# The Effect of Nitrogen Level on mMain Nutrient of Sugar Beet

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**Abstract:** The nitrogen content of sugar beet plant was significantly positive correlated with nitrogen amount used. At the beginning of beet growing, the distribution of nitrogen was mainly in leaves, but later the distribution rate of nitrogen increased in roots. However, the distribution rate of nitrogen in leaves was still on high level when treated with high amount of nitrogen, which would be against the accumulation of sugar. The contents of phosphorous and potassium of beet plant were also significantly positive correlated with nitrogen amount used, and nitrogen has obvious interaction effect with phosphorus and potassium. [Nature and Science. 2004;2(4):79-83].

**Key Words:** sugar beet; nitrogen metabolism; interaction effect

## 1. Introduction

Fertilizers are the main food for plant. Nitrogen is one of the three components in fertilizers, and also the sensitive element that affect the beet production and sugar content (Zhou, 1993). The study of nitrogen amount on beet production and sugar content will be important and significant (Qu, 1992). This article demonstrates the effect of nitrogen amount on main nutrients of sugar beet.

## 2. Materials and Methods

### 2.1 Species used in this experiment

Tianyan No.7, provided by Hulan sugar beet research institute, Heilongjiang Province, China.

### 2.2 Design of the experiment

Five treatments were used upon $P_{90}K_{90}$ (kg/hm$^2$): $N_0$, $N_{60}$, $N_{120}$, $N_{180}$, $N_{240}$ (kg/hm$^2$). Random group design was used, which including five rows and four repeats. The length of row was 11 m, the width of row was 0.6 m and the plot area was 33 m$^2$. The basic fertility of soil was: organic matter 25.57 g/kg, total nitrogen 1.71 g/kg, total phosphate 0.78 g/kg, total potassium 24.2 g/kg, alkalized nitrogen 145.1 g/kg, instant phosphate 35.0 mg/kg, instant potassium 202 mg/kg and pH 6.9 (Xu, 1983; Zheng, 1984).

### 2.3 Measurement methods

Total nitrogen: distillation method.
Total phosphate: colorimetry.
Total potassium: flame photometer.

## 3. Results and analysis

### 3.1 The nitrogen contents of sugar beet plant and their distribution

The nitrogen contents of sugar beet plant and their distribution with different nitrogen level were shown in Table 1.

**Table 1. The nitrogen contents of sugar beet plant and their distribution**

| Growing stages (Month.date) | Treatment | Nitrogen contents in beet plants | | Nitrogen distribution in beet plant (%) | |
|---|---|---|---|---|---|
| | | g/plant | % | leaves | roots |
| Seedling stage 5.30 | $N_0$ | $0.90\times10^{-2}$ | 2.61 | 93.93 | 6.07 |
| | $N_{60}$ | $1.00\times10^{-2}$ | 2.78 | 93.96 | 6.04 |
| | $N_{120}$ | $1.10\times10^{-2}$ | 2.87 | 94.36 | 5.64 |

**Continue Table 1:**

| | | | | | |
|---|---|---|---|---|---|
| | $N_{180}$ | $1.20\times10^{-2}$ | 2.96 | 94.40 | 5.60 |
| | $N_{240}$ | $1.20\times10^{-2}$ | 2.98 | 94.62 | 5.38 |
| **Leaf fascicle formation stage 7.4** | $N_0$ | 0.80 | 2.19 | 85.75 | 14.25 |
| | $N_{60}$ | 1.01 | 2.28 | 86.04 | 13.96 |
| | $N_{120}$ | 1.10 | 2.44 | 86.76 | 13.24 |
| | $N_{180}$ | 1.26 | 2.65 | 87.51 | 12.49 |
| | $N_{240}$ | 0.57 | 2.74 | 87.79 | 12.21 |
| **Epacme of root tuber 8.15** | $N_0$ | 1.53 | 1.13 | 79.84 | 20.16 |
| | $N_{60}$ | 2.05 | 1.33 | 81.19 | 18.81 |
| | $N_{120}$ | 2.64 | 1.42 | 82.16 | 17.84 |
| | $N_{180}$ | 3.04 | 1.50 | 82.56 | 17.44 |
| | $N_{240}$ | 3.57 | 1.67 | 83.79 | 16.21 |
| **Sugar accumulation stage 9.3** | $N_0$ | 1.24 | 0.70 | 69.12 | 30.79 |
| | $N_{60}$ | 1.61 | 0.87 | 74.14 | 25.86 |
| | $N_{120}$ | 2.10 | 1.06 | 78.03 | 21.97 |
| | $N_{180}$ | 2.38 | 1.11 | 78.32 | 21.68 |
| | $N_{240}$ | 2.84 | 1.32 | 81.19 | 18.81 |

There were different nitrogen contents absorbed in each organ of sugar beet plant. In all of the growth stage, the absolute nitrogen contents in leaves were higher than that in leafstalks and roots, while that in roots were higher than that in leafstalks. The nitrogen contents in leaves, leafstalks and roots were shown as unimodal curves. The maximum value of absolute nitrogen contents in leaves and leafstalks appeared at the middle of August, and that in roots were appeared at the beginning of September. The relative nitrogen contents of each organ with different treatments were shown the same regularity in the whole growth stage, that is, it was decreased from the beginning to the sugar accumulation stage. The relative nitrogen contents of each organ was leaves > roots > leafstalks.

With the increasing of nitrogen used, the nitrogen contents of each organ increased, too. They were positive correlation. The results showed that with the high nitrogen treatment, the nitrogen content of each organ were higher at the beginning of September, the overground grew too much and resulted in the low yield of roots. However, the sugar beet without nitrogen treatment reached the maximum value of absolute nitrogen contents, but the total nitrogen contents were too low and resulted in the fallen of leaves and low yield.

Among the treatment of different nitrogen levels, the nitrogen content of plant improved with the increasing quantity of the applied nitrogen, and both of them showed an extremely remarkable positive correlation, the correlation coefficient r = 0.995***.

The nitrogen distribution ratio of beet plant changed significantly because of the different growth stages (Table 1). More than 90% nitrogen was distributed to the overground in seedling stage and the distribution of nitrogen was mainly in overground, occupying 85%~90% of the amount of nitrogen in whole plant in the leaf fascicle formation stage, in which the nitrogen content of the root tuber is 10%~15%.

The distribution characteristic of nitrogen in plant was accordant to the nitrogenous metabolism in the beet, which was mainly in the earlier and intermediate stage of growth. The earlier and intermediate stage of beet growth was mainly the phase that the assimilative organs were formed and the period that the leaf quantity increased and the leaf area expanded most fast, so the distribution of nitrogen was mainly in the overground. According to the characteristic of the beet nitrogen metabolism, the nitrogenous fertilizer should be used at the beginning, assisting the top dressing of the earlier stage to ensure that the need for nitrogen in the earlier and intermediate stage of beet breeding, which also could avoid the rewardless growth of the leaf segment caused by excessive nitrogen absorbed in later stage

and the sugar accumulation.

After going into epacme of root tuber, the nitrogen distribution ratio of the root increased obviously, reaching about 50% in the middle of September. But for the beet with treatment of high nitrogen quantity, the nitrogen distribution ratio of the overground was still higher, so more photosynthesis continued to be used in the leaf growth and the maturation of the beet was lagged, which lead to root yield and the sugary ratio decreased. To obtain the beet of high yield and high sugar content the nitrogenous fertilizer must be applied properly both in quantity and time.

### 3.2 The phosphorus contents of sugar beet plant and their distribution

The three fertilizer elements have obvious interaction effect to each other, so the nitrogen level influences the phosphorus or potassium content of the beet plant and their distribution. Table 2 showed that absolute phosphorus content and the relative phosphorus content increased with the improving of the nitrogen level. The phosphorus content of the beet showed an extremely remarkable positive correlation to the quantity of nitrogen applied, the correlation coefficient r = 0.996***. The absolute phosphorus content of plant was lowest in seedling stage and increased with the development of breeding, reaching the maximum value in the epacme of root tuber, then decreased. The whole growth duration appeared a singlet curve. However, the relative content of phosphorus was highest in seedling stage, getting the lowest in harvest and the whole growth duration appeared a degression trend.

**Table 2. The phosphorus contents of sugar beet plant and their distribution**

| Growing stages (Month.date) | Treatment | phosphorus contents in beet plants | | phosphorus distribution in beet plant (%) | |
|---|---|---|---|---|---|
| | | g/plant | % | leaves | roots |
| Seedling stage 5.30 | $N_0$ | $0.43\times10^{-2}$ | 1.21 | 80.35 | 19.65 |
| | $N_{60}$ | $0.47\times10^{-2}$ | 1.28 | 80.75 | 19.25 |
| | $N_{120}$ | $0.54\times10^{-2}$ | 1.42 | 81.22 | 18.78 |
| | $N_{180}$ | $0.56\times10^{-2}$ | 1.45 | 82.22 | 17.78 |
| | $N_{240}$ | $0.60\times10^{-2}$ | 1.47 | 82.57 | 17.43 |
| Leaf fascicle formation stage 7.4 | $N_0$ | 0.38 | 1.03 | 78.72 | 21.28 |
| | $N_{60}$ | 0.47 | 1.06 | 78.94 | 21.06 |
| | $N_{120}$ | 0.52 | 1.14 | 79.85 | 20.16 |
| | $N_{180}$ | 0.56 | 1.19 | 80.14 | 19.86 |
| | $N_{240}$ | 0.72 | 1.25 | 80.61 | 19.39 |
| Epacme of root tuber 8.15 | $N_0$ | 0.99 | 0.73 | 69.47 | 30.53 |
| | $N_{60}$ | 1.11 | 0.78 | 70.42 | 29.58 |
| | $N_{120}$ | 1.49 | 0.80 | 71.22 | 28.78 |
| | $N_{180}$ | 1.76 | 0.87 | 72.20 | 27.30 |
| | $N_{240}$ | 1.99 | 0.93 | 74.08 | 25.92 |
| Sugar accumulation stage 9.3 | $N_0$ | 0.99 | 0.56 | 63.96 | 36.04 |
| | $N_{60}$ | 1.06 | 0.57 | 64.13 | 35.87 |
| | $N_{120}$ | 1.19 | 0.60 | 64.56 | 35.44 |
| | $N_{180}$ | 1.36 | 0.63 | 64.99 | 35.01 |
| | $N_{240}$ | 1.42 | 0.66 | 65.35 | 34.65 |

During the seedling phase of beet, 80% phosphorus in the plant was distributed to the overground part (Table 2). From the phyllome forms stage to middle August, the content of phosphorus in the phyllome accounted for a biggish proportion constantly, 70-80% of that in a plant. And in middle August, the accumulating quantity reached the peak. The accumulating quantity of phosphorus in the root

increased gradually with the growing process. After middle August, the distributing rate to the root of each kind of disposed phosphorus increased to 34-36%. Meanwhile, a great deal of sugar accumulated in the root. The distributing law of phosphorus was that at the early growing period, phyllome got the priority, cooperating firmly with nitrogen metabolism to promote the growth of the overground part. At the middle and late period, the distributing rate to the root increased obviously, which was helpful to the root development and the sugar accumulation. After middle August, the absorption of phosphorus waned. Therefore, the quantity of phosphorus supplied in the early period influenced the phosphorus level in the late period directly, thereby, related to the beet and sugar output. So in order to assure there is enough phosphorus to be absorbed during the early and middle phase and to meet the requirement in the whole growing period, the use of fertilizers in beet planting should mainly depends on the basic ones, with the seed fertilizers to be auxiliary.

### 3.3 The potassium contents of sugar beet plant and their distribution

The content of potassium in beet plant also increased with the enhancement of the nitrogen level (Table 3). They were significantly positive correlation, the correlation coefficient r = 0.996. The absolute potassium content was the lowest in seeding stage and reached the maximum at epacme of root tuber. The relative content of potassium was highest in seedling stage and lowest in harvest time.

**Table 3. The potassium contents of sugar beet plant and their distribution**

| Growing stages (Month.date) | Treatment | potassium contents in beet plants | | potassium distribution in beet plant (%) | |
|---|---|---|---|---|---|
| | | g/plant | % | leaves | roots |
| **Seedling stage 5.30** | $N_0$ | 1.72 | 4.76 | 91.08 | 8.92 |
| | $N_{60}$ | 1.81 | 4.88 | 91.23 | 8.77 |
| | $N_{120}$ | 1.87 | 4.91 | 91.31 | 8.69 |
| | $N_{180}$ | 1.93 | 4.95 | 91.45 | 8.55 |
| | $N_{240}$ | 2.10 | 5.13 | 91.53 | 8.47 |
| **Leaf fascicle formation stage 7.4** | $N_0$ | 0.69 | 1.89 | 80.32 | 19.68 |
| | $N_{60}$ | 0.91 | 2.06 | 81.38 | 18.62 |
| | $N_{120}$ | 1.01 | 2.23 | 82.32 | 17.68 |
| | $N_{180}$ | 1.08 | 2.28 | 82.53 | 17.47 |
| | $N_{240}$ | 1.37 | 2.39 | 82.63 | 17.37 |
| **Epacme of root tuber 8.15** | $N_0$ | 2.22 | 1.63 | 77.05 | 22.95 |
| | $N_{60}$ | 2.59 | 1.68 | 77.74 | 22.26 |
| | $N_{120}$ | 3.28 | 1.76 | 78.52 | 21.48 |
| | $N_{180}$ | 3.63 | 1.79 | 78.64 | 21.36 |
| | $N_{240}$ | 3.95 | 1.85 | 78.89 | 21.12 |
| **Sugar accumulation stage 9.3** | $N_0$ | 1.94 | 1.09 | 71.83 | 28.17 |
| | $N_{60}$ | 2.10 | 1.13 | 72.25 | 27.75 |
| | $N_{120}$ | 2.36 | 1.19 | 73.08 | 26.92 |
| | $N_{180}$ | 2.50 | 1.19 | 73.44 | 26.56 |
| | $N_{240}$ | 2.62 | 1.22 | 73.67 | 26.33 |

The distribution situation varied at different growing stages. 90% potassium was distributed to leaves and 10% was in roots (Table 3). The distribution of potassium to leaves was quite high in leaf fascicle formation stage and epacme of root tuber, which was 80%. The potassium in roots was increased with the proceeding of growing stages, which was 28% when harvesting.

The distribution regularity of potassium was mainly on leaves at the beginning of growing,

cooperated tightly with nitrogen and phosphorus metabolism and promoted the formation of assimilation organs. Later, the distribution of potassium obviously increased in roots, which could be benefits for the growing of roots and accumulation of sugar.

## 4. Conclusions

4.1 The content of nitrogen in beet plant increased with the elevation of nitrogen amount, which showed significantly positive correlation; The absolute content of nitrogen increased gradually with the growing proceeding, and reached the peak in root formation, then decreased.

4.2 The nitrogen level influenced the absorption of phosphorus and potassium by beet plant. The content of phosphorus and potassium showed significantly positive correlation with nitrogen amount used. Nitrogen showed obvious interaction effect with phosphorus and potassium.

4.3 Nitrogen fertilizer should be applied as basic fertilizer, then as accompanied fertilizer, phosphorus and potassium fertilizers should be used as basic ones.

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**Correction:**

The paper named "*Study on the Preparation and Regeneration of Protoplast from Taxol-producing Fungus Nodulisporium sylviforme*." which has been published in "*Nature and Science*"[2004,2(2): 52-59] should be corrected in page 58 as follows.

| Original (page 58) | Correction |
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