EFFECT OF NUTRIENTS SUPPLY WITH FOLIAR APPLICATION ON GROWING DEGREE DAYS, PROTEIN AND FATTY YIELD OF CORN IN MEDITERRANEAN CONDITIONS

Yakup Onur KOCA

Adnan Menderes University, Faculty of Agriculture, Department of Crop Science, Aydın – 09100, Turkey

Corresponding author email: koca2002@hotmail.com

Abstract

Nutrients are essential for plant growth and soil that was found with high pH levels in alkaline character regions negatively affected the uptake of micronutrients (Zn, B, Mn, Cu, Co, Mg, Se, and Fe) with the exclusion of molybdenum. Current practices in attempts to solve this problem is to add nutrient fertilizers and natural hormone combinations via foliar. In this study nutrients and natural hormone combinations that could not be taken by roots were applied to the leaf and the effects on corn analyses. The experiment carried out in 2010 and 2011 was under in the field conditions in Aydın. Plant materials used in this experiment were: NK-Arma, 31G98, Kermes and 31D24 hybrid corn varieties which is cultivated commercially in Turkey. The fertilizer solutions included: a solution (1) containing auxin and zinc (Zn) foliar and a solution (2) containing boron (B) fertilizers were used. At the end of the final study it was determined that the yield of 168.8-260.0 g in cob had been obtained. Protein measurement revealed between 826-1505 kg.ha⁻¹, fatty yield was determined between 359-574 kg.ha⁻¹ in the total yield. We observed that solution 1 (auxin and Zn) and solution 2 (B) applications positively affected both the corn yield and the quality in this study. Additionally it was found that foliar applications prolonged corn's vegetative period and increased GDD average values of the vegetative period with Auxin, Zn and B applications. The highest cob yield, protein yield and fatty yield values were found in 31D24 and this genotype stood out from all other genotypes in the research.

Key words: corn, foliar application, GDD, zinc, auxin, boron.

INTRODUCTION

FAO estimations state that by 2050 the human population will have increased by 34% from today (Anonymous, 2011a). It is emphasized that to meet the expected increase in population, agricultural production must be increased by 70% (Anonymous, 2011b). This demand necessitates not only bigger cultivated areas, but more efficient sustainable usage of the cultivated areas already in production. Current agriculture practices have utilized non-arable fields (high pH, defective drainage, inadequate structure etc.). However high yield is only achieved when optimum conditions are put into practice (Fageria, 2002). Corn's primary production is for human consumption that is utilized fresh and for processed products starch, flour, cooking syrup and crisp. Corn's secondary production is for animal feed and industrial uses such as ethanol (Remison, 2005). High corn yield is possible by providing sufficient water and nutrients during the short growing stage. We know that large cultivated areas of current agricultural soils are alkali characterized (pH up to 7 or more) and that this soil type negatively affects uptake of micronutrients by plants in Mediterranean areas (Cakmak et al., 1999). It is observed that there are decreases in uptakes of micronutrients (Zn, B, Mn, Cu, Co, Mg, Se, and Fe) with the exception of molybdenum at high pH levels (Basta and Tabatabai, 1992; Alcântara and Camargo, 2001; Fageria, 2002). These micronutrients are essential (Benett, 1993; Marschner, 1995) for many vital activities in plants from protein synthesis to carbohydrate and oil cycle, from photosynthesis and chlorophyll to chloroplast structures and energy cycle (Welch, 1995; Rodriguez et al., 2000; Čeylan et al., 2009). Insufficient presence of one or more of these elements negatively impacts on yield and quality (Genç et al., 2002; Yassen et al, 2010; Zayed et al., 2011). The relationship between micronutrient application on crops in terms of
grain yield and quality of product is undeniable. (Hossain et al., 2008; Potarzycki and Grzebisz, 2009; Safyan et al., 2012). Micronutrient deficiencies observed in plants in regions under the effect of Mediterranean climate have high alkaline characterized soil structure due to high pH and low organic substance (Cakmak, 2010). In these situations due to saltiness and high pH nutrient fertilizers can ensure uptake of micronutrients. The addition of Zn, Mn, Cu, Co and B treated from leaf increase grain yield and protein rates. It is observed that Zn has maximum effect especially on protein amount and fractions (Toma et al., 1973). B element has significant roles in carbohydrate and protein metabolism, tissue differentiation, auxin and phenol metabolism, membrane permeability, pollen germination and pollen tube growth (Marschner, 1995). It is also proven that B has positive effects in improving the ratio of K/Na (in favor of plant) which is a significant parameter in decreasing Na uptake, increasing K uptake of plants from soil and tolerance to salt (Muhammed et al., 1987; Maathuis and Altmann, 1999).

The plants response to auxin changes the effect on cell metabolism to coordination of the physical structure decreasing falling leaves and plant aging with cellular effects being inclusive of increase in proton exchange and membrane load (Marre, 1977). Numerous experimental results have indicated that cell expansion occurs in acid medium with auxins being considered as the promoter of this acidification (Mounla et al., 1980; Rayle and Cleland, 1992; Yang et al., 2000). The numerous experiments show that cereal yield is influenced positively with auxin (Ahmad et al., 2007; Ahmad et al., 2008a; Ahmad et al., 2008b; Karimi et al., 2012).

The importance of micronutrients in crop production with increase of population demands is for high yielding cultivars and intensive cropping systems (Ernani et al., 2002). Nutrient interaction in extern soil characteristics is the most important factor affecting yields (Fageria and Baligar, 1997). For example retention of Zn is strongly influenced by pH, the higher the pH the greater the retention (Alcántara and Camargo, 2001) influenced by the metal concentration in the soil, (Basta and Tabatabai, 1992) the organic matter content and by the soil mineralogical characteristics. Nutrient insufficiencies cause plants’ ions to become unbalanced (Lewitt, 1980).

The aim of this study is to investigate nutrient mixture impact using leaf composted in the condition of Western Turkey (Mediterranean climate) agricultural activities with alkaline soil on the growth, development periods of corn plant, cob yield and protein yield and fatty yield.

MATERIALS AND METHODS

The research was carried out 2010 and 2011 during the main crop period for the region selected in what was considered a typical Mediterranean climate, hot summers and mild winters. Aydin, is located in west Turkey at 37° 44' N 27° 44' E and is 65 m above sea level. Initial results of soil analysis are shown in Table 1.

The experimental soil of the studied field contained a sandy loamy structure with alkaline characteristic and it was mixed with quite low amounts of organic matter. In terms of the micronutrients, soil had a high P level. Table 2 indicates the pattern of soil micronutrient levels in this experiment. As it is shown in this table, the highest levels of microelements were determined for Ca (2978 ppm) and Mg (594 ppm) of all investigated microelements. K with 176 ppm and Na with 101 ppm took the next place in the ranking. Further studies revealed Fe, Zn, Mn, Cu and B in lower amounts in the experimental soil respectively. Aydin region’s climate hot and dry in summers, warm and rainy in winters was selected and found to present the best average for a typical Mediterranean climate. Monthly temperature average and rainfall values were taken into account and these for the years 2010 and 2011 are presented in Table 3. Monthly temperatures were recorded during the corn growth, April-August as shown in the data in Table 3. This data indicates that the temperature was higher in the first year of experiment in comparison to the second year during the corn growth period. The exception for the across the board lower temperature during the second year was the month of July
2011. Gathered precipitation data for both years, during the months January through July showed higher precipitation in the first year in comparison to the second year.

Experimental design
The experiment was based on 4 repetitions inclusive of two factors using a split plot experimental design plan. The area of the Parcel used was determined to be 28 m² for each genotype. In addition parcels were set up as a control feature and not applicable for treatment.

Table 1. Results of experimental soil texture and chemical analysis

<table>
<thead>
<tr>
<th>Soil texture (%)</th>
<th>Organic matter (%)</th>
<th>P (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>Silt</td>
<td>Clay</td>
</tr>
</tbody>
</table>

1: Bouyoucos; 2: 1:2.5 Saturasyon; 3: Walkley-Black; 4: Olsen

(Bouyoucos G.J. 1962; Ayers and Westcot 1989; Walkley and Black 1934; Olsen et al. 1954).

Table 2. Some mineral content of soil.

<table>
<thead>
<tr>
<th>K (ppm)</th>
<th>Ca (ppm)</th>
<th>Mg (ppm)</th>
<th>Cu (ppm)</th>
<th>B (ppm)</th>
<th>Zn (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>176</td>
<td>2978</td>
<td>594</td>
<td>1.8</td>
<td>0.25</td>
<td>1.1</td>
</tr>
</tbody>
</table>

5: A. Asetat; 6: DTPA; 7: Azomethin-H

(Li et al. 2004; Lindsay and Norvell 1978; Sah and Brown 1997)

4 hybrid corn varieties were used as experiment material. The varieties nominated were 31G98, 31D24, Kermes and NK-Arma. We cultivated these varieties on 04/May/2010 and 20/May/2011. Our first seed emergence observation was conducted on: May 13th 2010 and the following year May 27th 2011. The irrigation plan considered and used (5 times) for the corn plants was based on the standard (5x100 mm) taking climate conditions and plant necessity into consideration. Standard fertilizer application for the soil was applied as 200 kg.ha⁻¹ pure nitrogen (80 kg.ha⁻¹ with 15-15-15 composite was applied immediately at the beginning of cultivation – 120 kg.ha⁻¹ with urea (H₂NCONH₂ before first water), 80 kg.ha⁻¹ phosphor (P₂O₅) and 80 kg.ha⁻¹ potassium (K₂O).

In this experiment the fertilization plan was carried out using foliar forms when 6-8 leaves where observed on each plant. Fertilizer was supplied using 0.150% of total mixed nutrients. Furthermore, actual leaves compost fertilizing was applied through the experiment. Fertilizer application was performed June 6th 2010 in the first year and June 28th 2011 the second year. Foliar fertilizers were used in the study. The utilized fertilizer in this study was procured from a local company: Biokim Company (Izmir, Turkey).

Fertilizer combinations:
Solution 1 (containing auxin (growth hormone) and 8% soluble Zn): Increases membrane permeability and promotes the uptake of nutrients. Additionally these conditions increase the resistance of plants to pests and diseases. The nutrient mixture has a positive effect on the plant enzyme system and was found to encourage amino acid and carbohydrate synthesis.

Solution 2 (containing 10% soluble B): It is recommended against boron deficiency in the soil. Boron deficiency can cause to reduction in spike and grain. It is suggested these nutrient mixture can use boron deficiency conditions in the soil.

Zachary (1999) noted that plant development subjected to stress of certain extreme
temperature ranges either too high or too low results in stress during the period of development. It was reported that the value of temperature in the range of: 10°C and 30°C for corn plants created optimum conditions with rapid development of the plant at temperatures around 30°C. Many researchers have developed the following formula to calculate GDD values for corn and determined using the following equilibriums according to Cross and Zuber (1972) and in Germany et al. (1996) in their previous studies.

$$GDD = \left( \frac{T_{\text{max.}} + T_{\text{min.}}}{2} \right) - T_{\text{base}}$$

- **Tmax.**: Daily maximum temperature (up limit 30°C)
- **Tmin.**: Daily minimum temperature (down limit 10°C)
- **Tbase**: for corn 10°C

In order to understand the interactive effects of daily temperature variations on plant growth we observed and recorded the temperature during the two years to better understand the relationship between corn plant growth and daily effective temperature, GDD values. These were calculated to clearly explain how the daily range of temperature of both upper and lower limits affects growth and ultimately yield.

<table>
<thead>
<tr>
<th>Months</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td>37</td>
</tr>
<tr>
<td>May</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>June</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>July</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>August</td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td>September</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Aggregate (total)</td>
<td>0</td>
<td>29</td>
</tr>
</tbody>
</table>

The number of days that temperature values exceeded the limit value for C4 plant (Stewart et al., 1998; Crafts-Brandner and Salvucci, 2002) is presented in Table 4. Data showed lower restricted pointed at 10°C, whereas upper point indicated at 37.5°C and critical upper at 40°C. Table 4 indicated of number of days that temperature exceeded the limit of range during the two years of this experiment. The lower limit in temperature of 10 °C, the upper limit of 37.5°C and 40°C is taken as the critical upper limit (Stewart et al., 1998; Crafts-Brandner and Salvucci 2002).

Per cob yield was measured by taking their average of 20 cobs from parcel. Protein and oil content of corn grain were analysed by using NIRS-FT (Bruker MPA) (Gislum et al., 2004). Plant samples were gathered by weighing (90 g) as uniformly as possible in mini sample cups with a depth of approximately 2.8 cm and a diameter of 9 cm. Samples were analysed and outcome results were used to calculate protein and oil yield by the following formulas.

- **Oil yield (kg ha⁻¹)** = \(\frac{\text{Oil content (%) × Grain yield (kg.ha⁻¹)}}{100}\)
- **Protein yield (kg ha⁻¹)** = \(\frac{\text{Protein content (%) × Grain yield (kg.ha⁻¹)}}{100}\)

**Statistical Analyses of Data**

All the plant data collected from all treatments were statistically analysed using the TARİST package software (Açıkgöz et al., 1994). Data was used in attempt to determine the interactive effects of foliar fertilizers on varieties.

**RESULTS AND DISCUSSIONS**

Least Square means of measured parameters was calculated through variance analysis for each. It was found that genotype and fertilizer application provided significant different results in all varieties. We observed however a significant difference in interaction effects between the individual genotype, fertilizer application and the interaction effects of years of application on protein yield. Data is separated according to years and evaluated in Table 6, 7 and 8. LSD values of the important ones among variation resources are presented under the Tables.

GDD values of corn varieties were calculated at the end of different foliar fertilizer applications and are presented in Table 5. It was found that averages of varieties were close to each other. 31G98 genotype was found to have 1904 varieties which make it the highest number of varieties. This is followed by NK-Arma (1874), 31D24 (1865) and Keremes (1854) varieties. It was found that Auxin and Zn addition (1894) application was higher than Control (1881) and Boron (1856) applications were found to be...
lower than control. Obtained values which were found to be higher than the values determined by Kara (2011), in accordance with the values determined by Koca et al. (2010), and lower than the values determined by Roth and Yocum (1997).

Based on results, we would suggest that only auxin and Zn addition extended vegetation period of corn in this study. Fertilizer impact increased both vegetative and generative periods of corn. Boron application only increased in vegetative period. Our data indicated that GDD in corn was related with some growth parameters in many researches (Teal et al., 2006; Warrington and Kanemasu, 1983a; Warrington and Kanemasu, 1983b; Warrington and Kanemasu, 1983c) directly with grain yield in many studies (Baez-Gonzalez et al., 2002; Bollero et al., 1996) and it can change dramatically with the effect of environmental factors (Koca, 2009).

Application of some nutrients and hormones from leaf ensured the reduction of stress conditions and reactions. To attain a more positive result a more optimum environment was attempted to be created. In some applications, the period for a plant to reach the growing stage was extended. This result is in parallel with the result obtained by Thomason et al. (2007). When the results are analysed in terms of years, it revealed that 2010 was warmer than 2011. Heat sum of all of the varieties were higher in the first year. However, we determined that the second year was cooler than the year before, temperature values presented in Table 4 supports these findings. While daily minimum temperature was never below 10°C during application months, it fell below this level twice in 2011 and maximum temperature values were over limit values even more often.

Cob yield was analysed and it was indicated that the differences between first year varieties and applications were significant. 31D24 genotype products the highest yield value with Auxin, and Zn addition and B applications. There was also demonstrated the higher means values of solution 1 and solution 2 than control. Difference between these two applications was found to be insignificant. Therefore, the highest grain yield in the first year was obtained in 31D24 genotype, from B (260.0 g) application. This is followed Kermes genotype by auxin and Zn addition applications on (255.1 g).

Differences between varieties and applications were determined to be insignificant in the second year (2011). All applications provided greater cob yield than control in 31D24 genotype. Differences between the applications weren’t significant. The highest value was obtained from 31D24 genotype auxin and Zn addition (248.6 g) applications in the second year (2011). This is followed by B (232.9 g) applications. Results of the two years showed that 31D24 had high yield averages in comparison to the other studied genotypes.

In the first two years of the study, almost all of the applications resulted in high yields in control parcels. In particular B, auxin and Zn addition applications had significant positive effects on corn. It is stated that as a result of the soil analysis in the study, B element was deficient (Table 2). B deficiency is common in this soil. In terms of higher pH (8.4) plants are not able to uptake certain nutrients from these types of soil conditions despite sufficient nutrients being present in the soil. This decrease in ability to take in nutrients from soil through plant roots (Basta and Tabatabai, 1992; Alcântara and Camargo, 2001; Fageria, 2002) explains the reason why all the applications gave higher yields than control and it is in parallel with the results of the studies of Toma et al. (1973), Wojcik (2006), Usenik and Stampar (2007), Hossain et al. (2008), Potarzycki and Grzebisz (2009) and Safyan et al. (2012).

The GDD values indicated that fertilizer applications extended the plant’s vegetation period. However Auxin and Zn application ensured increase in both vegetative and generative periods, B application was found to increase only in vegetative period.

All these applications ensured yield values can be called high. It can be suggested that there is relationship between GDD values and grain yield (Bollero et al. 1996; Baez-Gonzalez et al. 2002). This obtained result is in parallel with the study of Bauder and Randall (1982) and Duchon (1986).

Both two years of the experiments were compared. It was found that the first year’s (2010) temperature values were higher than the second year (2011). It could be reason for the
first year’s GDD values (1885) being higher than the second year (1864). It can be suggested that the difference between the two years may be due to an emerged generative period. The first year average in yield value (222.4 g) was higher than the second year (212.5 g). These results were calculated to be due to increased temperature’s effect on grain yield of corn (Fraisse et al., 2001).

Protein yield values of corn varieties after different foliar fertilizer applications are presented in Table 7. Almost all of the applications in the first year increased protein yield. 31D24 showed the highest value in auxin and Zn addition application. The value was found to be higher and statistically more significant than the other applications (solution 2 and control). Increase of protein yield by auxin and Zn application and amino acid application was an expected result. This result is in parallel with the studies of Toma et al. (1973), Ahmad et al. (1994), Tejada and Gonzalez (2003), Delfine et al. (2005).

31D24 showed the highest value similar with the first year. Genotype was found to be different from others. Whereas 31G98 genotype in the second line only auxin and Zn applications demonstrated high protein yield average in the second year. Auxin and Zn application had positive effects in both years. This result is in parallel with the results of Özer (1994) and Ceylan et al. (2009).

Fatty yield values of different corn varieties, obtained from different foliar fertilizer applications are presented in Table 8. Generally all of the applied nutrient mixtures increased fatty yield of corn. But only genotype was determined to be significant on fatty yield. The highest yield value was showed from 31D24 genotype auxin and Zn applications.

31D24 genotype was determined as the genotype that had the highest fatty yield as well as the protein yield.

The second year all of the applications increased fatty yield. Auxin and Zn addition and B applications gave the higher than control values. In terms of varieties, 31G98 genotype produced highest fatty yield on average. However, all of the varieties except Kermes showed high fatty yield values. The Kermes genotype throughout the experiment suggested that application of B has a very positive effect on fatty yield in all genotypes. It was emphasized in many researches that B had positive effects on grain quality (Rerkasem and Jamjod 1997 and Soylu et al. 2004).

CONCLUSIONS

Regardless to cultivars auxin, added Zn and B have positive effects to grain yield and quality of corn. At the end of soil analysis, it was determined that B level was insufficient; this explains the positive effect of 10% water-soluble B (solution 1) on yield and quality. Zn contributed to increasing grain yield and quality values with auxin and Zn (solution 2). Calculated GDD values showed that Zn only with auxin extends vegetation period. Application increased both vegetative and generative periods for a few days. Boron application increased vegetative period.

31D24 genotype became prominent in terms of grain yield (crop yield) and quality (protein and fatty yield). The genotype gave positive reactions to almost all of the applications. It especially gave high values in auxin, Zn addition and B applications. The genotype showed high values in control application which indicates their quick and positive responses to given nutrients.

We noted however that especially in quality parameters, varieties gave different reactions to applications in different years. It is clear that many environmental, physiological, cellular, metabolic and molecular processes contribute to the relative deposition of protein and fatty in the developing corn kernel (Douglas and Robert, 1991). Obtained results were in accordance with this.

As a result, it can be said that increase in soil pH has negative effects on plant’s taking nutrients. It was seen that even though nutrients (Zn, B, Mn, Cu, Co, Mg, Se and Fe) exist in soils that have high pH, they cannot be taken up by the plant. It can be said that, application of nutrients that cannot be taken from soil that application to the leaf has a positive effect.
Table 5. Result of GDD (Growing Degree Days) value for different nutrient application in 2010 and 2011

<table>
<thead>
<tr>
<th>Year</th>
<th>NK-Arma</th>
<th>31G98</th>
<th>Kermes</th>
<th>31D24</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Veg Gen WGP</td>
<td>Veg Gen WGP</td>
<td>Veg Gen WGP</td>
<td>Veg Gen WGP</td>
<td>Veg Gen WGP</td>
</tr>
<tr>
<td>2010</td>
<td>732 1203 1935</td>
<td>705 1244 1949</td>
<td>732 1173 1905</td>
<td>695 1180 1875</td>
<td>716 1200 1916</td>
</tr>
<tr>
<td>2011</td>
<td>740 1172 1912</td>
<td>697 1215 1912</td>
<td>740 1145 1885</td>
<td>692 1175 1867</td>
<td>717 1177 1894</td>
</tr>
<tr>
<td></td>
<td>736 1188 1924</td>
<td>701 1230 1931</td>
<td>736 1159 1895</td>
<td>694 1178 1871</td>
<td>717 1189 1905</td>
</tr>
<tr>
<td>2010</td>
<td>Solution (1) Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>718 1128 1846</td>
<td>723 1240 1996</td>
<td>681 1167 1848</td>
<td>700 1188 1888</td>
<td>719 1169 1888</td>
</tr>
<tr>
<td></td>
<td>729 1104 1833</td>
<td>744 1160 1840</td>
<td>681 1162 1848</td>
<td>698 1186 1884</td>
<td>713 1173 1886</td>
</tr>
<tr>
<td>2010</td>
<td>Solution (2) Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>718 1172 1890</td>
<td>697 1215 1912</td>
<td>687 1153 1834</td>
<td>697 1165 1862</td>
<td>700 1168 1868</td>
</tr>
<tr>
<td></td>
<td>723 1139 1862</td>
<td>708 1223 1931</td>
<td>687 1162 1848</td>
<td>695 1175 1869</td>
<td>703 1179 1881</td>
</tr>
<tr>
<td>2010</td>
<td>Control Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>723 1168 1890</td>
<td>717 1223 1940</td>
<td>691 1155 1856</td>
<td>696 1176 1872</td>
<td>712 1171 1883</td>
</tr>
<tr>
<td></td>
<td>734 1130 1865</td>
<td>729 1149 1878</td>
<td>717 1123 1949</td>
<td>701 1160 1861</td>
<td>695 1179 1875</td>
</tr>
<tr>
<td></td>
<td>Year average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>729 1149 1878</td>
<td>718 1123 1949</td>
<td>695 1179 1875</td>
<td>711 1180 1891</td>
<td>711 1180 1891</td>
</tr>
</tbody>
</table>

Veg.: Vegetative period, Gen.: Generative period, WGP: Whole growth period

Table 6. Result of cob yield (g) value for different nutrient application in 2010 and 2011

<table>
<thead>
<tr>
<th>Year</th>
<th>NK-Arma</th>
<th>31G98</th>
<th>Kermes</th>
<th>31D24</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>225.6 231.3 255.1</td>
<td>246.6 239.7</td>
<td>208.7 230.2</td>
<td>248.6 252.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solution (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>237.4 231.8 207.9</td>
<td>260.0 234.3</td>
<td>228.4 206.9</td>
<td>232.9 219.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solution (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>201.6 191.2 199.1</td>
<td>211.4 188.1</td>
<td>211.5 185.0</td>
<td>197.9 185.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>221.5 218.1 207.2</td>
<td>239.3 224.9</td>
<td>208.4 207.4</td>
<td>226.5 210.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>221.5 218.1 207.2</td>
<td>239.3 224.9</td>
<td>208.4 207.4</td>
<td>226.5 210.0</td>
<td></td>
</tr>
</tbody>
</table>

LSD (0.05) Genotype*Application: 12.7

Table 7. Result of protein yield (kg.ha⁻¹) value for different nutrient application in 2010 and 2011

<table>
<thead>
<tr>
<th>Year</th>
<th>NK-Arma</th>
<th>31G98</th>
<th>Kermes</th>
<th>31D24</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>943 1174 1223</td>
<td>1505 1211</td>
<td>1000 1232 1131</td>
<td>1387 1188</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solution (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1076 1264 1041</td>
<td>1218 1150</td>
<td>1086 1113 961</td>
<td>1236 1099</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solution (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1075 1080 862</td>
<td>1303 1080</td>
<td>1092 1126 1004</td>
<td>1138 1090</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1031 1173 1042</td>
<td>1342 1147</td>
<td>1059 1157 1032</td>
<td>1254 1126</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1031 1173 1042</td>
<td>1342 1147</td>
<td>1059 1157 1032</td>
<td>1254 1126</td>
<td></td>
</tr>
</tbody>
</table>

LSD (0.05) Genotype x Application: 164.0

Table 8. Result of fatty yield (kg.ha⁻¹) value for different nutrient application in 2010 and 2011

<table>
<thead>
<tr>
<th>Year</th>
<th>NK-Arma</th>
<th>31G98</th>
<th>Kermes</th>
<th>31D24</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>507 520 483</td>
<td>566 519</td>
<td>515 568 489</td>
<td>570 536</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solution (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>515 574 453</td>
<td>491 508</td>
<td>519 534 449</td>
<td>553 514</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solution (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>490 462 359</td>
<td>508 455</td>
<td>497 498 450</td>
<td>488 483</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>504 519 432</td>
<td>522 494</td>
<td>510 533 463</td>
<td>537 511</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>504 519 432</td>
<td>522 494</td>
<td>510 533 463</td>
<td>537 511</td>
<td></td>
</tr>
</tbody>
</table>

LSD (0.05) Genotype: 39.0

REFERENCES


