Effects of Iron and Nitrogen Fertilizers on Yield and Yield Components of Peanut (Arachis hypogaea L.) in Astaneh Ashrafiyeh, Iran

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Abstract: An experiment was conducted to evaluate the effects of iron and nitrogen fertilizers on yield and yield components of peanut (Arachis hypogaea L.) in Astaneh Ashrafiyeh, North of Iran. A randomized complete block design was used to incorporate factorial combinations of four levels of nitrogen fertilizer (0, 30, 60 and 90 Kg/ha) and four levels of iron fertilizer (0, 1.5, 3 and 4.5 g/l per plot) with three replications in agricultural year of 2010. The results showed that maximum pod and seed yield values of 2916 and 1828kg/ha, respectively were recorded for the 4.5g/l iron fertilizer treatment. Furthermore, the use of 60kg/ha nitrogen fertilizer resulted in the highest pod and seed yields amounting to 2314 and 1376kg/ha, respectively. Results obtained in this study suggested 4.5g/l iron (6m²) and 60kg/ha nitrogen as the most suitable fertilizer management for peanuts grown under the region’s conditions.

Key word: Nitrogen • Iron • Peanut • Yield • Astaneh Ashrafiyeh

INTRODUCTION

Peanut is one of the most important and economical oilseeds in tropical and subtropical regions which is mostly grown due to its oil, protein and carbohydrates [1]. It is an annual shrub of Leguminosae family and Arachis genus which has a main straight root [2]. The peanut seed is rich in edible oil and contains 43-55% oil and 25-28% protein [3]. China, India, the United States, Nigeria, Indonesia, Burma and Senegal are the major peanut producing countries. In Iran, this product is grown in Golestan, Khouzestan and Guilan provinces. In Guilan, it is mostly planted in Astaneh Ashrafiyeh and also along Sepidroud river margin [4].

Nitrogen has a critical role in producing agricultural products and selecting the amount of nitrogen-containing fertilizers is necessary for having the highest production level. Adsorption of adequate amounts of nitrogen by a plant leads to more protein content and larger cereal and legume seeds. Generally, the more the concentration of nitrogen in leaves, the more the intensity of carbon-making would be because aside from being found as protein in plants, nitrogen is the main element in the chlorophyll synthesis and its fixation could lead to more growth of aerial parts. Usually, nitrogen shortage is observed when plant nutrition is not managed properly and this element is not provided in adequate amounts, which could result in the older leaves to turn yellow and eventually, the plant’s growth stops. In other cases, when too much nitrogen is provided for the plant, it normally leads to watering of protoplasm and brittleness of the plant itself which would result in becoming vulnerable to diseases and pests [5].

Iron is the most frequent element in the earth’s crust and its shortage is one of the common problems in most plant species. Iron chelate is a form of this element which passes through cells. Chelates are biologically synthesized in plants and are responsible for carrying ions [2]. Iron shortage in calcareous soils is one of the greatest challenges which farmers encounter while growing plants. Peanut (Arachis hypogaea) is usually planted in the soils of Sepidroud river banks and the Caspian Sea coastal zone. These soils have calcareous original beds and are quite rich in calcium bicarbonate and soluble calcium whose pH values are normally higher than 7. Hence, using iron for peanut growing is of great significance. A part of nitrogen fixation proteins that are responsible for transferring electron have iron in their structures. Since this element is present in many plant
growth processes including the synthesis of chlorophyll, energy transfer, respiration and photosynthesis processes, nitrogen fixation and reduction and is also present in many metabolism cycles and thus, in synthesizing protein, it has a special place among plants whose shortage would surely result in lower peanut yields [2]. Shortage of iron in Leguminosae family is effective in nitrogen fixation and causes the number of pods in the shrub and the seed yield to decrease [6]. Therefore, due to the vital role of this element in nitrogen fixation and reduction, its necessity gets doubled. Iron shortage symptoms are first seen as the yellowish color between leaf veins, especially in young leaves, which could result in the necrosis of all these leaves [5]. Peanut shrubs in some of their growth stages reveal iron shortage as yellow apex leaflets and shortened shrubs because they are very sensitive to the shortage. Studies have shown that iron shortage in the southern parts of Thailand resulted in the reduction of the number of peanut seeds in a pod and also the number of pods themselves which was attributed to decreased nitrogen fixation [6]. Also, Singh and Dayal [7] concluded that spraying iron would cause a 38-42% increase in the peanut yield in alkaline soils. With the above-mentioned findings taken into account, studying the effect of different amounts of iron and nitrogen fertilizers on peanut yield is necessary and this is why the present research was conducted.

MATERIALS AND METHODS

In order to study the effect of iron and nitrogen fertilizers on peanut yield and it yield components, during the 2010 crop year, an experiment was done in Astaneh Ashrafiyeh located in 37° 16’ latitude and 49° 56’ longitude in the north of Iran at an average altitude of 3 meters. Climatic data of the studied period were obtained from Astaneh Ashrafiyeh meteorological station. From the climatology perspective, this town is considered a temperate and humid region and has a loam soil with pH 7.4. Information on soil specifications and climatic data of the studied region are given in Tables 1 and 2. In this study, the experiment was done as a factorial in a completely random blocks plan with three replications. Each experimental unit was 3×2 m in area and had 10 rows of plantation. The agricultural land was at first plowed on May 5, 2010 and then, eleven days later (May 16, 2010) peanut seeds of the indigenous Guilbadam cultivar (NC) were sown both manually and in rows 3-4 cm deep. Before sowing, seeds were disinfected in 2:1000 Carboxin thiram as a fungicide [8]. Nitrogen fertilizer (as urea) amounts including no fertilizer (N₀), 30 (N₁), 60 (N₂) and 90 (N₃) kg/ha were used, while iron fertilizer (as Fe chelate) amounts were 0 (Fe₀), 1.5 (Fe₁), 3 (Fe₂) and 4.5 (Fe₃) g/l per plot. Half of the nitrogen fertilizer was used as the base fertilizer and the remaining was used in three equal portions 20, 30 and 40 days after plantation [9]. Half of the iron fertilizer was used at the time of branching and the rest was used during the blooming stage. Crop management measures in the field included three phases of weeding to control the weeds and also side dressings around the root. The crop was harvested on September 20, 2010. In order to estimate seed and pod yield, after excluding two rows from both sides, first, mature pods were harvested from the shrubs in each plot and then, they were exposed to open air for one week so that their moisture content would be reduced. Next, the pods were dried in an oven for 48 hours until they had a constant dry weight. When the pods were taken out of the oven, their dry weights were recorded using a digital scale with 0.01 precision. Then, the pods’ yield was calculated as kg/ha.

Table 1: Characteristics of soil in the study area

<table>
<thead>
<tr>
<th>Soil depths (cm)</th>
<th>Particle size distribution (%)</th>
<th>Total Nitrogen</th>
<th>Organic Carbon</th>
<th>Soil Texture</th>
<th>Potassium Absorbent (ppm)</th>
<th>Phosphorus Absorbent (ppm)</th>
<th>Electrical conductivity (dS/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20</td>
<td>49  32  32</td>
<td>0.084</td>
<td>0.68</td>
<td>Loamy</td>
<td>239</td>
<td>0.07</td>
<td>6.31</td>
</tr>
<tr>
<td>20-40</td>
<td>49  19  19</td>
<td>0.065</td>
<td>0.66</td>
<td>Loamy</td>
<td>191</td>
<td>2.17</td>
<td>5.65</td>
</tr>
</tbody>
</table>

Table 2: Information on meteorological data

<table>
<thead>
<tr>
<th>Month</th>
<th>Maximum Temperature (°C)</th>
<th>Minimum Temperature (°C)</th>
<th>Sun Shine (h)</th>
<th>Rain fall (mm)</th>
<th>Wind Speed (m/s)</th>
<th>Evaporation of pan (mm)</th>
<th>Maximum Humidity (%)</th>
<th>Minimum Humidity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>May</td>
<td>26.2</td>
<td>17.0</td>
<td>6.3</td>
<td>10.2</td>
<td>6.5</td>
<td>4.4</td>
<td>94.0</td>
<td>63.8</td>
</tr>
<tr>
<td>Jun</td>
<td>29.2</td>
<td>18.6</td>
<td>9.0</td>
<td>2.0</td>
<td>6.5</td>
<td>5.2</td>
<td>91.6</td>
<td>57.5</td>
</tr>
<tr>
<td>Jul</td>
<td>31.9</td>
<td>21.4</td>
<td>9.2</td>
<td>39.7</td>
<td>5.2</td>
<td>5.7</td>
<td>86.5</td>
<td>55.6</td>
</tr>
<tr>
<td>Aug</td>
<td>33.8</td>
<td>20.6</td>
<td>10.2</td>
<td>89.6</td>
<td>6.8</td>
<td>6.6</td>
<td>89.7</td>
<td>46.5</td>
</tr>
<tr>
<td>Sep</td>
<td>32.3</td>
<td>21.0</td>
<td>7.9</td>
<td>16.1</td>
<td>6.0</td>
<td>5.1</td>
<td>94.0</td>
<td>54.3</td>
</tr>
</tbody>
</table>
The number of mature pods in each shrub was determined by the total number of mature pods divided by the number of plants in each plot. After determining the number of mature pods in each plot, they were put in an oven at 60-65°C for 48 hours until they reached a constant dry weight. Then, the mature pods of each plot were weighed using a scale with a 0.01 precision. Therefore, a mature pod’s weight was calculated by the proportion of the weight of all mature pods in the harvest zone to the number of mature pods. In order to determine the weight of 100 seeds, first the seeds in 200g of mature pods from each plot were unshelled. Then, they were dried for 48 hours in an oven at 60°C. Next, the seeds were taken out of the oven among which 100 seeds were randomly selected and weighed using a digital scale and thus, were reported in grams. When mature pods were taken out of the oven, 200g of them were selected as a sample. Then, the shell and seed weights in this 200g pods were determined. Next, the shelling percentage was calculated by the proportion of seeds to mature pods [10]. Also, the plant’s height and seed lengths and widths were measured at the end of the crop year. To analyze the variance of data and to compare the mean values (Duncan test at the probability level of 5%), MSTATC software and in order to draw relevant diagrams, Excel software was used.

**RESULTS AND DISCUSSION**

**Pod Yield:** Results from the analysis of variance the effect of iron and nitrogen fertilizers on the peanut pod yield showed that there was a significant difference between the studied treatments (with 95% and 99% confidence coefficients, respectively). However, no significant statistical difference was observed in terms of nitrogen-iron interactions (Table 4). The maximum pod yield (2916 kg/ha) was that of the 4.5g/l iron treatment per plot (Figure 1). In other words, as the iron content increased, pod yield increased as well. Lachover et al. [11] reported that using 10kg/ha iron in a loam-clay soil with a 15% calcium carbonate content, increased pod yield up to 50%. Also, higher iron contents increased fertile flowers which resulted in more pod yield, increased number of mature pods and thus, improved each 100-seed weight and the shelling percentage. Furthermore, the present study indicated that, the highest pod yield average (2314kg/ha) was that of the N fertilizer treatment (Fig. 2). Increased nitrogen content inside the plant helped the chlorophyll in leaves to increase and thus the peanut yield increased as well. On the other hand, nitrogen shortage accelerated the aging process in vegetative organs such as leaves which are known as photosynthesizing organs. Of course, excessive nitrogen contents lengthened the vegetative period in peanuts delayed the maturity of the crop and thus, caused the yield to decrease [2].
Seed Yield: Analysis of variance results showed that there was a significant difference between different iron and nitrogen fertilizer treatments in terms of seed yield (with 95% and 99% confidence coefficients, respectively), but no interaction was seen between the said fertilizers and seed yield (Table 4). The highest average calculated for seed yield was that of the fertilizer with 4.5g/l iron content (per plot) (Fig. 3). Of the nitrogen fertilizer treatments, a consumption rate of 60kg/ha nitrogen, resulted in the highest yield (Fig. 4). Panjantendoust [2] studied different amounts of iron fertilizer used in two spraying and in-the-soil methods and observed that using this fertilizer in both methods affected the peanut seed yield. Janick and Simon [12] suggested that too much nitrogen caused food synthesis in the plant which in their research, it led to more vegetative growth and less seed yield.

100-seed Weight: Analysis of variance results in Table 3 indicated that there was a significant difference between iron and nitrogen fertilizer treatments in terms of their 100-seed weights (p<0.01). The effect of iron fertilizer was so that the highest 100-seed weight (M=66.4g) was obtained for 4.5g/l iron (per plot) treatment (Table 4). Also, the fertilizer treatment of 60kg/ha nitrogen (M=59.7g) gave the highest 100-seed weight compared with other treatments (Table 4).

Plant Height: Data in Table 3 showed that there was a significant difference between various iron and nitrogen fertilizers and their interaction with plant height (p<0.05). Among iron fertilizer treatments, the 4.5g/l iron use (per plot) caused the greatest peanut height (M=38.6cm). Moreover, among the nitrogen fertilizer treatments, the greatest height (M=38.2cm) was that of the 60kg/ha nitrogen treatment (Table 4). Also, regarding the interaction between fertilizers, the greatest height was found in the 4.5g/l iron (per plot) and 60kg/ha nitrogen fertilizer treatment (M=43.1cm), while the lowest height was observed in the no fertilizer treatment (M=22.5cm) (Figure 5). With consideration of the fact that nitrogen stimulates the vegetative growth, this height increase could stimulate buds in the stalk and increase their branching [12]. Too much nitrogen resulted in the increase of height and shading on lower leaves which would in turn lead to auxin production and eventually, stop the plant’s growth [13].

Number of Mature Pods in a Shrub: In this study, the increase of iron concentration had a significant effect on the number of mature pods in a shrub (p<0.01). Also, none of the nitrogen fertilizer treatments had a significant effect on the said number (Table 3). The effect of iron fertilizer showed that the maximum number of matured pods in a shrub (M=39.2g) was that of the 4.5g/l iron (per plot)
Fig. 5: Plant height regarding reciprocal effect of iron and nitrogen fertilizers

\[ y = 1.305x + 16.86 \]
\[ R^2 = 0.69 \]

Fig. 6: Relationship between number of mature pods in a shrub and amount iron fertilizer

Fig. 7: Amounts of shelling percentage regarding reciprocal effect of iron and nitrogen fertilizers
which compared with the no fertilizer treatment had a 71.5% increase (Table 4 and Fig. 6). It seems that the increase of iron content has a positive effect on the number of fertile flowers and peg production in peanut shrubs the result of which would be the increase of the number of mature pods in the bushes because the number of mature pods depends on the number of pegs which have penetrated the soil and also on the their growth underground.

A Mature Pod's Weight: The present data showed that different iron and nitrogen contents had a positive effect on a mature pod’s weight (p<0.01), but the interaction of iron and nitrogen with this variable was not significant (Table 3). The maximum weight of a mature pod (M=1.1g) was recorded for the 4.5g/l iron (per plot) treatment which compared with the no fertilizer, 1 and 3g/l iron treatments resulted in a 40.3%, 18.2% and 2.8% increase, respectively (Table 4). Among different levels of nitrogen fertilizer, 60kg/ha content recorded the highest value of this variable compared with other treatments (Table 4). In other words, a mature pod’s weight under iron fertilizer conditions had a noticeable increase which could be due to the production of larger and thus, heavier seeds in iron fertilizer treatments.

Seed Length and Width: In iron fertilizer management, seed length and width became significant at the probability level of 1%, while in nitrogen management, this happened at the probability level of 5%. However, the fertilizers’ interaction was not significant in terms of seed length and width (Table 3). The highest seed length and width values were observed in the iron fertilizer treatment as 2cm and 1.02cm, respectively (Table 4). The effect of nitrogen fertilizer was so that the maximum values of the said variables averaged as 1.58cm and 0.81cm were observed in the 60kg/ha nitrogen fertilizer treatment (Table 4). Also, Singh et al. [14] showed that peanut shrubs, for which iron fertilizer was used, had larger seeds with better shapes.

Shelling Percentage: In this study, there was a significant difference between treatments in terms of the effect of different levels of iron (p<0.01) and nitrogen (p<0.01) fertilizers and their interaction (p<0.05) on the shelling percentage in peanut (Table 3). Results obtained from the comparison of average values of this percentage showed that the 4.5g/l iron (per plot) was preferred compared with other treatments (M=0.605) (Table 4). The highest shelling percentage in nitrogen fertilizer treatments was found in the 60kg/ha treatment (M=0.545) (Table 4). The interaction between iron and nitrogen fertilizers suggested the preference of 4.5g/l iron and 60kg/ha nitrogen treatments, which compared with other treatments with an average value of 0.65, were at the highest level (Fig.7). Based on the obtained results in this research, higher iron concentrations caused the shelling percentage in peanuts to increase. It seems that this was a result of providing a suitable nutritional environment for the growing peanut pods. Also, Singh et al. [14] reported that using iron in different methods during peanut’s growth period increased the shelling percentage in the plant.

CONCLUSION

As a whole, results of the present study suggested that iron and nitrogen fertilizers affect all the measured traits of peanut. Among iron fertilizer treatments, maximum pod and seed yield values of 2916 and 1828kg/ha, respectively were recorded for the 4.5g/l iron fertilizer treatment. Also, consumption of this fertilizer increased the number of fertile flowers which consequently, resulted in the increased number of mature pods and thus, improved shelling percentage, the 100-seed weight and finally, pod and seed yields. Furthermore, the use of 60kg/ha nitrogen fertilizer resulted in the highest pod and seed yields amounting to 2314 and 1376kg/ha, respectively. Results obtained in this research suggested 4.5g/l iron (6m²) and 60kg/ha nitrogen as the most suitable fertilizer management for peanuts grown under the region’s conditions.

REFERENCES


