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# Influence of Different Nitrogen Applications on Mineral Content of Fruits in Apple

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**ABSTRACT**

The experiment was carried out during 2009 - 2011 period under the Yalova location. The aim of this experiment to determine with different nitrogen doses (0, 30, 60, 90 g tree-1) and application times (Application 1: It starts in early spring before the buds burst and finish 40-45 days ago from harvest, Application 2: It starts in early spring before the buds burst and finish 40-45 days ago from harvest and postharvest foliar nitrogen application, Application 3: It starts after blooming and finish 40-45 days ago from harvest, Application 4: It starts after blooming and finish 40-45 days ago from harvest and postharvest foliar nitrogen application) effects on fruit mineral composition on Golden Sel-B apple cultivar. The experiment was designed according to randomized block design with three replication. According to results increasing doses of nitrogen increased the nitrogen and copper content and decreased calcium content but did not influence the phosphorus, potassium, magnesium, iron, manganese, zinc and boron content of fruits. Nitrogen application times were non-significant for mineral content of fruits.

**Keyword:** Apple, nitrogen, fertilization, mineral content

## INTRODUCTION

Turkey is one of the limited countries in the world in terms of both species and types of horticultures that is located within the mild temperature zone. Apple has been the most important fruit in Turkey in the historical process [1]. Cultivated apple is grown in almost every region of the country [2].

The global production volume of apples is approximately 80 million tons per annum according to the latest data. While China realizes nearly half of this production on its own, Turkey ranks the third globally in terms of apple production volume as one of the significant producer countries [3].

Establishing the orchard in agreeable climate and soil conditions and applying all cultivation applications with sufficient and correct techniques at the right time, carries great importance in terms of increasing and preserving the productivity and quality of plants. Among these said applications, the matter of fertilization for the sufficient nutrition of the plants very significant.

It is stated that negative consequences in the intake of certain nutrition elements occur as a function of increased fertilizer use [4].

The nutritional elements contents of several organs of various plants such as leaves, fruits and leaf stems are good indicators for the quantity and quality of the final product that is produced [5].

This study examines the effects of different fertilizer amounts and fertilization times on the mineral nutrient content of fruits by means of mainly using the fertigation technique on Golden Sel B apple variety grafted on M9 rootstock.

## MATERIALS AND METHODS

This experiment was carried out between 2009 and 2011 for a period of 3 years in Yalova location. The fertilization practices were continued for three years as part of the study and the values pertaining to mineral material contents of fruits were received in the final year of the study. Some characteristics of the soil of the trial area are shown in the Table 1.

As Kacar [6] put it, the samples were prepared for analysis in the laboratory. The fractions of sand, clay and silt were identified using the hydrometer method and the texture classes were determined [7]. pH degree was quantified by means of pH-metre with glass electrode in soil-water mixture in ratio 1:2,5 and electrical conductivity was measured with EC-metre in the same mixture [8]. Çağlar [9] put it that the lime ratio of the samples was identified by means of Scheibler calcimetre; content ratios in terms of organic substances, on the other hand, was identified using the modified method of Walkley-Black [10]. While available phosphorus was identified with the method reported by Olsen et al. [11], 1 N ammonium acetate (pH 7) extraction was used for the quantification of the available potassium ratio [8].

The experiment was conducted in 3 repetitions according to the randomized blocked factorial experiment design and 5 trees were used on each parcel.

4 different doses of nitrogen were administered at 4 different application times during the experiment which lasted for three years. The doses of nitrogen were determined as below.

N0= 0 g/tree
N1= 30 g/tree
N2= 60 g/tree
N3= 90 g/tree

The application times for the fertilizer with nitrogen were performed as below:

Application (A1): Started in early spring before the buds were burst (March) and ended 40-45 days ago from harvest (August). Fertilization was performed using the fertigation method.

Application (A 2): Started in early spring before the buds were burst (March) and continued 40-45 days ago from harvest (August) with the fertigation method and another foliar nitrogen application was administered after harvest, before defoliation (November).

Application (A 3): Started after blooming (end of April-beginning of May) and ended 40-45 days ago from harvest (August). Fertilization was performed using the fertigation method.

Application (A 4): Started after blooming (end of April-beginning of May) and continued 40-45 days ago from harvest (August) with the fertigation method and another foliar nitrogen application was administered after harvest, before defoliation (November).

The postharvest nitrogen fertilizer applications were administered by means of spraying the 5 % urea solution on the leaves. Nitrogen was applied ammonium nitrate fertilizer containing 33% nitrogen during other periods. The fertilizer was applied by means of the fertigation method.

Fruit samples were collected during the harvest period and made ready for analysis [12]. The samples were subjected to washing, drying and grounding procedures after which they were extracted using the fresh-burning method [8]. The total levels of potassium, calcium, magnesium, iron, zinc, manganese and copper in the derived plant extracts were measured in atomic absorption spectrophotometer while the levels of phosphor in the same extracts were measured calorimetrically by using the vanado molibdophosphoric acid method[13]. In the samples that were burned dry, the total levels of boron were identified via the method Azomethine-H [14] while the levels of nitrogen were determined via the Kjedahl method [12].

Variance analyses were performed on the results obtained from the experiment established according to randomized blocked factorial experiment design and the least significant differences (LSD) was calculated and the differences were indicated on the results.

## RESULTS AND DISCUSSION

The data on macro-elements obtained in order to determine the effects of nitrogen application at various amounts and times on the mineral matter content of fruit samples are provided in Table 2 while the data on micro-elements are provided in Table 3.

An examination of the results shows that no differences occurred in the derived values with respect to the differences in the application time of nitrogen. It is seen that the differences occurred as a function of nitrogen doses.

The variance analysis conducted on the total nitrogen values derived from fruit samples showed differences at a significance level of 1% in parallel with nitrogen doses. While the lowest nitrogen values were identified at the level of N0 (control - no nitrogen application) and at the dose of N1 (application of 30 g nitrogen / tree), the nitrogen contents of fruits increased in parallel with rising nitrogen doses. The highest values were obtained at the dose of N3 (application of 90 g nitrogen / tree).

In a study conducted on Elise variety of apple, nitrogen and calcium were administered in the form of spray and it was concluded that the increasing amounts of nitrogen significantly increased fruit nitrogen contents, as well [15]. In a study conducted to demonstrate the effects of nitrogen on Fuji variety of apples, nitrogen at doses of 0, 50, 100 and 200 kg ha-1 was applied to trees for a period of nine years and it was demonstrated in year 3 of the study that increased nitrogen doses resulted in a linear increase in the nitrogen contents of fruits [16].

As part of the assessment conducted on the other macro-nutrition elements, it was identified that nitrogen applications did not have any effects on the phosphorus, potassium and magnesium contents of fruits whereas it had an effect on calcium content. The effect on calcium content that was identified was due to the doses of nitrogen and the lowest calcium content was obtained as a result of the highest nitrogen dose application.

A study conducted on apples reported that nitrogen fertilization application at increasing doses did not result in any differences in the phosphor contents of apples [17]. It was reported that no differences were seen in the minerals other than nitrogen in fruit mineral contents even though the application of nitrogen through the soil and leaf on Golden Delicious variety of apples had various effects on the yield and the mineral contents of leaves [18]. In a study conducted on kiwifruit, nitrogen was administered at increasing rates along with potassium and it was delivered at doses of 0, 30, 60 and 90 kg N per hectare. The researchers specified that they found the lowest level of calcium with the application of 90 k N per hectare [19]. It was reported that there was an increase in the fruit calcium contents as a function of nitrogen fertilization at increasing amounts in the Fuji variety of apples in Brazil [16]. Various studies conducted on macro-nutrition components demonstrate results that are similar to our results.

When the micro-nutrition element contents of fruits were examined, it was seen that the time of application did not have any effects on the element contents. With respect to nitrogen doses, it was identified that increasing doses of nitrogen did not have any effects on the contents of iron, manganese, zinc and boron whereas it resulted in a statistically significant difference of 5% on copper contents. While the lowest value for copper was obtained in the control group with no nitrogen application, the copper contents of fruits in groups that received nitrogen application were found to be at higher values.

In a study conducted to examine the effects of nitroge-

**Table 1.** Some physical and chemical properties of the experiment area soil

| Depth (cm) | Texture | pH 1:2,5 soil:water | EC 1:2,5 soil:water (mmhos/ cm) | $CaCO_3$ (%) | Organic matter (%) | Total nitrogen (%) | Available phosphor (mg $kg^{-1}$) | Exchangeable cations (me 100 $g^{-1}$) | | | Available micro nutrients (mg $kg^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | K | Ca | Mg | Fe | Mn | Zn | Cu |
| 0-20 | SCL | 7.70 | 0,23 | 1,62 | 2,98 | 0.11 | 18,90 | 0.52 | 26,54 | 2,83 | 11,82 | 28,83 | 1,19 | 9,24 |
| 20-40 | SCL | 7.60 | 0,21 | 0,61 | 2,47 | 0.10 | 14,20 | 0.38 | 26,39 | 1,94 | 13,00 | 28,02 | 0,86 | 8,49 |

**Table 2.** Effect of nitrogen application at different doses and times on the fruit macro-mineral matter content in apple

| | Nitrogen doses / Application times | N0 | N1 | N2 | N3 | Average |
|---|---|---|---|---|---|---|
| Total N (mg 100 g$^{-1}$) | A1 | 209,67 | 223,83 | 227,33 | 266,83 | 231,92 |
| | A2 | 209,67 | 218,22 | 235,67 | 252,67 | 229,06 |
| | A3 | 209,67 | 206,06 | 245,39 | 273,00 | 233,53 |
| | A4 | 209,67 | 224,44 | 223,78 | 257,11 | 228,75 |
| | Average | 209,67 c** | 218,14 c | 233,04 b | 262,40 a | |
| Total P (mg 100 g$^{-1}$) | A1 | 78,50 | 82,50 | 89,00 | 81,17 | 82,79 |
| | A2 | 78,50 | 87,70 | 74,60 | 85,10 | 81,48 |
| | A3 | 78,50 | 86,40 | 83,77 | 82,47 | 82,78 |
| | A4 | 78,50 | 91,63 | 74,63 | 79,83 | 81,15 |
| | Average | 78,50 | 87,06 | 80,50 | 82,14 | |
| Total K (mg 100 g$^{-1}$) | A1 | 573,86 | 590,24 | 626,73 | 570,65 | 590,37 |
| | A2 | 573,86 | 549,74 | 535,83 | 537,48 | 549,23 |
| | A3 | 573,86 | 559,92 | 576,30 | 610,42 | 580,12 |
| | A4 | 573,86 | 591,35 | 547,10 | 590,73 | 575,76 |
| | Average | 573,86 | 572,81 | 571,49 | 577,32 | |
| Total Ca (mg 100 g$^{-1}$) | A1 | 28,22 | 25,40 | 28,66 | 22,78 | 26,26 |
| | A2 | 28,22 | 27,46 | 26,90 | 24,81 | 26,85 |
| | A3 | 28,22 | 25,81 | 23,39 | 24,95 | 25,59 |
| | A4 | 28,22 | 26,83 | 23,99 | 22,71 | 25,44 |
| | Average | 28,22 a* | 26,37 ab | 25,74 ab | 23,81 b | |
| Total Mg (mg 100 g$^{-1}$) | A1 | 39,24 | 38,06 | 34,18 | 38,03 | 37,38 |
| | A2 | 39,24 | 36,99 | 39,31 | 33,68 | 37,31 |
| | A3 | 39,24 | 32,90 | 37,54 | 39,65 | 37,33 |
| | A4 | 39,24 | 36,21 | 34,31 | 35,92 | 36,42 |
| | Average | 39,24 | 36,04 | 36,34 | 36,82 | |

The differences between the means indicated by different letters is important on a 1% and 5% level, (**) P<0,01, (*) P<0,05

**Table 3.** Effect of nitrogen application at different doses and times on the fruit micro-mineral matter content in apple

| | Nitrogen doses / Application times | N0 | N1 | N2 | N3 | Average |
|---|---|---|---|---|---|---|
| Total Fe (mg 100 g$^{-1}$) | A1 | 1,07 | 0,97 | 0,95 | 1,11 | 1,03 |
| | A2 | 1,07 | 1,07 | 1,01 | 1,00 | 1,04 |
| | A3 | 1,07 | 1,02 | 0,99 | 1,04 | 1,03 |
| | A4 | 1,07 | 0,93 | 0,95 | 0,84 | 0,95 |
| | Average | 1,07 | 1,00 | 0,98 | 1,00 | |
| Total Mn (mg 100 g$^{-1}$) | A1 | 0,24 | 0,22 | 0,24 | 0,23 | 0,23 |
| | A2 | 0,24 | 0,24 | 0,24 | 0,21 | 0,23 |
| | A3 | 0,24 | 0,21 | 0,24 | 0,25 | 0,23 |
| | A4 | 0,24 | 0,24 | 0,22 | 0,22 | 0,23 |
| | Average | 0,24 | 0,23 | 0,23 | 0,23 | |
| Total Zn (mg 100 g$^{-1}$) | A1 | 0,64 | 0,77 | 0,76 | 0,80 | 0,74 |
| | A2 | 0,64 | 0,84 | 0,81 | 0,74 | 0,76 |
| | A3 | 0,64 | 0,73 | 0,60 | 0,85 | 0,71 |
| | A4 | 0,64 | 0,51 | 0,65 | 0,60 | 0,60 |
| | Average | 0,64 | 0,71 | 0,71 | 0,75 | |
| Total Cu (mg 100 g$^{-1}$) | A1 | 0,294 | 0,309 | 0,316 | 0,326 | 0,312 |
| | A2 | 0,294 | 0,337 | 0,303 | 0,298 | 0,308 |
| | A3 | 0,294 | 0,298 | 0,306 | 0,322 | 0,305 |
| | A4 | 0,294 | 0,315 | 0,290 | 0,303 | 0,301 |
| | Average | 0,294 b* | 0,315 a | 0,304 ab | 0,312 a | |
| Total B (mg 100 g$^{-1}$) | A1 | 1,33 | 1,28 | 1,31 | 1,39 | 1,33 |
| | A2 | 1,33 | 1,25 | 1,28 | 1,26 | 1,28 |
| | A3 | 1,33 | 1,26 | 1,17 | 1,36 | 1,28 |
| | A4 | 1,33 | 1,27 | 1,12 | 1,43 | 1,29 |
| | Average | 1,33 | 1,27 | 1,22 | 1,36 | |

The differences between the means indicated by different letters is important on a 1% and 5% level, (**) P<0,01, (*) P<0,05

nous and phosphorous fertilization on the mineral content of leaves, 0, 150, 300 and 450 g nitrogen per tree was administered. The researchers found the lowest copper content in leaves at the control dose at the end of the application and reported that the values of copper they found with increasing nitrogen rates pertained to the same group[20] . In another study, it was expressed that nitrogenous fertilizer increased the content of copper in leaves of apple trees [21]. A study conducted on Deveci variety of pear application nitrogen at different times and increasing amounts and then attempted to determine the effects of application on the nutrition element contents of leaves. It was identified that no differences occurred in micro-elements contents as a function of application times, the zinc contents decreased and copper contents increased as a function of increasing nitrogen doses whereas the boron contents remained unchanged [22].

## CONCLUDING COMMENTS

In conclusion, the study we conducted was aimed at identifying the changes in mineral materials, one of the influencing factors for nutritional value of fruits, via application of nitrogen fertilization at different doses and times. No differences occurred in the mineral contents of fruits as a result of the application of nitrogen at different times. Additionally, the nitrogen and copper contents of fruits were increased as a function of the increase in the amount of nitrogenous fertilizer while there was a decrease in the calcium contents. The increased nitrogen amounts had no increasing or decreasing effects on the elements other than the ones mentioned.

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