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# EFFECT OF MINERAL AND BIOLOGICAL NITROGEN FERTILIZATION ON THOMPSON SEEDLESS GRAPE TRANSPLANTS. II. EFFECT ON LEAF MINERAL CONTENT.

**BY**

**Shawky, I. *; EL-Shazly, S. *; EL-Gazzar, A. *; Selim, S. ** and Noha Mansour ***

* Dept. of Horticulture, Fac. of Agric., Ain Shams Univ.
** Dept. of Microbiology, Fac. of Agric., Ain Shams Univ.

## ABSTRACT

A pot experiment was carried out in 2001 and 2002 seasons on Thompson Seedless grape transplants to study the effect of two sources of nitrogen fertilizers (mineral and biological) on leaf mineral content of transplants. The experiment included three levels of mineral nitrogen ($M_1$=zero, $M_2$=5 and $M_3$=10g N/plant/year) and four levels of biological nitrogen ($B_1$=zero, $B_2$=50, $B_3$=100 and $B_4$=200ml) of liquid culture of free living nitrogen fixation bacteria *"Azotobacter chroococcum"*. Thus, the study is a factorial experiment in a randomized complete block design. Generally in both the two seasons levels of mineral and biological nitrogen affected mineral content in leaves (blades & petioles) and the promising levels were ($M_2$) from mineral and ($B_3$) & ($B_4$) for biological levels. The interaction between mineral and biological fertilization indicated that in both the two seasons, fertilizing with mineral nitrogen alone [treatments ($M_2$ x $B_1$) and ($M_3$ x $B_1$)]increased mineral content of nitrogen, phosphorus and potassium compared with unfertilized transplants [treatment ($M_1$ x $B_1$) ]. However, fertilizing with mineral nitrogen alone had no promising effect on iron, zinc and manganese. On the other hand, fertilizing with biological nitrogen alone [treatments ($M_1$ x $B_2$), ($M_1$ x $B_3$) and ($M_1$ x $B_4$) ] increased mineral content compared with unfertilized transplants and the promising biological treatment was ($M_1$ x $B_3$) in the two seasons. When combining mineral nitrogen with biological nitrogen, higher values were obtained especially when combining the second or the third levels of mineral nitrogen with any different rate of biological nitrogen especially levels $B_3$ and $B_4$. Treatments ($M_2$ x $B_3$), ($M_2$ x $B_4$) and ($M_3$ x $B_4$) gave the highest values for N, P, K, Fe, Zn, Mn.

In other words, inoculation of nitrogen fixation bacteria *"Azotobacter chroococcum"* to the rhizosphere can provide a part of nitrogen requirements of grape transplants and combining mineral with biological nitrogen more increasing effect on mineral content of transplants was obtained than adding any form alone and the recommended treatment was ($M_2$ x $B_3$)

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**Key words:** Thompson Seedless, grape, mineral nitrogen, mineral content,N,P. K, Fe, Zn, Mn.

## INTRODUCTION

The free nitrogen fixation bacteria such as *Azotobacter chroococcum* and *Azospirillum sp.* can be used as a biofertilizer to provide some nitrogen requirements to agriculture plants. This method of fertilization was tested to know how much nitrogen and possibly other nutrients can be affected by this biofertilizer. In this respect, research with biofertilization indicated that this method affect nutrient content in treated plants. Mahmoud and Mahmoud (1999) found that the application of a mixture of "*Azotobacter chroococcum*" isolates and "*Bacillus megatarium*" isolates to peach seedlings, increased leaf N content compared with the control plants. On the other hand, all biofertilizer treatments did not affect P and K % in the treated plants.Moreover, Sharma (2000) found that, the highest content of N, P, Zn, Cu and Fe in leaves of apple seedling was recorded from the dual inoculation with "*Azotobacter chroococcum*" and "*Glomus fasciculatum*".

Thus the main goal of this work is to study the effect of two sources of nitrogen fertilizer (mineral and biological) on leaf mineral content of Thompson Seedless grape transplants.

## MATERIALS AND METHODS

The present study was conducted throughout two successive seasons (2001 and 2002) to investigate the effect of two sources of nitrogen (mineral and biological) on mineral content of Thompson Seedless (*Vitis vinifera* L.) grape transplants.All transplants were growing in a saran green house, Faculty of Agriculture, Ain Shams Univ., Shoubra EL- Khaima, Egypt.

One- year- old transplants were planted in a plastic containers filled with sandy loam soil(about 22 kg/container). The physical and chemical compositions of the soil are shown in Table (1)

Ammonium sulphate (20.5%) was used as mineral nitrogen fertilizer. Mineral nitrogen treatments included three levels of nitrogen namely ($M_1$=zero, $M_2$=5 and $M_3$= 10g N/plant/year). Each nitrogen level was added at 20 applications at ten days intervals during the growing season from March to September in each season.

Biological nitrogen fertilizer involved a mixture of two local strains ($L_4$ and $L_6$) of nonsymbiotic nitrogen fixers " *Azotobacter chroococcum*". The biological nitrogen treatments included four levels of nitrogen biofertilizer, namely ($B_1$=zero, $B_2$=50,$B_3$=100, and $B_4$=200ml of liquid culture/plant/year). It should be pointed out that The bacteria count in stock fresh liquid culture were ca. 16.0 x $10^8$ cell/ml. Before applying biological nitrogen fertilizer and to secure covering the soil rhizosphere with the bacteria, four holes (each of 15 cm in length x 1.5 cm in diameter) were dug in the soil of each pot, then the given amount of each level was applied to the surface of each pot. All biological nitrogen treatments were applied in the first week of April in each season

Accordingly, the study involved three levels of mineral nitrogen and four levels of biological nitrogen in a factorial experiment in a randomized complete block design. Each treatment was replicated five times and each replicate was represented by two plants

**Table (1): Physical and chemical analysis of soil.**

| Soil characteristics | 2001 Season | 2002 Season |
|---|---|---|
| **Particle size distribution %:** | | |
| **Coarse sand (%)** | 3.7 | 70.5 |
| **Fine sand (%)** | 81.8 | 11.2 |
| **Silt (%)** | 3.2 | 3.4 |
| **Clay (%)** | 11.4 | 15.0 |
| **Soil texture** | Sandy loam | Sandy loam |
| **pH 1:2.5 (susp.)** | 7.80 | 7.80 |
| **EC, mmohs/cm** | 2.55 | 0.93 |
| **Soluble anions (meq/100g soil):** | | |
| $CO_3^{--}$ | - | - |
| $HCO^-$ | 1.7 | 2.0 |
| $Cl^-$ | 1.5 | 2.0 |
| $SO4^{--}$ | 14.2 | 18.6 |
| **Soluble cations (meq/100g soil):** | | |
| $Na^+$ | 2.7 | 2.5 |
| $K^+$ | 0.51 | 0.65 |
| $Ca^{++}$ | 3.3 | 2.6 |
| $Mg^{++}$ | 4.4 | 5.3 |
| **Available macronutrients (ppm):** | | |
| **Nitrogen** | 32.2 | 39.2 |
| **Phosphorus** | 49.4 | 41.8 |
| **Available micronutrients (ppm):** | | |
| **Fe** | 13.6 | 11.6 |
| **Mn** | 20.0 | 16.0 |
| **Zn** | 3.2 | 3.6 |

**Mineral analysis:**

For the determination of nutrient content, samples of fully expanded mature leaves were collected from the 5-7th nodes (Shawky *et al.*, 1996) from plant top. Two leaves from each replicate were taken at monthly intervals from July to October in each season. For each replicate, the blades and petioles were separated and washed with tap water followed by distilled water then oven dried at 70°C until a constant weight. Dried samples were ground by means of an electric mill. Ground samples were digested according to the method of (Jackson, 1958) and the digested solutions of each of blades or petioles were used to determine nitrogen, phosphorus and potassium, but micro nutrients, namely iron, zinc and manganese were determined in the digested solution of the blades only.

It should be pointed out that weights of petioles samples were too small so, a composed sample from all replicates of each treatment was obtained. From each composed sample three samples were digested to determined N, P, and K only as mentioned before. So, data of mineral content in petioles were not analyzed statistically.

Total nitrogen was determined by micro Kjeldahl method as described by Pregl (1945). Phosphorus content was determined by means of spectrocolourimeter, using the method of Truog and Mayer (1929). Potassium content was estimated by a flame photometer according to Brown and Lilleland (1946). Iron, zinc and manganese were determined with an atomic absorption spectrophotometer.

Each of nitrogen, phosphorus and potassium content were expressed as percent of dry matter, whereas iron, zinc and manganese were calculated as parts per million (ppm).

Data of nutrient content in the two seasons were statistically analyzed by using the analysis of variance (Snedecor and Cochran, 1980). Means were differentiated by using Duncan's multiple range test at 5 %(Duncan, 1955).

## RESULTS AND DISCUSSION

**Mineral content:**

**1. Effect on nitrogen content in blades and petioles of leaves:**

Results in Tables 2 & 3 indicated that nitrogen percentages in leaf blade of untreated plants ranged between 1.52 and 1.69% with an average of 1.65% in the first season and ranged between 1.45 and 1.88 % with an average of 1.71% in the second season. The analogous percentages for leaf petiole ranged between 0.98 and 1.11% with an average of 1.03% in the first season and ranged between 0.95 and 1.00 %. with an average of 0.973 %in the second season. Thus, it is clear that leaf blade has about 53-70 % more nitrogen than that of leaf petiole. So, leaf blade may be considered as a proper organ to determine nitrogen status in grape vines.

Similar results were obtained by Albert (1942), mentioned that as the leaf blades constitute the bulk of the leaf so the percentages of nitrogen in blades would be higher than that in leaf petioles. Also Ahmed (1989), Ezz (1992), Patel and Chadha (2002) who found that, the concentration of nitrogen in leaf petiole was lower than in leaf blade. In harmony, Pire *et al.* (2001) reported that leaf blade of three grape cultivars "Queen", "Tucupita" and "Villanueva" was the plant part that removed the largest amount of nitrogen. On the contrary, Lavin (1984), found that nitrogen percentage decreased in leaf blade of Pais grapevines compared with leaf petiole.

Generally, results in Tables 3 & 4 show that nitrogen content in blades & petioles of leaves at the beginning of the season, was higher than that at the end of the season. So, the values in July & August were higher than those in September. In other words, leaves emerged early showed higher nitrogen content than leaves emerged later in the season. Nitrogen content reached low values in October at the end of the season. This may be due to the back translocation of nitrogen from the leaves before defoliation and before the rest period which takes place in late autumn and winter.

Table (2) : **Effect of mineral and biological nitrogen fertilization on nitrogen content(% in leaf blades of Thompson Seedless grape transplants during 2001 and 200 seasons.**

| Treat .of Bio. N* (ml/plant) | Treatments of Mineral nitrogen (g N /plant) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **July** | | | | **August** | | | | **September** | | | | **October** | | | |
| | 0(M1) | 5(M2) | 10(M3) | Mean | 0(M1) | 5(M2) | 10(M3) | Mean | 0(M1) | 5(M2) | 10(M3) | Mean | 0(M1) | 5(M2) | 10(M3) | Mean |
| | **2001 season** | | | | | | | | | | | | | | | |
| **0 (B1)** | 1.69 e | 2.17d | 2.20cd | 2.02 C' | 1.82 i | 2.01gh | 1.98h | 1.94D' | 1.55 h | 1.89f | 1.89f | 1.78 D' | 1.52 f | 1.67e | 1.89c | 1.69 C' |
| **50 (B2)** | 2.33 b | 2.50a | 2.25c | 2.36 A' | 2.14 f | 2.46 b | 2.33d | 2.31B' | 1.89 f | 2.20a | 2.07c | 2.05 B' | 1.68e | 1.83d | 2.01a | 1.84 B' |
| **100(B3)** | 2.20cd | 2.45a | 2.36b | 2.34 AB | 2.13 f | 2.52 a | 2.42c | 2.36A' | 2.01de | 2.14b | 2.20a | 2.12 A' | 1.95b | 2.01a | 1.86d | 1.94 A' |
| **200(B4)** | 2.20cd | 2.33b | 2.33b | 2.28 B' | 2.03 g | 2.14 f | 2.17e | 2.11C' | 1.79 g | 2.03d | 1.98e | 1.93 C' | 1.68e | 1.89c | 2.01a | 1.86 B' |
| **Mean** | 2.11C | 2.36A | 2.29B | | 2.03C | 2.28A | 2.23B | | 1.81C | 2.07A | 2.04B | | 1.71C | 1.85B | 1.94A | |
| | **2002 season** | | | | | | | | | | | | | | | |
| **0 (B1)** | 1.74 h | 2.30f | 238df | 2.14 C' | 1.88 i | 2.20f | 2.15g | 2.08 C' | 1.76 d | 2.10bc | 2.00 c | 1.95 B' | 1.45 e | 1.95 cd | 1.95cd | 1.78 B' |
| **50 (B2)** | 2.14 g | 2.63b | 245oe | 2.41 B' | 2.05h | 2.44d | 2.62a | 2.37B' | 1.94cd | 2.43 a | 2.40 a | 2.26 A' | 1.51 e | 2.35 a | 2.40a | 2.09 A' |
| **100 (B3)** | 2.32 ef | 253bd | 2.59bc | 2.48A'B' | 2.32e | 2.53b | 2.48c | 2.44A' | 2.02 c | 2.30 a | 2.27ab | 2.20 A' | 2.02cd | 2.20 ac | 207bd | 2.10 A' |
| **200(B4)** | 2.35ef | 2.80a | 253bd | 2.56 A' | 2.09h | 2.56b | 2.48c | 2.38B' | 2.00 c | 2.45 a | 2.10bc | 2.18 A' | 1.82d | 2.29 ab | 2.00cd | 2.04A' |
| **Mean** | 2.14B | 2.57A | 2.49A | | 2.09B | 2.43A | 2.43A | | 1.93B | 2.32A | 2.19A | | 1.70B | 2.20 A | 2.11A | |

* Biological nitrogen = nitrogen fixation bacteria ( *Azotobacter chroococcum*).
In each month in each season, means of each of mineral nitrogen, biological nitrogen levels or their interactions having the same letters are not significantly different at 5% level

Table (3): **Effect of mineral and biological nitrogen fertilization on nitrogen content(%) in leaf petioles of Thompson Seedless grape transplants during 2001 and 2002 seasons.**

| Treat .of Bio. N* (ml/plant) | Treatments of Mineral nitrogen (g N / plant) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **July** | | | | **August** | | | | **September** | | | | **October** | | | |
| | 0(M1) | 5(M2) | 10(M3) | Mean | 0(M1) | 5(M2) | 10(M3) | Mean | 0(M1) | 5(M2) | 10(M3) | Mean | 0(M1) | 5(M2) | 10(M3) | Mean |
| | **2001 season** | | | | | | | | | | | | | | | |
| **0 (B1)** | 1.11 | 1.41 | 1.48 | 1.33 | 1.03 | 1.10 | 1.09 | 1.07 | 1.00 | 1.20 | 1.23 | 1.14 | 0.98 | 1.17 | 1.16 | 1.10 |
| **50 (B2)** | 1.46 | 1.58 | 1.29 | 1.44 | 1.10 | 1.23 | 1.33 | 1.22 | 1.19 | 1.23 | 1.31 | 1.24 | 1.20 | 1.08 | 1.31 | 1.19 |
| **100(B3)** | 1.42 | 1.50 | 1.25 | 1.39 | 1.18 | 1.41 | 1.42 | 1.33 | 1.17 | 1.29 | 1.27 | 1.24 | 1.12 | 1.23 | 1.25 | 1.20 |
| **200(B4)** | 1.16 | 1.42 | 1.48 | 1.35 | 1.31 | 1.08 | 1.07 | 1.15 | 1.11 | 1.14 | 1.20 | 1.15 | 1.08 | 1.27 | 1.28 | 1.21 |
| **Mean** | 1.29 | 1.48 | 1.38 | | 1.16 | 1.20 | 1.23 | | 1.12 | 1.22 | 1.25 | | 1.09 | 1.19 | 1.25 | |
| | **2002 season** | | | | | | | | | | | | | | | |
| **0 (B1)** | 0.95 | 1.08 | 1.08 | 1.03 | 1.00 | 1.19 | 1.23 | 1.14 | 0.97 | 1.12 | 1.12 | 1.07 | 0.97 | 1.04 | 1.29 | 1.10 |
| **50 (B2)** | 1.03 | 1.23 | 1.14 | 1.13 | 1.08 | 1.53 | 1.41 | 1.34 | 1.05 | 1.10 | 1.15 | 1.10 | 1.03 | 1.06 | 1.14 | 1.08 |
| **100(B3)** | 1.00 | 1.27 | 1.08 | 1.12 | 1.07 | 1.28 | 1.36 | 1.24 | 1.03 | 1.60 | 1.16 | 1.26 | 1.04 | 1.14 | 1.52 | 1.23 |
| **200(B4)** | 1.05 | 1.12 | 1.16 | 1.11 | 1.08 | 1.20 | 1.51 | 1.26 | 1.08 | 1.40 | 1.08 | 1.19 | 1.04 | 1.14 | 1.27 | 1.15 |
| **Mean** | 1.00 | 1.18 | 1.12 | | 1.06 | 1.30 | 1.38 | | 1.03 | 1.31 | 1.13 | | 1.02 | 1.10 | 1.31 | |

* Biological nitrogen = nitrogen fixation bacteria ( *Azotobacter chroococcum*).

These results seemed to be in accordance with those reported by Nelson and Kimball (1956) which indicated that the nitrogen content of the concord grape leaf blades is more than twice that of the petioles and the nitrogen percentages decreased as the season advanced in both the two organs.

**1 –1 Nitrogen in leaf blades:**

**Results in Table 2 show that levels of mineral and biological nitrogen fertilization and their interaction affected significantly nitrogen content in leaf blades in the two seasons.**

**Effect of mineral nitrogen levels:**

In both the two seasons, level ($M_1$) gave the least significant values in any given month. However, the effects of levels ($M_2$) and ($M_3$) varied from season to season. In the first season, level $M_2$ (5 g/N/ plant/year) gave the highest significant value of nitrogen content when compared with any other level. This was true in any given month during the growing season except in October. On the contrary, increasing nitrogen rate up to 10 g/N/ plant/year [level ($M_3$)] gave lower values than that of the preceding level (except in October) but in the same time it was significantly higher than that of level $M_1$.

In the second season, results proved that levels ($M_2$& $M_3$) gave the highest values for nitrogen content without any significant difference between them.

Therefore, it could be concluded that the medium level of mineral nitrogen ($M_2$) gave the highest value of nitrogen content in leaf blades of Thompson Seedless grape transplants in the two seasons.

**Effect of biological nitrogen levels:**

In the first season, fertilizing with level $B_3$ (100 ml/plant) gave the highest value of nitrogen content in any given month during the growing season except in July. Reducing or increasing the rate of biological nitrogen (levels $B_2$ and $B_4$) gave more or less similar values in all months but level $B_1$ (0 ml/plant) gave the least value of nitrogen content in any given month.

In the second season, level $B_3$ and $B_4$ gave the highest significant values of nitrogen content in July. However, level $B_3$ gave the highest value in August. In September & October all biological nitrogen levels ($B_2$, $B_3$ and $B_4$) gave similar values but these values were significantly higher than that of level $B_1$.

Accordingly, it could be concluded that level ($B_3$) seems to give the highest values of nitrogen content in the two seasons.

**The interaction between mineral and biological nitrogen:**

In the two seasons, unfertilized treatment ($M_1$ x $B_1$) gave the least value of nitrogen content in any given month. Fertilization with mineral nitrogen alone[treatments ($M_2$ x $B_1$) and ($M_3$ x $B_1$)]increased nitrogen content as compared with the unfertilized treatment. However, in most cases, the difference between the above two treatments was not significant especially in the second season. Biological nitrogen alone [treatments ($M_1$ x $B_2$), ($M_1$ x $B_3$) and ($M_1$ x $B_4$)] increased nitrogen content gradually as the rate of biological nitrogen increased up to 100 ml/plant [treatment ($M_1$ x $B_3$)]. However, more increase in the rate of biological nitrogen [treatment ($M_1$ x $B_4$)] tended to reduce nitrogen content in any given month except in July in both the two seasons.

Other combinations in both the two seasons, gave higher values than those of the above two sets of treatments. For instance, under the second and third levels of mineral nitrogen, increasing the level of biological nitrogen up to 200 ml/plant increased nitrogen content in leaf blade. However, this trend varied slightly from month to month in both the two seasons.

Therefore, it seems that fertilizing with mineral or biological nitrogen alone increased nitrogen content in leaf blades. However, more increase in nitrogen content was obtained by combining mineral & biological nitrogen especially by treatments [($M_2$ x $B_3$) &($M_2$ x $B_4$)].

**1-2 Nitrogen in leaf petioles:**

Results in Table 3 show that nitrogen content in leaf petioles was affected considerably by levels of mineral and biological nitrogen fertilization and their interaction in the two seasons.

**Effect of mineral nitrogen levels:**

In the two seasons, level ($M_1$) gave the least values in any given month. On the contrary, the medium nitrogen level ($M_2$) gave the highest values of nitrogen content in July. However, in August & September, levels ($M_2$&$M_3$) gave the highest values for nitrogen content. At the end of the growing season (October), level ($M_3$) gave the highest value for nitrogen content.

Thus, it seems that the medium level of mineral nitrogen($M_2$) may be promising than other levels for increasing nitrogen content in leaf petiole.

**Effect of biological nitrogen levels:**

In the two seasons, level ($B_1$) gave the least values of nitrogen content in any given month except in October in the second season.

In the first season, levels ($B_2$ & $B_3$) gave the highest values of nitrogen content in most months.

In the second season, levels ($B_2$ & $B_3$& $B_4$) gave similar values of nitrogen content in the first half of the growing season (July & August). However, in September & October, level ($B_3$) gave the highest values for nitrogen content.

Accordingly, it could be concluded that level ($B_3$) gave the highest value of nitrogen content in the two seasons. Reducing or increasing the levels of biological nitrogen ($B_2$ & $B_4$) almost gave more or less similar values but these values were lesser than that of level ($B_3$).

**The interaction between mineral and biological nitrogen:**

In the two seasons, unfertilized transplants [treatment ($M_1$ x $B_1$)] gave the least value of nitrogen content.

Fertilization with mineral nitrogen alone [treatments ($M_2$ x $B_1$) &($M_3$ x $B_1$)] increased nitrogen content compared with unfertilized treatment ($M_1$ x $B_1$). However, treatments ($M_2$ x $B_1$) &($M_3$ x $B_1$) gave similar values in most cases.

Fertilization with biological nitrogen alone[treatments ($M_1$ x $B_2$), ($M_1$ x $B_3$) and($M_1$ x $B_4$)] stimulated the increase of nitrogen content and treatment ($M_1$ x $B_2$) gave high nitrogen content in most months in the first season. In the second season, all the three biological treatments gave similar response.

Other combinations gave variable results in the two seasons. In the first season, the highest values were obtained by treatments ($M_2$ x $B_2$) and ($M_2$ x $B_3$) in July & ($M_3$ x $B_2$) in September and October and treatment ($M_3$ x $B_3$) in August. In the second season, treatment ($M_2$ x $B_3$) in July & September, treatment ($M_2$ x $B_2$) in August, and treatment ($M_3$ x $B_3$) in October gave the highest values.

Consequently, it seems that under the medium and high level of mineral nitrogen [($M_2$) & ($M_3$)] increasing the level of biological nitrogen up to 100 ml/plant tended to increase nitrogen content in leaf petioles.

In conclusion, results of nitrogen content in blades and petioles of leaves in the two seasons proved that fertilizing with mineral or biological nitrogen alone increased nitrogen content in both the two organs of the leaf. However, more increase in nitrogen content was obtained by combining mineral & biological nitrogen especially treatment($M_2$ x $B_3$).

Dhillon *et al.* (2002) found that nitrogen in the petioles of Perlette grapevines was increased with increasing mineral nitrogen levels.

**2. Effect on phosphorus content in blades and petioles of leaves:**

Results in Tables 4 & 5 indicated that phosphorus content in leaf blades of untreated plants ranged between 0.110 and 0.150% with an average of 0.124% in the first season and ranged between 0.110 and 0.142 % with an average of 0.123% in the second season. The analogous percentages for leaf petioles ranged between 0.120 and 0.150%. with an average of 0.134& in the first season and ranged between 0.125 and 0.145% with an average of 0.134% in the second season. This Phosphorus content varied from season to season and leaf blades tended to have slight lower values than those of leaf petioles.

Similar results were obtained by Mattheou *et al.* (1994) who found that phosphorus concentrations in petioles were always higher than those in blades.

On the contrary, Saayman and Lambrechts (1998) reported that, leaf blades of Barlinka table grapes had significantly lower concentrations of all nutrients analysed except nitrogen and phosphorus.

Table (4) : **Effect of mineral and biological nitrogen fertilization on phosphorus content (%) in leaf blades of Thompson Seedless grape transplants during 2001 and 2002 seasons.**

| Treat. of Bio. N* (ml/plant) | July 0($M_1$) | July 5($M_2$) | July 10($M_3$) | July Mean | August 0($M_1$) | August 5($M_2$) | August 10($M_3$) | August Mean | September 0($M_1$) | September 5($M_2$) | September 10($M_3$) | September Mean | October 0($M_1$) | October 5($M_2$) | October 10($M_3$) | October Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2001 season** | | | | | | | | | | | | | | | | |
| 0 ($B_1$) | 0.150k | 0.166i | 0.158j | 0.158D' | 0.110k | 0.170h | 0.130j | 0.137D' | 0.116i | 0.136h | 0.156g | 0.136C | 0.120g | 0.114g | 0.130f | 0.121D' |
| 50 ($B_2$) | 0.166i | 0.184h | 0.224d | 0.191C' | 0.150i | 0.222f | 0.264b | 0.212C' | 0.176f | 0.228b | 0.242a | 0.215AB | 0.140e | 0.204ab | 0.200ab | 0.181C' |
| 100($B_3$) | 0.192g | 0.196f | 0.278a | 0.222B' | 0.174g | 0.242c | 0.244c | 0.220B' | 0.196e | 0.218c | 0.226b | 0.213B' | 0.160d | 0.198b | 0.208a | 0.188B' |
| 200($B_4$) | 0.200e | 0.246b | 0.238c | 0.228A' | 0.238d | 0.272a | 0.230e | 0.247A' | 0.218c | 0.230b | 0.204d | 0.217A' | 0.196b | 0.208a | 0.184c | 0.196A' |
| Mean | 0.177C | 0.198B | 0.225A | | 0.168C | 0.227A | 0.217B | | 0.176C | 0.203B | 0.207A | | 0.154B | 0.181A | 0.181A | |
| **2002 season** | | | | | | | | | | | | | | | | |
| 0 ($B_1$) | 0.122g | 0.166ef | 0.172ef | 0.153B' | 0.142j | 0.182g | 0.152i | 0.159D' | 0.118e | 0.144d | 0.140d | 0.134C' | 0.110f | 0.128e | 0.124e | 0.121C' |
| 50 ($B_2$) | 0.156f | 0.200c | 0.240 a | 0.199A' | 0.190f | 0.204e | 0.244a | 0.213B' | 0.142d | 0.204b | 0.206b | 0.184B' | 0.140d | 0.180b | 0.200a | 0.173B' |
| 100 ($B_3$) | 0.180de | 0.240a | 0.190cd | 0.203A' | 0.166h | 0.224c | 0.212d | 0.201C' | 0.184c | 0.200b | 0.180c | 0.188B' | 0.154c | 0.196a | 0.180b | 0.176B' |
| 200($B_4$) | 0.204bc | 0.220b | 0.200c | 0.208A' | 0.236b | 0.246a | 0.222c | 0.235A | 0.200b | 0.230a | 0.200b | 0.210A' | 0.194a | 0.200a | 0.170b | 0.188A' |
| Mean | 0.167B | 0.207A | 0.201A | | 0.184C | 0.214A | 0.208B | | 0.161C | 0.195A | 0.182B | | 0.150B | 0.176A | 0.169A | |

Treatments of Mineral nitrogen (g N /plant)

* Biological nitrogen = nitrogen fixation bacteria ( *Azotobacter chroococcum*).
In each month in each season, means of each of mineral nitrogen, biological nitrogen levels or their interactions having the same letters are not significantly different at 5% level

Table (5): **Effect of mineral and biological nitrogen fertilization on phosphorus conten and (%) in leaf petioles of Thompson Seedless grape transplants during 20 2002 seasons.**

| Treat. of Bio. N* (ml/plant) | July 0($M_1$) | July 5($M_2$) | July 10($M_3$) | July Mean | August 0($M_1$) | August 5($M_2$) | August 10($M_3$) | August Mean | September 0($M_1$) | September 5($M_2$) | September 10($M_3$) | September Mean | October 0($M_1$) | October 5($M_2$) | October 10($M_3$) | October Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2001 season** | | | | | | | | | | | | | | | | |
| 0 ($B_1$) | 0.150 | 0.180 | 0.140 | 0.156 | 0.120 | 0.140 | 0.140 | 0.133 | 0.135 | 0.150 | 0.120 | 0.135 | 0.130 | 0.120 | 0.130 | 0.126 |
| 50 ($B_2$) | 0.185 | 0.190 | 0.160 | 0.178 | 0.160 | 0.200 | 0.165 | 0.175 | 0.185 | 0.200 | 0.160 | 0.181 | 0.155 | 0.130 | 0.165 | 0.150 |
| 100($B_3$)) | 0.180 | 0.175 | 0.160 | 0.171 | 0.170 | 0.185 | 0.175 | 0.177 | 0.195 | 0.180 | 0.150 | 0.175 | 0.190 | 0.140 | 0.170 | 0.166 |
| 200($B_4$) | 0.170 | 0.215 | 0.240 | 0.208 | 0.175 | 0.210 | 0.180 | 0.188 | 0.210 | 0.225 | 0.230 | 0.221 | 0.185 | 0.200 | 0.190 | 0.191 |
| Mean | 0.171 | 0.190 | 0.175 | | 0.156 | 0.183 | 0.165 | | 0.181 | 0.188 | 0.165 | | 0.165 | 0.147 | 0.163 | |
| **2002 season** | | | | | | | | | | | | | | | | |
| 0 ($B_1$) | 0.130 | 0.155 | 0.160 | 0.148 | 0.135 | 0.145 | 0.160 | 0.146 | 0.145 | 0.155 | 0.185 | 0.161 | 0.125 | 0.150 | 0.160 | 0.145 |
| 50 ($B_2$) | 0.140 | 0.145 | 0.140 | 0.141 | 0.175 | 0.180 | 0.190 | 0.181 | 0.185 | 0.205 | 0.185 | 0.191 | 0.150 | 0.160 | 0.170 | 0.160 |
| 100($B_3$) | 0.215 | 0.195 | 0.190 | 0.200 | 0.160 | 0.190 | 0.190 | 0.180 | 0.195 | 0.190 | 0.195 | 0.193 | 0.175 | 0.190 | 0.190 | 0.185 |
| 200($B_4$) | 0.165 | 0.185 | 0.220 | 0.190 | 0.210 | 0.215 | 0.210 | 0.211 | 0.195 | 0.230 | 0.220 | 0.215 | 0.190 | 0.195 | 0.185 | 0.190 |
| Mean | 0.162 | 0.170 | 0.177 | | 0.170 | 0.182 | 0.187 | | 0.180 | 0.195 | 0.196 | | 0.160 | 0.174 | 0.176 | |

Treatments of Mineral nitrogen (g N / plant)

* Biological nitrogen = nitrogen fixation bacteria ( *Azotobacter chroococcum*).

**2-1 Phosphorus in leaf blades:**

Results in Table 4 show that phosphorus content in leaf blade was affected significantly by levels of mineral and biological nitrogen fertilization and their interaction

**Effect of mineral nitrogen levels:**

In the two seasons, the low nitrogen level ($M_1$) gave the least significant values in any given month during the growing season.

In the first season, the highest significant values of phosphorus were obtained in July & September by level ($M_3$) and by level($M_2$) in August. Nevertheless, similar values were obtained by the two above levels in October.

In the second season, the high value was obtained by level ($M_2$) in any given month during the season followed in decreasing order by those of levels ($M_3$) and ($M_1$)respectively.

Therefore, it seems that mineral nitrogen increased phosphorus content in leaf blades and level ($M_2$) may be promising in this respect.

**Effect of biological nitrogen levels:**

In the two seasons, level $B_4$ gave the highest significant value of phosphorus content followed in decreasing order by those of levels $B_3$, $B_2$ and $B_1$, respectively. This was true in any given month except July in the second season.

Therefore, it seems that phosphorus content was gradually increased by increasing the level of biological nitrogen up to 200 ml/plant (level $B_4$).

**- The interaction between mineral and biological nitrogen:**

In the two seasons, unfertilized transplants [treatment ($M_1$ x $B_1$)] gave the lowest value of phosphorus content in any given month expect in October in the first season.

Fertilizing with mineral nitrogen alone [treatments($M_2$ x $B_1$) and ($M_3$ x $B_1$)] increased phosphorus content compared with unfertilized transplants [treatment ($M_1$ x $B_1$)]. Treatment ($M_2$ x $B_1$) gave the highest values of phosphorus content in (July & August) of the first season and in all months in the second season except July.

In the two seasons, fertilizing with biological nitrogen alone[treatments ($M_1$ x $B_2$), ($M_1$ x $B_3$) and ($M_1$ x $B_4$)] increased phosphorus content compared with unfertilized plants[treatment ($M_1$ x $B_1$)]. In most cases, values were gradually increased by increasing the level of biological nitrogen. In other words, the highest values were obtained by treatment ($M_1$ x $B_4$).

Regarding other combinations, it is observed in the two seasons that under the second and third levels of mineral nitrogen, increasing the level of biological nitrogen up to 200 ml/plant increased phosphorus content. However, this trend varied slightly from month to month in both the two seasons.

Patel and Chadha (2002) found that the increase in level of N (1000g urea/vine) resulted in decrease in P concentration after an initial increase with lower doses (250 and 500 g urea/vine).

**2-2 Phosphorus in leaf petioles:**

Results in Table 5 show that phosphorus content in petioles was affected considerably by levels of mineral and biological nitrogen fertilization, and their interaction in the two seasons.

**Effect of mineral nitrogen levels:**

Phosphorus content seems to be stable in leaf petioles during the two seasons. However, in the first season, level ($M_2$) gave the highest values of phosphorus content in any given month except in October.

In the second season, level ($M_3$) tented to give slight higher values than those of level ($M_2$) in any given month. Conversely, level ($M_1$) gave the least value of phosphorus content in any given month during the two seasons.

Thus it seems that during the two seasons, mineral nitrogen increased phosphorus content and levels $M_2$ & $M_3$ gave more or less similar values but these values were higher than that of level ($M_1$).

**Effect of biological nitrogen levels:**

In the two seasons, the least value was obtained by level ($B_1$) in any given month except in July in the second season. However, phosphorus content was increased gradually as the biological nitrogen increased up to 200 ml/plant (level $B_4$). This was true in any given month except July in the second season.

**The interaction between mineral and biological nitrogen:**

In both the two seasons and in most months, unfertilized transplants [treatment ($M_1$ x $B_1$)] gave the least values of phosphorus content.

In both the two seasons, fertilization with mineral nitrogen alone [treatments ($M_2$ x $B_1$) & ($M_3$ x $B_1$) ] increased phosphorus content in most months in the first season and in all months in the second season.

Biological nitrogen alone [treatments ($M_1$ x $B_2$),($M_1$ x $B_3$) & ($M_1$ x $B_4$) ] gave similar response but their values were higher than that of unfertilized treatment ($M_1$ x $B_1$). However, in most months treatment ($M_1$ x $B_4$) gave the highest values especially in the second season.

Other combinations in both the two seasons, showed that under any given level of mineral nitrogen, increasing the level of biological nitrogen up to 200 ml/plant (level $B_4$) increased phosphorus content.

Consequently, it could be concluded that during the two seasons, treatment ($M_2$ x $B_4$) and ($M_3$ x $B_4$) gave the highest values of phosphorus content in petioles.

Generally, results of phosphorus content in blades and petioles of leaves proved that biological fertilization alone increased phosphorus content than mineral fertilization alone and combining mineral with biological nitrogen fertilization showed more beneficial effect on phosphorus content in leaf blades and petioles especially treatments($M_2$ x $B_4$) and ($M_3$ x $B_4$).

**3. Effect on potassium content in blades and petioles of leaves:**

Results in Tables 6 & 7 indicated that potassium content in leaf blades of untreated plants ranged between 1.24 and 1.62 % with an average of 1.43% in the first season and ranged between 1.21 and 1.33 % with an average of 1.26% in the second season. The analogous values for leaf petiole ranged between 1.65 and 1.87 %. with an average of 1.62% in the first season and ranged between 1.25 and 1.64 % with an average of 1.47% in the second season. This means that potassium content varied from season to season and leaf petiole has slight higher values than those of leaf blade.

In this respect, Albert (1942 $_b$) proved that the potassium content of the leaf petioles reflected the potassium status of the vines better than that of the leaf blades. On the other hand, Bavaresco and Fogher (1996) reported that the positive and significant correlations between the blade and petiole concentrations of nitrogen and potassium support the possibility of checking the nutritional status of grapevine by assaying either the blade or petiole.

Potassium content (Tables 7& 8) varied from month to month and the values in leaves collected in July or August were higher than those developed later and sampled in September and October. This trend was the same in the two seasons.

**3-1 Potassium in leaf blades:**

Potassium content (Table 6) was affected significantly by levels of mineral, and biological nitrogen fertilization and their interaction in the two seasons

**Effect of mineral nitrogen levels:**

In the two seasons, level $M_1$ (0g N/plant) gave the least significant value in any given month except October in the first season and in July the second season. Whereas, the medium level ($M_2$) gave the highest significant value for potassium content in any given month except July & August in the first season. The high nitrogen level($M_3$) gave lower values than those of the preceding level.

Thus, it seems that the second level of mineral nitrogen (level $M_2$) gave the highest value of potassium content in leaf blades in the two seasons.

**Effect of biological nitrogen levels:**

In the two seasons, the least significant value of potassium content was obtained by level ($B_1$). On the other hand, fertilizing with level $B_3$ (100 ml/plant) gave the highest significant value in blades in any given month. Intermediate values were obtained by levels $B_2$ and $B_4$ which gave more or less similar values in all months.

Table (6) : **Effect of mineral and biological nitrogen fertilization on potassium content (%) in leaf blades of Thompson Seedless grape transplants during 2001 and 2002 seasons.**

| Treat .of Bio. N* (ml/plant) | Treatments of Mineral nitrogen (g N /plant) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | July | | | | August | | | | September | | | | October | | | |
| | 0(M1) | 5(M2) | 10(M3) | Mean | 0(M1) | 5(M2) | 10(M3) | Mean | 0(M1) | 5(M2) | 10(M3) | Mean | 0(M1) | 5(M2) | 10(M3) | Mean |
| **2001 season** | | | | | | | | | | | | | | | | |
| 0 (B1) | 1.62i | 1.74gh | 1.71hi | 1.69C' | 1.50g | 1.13h | 1.53g | 1.39D' | 1.24j | 1.76g | 1.80f | 1.60D' | 1.34h | 1.44g | 1.51f | 1.43C' |
| 50 (B2) | 1.85f | 2.59b | 2.00de | 2.15A'B' | 1.76e | 1.82e | 2.20c | 1.93B' | 1.84e | 1.93d | 1.87e | 1.88B' | 1.71e | 1.82d | 1.48fg | 1.67B' |
| 100(B3) | 2.01d | 1.81f-h | 2.81a | 2.21A' | 1.97d | 2.52a | 2.34b | 2.28A' | 1.99c | 2.52a | 1.86e | 2.12A' | 2.06a | 1.92c | 1.52f | 1.83A' |
| 200(B4) | 2.47c | 1.90ef | 1.82fg | 2.06B' | 1.65f | 2.35b | 1.56g | 1.85C' | 1.44i | 2.42b | 1.67h | 1.84C' | 1.52f | 2.00b | 1.88cd | 1.80A' |
| Mean | 1.99B | 2.01AB | 2.09A | | 1.72B | 1.96A | 1.91A | | 1.63C | 2.16A | 1.80B | | 1.65B | 1.80A | 1.60C | |
| **2002 season** | | | | | | | | | | | | | | | | |
| 0 (B1) | 1.25i | 1.52h | 1.53h | 1.43C' | 1.33i | 1.62h | 1.62h | 1.52C' | 1.21j | 1.45i | 1.70e | 1.45D' | 1.25h | 1.51f | 1.63e | 1.46D' |
| 50 (B2) | 1.89e | 2.11c | 1.69f | 1.90B' | 1.92d | 2.06c | 1.78f | 1.92B' | 1.53h | 1.73e | 1.64e | 1.63C' | 1.50f | 1.70d | 1.42g | 1.54C' |
| 100 (B3) | 2.03d | 2.24a | 2.03d | 2.10A' | 1.63h | 2.24a | 2.05c | 1.97A' | 2.00c | 2.39a | 1.92d | 2.10A' | 1.91b | 1.99a | 1.73c | 1.88A' |
| 200(B4) | 2.02d | 2.14b | 1.62g | 1.93B' | 1.83e | 2.18b | 1.72g | 1.91B' | 1.58g | 2.11b | 1.53h | 1.74B' | 1.51f | 1.99a | 1.69d | 1.73B' |
| Mean | 1.80B | 2.00A | 1.72C | | 1.68C | 2.03A | 1.79B | | 1.58C | 1.92A | 1.70B | | 1.54C | 1.80A | 1.62B | |

* Biological nitrogen = nitrogen fixation bacteria ( *Azotobacter chroococcum*).
In each month in each season, means of each of mineral nitrogen, biological nitrogen levels or their interactions having the same letters are not significantly different at 5% level

Table (7): **Effect of mineral and biological nitrogen fertilization on potassium content(% in leaf petioles of Thompson Seedless grape transplants during 2001 and 20[illegible] seasons.**

| Treat .of Bio. N* (ml/plant) | Treatments of Mineral nitrogen (g N / plant) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | July | | | | August | | | | September | | | | October | | | |
| | 0(M1) | 5(M2) | 10(M3) | Mean | 0(M1) | 5(M2) | 10(M3) | Mean | 0(M1) | 5(M2) | 10(M3) | Mean | 0(M1) | 5(M2) | 10(M3) | Mean |
| **2001 season** | | | | | | | | | | | | | | | | |
| 0 (B1) | 1.65 | 1.46 | 1.35 | 1.49 | 1.86 | 1.84 | 1.24 | 1.65 | 1.87 | 1.48 | 1.99 | 1.78 | 1.82 | 1.30 | 1.58 | 1.57 |
| 50 (B2) | 1.86 | 1.56 | 1.16 | 1.53 | 2.09 | 1.86 | 1.92 | 1.96 | 2.06 | 1.61 | 2.02 | 1.91 | 1.76 | 1.90 | 1.96 | 1.87 |
| 100(B3)) | 1.35 | 1.70 | 1.34 | 1.46 | 2.13 | 2.14 | 2.00 | 2.09 | 1.62 | 1.95 | 2.03 | 1.87 | 1.58 | 1.97 | 1.86 | 1.80 |
| 200(B4) | 1.66 | 1.45 | 1.59 | 1.57 | 2.39 | 2.01 | 1.86 | 2.09 | 2.05 | 2.04 | 1.56 | 1.88 | 2.13 | 1.60 | 1.49 | 1.74 |
| Mean | 1.63 | 1.54 | 1.36 | | 2.12 | 1.96 | 1.76 | | 1.90 | 1.77 | 1.90 | | 1.82 | 1.69 | 1.72 | |
| **2002 season** | | | | | | | | | | | | | | | | |
| 0 (B1) | 1.25 | 1.30 | 1.45 | 1.33 | 1.48 | 1.61 | 1.63 | 1.57 | 1.64 | 1.62 | 1.74 | 1.67 | 1.50 | 1.58 | 1.65 | 1.58 |
| 50 (B2) | 1.78 | 1.43 | 1.23 | 1.48 | 1.84 | 2.01 | 1.73 | 1.86 | 1.91 | 2.03 | 1.77 | 1.90 | 1.89 | 1.97 | 1.71 | 1.86 |
| 100(B3) | 1.90 | 1.99 | 1.40 | 1.76 | 1.95 | 2.12 | 1.89 | 1.99 | 1.90 | 2.14 | 2.03 | 2.02 | 2.00 | 1.99 | 1.99 | 1.99 |
| 200(B4) | 1.90 | 1.97 | 1.62 | 1.83 | 2.00 | 1.99 | 1.69 | 1.89 | 2.03 | 2.04 | 1.69 | 1.92 | 1.98 | 1.99 | 1.58 | 1.8[illegible] |
| Mean | 1.71 | 1.67 | 1.43 | | 1.82 | 1.93 | 1.74 | | 1.87 | 1.96 | 1.81 | | 1.84 | 1.88 | 1.73 | |

* Biological nitrogen = nitrogen fixation bacteria ( *Azotobacter chroococcum*).

From the aforementioned results, it seems that level ($B_3$) gave the highest value of potassium content in leaf blades in the two seasons.

**The interaction between mineral and biological nitrogen:**

In the two seasons, unfertilized transplants ($M_1$ x $B_1$) gave the lowest values of potassium content in all months expect August in the first season.

Generally in both the two seasons, mineral nitrogen alone[treatments($M_2$ x $B_1$) and ($M_3$ x $B_1$)] increased potassium content compared with unfertilized transplants [treatment ($M_1$ x $B_1$)]. However, treatment ($M_3$ x $B_1$) gave the highest values of potassium content in any given month except in July in the first season.

In the two seasons, biological nitrogen alone[treatments ($M_1$ x $B_2$),($M_1$ x $B_3$) & ($M_1$ x $B_4$) ] increased potassium content gradually as the rate of biological nitrogen increased up to 100 ml/plant [treatment ($M_1$ x $B_3$)]. However, more increase in the rate of biological nitrogen [treatment ($M_1$ x $B_4$)] reduced potassium content in any given month except in July in the first season and in August in the second season.

Other combinations, in both the two seasons, proved that combining mineral with biological nitrogen created a stimulative effect on potassium content than fertilizing with either mineral or biological nitrogen. The highest value was obtained by treatment ($M_2$ x $B_3$) especially in the second season.

Therefore, it seems that mineral nitrogen alone gave lower values than those of biological nitrogen alone and combining mineral with biological nitrogen induced more increase in potassium content and treatment ($M_2$ x $B_3$) gave the highest values of potassium content in leaf blades in the two seasons.

**3-2 Potassium in leaf petioles:**

The effect of mineral and biological nitrogen fertilization and their interaction on potassium content in leaf petioles in 2001 and 2002 seasons are presented in Table 7.

**Effect of mineral nitrogen levels:**

In the first season, potassium content seems to be affected considerably by mineral nitrogen levels. The first level ($M_1$) gave the highest values of potassium content in all months but levels ($M_2$) and ($M_3$) gave more or less similar values.

In the second season, it is observed that the highest values were obtained by level ($M_2$) in any given month during the growing season except in July. On the contrary, the high nitrogen level ($M_3$) gave the least values of potassium content in any given month.

Therefore, the obtained results proved that the high mineral nitrogen level ($M_3$) tended to decrease potassium content than other levels [($M_1$) or ($M_2$)]. This was true in the two seasons. On the other hand, level ($M_1$) and ($M_2$) gave contradicting results in the two seasons where level ($M_1$) gave the highest values in the first season and level ($M_2$) gave the highest values in the second season.

**Effect of biological nitrogen levels:**

In the two seasons, the least value was obtained by level ($B_1$). However, different levels of biological nitrogen behaved similarly in the first season and gave higher values of potassium content than level ($B_1$) and the highest values were obtained by level ($B_2$) except in August.

In the second season, the highest values were obtained by level $B_3$ in any given month except in July.

Consequently, it seems that levels ($B_2$) & ($B_3$) almost gave the highest values of potassium content especially in the second season.

**The interaction between mineral and biological nitrogen:**

In the first season, fertilizing with mineral nitrogen alone[treatments($M_2$ x $B_1$) and ($M_3$ x $B_1$)] decreased potassium content as compared with unfertilized treatment ($M_1$ x $B_1$). In the second season, the same treatments gave more or less similar values as that of unfertilized treatment.

Fertilization with biological nitrogen alone[treatments ($M_1$ x $B_2$),($M_1$ x $B_3$) & ($M_1$ x $B_4$)] increased potassium content in leaf petioles and in most cases treatment ($M_1$ x $B_4$)gave the highest values of potassium content in the first season. In the second season, fertilization with treatments ($M_1$ x $B_3$) & ($M_1$ x $B_4$) gave similar values but these values were higher than those of treatments ($M_1$ x $B_1$) & ($M_1$ x $B_2$]

Other combinations in both the two seasons showed a slight effect on potassium content in all months. For instance, in the first season, all combinations gave variable results. However, treatment ($M_2$ x $B_3$) always gave the high values in all over the growing season.

In the second season, treatment ($M_2$ x $B_3$) gave the highest values of potassium content in any given month during the growing season except in October.

Therefore, it could be concluded that potassium content was affected considerably by different treatments. Mineral fertilization alone tented to decrease potassium content while biological fertilization alone increased potassium content more than those obtained by mineral fertilization alone. However, combining mineral fertilization with biological fertilization induced slight or no increase in potassium content when compared with biological fertilization alone.

In this respect Ahmed *et al.*, (2000) indicated that N application did not affected K % in petioles significant. On the other hand, Dhillon *et al.* (2002) found that potassium content in the petioles of Perlette grapevines was increased with increasing mineral nitrogen levels.

**4 Effect on iron content in leaf blades:**

Results in Table 8 show the effect of mineral and biological nitrogen fertilization and their interaction on iron content in leaf blades in 2001 and 2002 seasons. Generally, iron content in leaf blades of unfertilized transplants ranged between 81.7 and 92.3 ppm with an average of 86.6 ppm in the first season and ranged between 88.7 and 96.7 ppm. with an average of 91.5 ppm in the second season. This means that iron content in leaf blade varied slightly from season to season.

**Effect of mineral nitrogen levels:**

In both the two seasons, iron content was not affected significantly by mineral nitrogen levels except in July. However, level $M_2$ tended to give the highest values of iron content when compared with any other level in any given month in the two seasons except in July.

Therefore, it seems that different levels of mineral fertilization had small effect on iron content although level ($M_2$) gave the highest value of iron content.

**Effect of biological nitrogen levels:**

In the two seasons, level $B_1$ gave the least value of iron content in any given month during the growing seasons except in July in the first season and in October in the second season.

Iron content was affected significantly by levels of biological nitrogen except in August in the first season and July & August in the second season. However, in the first season, level $B_3$ gave the highest values of iron content in July & September but level $B_4$ gave the highest values in August & October.

In the second season, level $B_3$ and level $B_4$ gave the highest values of iron content in July & August and September & October respectively.

Therefore, results proved that the level of biological nitrogen affected iron content in leaf blades and levels $B_3$& $B_4$ gave the highest values of iron content in the two seasons.

**The interaction between mineral and biological nitrogen:**

In the two seasons, unfertilized transplants [treatment ($M_1$ x $B_1$)] gave the least values of iron content in any given month.

Generally, in both the two seasons, fertilization with mineral nitrogen alone [treatments ($M_2$ x $B_1$) &($M_3$ x $B_1$)] increased iron content compared with unfertilized treatment ($M_1$ x $B_1$). However, in most cases the differences between the above mentioned treatments were not significant.

Biological nitrogen alone[treatments ($M_1$ x $B_2$), ($M_1$ x $B_3$) and ($M_1$ x $B_4$)] affected iron content slightly although in most cases treatment ($M_1$ x $B_3$) gave slight higher values than other biological nitrogen treatments. This was true in the two seasons.

Other combinations gave variable values in the two seasons whereas, the highest value was obtained by treatment ($M_2$ x $B_3$) in the first season except in July. However, in the second season, it was hard to recognize a particular treatment since most combinations gave more or less similar values.

Therefore, it is clear that all treatments tended to increase iron content in leaf blade as compared with unfertilized plants especially when combining mineral with biological nitrogen but it is hard to determine a particular treatment in this respect.

**5. Effect on zinc content in leaf blade:**

Results in Table 9 show the effect of mineral and biological nitrogen fertilization and their interaction on zinc content in leaf blades in 2001 and 2002 seasons. Generally, zinc content in leaf blades of unfertilized plants ranged between 57.0 and 61.0 ppm with an average of 59.5 ppm in the first season and ranged between 59.7 and 65.1 ppm with an average of 62.6 ppm in the second season. Thus it seems that zinc content in leaf blade was stable in the two seasons.

**Effect of mineral nitrogen levels:**

In both the two seasons, zinc content was not affected significantly by mineral nitrogen levels except in October. However, the different levels of mineral nitrogen gave similar values.

**Effect of biological nitrogen levels:**

In both the two seasons, zinc content seems to be affected significantly by biological nitrogen levels. Zinc content was gradually increased as the concentration of biological nitrogen increased up to 100 ml/plant (level $B_3$). However, more increase in biological level ($B_4$) gave the highest values of zinc content but without any significant difference between the above two levels except in October in the first season.

**The interaction between mineral and biological nitrogen:**

Generally in both the two seasons, transplants fertilized with mineral nitrogen alone [treatments($M_2$ x $B_1$) and ($M_3$ x $B_1$)] had similar effect as that of the unfertilized plants [treatment ($M_1$ x $B_1$)]. However, [treatments($M_1$ x $B_1$) and ($M_2$ x $B_1$)] gave the highest values when compared with those of treatment ($M_3$ x $B_1$).

Fertilizing with biological nitrogen alone[treatments ($M_1$ x $B_2$),($M_1$ x $B_3$) & ($M_1$ x $B_4$) ] in both the two seasons, increased zinc content gradually as the rate of biological nitrogen increased. Almost the highest values were obtained by **treatment ($M_1$ x $B_4$).**

Other combinations, gave variable results in the two seasons. However, it is clear that zinc content was increased by combining any level of mineral nitrogen with levels $B_3$ & $B_4$ of biological nitrogen.

Table (8): **Effect of mineral and biological nitrogen fertilization on iron content(ppm) in leaf blades of Thompson Seedless grape transplants during 2001 and 2002 seasons.**

| Treat. of Bio. N* (ml/plant) | Treatments of Mineral nitrogen (g N / plant) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **July** | | | | **August** | | | | **September** | | | | **October** | | | |
| | $0(M_1)$ | $5(M_2)$ | $10(M_3)$ | Mean | $0(M_1)$ | $5(M_2)$ | $10(M_3)$ | Mean | $0(M_1)$ | $5(M_2)$ | $10(M_3)$ | Mean | $0(M_1)$ | $5(M_2)$ | $10(M_3)$ | Mean |
| | **2001 season** | | | | | | | | | | | | | | | |
| 0 $(B_1)$ | 82.2e | 113.8oe | 104.1oe | 100.4B' | 81.7a | 96.9a | 86.4a | 88.3A' | 89.0d | 89.9d | 90.0d | 89.6C' | 92.3b-d | 83.0e | 87.0de | 87.4C' |
| 50 $(B_2)$ | 89.8de | 103.5oe | 107.5oe | 100.3B' | 104.8a | 80.0a | 88.4a | 91.1A' | 104.7ac | 106.3ab | 91.6cd | 100.9B | 98.3ab | 102.0a | 90.0c-e | 96.8B' |
| 100$(B_3)$) | 130.2bc | 123.6bd | 166.0 a | 139.9A' | 81.5a | 108.6a | 77.9a | 89.3A' | 99.2b-d | 118.2a | 113.3ab | 110.2A | 91.7b-d | 105.3a | 104.0a | 100.3A' |
| 200$(B_4)$ | 124.2bd | 105.3oe | 158.1ab | 129.2A' | 95.1a | 97.6a | 81.7a | 91.5A' | 108.4ab | 104.5ac | 110.0ab | 107.6A | 102.7a | 97.3ac | 103.7a | 101.2A' |
| Mean | 106.9B | 111.6B | 133.9A | | 90.8A | 95.8A | 83.6A | | 100.3A | 104.7A | 101.2A | | 96.3A | 96.9A | 96.2A | |
| | **2002 season** | | | | | | | | | | | | | | | |
| 0 $(B_1)$ | 90.0b | 94.8ab | 87.4b | 90.7B' | 96.7de | 102.7be | 94.5de | 98.0B' | 88.7ab | 87.6ab | 77.8b | 84.7B' | 90.7ab | 90.0ab | 100.1ab | 93.6A'B' |
| 50 $(B_2)$ | 94.6ab | 87.4b | 113.4a | 98.5A'B' | 102.9be | 121.6a | 87.0e | [illegible] | 93.2ab | 91.0ab | 80.7b | 88.3B' | 97.1ab | 96.4ab | 80.6b | 91.4B' |
| 100$(B_3)$ | 101.9ab | 103.4ab | 106.5ab | 104.0A' | 119.2ab | 105.6ad | 103.5be | 109.4A | 85.9ab | 91.5ab | 94.4ab | 90.6B' | 102.7ab | 108.2ab | 101.2ab | 104.0A'B' |
| 200$(B_4)$ | 86.4b | 104.7ab | 98.3ab | 96.5A'B' | 110.2ad | 100.4oe | 115.8ac | 108.8A | 101.8ab | 123.2a | 97.9ab | 107.6A' | 96.8ab | 115.1a | 107.1ab | 106.3A' |
| Mean | 93.2B | 97.6AB | 101.4A | | 107.3A | 107.6A | 100.2B | | 92.4A | 98.3A | 87.7A | | 96.8A | 102.4A | 97.3A | |

* Biological nitrogen = nitrogen fixation bacteria ( *Azotobacter chroococcum*).
In each month in each season, means of each of mineral nitrogen, biological nitrogen levels or their interactions having the same letters are not significantly different at 5% level

Table (9): **Effect of mineral and biological nitrogen fertilization on zinc content (ppm) in leaf blades of Thompson Seedless grape transplants during 2001 and 2002 seasons.**

| Treat. of Bio. N* (ml/plant) | Treatments of Mineral nitrogen (g N / plant) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **July** | | | | **August** | | | | **September** | | | | **October** | | | |
| | $0(M_1)$ | $5(M_2)$ | $10(M_3)$ | Mean | $0(M_1)$ | $5(M_2)$ | $10(M_3)$ | Mean | $0(M_1)$ | $5(M_2)$ | $10(M_3)$ | Mean | $0(M_1)$ | $5(M_2)$ | $10(M_3)$ | Mean |
| | **2001 season** | | | | | | | | | | | | | | | |
| 0 $(B_1)$ | 61.0e | 58.3e | 66.2c-e | 61.8C' | 59.2de | 63.7ce | 56.7e | 59.9C | 60.7fg | 58.3g | 64.7e-g | 61.2C | 57.0e | 59.3de | 60.0de | 58.8C |
| 50 $(B_2)$ | 62.8de | 78.4a-c | 71.0b-e | 70.7B' | 65.4bd | 64.3be | 66.7b-d | 65.5B | 66.0c-f | 65.7dg | 67.1b-f | 66.3B | 63.2c-e | 68.8bc | 68.0bc | 66.7B |
| 100$(B_3)$) | 84.8a | 75.7a-c | 83.9ab | 81.5A | 69.8bc | 72.3b | 80.9a | 74.3A | 70.0a-e | 75.6a | 77.6 a | 74.4A | 66.0b-d | 73.1ab | 69.5bc | 69.5B |
| 200$(B_4)$ | 81.5ab | 86.0a | 85.9a | 84.5A | 84.3a | 80.3a | 70.2bc | 78.3A | 74.6ab | 73.3a-c | 73.0a-d | 73.6A | 74.2ab | 78.0a | 70.0bc | 74.1A |
| Mean | 72.5A | 74.6A | 76.8A | | 69.7A | 70.2A | 68.6A | | 67.8A | 68.2A | 70.6A | | 65.1B | 69.8A | 66.9AB | |
| | **2002 season** | | | | | | | | | | | | | | | |
| 0 $(B_1)$ | 65.1a | 64.3a | 63.5a | 64.3B | 61.4b | 62.1b | 62.2b | 61.9B | 64.3c-e | 60.7e | 62.3e | 62.4C | 59.7e | 59.3e | 62.0de | 60.3C |
| 50 $(B_2)$ | 69.6a | 77.6a | 69.4a | 72.2AB | 62.3b | 69.5ab | 67.2ab | 66.3B | 62.8de | 70.0ab | 70.7ab | 67.8B | 63.7d | 68.7bc | 67.0c | 66.5B |
| 100$(B_3)$ | 60.9a | 83.1a | 86.1a | 76.7AB | 76.4a | 76.3a | 70.2ab | 74.3A | 67.2b-d | 70.8ab | 70.8ab | 69.6AB | 68.0c | 71.3ab | 71.7ab | 70.3A |
| 200$(B_4)$ | 77.0a | 80.9a | 79.7a | 79.2A | 76.0a | 75.5a | 78.3a | 76.6A | 72.6a | 71.9ab | 67.9a-c | 70.8A | 73.0a | 71.7ab | 69.0bc | 71.2A |
| Mean | 68.2A | 76.5A | 74.7A | | 69.0A | 70.9A | 69.5A | | 66.7A | 66.4A | 67.9A | | 66.1B | 67.8A | 67.4AB | |

* Biological nitrogen = nitrogen fixation bacteria ( *Azotobacter chroococcum*)
In each month in each season, means of each of mineral nitrogen, biological nitrogen levels or their interactions having the same letters are not significantly different at 5% level

Consequently, it is observed that mineral nitrogen alone gave low values of zinc content as those of the unfertilized transplants in the two seasons. On the contrary, biological nitrogen alone especially the high levels ($B_3$ and $B_4$) or other combinations specially [treatments ($M_2$ x $B_3$), ($M_2$ x $B_4$), ($M_3$ x $B_3$) and ($M_3$ x $B_4$)] created more increase in zinc content. In other words, combining mineral with biological nitrogen fertilization showed more beneficial effect on zinc content in leaf blades.

**6. Effect on manganese content:**

Results in Table 10 show the effect of mineral and biological nitrogen fertilization and their interaction on manganese content in leaf blades in 2001 and 2002 seasons. In general, manganese content in leaf blades of unfertilized plants ranged between 20.7 and 21.9 ppm with an average of 21.2 in the first season and ranged between 20.5 ppm and 23.8 ppm with an average of 22.0 ppm in the second season. Thus it is clear that manganese content was constant in the two seasons.

**Effect of mineral nitrogen levels:**

In both the two seasons, manganese content was affected significantly by mineral nitrogen levels except in August & October in the first season and July in the second season. However, the medium and high mineral nitrogen levels ($M_2$ & $M_3$) gave the highest values for manganese content without any significant difference between them in both the two seasons. On the other hand, level ($M_1$) gave the least value of manganese content.

**Effect of biological nitrogen levels:**

In the two seasons, level ($B_1$) gave the least values but level ($B_3$) gave the highest value of manganese content. This was true in any given month except in September in the second season. On the contrary, levels $B_2$ and $B_4$ gave lower values than that of the preceding level without any significant difference in most cases.

Therefore, it seems that level ($B_3$) gave the highest value of manganese content in the two seasons.

**The interaction between mineral and biological nitrogen:**

Generally in both the two seasons, unfertilized transplants [treatment ($M_1$ x $B_1$)] gave the least values of manganese content.

Fertilizing with mineral nitrogen alone [treatments ($M_2$ x $B_1$) &($M_3$ x $B_1$)] had no promising effect on manganese content where all values were more or less similar to those of the unfertilized treatment ($M_1$ x $B_1$).

Fertilizing with biological nitrogen alone[treatments ($M_1$ x $B_2$) & ($M_1$ x $B_3$) and ($M_1$ x $B_4$)] increased manganese content and the highest values were obtained by treatment ($M_1$ x $B_3$) in the first season. However in the second season, the highest values were obtained by treatment ($M_1$ x $B_2$) but more increase in the rate of biological nitrogen tended to reduce manganese content except in July.

Table (10): **Effect of mineral and biological nitrogen fertilization on manganese content (ppm) in leaf blades of Thompson Seedless grape transplants during 2001 and 2002 seasons.**

| Treat .of Bio. N* (ml/plant) | Treatments of Mineral nitrogen (g N / plant) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **July** | | | | **August** | | | | **September** | | | | **October** | | | |
| | $0(M_1)$ | $5(M_2)$ | $10(M_3)$ | Mean | $0(M_1)$ | $5(M_2)$ | $10(M_3)$ | Mean | $0(M_1)$ | $5(M_2)$ | $10(M_3)$ | Mean | $0(M_1)$ | $5(M_2)$ | $10(M_3)$ | Mean |
| **2001 season** | | | | | | | | | | | | | | | | |
| 0 $(B_1)$ | 20.7d | 24.3cd | 21.3d | 22.1C' | 21.9b | 22.8b | 21.6b | 22.1C | 20.7e | 22.4de | 24.6c-e | 22.6C | 21.4f | 22.5ef | 22.2ef | 22.0C |
| 50 $(B_2)$ | 24.7cd | 24.7cd | 32.6ab | 27.3B' | 24.5b | 23.8b | 31.9a | 26.7B | 25.6b-e | 25.8b-e | 33.2ab | 28.2B | 28.0b-d | 24.8b-f | 30.4a-c | 27.7B |
| 100$(B_3)$) | 30.9a-c | 37.0a | 32.7ab | 33.5A | 33.0a | 32.3a | 32.1a | 32.5A | 31.2a-c | 32.8ab | 34.3a | 32.8A | 31.4ab | 33.9a | 30.0a | 31.8A |
| 200$(B_4)$ | 30.8a-c | 34.7a | 27.2b-d | 30.9AB | 25.9b | 34.8a | 26.2b | 29.0B | 28.9a-d | 34.6a | 31.7a-c | 31.7AB | 28.1b-d | 34.5a | 26.5c-e | 29.7B |
| Mean | 26.8B | 30.2A | 28.5AB | | 26.3A | 28.4A | 28.0A | | 26.6B | 28.9AB | 31.0A | | 27.2A | 28.9A | 27.3A | |
| **2002 season** | | | | | | | | | | | | | | | | |
| 0 $(B_1)$ | 23.8d | 27.4 bd | 22.3d | 24.5B | 22.7c | 23.6c | 24.0c | 23.4B | 20.8d | 21.3cd | 21.4cd | 21.2B | 20.5f | 22.4df | 20.9ef | 21.3C |
| 50 $(B_2)$ | 23.2d | 33.4a-c | 28.2 bd | 28.3B | 25.5bc | 31.7ab | 29.4 a-c | 28.9A | 29.4b | 31.2ab | 36.4a | 32.3A | 26.7b-d | 28.4bc | 31.4ab | 28.8B |
| 100$(B_3)$ | 34.6ab | 30.8b-d | 41.1a | 35.5A | 23.5c | 32.1ab | 31.9ab | 29.2A | 26.8b-d | 31.3ab | 37.0a | 31.7A | 25.9c-e | 35.4a | 36.0a | 32.4A |
| 200$(B_4)$ | 25.2cd | 26.3b-d | 24.4cd | 25.3B | 25.9ac | 32.5a | 27.2a-c | 28.5A | 31.3ab | 30.8ab | 27.5bc | 29.9A | 27.7bc | 25.5c-f | 26.4bd | 26.5B |
| Mean | 26.7A | 29.5A | 29.0A | | 24.4B | 30.0A | 28.1A | | 27.1B | 28.7AB | 30.6A | | 25.2B | 27.9A | 28.7A | |

* Biological nitrogen = nitrogen fixation bacteria ( *Azotobacter chroococcum*).
In each month in each season, means of each of mineral nitrogen, biological nitrogen levels or their interactions having the same letters are not significantly different at 5% level

Other combinations gave variable values in the two seasons. The highest values were obtained by treatment ($M_2$ x $B_4$) in the first season except in July and treatment ($M_3$ x $B_3$) in the second season except in August but other treatments gave similar values.

Consequently, it could be concluded that manganese content in leaf blade was not affected significantly by mineral nitrogen fertilization alone but manganese content was increased by biological fertilization alone. More increase in manganese content was obtained by fertilizing with a combination of mineral and biological nitrogen. This increment was obtained by treatments ($M_2$ x $B_4$) and ($M_3$ x $B_3$).

## GENERAL CONCLUSION

From the foregoing results, the analysis of nutrient content in mature leaves of untreated plants showed that the concentration of nitrogen was low in petioles than that in leaf blades but petioles contained slightly more phosphorus and potassium compared with leaf blades. So, leaf blades may be suitable to diagnose nutrients content in grape transplants.

Regarding the effect of mineral and biological nitrogen fertilization on leaf nutrient content, results proved that unfertilized transplants gave the lowest values for all elements (N, P, K, Fe) except K in petioles and Zn & Mn in blades. Mineral fertilization alone increased mineral content without any significant difference between them. Biological fertilization alone increased mineral content and treatment ($M_1$ x $B_3$) gave the highest values of N, K, Fe and Mn in blades. On the contrary treatment ($M_1$ x $B_4$) gave the highest values of P and Zn in leaf blades & P,K in leaf petioles. So, it could be concluded that inoculation the rhizosphere with free living nitrogen fixation bacteria (*A. chroococcum*) did not only meet a part of nitrogen requirements of transplants but also enhanced the absorption of other nutrients such as P,K, Fe, Zn, and Mn. Combining mineral with biological nitrogen gave more increase in mineral content and in most cases treatments($M_2$ x $B_3$) ($M_2$ x $B_4$) and ($M_3$ x $B_4$) gave the highest values of different nutrients in leaves.

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# تأثير التسميد النتروجينى المعدنى والحيوى على شتلات العنب البناتى صنف طومسون سيدلس

## II- التأثير على المحتوى المعدنى فى الاوراق .

إبراهيم شوقى* ، سعيد الشاذلى* ، أحمد الجزار* ، شوقى سليم** ، نهى منصور*
* قسم البساتين – كلية الزراعة – عين شمس
** قسم الميكروبيولوجى – كلية الزراعة – عين شمس

أجريت تجربة أصص خلال موسمي ٢٠٠١ – ٢٠٠٢ على شتلات العنب البناتي " صنف طومسون سيدلس " لدراسة تأثير مصدرين من التسميد النتروجينى (معدنى وحيوى) على المحتوى المعدنى للشتلات وقد اشتملت التجربة على ثلاثة مستويات من التسميد النتروجينى المعدنى (م١ = صفر، م٢ =٥، م٣ =١٠ جم ن/نبات/سنة) وأربعة مستويات من التسميد النتروجينى الحيوى (ح١ = صفر، ح٢=٥٠، ح٣= ١٠٠، ح٤=٢٠٠ مل من المزرعة السائلة ل *Azotobacter chroococcum*) فى تجربة عاملية فى تصميم قطاعات كاملة العشوائية.

وقد أوضحت النتائج أن المستوى الثانى من السماد المعدنى(م٢ =٥ جم ن/نبات/سنة)أوالمستوى الثالث أوالرابع من السماد الحيوى (ح٣ & ح٤) أعطوا أعلى محتوى معدنى للاوراق (أنصال & أعناق) من العناصر المختلفة (ن، فو، بو، ح، ز، من).

وبالنسبة للتفاعل وجدأن التسميد بمعاملات السماد المعدنى بمفرده [(م٢×ح١)، (م٣ × ح١) ]أدت الى زيادة محتوى الاوراق (أنصال & أعناق) من النتروجين والفوسفور والبوتاسيوم مقارنة بالمعاملة غير المسمدة (م١ × ح١) وبالرغم من ذلك فان التسميد المعدنى بمفرده لم يؤثر على الحديد والزنك والمنجنيز.

ومن جهة أخرى وجدأن التسميد بمعاملات السماد الحيوى بمفرده[(م١×ح٢)، (م١×ح٣)، (م١×ح٤) أدت الى زيادة المحتوى المعدنى للاوراق (أنصال & أعناق)مقارنة بالنباتات غير المعاملة(م١×ح١) وكانت المعاملة(م١ × ح٣) هى الأفضل خلال الموسمين. وقد أحدثت أكبر زيادة فى المحتوى المعدنى من خلال التركيبات المختلفة بين السماد المعدنى والحيوى وبخاصة عند تداخل المستوى الثانى والثالث للسماد المعدنى مع مستويات التسميد الحيوى المختلفة وبصفة خاصة مع المستوى الثالث والرابع (ح٣ & ح٤) حيث أعطت المعاملات (م٢ × ح٣) ،(م٢ × ح٤)، (م٣ × ح٤) أعلى محتوى معدنى للاوراق (أنصال & أعناق) من العناصر المختلفة(ن ، فو، بو، ح، ز ، من).

ومن ذلك يستخلص ان تلقيح وسط الجذور ببكتريا الازتوباكتر المثبتة لنيتروجين الهواء الجوى بصورة حرة لم تمد النبات بجزء من احتياجاته من النيتروجين فقط بل سببت زيادة من بعض العناصر الغذائية الاخرى. ومن الملاحظ ايضا ان التسميد بالتركيبات المختلفة بين السماد المعدنى والحيوى أدت الى زيادة المحتوى المعدنى للشتلات عما اذا اضيفت كل صورة بمفردها. ومن ثم فان أفضل المعاملات الموصى بهاهى التسميد بالمستوى الثانى معدنى مع الثالث حيوى (م٢×ح٣).