilizer as the main factor was in 3 levels (control, biologic fertilizers (reconciling Azetobacter, Azospirillum and Azorhizobium bacteria) and chemical fertilizer of nitrogen (150 kg ha⁻¹ urea)) and two subsidiary factors were fertilizers of Zn and Fe-EDDHA in two levels (control and using 5 in 1000 EDTA EDDHA in the form of leaf). Results showed that the effect of nitrogen fertilizer on stalk length, number of grain per cluster and the content of grain was meaningful in 1%. Reciprocal effects of nitrogen and Zn on the number of tillers in square meter and reciprocal effect of nitrogen, Zn and Fe on the length of cluster was meaningful in 5%. The highest mean of stalk (113 cm), number of grain per cluster (89.4) and the content of grain (54.2 kg ha⁻¹) was achieved by using urea fertilizer.

Key words: Rice, biologic and chemical fertilizer, nitrogen, Fe-EDDHA, Zn (Zinc)-EDDHA

INTRODUCTION

Cereals are one of the important sources which provide necessary food of human beings. Today, using chemical fertilizers such as nitrogen for promoting their operation has increased considerably. Chemical fertilizers are tonic salts but many times they are destroyer and in long run will decrease penetrability, increase special exterior weight, pollution and soil salinity, make stem penetration problematic and finally reduce the operation. In addition to this, high cost of producing these fertilizers and also biologic problems of their unprincipled consumption necessitates reviewing nutrition methods of these plants (Malakouti, 1996; Ventura, 1992). However, nitrogen is one of the necessary elements of plant and plant’s need for nitrogen is more than other elements. Morphologic and physiologic traits of plants often change in reaction to the amount of availability of sources (such as fertilizer). Considering that the plant growth and its’ operation is dependant on photosynthesis process and nitrogen can have a direct effect on the value of photosynthesis in leaf level unit, its shortage might result in the reduction of carbon dioxide absorption and therefore, plant nitrogen balance is directly related to carbon dioxide balance because nitrogen consumption lead to increasing its density in plant, increasing photosynthesis enzymes density and chlorophyll density in photosynthesis reaction centers in the plant (Ceccin, 1997). Whereas there is a near relationship between the value of leaf photosynthesis and nitrogen density (Mohrshami, 2001), it is necessary to balance leaf nitrogen value along the growth period to get to a high operation (Keshavarzi, 1999). Traits which lead to operation promotion have a good correlation with nitrogen consumption value. Continuous and long term cultivation of rice in farmlands and usage of high consumption chemical fertilizers such as nitrogen and phosphor and non-consumption of other elements such as Zinc (Zn) lead to the lack of nutrient elements in farms soil. In special, after nitrogen and phosphor, Zn is the most important restricting element of rice growth in flooding situation (Toghi and Najafi, 2001). Lack of Fe can be observed in a wide spectrum of soils other than acidic soils. Soils >6 pH are usually in lack of Fe. Fe like some of the nutrient elements in these soils would become insoluble, immobile and unavailable (Fajeria, 1996). Perhaps, note that proportion of H⁺/OH⁻ ions which would be sprinkled from stem in the soil create a completely complex process with Fe nourishment in plants which are highly dependent on soil parameters including soil calcium carbonate content (Fajeria, 1996).

Fe and Zn elements have an important role in grain formation and increasing its weight and helping carbohydrates and proteins synthesis. Zn has a key role...
in helping material metabolism and affecting electron transmission reactions in Krebs cycle by increasing the value of growth regulators and iron has a key role in increasing grain weight and number and finally grain operation by participating in hydrocarbon and protein materials metabolism and their transmission and also affecting generative processes (Welch and Shuman, 1995). Meanwhile using biologic products for cereal nourishment seems to be one of the important and beneficial solutions. Azotobacter and Azospirillum bacteria are the most important motive bacteria for plant growth which in addition to nitrogen biologic stabilization would affect plants growth and operation by producing considerable amounts of growth motive hormones, especially auxin, gibberellin and cytokinins. Growth motive bacteria such as Azospirillum and Azotobacter beside the ability to stabilize nitrogen cooperate in vitamins creation process (Hegde et al., 1999). Suneja et al. (1994) reported that Azotobacter inhibits Fe sediment and helps Fe absorption of the plant by producing sidrophors. Results of the study by Elbaim and Aly (2004) showed that using 50 mg L\(^{-1}\) Zn with Azotobacter and Azospirillum leads to the increase of the value of nitrogen, magnesium, manganese, carbohydrate and the whole proteins saluted in stalk. Ardakani reported increased absorption of iron, magnesium, Zn, copper, nitrogen, phosphor and potassium, respectively 16, 20, 18, 21, 17, 14 and 20% because of the effect of wheat seed fertilization with azospirillum bacterium. The goal of the present research is to study the effect of nitrogen biologic stabilizers and chemical fertilizers on quantitative and qualitative characteristics of rice.

MATERIALS AND METHODS

To study the effects of nitrogen biologic stabilizers and chemical fertilizers on the quantitative and qualitative characteristics of rice, a split-factorial test with the basic plan of complete random block was conducted with 3 replication in Anzali County in 2011. In this study, nitrogen fertilizer as the main factor was in 3 levels (control, biologic fertilizers (Azotobacter, Azospirillum and Azorhizobium)) and chemical fertilizer of nitrogen (150 kg ha\(^{-1}\) urea in three stages)) and two subsidiary factors were fertilizers of Zn and Fe-EDDHA in two levels (control and 5 in 1000 iron EDTA-EDDHA). Consumption of EDTA Fe and Zn-EDDHA fertilizers in plant midtiltering was done in the form of leaf solution scattering. Nitrogen fertilizer consumption had three stages of transplanting, midtiltering and blooming and in each stage 50 kg urea fertilizer was used. The test was conducted in 36 Kurt of 2.5×2.5 m. Farm plowing was in late February and troweling and flattening was early in spring. In April 5th, seeding of Hashemi genotype was done and transplants in 4×5 leaf stage were transmitted to the main land in 27th of May. Firstly, side effects were removed for determining operation component and morphologic traits. Then, 10 bushes were randomly selected from each Kurt and their mean was considered for each Kurt. After drying the samples, ash method was used to measure grain Iron and Zn content and density. Chloric acid was used for decoction. Fe and Zn density was then measured in the samples by atomic absorption machine. Data were analyzed by software and test was used for mean comparison.

RESULTS AND DISCUSSION

Stalk length: Variance analysis results showed that the effect of nitrogen fertilizer on plant height was meaningful in 1% probability level (Table 1). The most and least stalk height was respectively in chemical fertilizer treatment with the mean of 113 cm and usage of biologic, Zn and Fe fertilizers with the height of 98 cm. Bush height in chemical fertilizer treatment had a meaningful difference with biologic and control fertilizers in 1% probability level (Table 1). Other researchers reported increase of rice stalk length because of using nitrogen fertilizer (Liagas et al., 1987; Islam et al., 2008; Rezaei et al., 2009).

Number of tillers: There was a meaningful difference between reciprocal effect treatment of Zn and nitrogen in the number of tillers in square meter with 5% probability level (Table 1). Most tillers were in urea fertilizer treatment (23.8 tillers m\(^{-2}\)) and the least were in control treatment (20.41 m\(^{-2}\)) (Table 2). Sadrazadeh (2002) reported that increasing nitrogen fertilizer lead to the increase of tillers in square meter. Reports showed that beside nitrogen fertilizer, solution scattering of some of the cereal with low consumption elements, including Copper, Manganese, Fe and Zn also results in the increase of fertilized tillers in the surface unit (Seadh et al., 2009).

Cluster length: Reciprocal effect of nitrogen, Zn and Fe on cluster length was meaningful in 5% probability level (Table 1). Rice cluster length in usage treatment of Zn fertilizer along with nitrogen chemical fertilizer with the value of 27.1 cm was the lowest and the highest cluster was achieved in the treatment of Fe fertilizer and biologic fertilizer (Table 2). Chemical fertilizer in Fe and Zn non-consumption situation, lead to the increase of rice

Table 1: Analysis of variance for effect of biological stabilization of nitrogen and chemical fertilizers (urea, zinc and iron) on quantitative and qualitative of rice

<table>
<thead>
<tr>
<th>SOY</th>
<th>df</th>
<th>Stems length</th>
<th>Cluster length</th>
<th>No. of grain</th>
<th>No. of tillers in cluster</th>
<th>Zn content of grains</th>
<th>Fe content of grains</th>
<th>Grain yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replication</td>
<td>2</td>
<td>71.250</td>
<td>1.643</td>
<td>210.251</td>
<td>4.539</td>
<td>13.185</td>
<td>223.747</td>
<td>10128.00</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>2</td>
<td>523.490**</td>
<td>1.961</td>
<td>233.011**</td>
<td>15.315</td>
<td>768.745*</td>
<td>2852.560</td>
<td>7627.16</td>
</tr>
<tr>
<td>Error</td>
<td>4</td>
<td>21.439</td>
<td>1.305</td>
<td>11.597</td>
<td>0.989</td>
<td>85.626</td>
<td>3288.506</td>
<td>4218.88</td>
</tr>
<tr>
<td>Zn</td>
<td>1</td>
<td>113.778</td>
<td>2.250</td>
<td>354.694*</td>
<td>0.035</td>
<td>325.021</td>
<td>296.241</td>
<td>11319.18</td>
</tr>
<tr>
<td>Nitrogen and Zn</td>
<td>2</td>
<td>113.138</td>
<td>0.766</td>
<td>23.630</td>
<td>6.975*</td>
<td>426.204</td>
<td>7900.457</td>
<td>2601.20</td>
</tr>
<tr>
<td>Fe</td>
<td>1</td>
<td>9.060</td>
<td>0.028</td>
<td>12.018</td>
<td>3.890</td>
<td>0.760</td>
<td>116.460</td>
<td>22.29</td>
</tr>
<tr>
<td>Nitrogen and Fe</td>
<td>2</td>
<td>4.203</td>
<td>0.617</td>
<td>5.959</td>
<td>0.877</td>
<td>12.695</td>
<td>710.835</td>
<td>513.03</td>
</tr>
<tr>
<td>Zn and Fe</td>
<td>1</td>
<td>10.671</td>
<td>1.068</td>
<td>6.084</td>
<td>5.577</td>
<td>32.699</td>
<td>0.226</td>
<td>0.69</td>
</tr>
<tr>
<td>Nitrogen and Zn and Fe</td>
<td>2</td>
<td>77.141</td>
<td>3.089*</td>
<td>13.700</td>
<td>2.431</td>
<td>1.893</td>
<td>6532.280</td>
<td>352.91</td>
</tr>
<tr>
<td>Error</td>
<td>18</td>
<td>58.695</td>
<td>0.789</td>
<td>74.031</td>
<td>1.913</td>
<td>188.390</td>
<td>3917.300</td>
<td>2875.90</td>
</tr>
</tbody>
</table>

*Significant at p<0.05 and **Significant at p<0.01

Table 2: Mean comparison of the effect of biological stabilization of nitrogen and chemical fertilizers (urea, zinc and iron) on quantitative and qualitative of rice by Tukey test

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Categories</th>
<th>Stem length (cm)</th>
<th>Cluster length (cm)</th>
<th>No. of seeds in cluster</th>
<th>No. of tillers (m²)</th>
<th>Zn content of grains (g)</th>
<th>Fe content of grains (g)</th>
<th>Grain yield (g/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Zn</td>
<td>102.460</td>
<td>25.760</td>
<td>83.860</td>
<td>21.180</td>
<td>47.390</td>
<td>184.170</td>
<td>303.440</td>
</tr>
<tr>
<td>Control</td>
<td>Zn</td>
<td>99.100</td>
<td>24.960</td>
<td>77.300</td>
<td>21.350</td>
<td>33.280</td>
<td>152.530</td>
<td>246.210</td>
</tr>
<tr>
<td>Control</td>
<td>Zn</td>
<td>102.090</td>
<td>25.460</td>
<td>82.760</td>
<td>22.970</td>
<td>51.430</td>
<td>206.790</td>
<td>302.330</td>
</tr>
<tr>
<td>Control</td>
<td>Zn</td>
<td>119.530</td>
<td>27.100</td>
<td>93.360</td>
<td>22.800</td>
<td>58.970</td>
<td>156.120</td>
<td>318.990</td>
</tr>
<tr>
<td>Control</td>
<td>Zn</td>
<td>110.360</td>
<td>26.430</td>
<td>86.430</td>
<td>24.450</td>
<td>50.570</td>
<td>171.350</td>
<td>288.440</td>
</tr>
<tr>
<td>Control</td>
<td>Zn</td>
<td>107.900</td>
<td>26.260</td>
<td>82.930</td>
<td>23.150</td>
<td>49.830</td>
<td>206.710</td>
<td>306.770</td>
</tr>
<tr>
<td>Control</td>
<td>Fe</td>
<td>98.000</td>
<td>25.430</td>
<td>85.060</td>
<td>21.830</td>
<td>36.710</td>
<td>152.740</td>
<td>268.440</td>
</tr>
<tr>
<td>Control</td>
<td>Zn</td>
<td>106.200</td>
<td>24.200</td>
<td>83.760</td>
<td>23.320</td>
<td>45.460</td>
<td>224.180</td>
<td>245.100</td>
</tr>
<tr>
<td>Control</td>
<td>Zn</td>
<td>99.350</td>
<td>24.860</td>
<td>79.660</td>
<td>22.130</td>
<td>40.920</td>
<td>209.520</td>
<td>257.880</td>
</tr>
<tr>
<td>Q</td>
<td>13.869</td>
<td>1.536</td>
<td>14.901</td>
<td>2.394</td>
<td>23.772</td>
<td>108.405</td>
<td>92.866</td>
<td></td>
</tr>
</tbody>
</table>

cluster length. While, biologic fertilizer was not effective in increasing cluster length. Sadrazadeh (2002) reported that different levels of nitrogen fertilizer lead to the increase of cluster length. In a research by Ashraf et al. (1994), the highest cluster length was achieved in 120 kg ha⁻¹ urea and the lowest cluster length in the control treatment.

The number of grain each cluster: Nitrogen and Zn fertilizers had a meaningful effect on the number of grain per cluster in the probability level of respectively, 1 and 5% (Table 1). Chemical fertilizer, Zn and Fe treatment showed the most amount of grain per cluster (mean of 94.93) (Table 2). Sirjani studied the effect of using biologic fertilizer, Zn sulfate and nitrogen fertilizer on qualitative and quantitative operation of wheat and reported that the most amount of grain was achieved from the treatment of Azetobacter fertilizer, Zn usage and second level factor of nitrogen fertilizer division (120 kg ha⁻¹). This improvement in grain number can be related to the high level of the output of nitrogen fertilizer consumption in jointing and ear emergence.

Increased number of grain by using Zn Sulphat can be attributed to the direct role of this element in enzyme activities (Carbonic anhydrase, hydrogenase, proteinase, nitrate reductase) Auxine metabolism, photosynthesis, chlorophyll and catalyst activity (Brennan, 1992; Ekiz et al., 1998).

Grain content: Results of variance analysis (Table 1) showed that using different levels of nitrogen fertilizer became meaningful in grain content in 5% probability level. Usage treatment of chemical nitrogen fertilizer had the highest value in grain content with the amount of 54.2 g ha⁻¹ which had a meaningful, difference with biologic and control fertilizers. Biologic and control fertilizers were also in the same statistical level. While grain density did not change, grain operation increase lead to the increase of stores on grains in surface unit.

It was observed in a test on corn hybrid that the reciprocal effect on (nitrogen and type) the amount of grain was meaningful in 5% probability level. Reciprocal effect (nitrogen and Zn) on the amount of corn leaf was also meaningful in 5% statistical level (Shafe et al., 2001). According to Karimian (1995), Nitrogen consumption increased Zn density and absorption in corn.

Fe content of grain: Variance analysis results showed that using different levels of nitrogen fertilizer, Zn and Fe-EDDHA and their reciprocal effect on the amount of
rice grain operation was not meaningful (Table 1) but the
most content of grain Fe (228.84 g mm⁻²) was achieved
from the treatment of chemical nitrogen, Zn and Fe
fertilizers and the least (137.02 g mm⁻²) from control
treatment.

Chemical and Zn fertilizer consumption resulted in
the most content of grain but did not lead to any
meaningful effect on this trait while chemical fertili-
zer consumption resulted in the meaningfulness of
the content of grain, therefore these two elements compete
with each other in the stage of transmission to grain
(negative interaction). Generally, increasing the amount of
Zn leads to the decrease of Fe absorption in the plant. When
there is lack of Fe, Zn absorption and Zn density on the
stalk will considerably increase in plants (Bayvordi,
2006).

**Grain operation**: Variance analysis results showed that
the effect of different levels of nitrogen, Zn and
Fe-EDDHA fertilizers and their reciprocal effects on grain
operation of rice didn’t become meaningful (Table 1),
however the most operation of grain (318.99 g mm⁻²) was
achieved from chemical nitrogen and Zn fertilizer
treatment and the least amount (220.66 g mm⁻²) was from
control treatment. When there is not proportion between
nutrients, increasing one nutrient element not only would
not improve operation but also reduce it (Siadat et al.,
2004).

**CONCLUSION**

Results show that the highest amount of tiller (23.8)
was also achieved in the treatment of nitrogen and Zn
fertilizer and the longest cluster (27.1) in the treatment of
urea, Zn and Fe fertilizers.

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