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Impact of Slow-Release and Organic Fertilizers on Growth, Yield, and CLUSTER Quality of Thompson Seedless Grapevines (H4 Strain) growing in Sandy Soil.

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ABSTRACT

Starting in 2022, Thompson seedless grapevines (H4 strain) received 50 kg of actual nitrogen per Fed. (about 71.4 g N/ vine) combined from three different sources for two consecutive seasons. Control plants received 100% fast-release nitrogen fertilizer (NH_4NO_3 33.5% N). Treatment groups received triple combinations of 50% or 25% from NH_4NO_3, 25% or 37.5% organic N fertilizer (plant compost, 2% N), and 25% or 37.5% from one slow-release N fertilizer, namely urea formaldehyde (UF, 38.37% N), phosphorus-coated urea (PCU, 37.11% N), or Sulphur-coated urea (SCU, 41% N). The target was to select the best ratio and the preferred source of slow-release nitrogen.

Using nitrogen as 25% NH_4NO_3, 37.5% plant compost, and 37.5% slow-release nitrogen (UF, PCU, or SCU) significantly improved berries' growth, yield, and physicochemical properties compared with other treatments. The results showed that the best slow-release nitrogen sources were SCU, PCU, and UF. Conversely, an apparent reduction in these traits was in the vines treated with 100% nitrogen as ammonium nitrate.

To enhance the growth, yield, and cluster quality of Thompson Seedless grapevines (H4 strain), it is recommended to utilize a combination of nitrogen fertilizers: 25.0% fast-release (NH_4NO_3), 37.5% organic (plant compost) and 37.5% slow-release (e.g., SCU).

Keywords: Thompson seedless grapevines, H4 strain, fast-release, slow-release, organic nitrogen fertilizers, urea-formaldehyde (UF), phosphorus-coated urea (PCU), sulphur-coated urea (SCU).

INTRODUCTION

Grapevine cultivars (cvs) are important deciduous fruit trees cultivated in Egypt. Due to their remarkable shelf life, Thompson seedless grapes have gained significant popularity, rendering them the preferred choice among seedless grape varieties **(Lo'ay and El-Khateeb, 2018)**, especially the contemporary strains of Thompson 2A, H4, and H5. The H4 strain exhibits a highly discernible and succulent flavor profile with notable sweetness. They have crisp, firm skin with a juicy pulp **(Zoffoli *et al.*, 2009)**. The H4 strain has a noteworthy abundance of simple sugars, comprising an equal proportion of fructose and glucose. In addition, they provide nutritional fiber and essential vitamins while also containing adequate quantities of potassium and iron, not to mention low salt content **(Belal, 2019, Al-Sagheer *et al.*, 2023)**.

The role of nitrogen in plant nutrition and development is of great importance and is widely acknowledged **(Leghari *et al.*, 2016).** The nucleic acid synthesis process is of utmost significance in plants as it fulfills various vital roles, such as generating genetic information and its subsequent regulation. Moreover, nitrogen has a crucial role in facilitating diverse enzyme activities, hence facilitating the optimization of metabolic processes inside the plant. Furthermore, nitrogen plays a pivotal role in producing proteins, which are required for many physiological functions, including growth, photosynthesis, and defense systems. Therefore, ensuring a sufficient nitrogen supply is crucial to optimize plant development, enhance productivity, and improve overall quality (**Ingestad and Ågren, 1992; Refaai, 2016; El-Salhy *et al.*, 2017; Majidi and Baneh, 2020).**

The utilization of fast-release nitrogen fertilizers often leads to significant nitrogen loss through leaching. As a result, incorporating slow-release nitrogen fertilizers can improve nitrogen use efficiency, as these fertilizers gradually release nitrogen over an extended period **(Varadachari and Goertz, 2010, El-Sabagh *et al.*, 2011, El-Salhy *et al.*, 2017, Majidi and Baneh, 2020)**.

The application of slow-release and organic nitrogen fertilizers has been found to have a positive impact on the fruiting of fruit crops in comparison to the use of fast-release fertilizers **(Refaai, 2016)**. Many studies illustrated the superiority of slow-release and organic nitrogen fertilizers over their fast-release counterparts on grapevine cultivars' productivity and fruit quality (**Alam, 2014; Akl *et al.*, 2019)**.

The primary objective of this study was to assess the impact of utilizing slow-release and organic nitrogen fertilizers in comparison with fast-release nitrogen, specifically ammonium nitrate, on the growth, yield, and quality of Thompson seedless grapevines (H4 strain) cultivated in sandy soil.

MATERIALS AND METHODS

The present study involved a sample of forty-two Thompson seedless grapevines (H4 strain) that were seven years old and of equal vigor during 2022 and 2023. These grapevines were grafted onto freedom rootstock and propagated within a privately owned vineyard in the West Abo-Qurqas District of the Minia Governorate in Egypt.

As illustrated in Table 1, the vineyard's soil has a sandy texture. Furthermore, the soil possessed excellent drainage capabilities, ensuring efficient water flow. It is worth noting that the water table maintains a minimum depth of two meters, indicating sufficient distance between the surface and groundwater level.

Table (1): Analysis of soil of the study vineyard (**Wilde *et al.*, 1985**).

Characters	Values	Characters	Values
Particle size distribution		**Macronutrients**	
Sand %	84.4	N (%)	0.036
Silt %	11.4	P (Olsen method, ppm)	1.9
Clay %	4.2	K (ammonium acetate, ppm)	44.0
Texture grade	Sandy	**EDTA micronutrients (ppm)**	
pH (1:2.5 extract)	7.99	Zn (ppm)	0.99
E.C. (1:2.5 extract) mmhos/ 1cm	1.63	Fe (ppm)	1.13
O.M. %	0.25	Mn (ppm)	0.96
$CaCO_3$%	4.88		

The selected vines are planted at a 3.0 x 2.0 m spacing, with a vine density of 700 plants per Fedd. Conventional cane pruning was implemented in the 1st week of January so that each vine carried eight fruiting canes (10 eyes each) and eight renewal spurs (two eyes each), adding up to 96 eyes.

Using the Barun-supported method, the vines received drip irrigation of underground water (salinity: 1030 ppm). The same system was used for fertilizer application. Apart from nitrogen fertilizer treatments, all the studied vines received the standard commonly implemented vineyard horticultural procedures.

This experiment comprised seven nitrogen fertilization treatments from different sources. Ammonium nitrate (NH_4NO_3, 33.5% N) served as a fast-release nitrogen fertilizer, and plant compost (2.0% N) as an organic N source. Besides, three slow-release fertilizers were included in the study design: urea-formaldehyde (UF, 38.37% N), phosphorus-coated urea (PCU, 37.11% N), and Sulphur-coated urea (SCU, 41% N). A 50 kg/fed total nitrogen fertilization protocol was followed (**Montasser *et al.*, 2003**), which secured 71.4 g N/vine/year from the following different treatments:

T_1- Soil addition of 100% ammonium nitrate (214.0 g / vine/ year).

T_2- Soil addition of 50% ammonium nitrate (107.0 g / vine/ year) plus 25% plant compost (892.5 g/ vine / year) plus 25% urea formaldehyde (46.5 g/ vine/ year).

T_3- Soil addition of 50% ammonium nitrate (107.0 g / vine/ year) plus 25% plant compost (892.5 g/ vine / year) plus 25% phosphorus –coated urea (48.1 g/ vine/ year).

T_4- Soil addition of 50% ammonium nitrate (107.0 g / vine/ year) plus 25% plant compost (892.5 g/ vine / year) plus 25% sulphur–coated urea (43.5 g/ vine/ year).

T_5- Soil addition of 25% ammonium nitrate (53.5 g / vine/ year) plus 37.5% plant compost (1339.0 g/ vine / year) plus 37.5% urea formaldehyde (69.75 g/ vine/ year).

T_6- Soil addition of 25% ammonium nitrate (53.5 g / vine/ year) plus 37.5% plant compost (1339.0 g/ vine / year) plus 37.5% phosphorus –coated urea (72.15 g/ vine/ year).

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T_7- Soil addition of 25% ammonium nitrate (53.5 g / vine/ year) plus 37.5% plant compost (1339.0 g/ vine / year) plus 37.5% sulphur–coated urea (65.25 g/ vine/ year).

All treatments were repeated three times, two vines each. Application of ammonium nitrate was 40% at the growth start, 40% immediately after berry setting, and the remaining 20% after one month. Plant compost was applied during the last week of Jan. On the other hand, the total amount of the slow-release N fertilizers (UF, PCU, or SCU) was added once at growth start (last week of Mar.) in circular excavations surrounding each vine, leaving an approximate distance of 50 cm from the trunk, and covered with soil.

The study followed a Randomized Complete Block Design (RCBD) of the seven treatment groups.

The following parameters were measured in both seasons for all the vines under study:

1-Vegetative Growth:

Markers of plant growth were determined according to **Ahmed and Morsy (1999)** during the 1st week of May by measuring the length (cm) of shoots, the average leaf area (cm^2), and counting the average leaves/shoot.

In the last week of October, we determined the coefficient of wood ripening, the average cane thickness, and the weight of wood pruning (kg/vine) according to previously described methods (**Bouard, 1966**).

2-Chemical properties of the leaves:

The petioles of the leaves opposite the basal clusters in the first week of July were used for the determination of N, P, and K as percentages **(Sharaf El-Deen and Ashour, 2009)** and the content of Zn, Fe, and Mn (ppm) (**Summer, 1985 and Chapman and Pratt, 1987**).

The leaf contents of α-Chlorophyll (chlorophyll a), β-Chlorophyll (chlorophyll b), total chlorophylls, and total carotenoids were determined as mg/g leaf weight by the methods described by **Von-Wettsein (1957).**

3-Yield and cluster measures:

The harvesting time was determined when the percentage of total soluble solids (TSS%) to acidity content reached 25:1. The yield per vine was calculated as the number of clusters/vine and the average weight of total harvest/vine. Besides, the average cluster weight (g) and its dimensions (cm) were determined.

4-Some physical and chemical characteristics of the berries:

Several parameters were assessed to evaluate the quality of berries in this study. Berry weight (g) and its dimensions including diameter and length (cm), were measured. The total soluble solids percentage (TSS%) in the berry juice was determined using a convenient refractometer, indicating the sweetness level. The reducing sugar percentage was analyzed following the method described by **Lane and Eynon (1965)**. Additionally, the total acidity of the juice was measured as equivalents of tartaric acid per 100 ml, following the guidelines outlined by the Association of Official Agricultural Chemists (**A.O.A.C., 2000**).

Data were tabulated and analyzed for the difference between means by ANOVA followed by Fisher's least significant difference (LSD) at a 5% level of statistical significance according to methods outlined by **Mead *et al.* (1993**).

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RESULTS AND DISCUSSION

1-Some vegetative growth aspects:

The data presented in Table (2) demonstrate the effects of different nitrogen sources on the growth characteristics of Thompson seedless grapevines (H4 strain). The data show that fertilizing Thompson seedless grapevines (H4 strain) with a tripartite combination of fast-release nitrogen fertilizers (50% or 25% from NH_4NO_3), and organic (25% or 37.5% from plant compost), and a slow-release nitrogen fertilizer (25% or 37.5% from UF, PCU, or SCU) significantly increased the vine shoot length and number of leaf number, leaf surface area, wood ripening coefficient, cane thickness, and pruning weight in comparison with using fast-release nitrogen (100% from NH_4NO_3) alone.

Besides plant compost, the observed positive effects were significantly associated with fertilization treatments containing SCU followed by PCU and UF in descending order. The best results were registered on the vines that received 25% fast-release (NH_4NO_3), 37.5% organic (plant compost), and 37.5 % slow-release (SCU) nitrogen fertilizers. The vines that received 100% nitrogen as NH_4NO_3 displayed the lowest growth characteristics. These findings were consistent throughout the 2021 and 2022 seasons.

2-Leaf chemical composition:

The application of nitrogen to H4 Thompson seedless grapevines in the form of a combination of mineral N (NH_4NO_3, 25% or 50%), organic N (plant compost, 25% or 37.5%), and slow-release N sources significantly enhanced leaf chemical parameters compared with mineral N treatment alone. Specifically, this combined approach increased the concentrations of chlorophylls (a, b, and total), total carotenoids, nitrogen

(N), phosphorus (P), potassium (K), zinc (Zn), iron (Fe), and manganese (Mn).

Slow-release nitrogen fertilizers SCU, PCU, and UF showed the best results in descending order. Indeed, the highest values of these leaf chemical parameters were reported in the treatment group T_7 (25% ammonium nitrate, 37.5% plant compost, and 37.5% SCU). Supplying vines with ammonium nitrate alone exhibited the lowest levels. The findings were similar in both seasons.

3-The yield and cluster aspects:

The data presented in Table (5) provides clear evidence that the provision of nitrogen to Thompson seedless grapevines (H4 strain) through a combination of fast-release N (25 to 50%), organic N (25 to 37.5%), and slow-release N (25 to 37.5%) significantly enhances the yield/vine measured as cluster weight and number, and dimensions compared with the application of nitrogen solely through fast-release N fertilizer. However, the number of clusters per vine in the initial seasons of the study showed no significant impact from the implemented treatments. The most effective slow-release nitrogen preparations were SCU, PCU, and UF, listed in descending order.

During the 2021 and 2022 seasons, control vines that received solely ammonium nitrate exhibited the lowest yield: 15.40 and 16.10 kg per vine, respectively. It was noted that the vines supplied with a combination of 25% ammonium nitrate, 37.5% plant compost, and 37.5% SCU had the highest yield per vine: 17.92 and 22.75 kg, with a 16.36% and 41.30% increase over the control treatment in the 2021 and 2022 seasons respectively.

4-Some physical and chemical characteristics of the berries:

Table (6) illustrates that providing the H4 strain Thompson seedless grapevines with 25 or 50% fast-release nitrogen fertilizers (ammonium nitrate) plus 3.75 or 25% organic N fertilizers (plant compost) plus 37.5% or 25% slow-release N fertilizers (UF, PCU, or SCU) significantly improved the physical and chemical characteristics of berries compared to the 100% fast-release nitrogen fertilizer treatment. The combined treatments increased berry weight, length, diameter, and TSS% in addition to enhancing the percentage of reducing sugars while decreasing the total acidity %.

Decreasing the amount of slow-release N to 25% significantly improved berry quality when combined with 37.5% organic N and 37.5% slow-release N fertilizers, primarily when SCU was used; a combination that showed the best berry quality results. On the other hand, the lowest indicators of berry quality were obtained when the vines were fertilized with 100% ammonium nitrate. These results were reproduced in both seasons.

DISCUSSION

The comparative advantage of certain slow-release over fast-release N fertilizers lies in their ability to gradually release nutrients into the soil, resulting in reduced leaching rates and ultimately improved efficiency **(Varadachari and Goertz, 2010; Wei *et al.*, 2020)**. Recently, novel methodologies have emerged for fertilizing fruit trees cultivated on sandy soil **(Elamin *et al.*, 2017; Chatzistathis *et al.*, 2021)**. The development of certain slow-release nitrogen fertilizers has primarily aimed to decrease the frequency of yearly applications, lower production costs, enhance the efficiency of nitrogen utilization by vines, and mitigate rapid denitrification **(Refaai, 2016; El-Salhy *et al.*, 2017; Majidi and Baneh, 2020).**

In the present investigation, the improvement of growth and fruiting of Thompson Seedless grapevines (H4 strain) with the application of slow-release nitrogen fertilizers can be attributed to several factors. Slow-release fertilizers facilitate nitrogen uptake; thus, the plants can effectively utilize nitrogen for their physiological processes **(Varadachari and Goertz, 2010; Refaai, 2016; Wei *et al.*, 2020)**. Another important aspect is that nitrogen is released slowly over time, which supports the plants' nutrient requirements during different growth stages. Besides, slow-release nitrogen fertilizers minimize leaching to the deeper soil, ensuring nitrogen remains available for plant uptake rather than being lost to the environment **(Trenkel, 2021; Tyagi *et al.*, 2022)**.

These factors may regulate vine growth and save mineral and organic nutrients essential for fruiting. Recent studies also found that slow-release nitrogen fertilizers improve Thompson seedless grapevines' development and nutrient control **(Al-Sagheer *et al.*, 2023; Verma and Gaikwad, 2023)**.

On the other hand, relying only on fast-release nitrogen fertilizers substantially causes nitrogen loss through leaching **(Varadachari and Goertz, 2010; El-Sabagh *et al.*, 2011; El-Salhy *et al.*, 2017; Majidi and Baneh, 2020)**.

Furthermore, the beneficial effects of certain slow-release nitrogen fertilizers, particularly sulphur-coated urea, can also be attributed to their impact on soil pH **(Liu *et al.*, 2022)**; the ability of these fertilizers to reduce soil pH facilitates the uptake of certain nutrients by plants as a result of enhanced solubility and availability of essential nutrients. This improved nutrient uptake can contribute to the observed favorable effects on plant growth and development **(Wei *et al.*, 2020; Trenkel, 2021; Liu *et al.*, 2022)**.

The positive effects of certain slow-release nitrogen fertilizers on Thompson Seedless grapevines (H4 strain) in this study are consistent with prior research conducted by other scholars (**Alam, 2014; Akl *et al.*, 2019**). These consistent findings further endorse the efficacy of slow-release nitrogen fertilizers in enhancing various aspects of grapevine cultivation, including vine growth, nutrient status, and, ultimately, the yield and quality of berries **(El-Salhy *et al.*, 2017; Majidi and Baneh, 2020; Al-Sagheer *et al.*, 2023)**.

CONCLUSION

To optimize the development, productivity, and fruit characteristics of Thompson Seedless grapevines (H4 strain) cultivated in sandy soils, it is advised to employ a fertilizer blend consisting of 25.0% rapidly-releasing nitrogen fertilizer (specifically ammonium nitrate), 37.5% nitrogen derived from organic sources (such as plant compost), and 37.5% nitrogen form a slow-releasing source (sulphur-coated urea).

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Table (2): Effect of soil application fast, organic and some slow release nitrogen fertilizers on some vegetative growth characteristics of Thompson seedless grapevines (H4 strain) during 2022 and 2023 season.

Treatments	**Main shoot length (cm.)**		**Number of leaves/ shoot (leaf)**		**Leaf area (cm)^2**		**Wood ripening coefficient**		**Pruning wood weight vine/ kg.)**		**Cane diameter (cm.)**	
	2022	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
T_1-100 % N	102.5	103.0	14.0	14.0	101.0	103.0	0.72	0.72	1.66	1.68	1.03	1.03
T_2- 50% AN + 25% compost + 25% UF	108.0	109.0	15.5	16.0	105.0	106.5	0.74	0.76	1.72	1.73	1.05	1.07
T_3- 50% AN + 25% compost + 25% PCU	109.5	110.5	16.0	16.5	107.5	109.0	0.77	0.78	1.77	1.78	1.08	1.09
T_4- 50% AN + 25% compost + 25% SCU	111.0	112.0	16.5	17.0	111.0	113.0	0.81	0.82	1.82	1.84	1.10	1.11
T_5- 25% AN + 37.5% compost + 37.5% UF	114.5	115.0	17.0	17.5	115.0	117.0	0.83	0.84	1.88	1.89	1.13	1.15
T_6- 25% AN + 37.5% compost + 37.5% PCU	119.0	120.0	18.0	19.0	120.5	121.5	0.85	0.86	1.92	1.94	1.15	1.6
T_7- 25% AN + 37.5% compost + 37.5% SCU	121.0	122.5	19.0	20.0	122.5	123.0	0.87	0.88	1.94	1.95	1.16	1.18
New L.S.D. at 5%	1.0	1.1	0.8	0.9	1.3	1.4	0.03	0.04	0.12	0.14	0.02	0.03

=AN: Ammonium nitrate =PCU : Phosphorus-coated urea

=UF : urea formaldehyde = SCU : Sulphur – coated urea

Table (3): Effect of soil application fast, organic and some slow release nitrogen fertilizers on chlorophylls a , b , total chlorophylls , total carotenoids (mg/ g F.W.) , N and P (as %) in the leaves of Thompson seedless grapevines (H4 strain) during 2022 and 2023 season.

Treatments	**Chlorophyll a(mg/ g F.W.)**		**Chlorophyll b (mg/ g F.W.)**		**Total chlorophylls (mg/ g F.W.)**		**Total carotenoids (mg/ g F.W.)**		**Leaf N %**		**Leaf P%**	
	2022	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
T_1-100 % N	2.39	2.41	1.09	1.09	3.48	3.50	1.15	1.14	1.62	1.63	0.13	0.14
T_2- 50% AN + 25% compost + 25% UF	2.56	2.58	1.12	1.13	3.68	3.71	1.18	1.19	1.66	1.68	0.16	0.17
T_3- 50% AN + 25% compost + 25% PCU	2.71	2.73	1.16	1.17	3.87	3.90	1.21	1.23	1.69	1.71	0.18	0.19
T_4- 50% AN + 25% compost + 25% SCU	2.83	2.84	1.18	1.19	4.01	4.03	1.24	1.26	1.71	1.73	0.21	0.22
T_5- 25% AN + 37.5% compost + 37.5% UF	2.91	2.93	1.21	1.23	4.12	4.16	1.27	1.29	1.75	1.78	0.24	0.25
T_6- 25% AN + 37.5% compost + 37.5% PCU	2.96	2.99	1.23	1.25	4.19	4.24	1.29	1.31	1.79	1.81	0.27	0.28
T_7- 25% AN + 37.5% compost + 37.5% SCU	3.04	3.08	1.25	1.27	4.29	4.36	1.31	1.33	1.88	1.90	0.30	0.31
New L.S.D. at 5%	0.11	0.12	0.08	0.09	0.15	0.16	0.06	0.07	0.08	0.09	0.03	0.04

=AN: Ammonium nitrate =PCU : Phosphorus-coated urea

=UF : urea formaldehyde = SCU : Sulphur – coated urea

Table (4): Effect of soil application fast, organic and some slow release nitrogen fertilizers on percentage of potassium and content of Zn, Fe and Mn (as ppm) in the leaves of Thompson seedless grapevines (H4 strain) during 2022 and 2023 season.

Treatments	**Leaf K %**		**Leaf Zn (ppm)**		**Leaf Fe (ppm)**		**Leaf Mn (ppm)**	
	2022	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
T_1-100 % N	1.14	1.15	42.4	42.5	52.4	53.0	46.4	46.6
T_2- 50% AN + 25% compost + 25% UF	1.17	1.18	44.0	44.8	53.6	54.0	47.3	48.0
T_3- 50% AN + 25% compost + 25% PCU	1.20	1.21	45.5	46.1	54.8	55.2	48.1	48.8
T_4- 50% AN + 25% compost + 25% SCU	1.25	1.26	46.8	47.5	56.2	56.9	49.5	50.0
T_5- 25% AN + 37.5% compost + 37.5% UF	1.32	1.33	48.2	49.0	58.0	59.1	50.2	50.5
T_6- 25% AN + 37.5% compost + 37.5% PCU	1.41	1.43	49.3	49.6	59.1	59.9	51.5	51.9
T_7- 25% AN + 37.5% compost + 37.5% SCU	1.51	1.52	50.0	50.2	59.6	60.3	51.8	52.4
New L.S.D. at 5%	0.06	0.07	1.3	1.4	1.6	1.7	1.1	1.2

=AN: Ammonium nitrate =PCU : Phosphorus-coated urea

=UF : urea formaldehyde = SCU : Sulphur – coated urea

Table (5): Effect of soil application fast, organic and some slow release nitrogen fertilizers on the yield expressed in weight (kg.) and number of cluster / vine as well as weight and dimensions of Thompson seedless grapevines (H4 strain) during 2022and 2023 season.

Treatments	Number of cluster / vine		Yield/ vine (kg.)		Cluster weight (g.)		Cluster length (cm.)		Cluster width (cm.)	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
T_1-100 % N	28.0	29.0	15.40	16.10	550.0	555.0	25.0	25.0	11.2	11.3
T_2- 50% AN + 25% compost + 25% UF	29.0	30.0	16.24	16.95	560.0	565.0	26.2	26.6	11.8	12.0
T_3- 50% AN + 25% compost + 25% PCU	29.0	31.0	16.68	17.98	575.0	580.0	27.5	27.9	12.4	12.6
T_4- 50% AN + 25% compost + 25% SCU	28.0	31.0	16.66	18.60	595.0	600.0	29.2	30.0	12.9	13.0
T_5- 25% AN + 37.5% compost + 37.5% UF	29.0	33.0	17.98	20.79	620.0	630.0	30.0	30.6	13.1	13.3
T_6- 25% AN + 37.5% compost + 37.5% PCU	29.0	34.0	18.24	21.76	635.0	640.0	31.2	31.8	13.6	13.8
T_7- 25% AN + 37.5% compost + 37.5% SCU	28.0	35.0	17.92	22.75	640.0	650.0	32.4	33.0	13.8	14.0
New L.S.D. at 5%	Ns	1.1	0.68	0.71	7.4	7.6	0.6	0.7	0.3	0.4

=AN: Ammonium nitrate =PCU : Phosphorus-coated urea

=UF : urea formaldehyde = SCU : Sulphur – coated urea

Table (6): Effect of soil application fast, organic and some slow release nitrogen fertilizers on some physical and chemical parameters of the berries of Thompson seedless grapevines (H4 strain) during 2022 and 2023 season.

Treatments	**Berry weight (g.)**		**Berry length (cm.)**		**Berry diameter (cm.)**		**TSS%**		**Total acidity %**		**Reducing sugars %**	
	2022	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
T_1-100 %N	1.82	1.84	1.6	1.6	1.2	1.2	17.6	17.7	0.685	0.680	15.0	15.1
T_2- 50% AN + 25% compost + 25% UF	1.86	1.88	1.8	1.9	1.3	1.4	18.0	18.2	0.666	0.660	15.3	15.5
T_3- 50% AN + 25% compost + 25% PCU	1.90	1.91	2.1	2.2	1.5	1.7	18.4	18.8	0.650	0.645	15.6	15.8
T_4- 50% AN + 25% compost + 25% SCU	1.94	1.96	2.3	2.3	1.7	1.8	18.9	19.3	0.630	0.620	16.0	16.1
T_5- 25% AN + 37.5% compost + 37.5% UF	2.00	2.05	2.5	2.6	1.8	1.9	19.5	19.8	0.600	0.585	16.3	16.5
T_6- 25% AN + 37.5% compost + 37.5% PCU	2.08	2.10	2.6	2.7	1.9	1.9	20.0	20.3	0.580	0.565	16.8	16.9
T_7- 25% AN + 37.5% compost + 37.5% SCU	2.12	2.15	2.7	2.8	2.1	2.1	20.4	20.8	0.560	0.550	17.1	17.3
New L.S.D. at 5%	0.04	0.05	0.02	0.03	0.01	0.02	0.5	0.6	0.031	0.033	0.3	0.4

=AN: Ammonium nitrate =PCU : Phosphorus-coated urea

=UF : urea formaldehyde = SCU : Sulphur – coated urea