KSÜ Tarım ve Doğa Derg 25 (Ek Sayı 1), 180-191, 2022
KSU J. Agric Nat 25 (Suppl 1), 180-191, 2022
https://doi.org/10.18016/ksutarimdoga.vi.959149

The Effect of Farm Manure on Yield and Some Soil Properties in a Pear Garden in Yozgat

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ABSTRACT
The aim of this study is to determine the effect of farm manure applied at two doses on some chemical and physical properties of the soil. In addition, it was conducted to determine the relationships between the contribution of improved soil health and quality to the development of pear trees. For this purpose, farmyard manure of Etruşka variety grafted on a 6-year-old OHF 333 rootstock planted in Gedikhasanlı Research and Application Center was applied to the crown projection of the trees in three different doses (control, half dose: 5 kg tree^{-1} and full dose: 10 kg tree^{-1}). At the end of the study, while there was no statistical difference between applications in 2018 and 2019 measurements in tree height measurements, 5 kg tree^{-1} and 10 kg tree^{-1} farm manure applications affected 2020 measurements significantly. When the number of shoots was examined, there was no statistical difference in the year of application (2018) and one year after (2019), while in 2020, 5 kg tree^{-1} and 10 kg tree^{-1} farm manure applications were higher than control. With the application of 10 kg farm manure per tree, the organic matter content of the soil was increased from "low" level (1.02%) to "medium" level (3.03%) at the end of the first year. A similar situation was valid for 5 kg tree^{-1} dose application, although the increase in the amount of organic matter was lower (2.45%). At the end of the second year, while the level of organic matter in soils where high dose application was applied was preserved as "medium" (2.14%), the low dose application lost its effectiveness and the level of organic matter fell back to the "low" class (1.45%). The most effective application reducing bulk density and penetration resistance was 10 kg tree^{-1} dose.

Horticulture

Araştırma Makalesi

Makale Tarihçesi
Geliş Tarihi : 29.06.2021
Kabul Tarihi : 08.03.2022

Anahtar Kelimeler
Pear
Farm manure
Organic matter
Plant growth and yield
Soil physical properties

Yozgat'ta Bir Armut Bahçesinde Çiftlik Gübresinin Verim ve Bazı Toprak Özelliklerine Etkisi

ÖZET
Bu çalışmanın amacı iki farklı dozlarda uygulanan çiftlik gübresinin toprağın bazı kimyasal ve fiziksel özellikleri üzerine etkisini belirlemektir. Ayrıca iyileşen toprak sağlığı ve kalitesinin armut ağaçlarının gelişimine katkısı arasındaki ilişkileri tespit etmektir. Bu amaçla Gedikhasanlı Araştırma ve Uygulama Merkezi'nde dikili olan 6 yaşındaki OHF 333 anacına aşılı Etruşka çeşidi armut bahçesinde ihtimar edilmiş çiftlik gübresi, ağaçların taç izdüşümüne iki farklı dozda (yarım doz: 5 kg ağaç$^{-1}$ ve tam doz: 10 kg ağaç$^{-1}$) uygulanmıştır. Çalışma sonunda armut ağaç boyu 2018 ve 2019 yılları ölçümlerinde uygulamalar arasında istatistiksel fark yokken 2020 yılı ölçümlerinde yarım doz ve tam doz çiftlik gübresi uygulamaları kontrole göre önemli bulunmuştur. Sürgün sayısı incelendiğinde uygulamanın yapıldığı yıl (2018) ve bir yıl sonrasında (2019) istatistiksel fark yokken, 2020 yılında yarım doz ve tam doz çiftlik gübresi uygulamaları kontrole göre daha yüksek bulunmuştur. Ağaç başına 10 kg çiftlik gübresi uygulaması ile toprağın organik madde içeriğini birinci yılın sonunda "düşük" seviyeden (%1.02) "orta" seviyeye (%3.03) çıkarılmıştır. Benzeri bir

Bahçe Bitkileri

Research Article

Article History
Received : 29.06.2021
Accepted : 08.03.2022

Keywords
Armut
Çiftlik gübresi
Organik madde
Bitki gelişimi ve verim
Toprak fiziksel özellikleri

durum organik madde miktarındaki artış daha düşük olmakla birlikte 5 kg ağaç$^{-1}$ doz uygulaması için de geçerlidir (%2.45). İkinci yılın sonunda ise yüksek doz uygulaması yapılan topraklarda organik madde seviyesi "orta" olarak korunurken (%2.14) düşük doz uygulaması etkinliğini yitirerek organik madde seviyesi yeniden "düşük" sınıfına gerilemiştir (%1.45). Hacim ağırlığı ve penetrasyon direncini azaltmada en etkili uygulama 10 kg ağaç$^{-1}$ dozu olmuştur.

To Cite : Koç A, Yakupoğlu T 2022. The Effect of Farm Manure on Yield and Some Soil Properties in a Pear Garden in Yozgat. KSU J. Agric Nat 25 (Suppl 1): 180-191. https://doi.org/10.18016/ksutarimdoga.vi.959149

Atıf Şekli: Koç A, Yakupoğlu T 2022. Yozgat'ta Bir Armut Bahçesinde Çiftlik Gübresinin Verim ve Bazı Toprak Özelliklerine Etkisi. KSÜ Tarım ve Doğa Derg 25 (Ek Sayı 1): 180-191. https://doi.org/10.18016/ksutarimdoga.vi.959149

INTRODUCTION

With its increasing commercial value, pear is grown widely in countries such as China, America, Italy, Argentina, and Spain, along with Turkey. Particularly concentrated in temperate climates, this species is systematically included in the *Pyrus* genus, which includes about 20 pear species within the *Pomoideae* subfamily of the *Rosaceae* family. The species in the *Pyrus* genus, which is economically grown; classified as eastern and western pears (Gökmen, 1973). The western pear group includes *Pyrus communis* species grown in Europe, North and South America, and Africa, while the eastern pear group includes *P. ussuriensis*, *P. bretschneideri* and *P. sinkiangensis* grown in China, and *P. pyrifolia* species growing in China and Japan (Bell, 1990).

According to the data of FAO (2020), world pear production in 2019 is 23.919.075 tons. China is first place with 17 million tonnes in production when followed by the USA (661.340 tonnes), Argentina (595.427 tonnes), Turkey (530.723 tonnes), Italy (429.290 tons), South Africa (407.212 tonnes) and the Netherlands (373.000 tons). Turkey ranks fourth in the world in terms of pear production quantity and pear production area (530.723 tonnes and 26.299 ha).

The dense planting systems that European countries have been implementing for years in today's fruit growing have been increasingly preferred by the growers of Turkey in recent years. Saplings are the most basic material of modern orchards established as a garden with sustainable production techniques. A healthy and standard well-branched sapling is the most important step in profitability in a garden facility (Wertheim et al., 2001). It has been reported that the number of side branches of the seedlings, the angle of the side branches, and the height of the seedlings is very effective in the early yield and high yield of the garden (Hrotko et al., 1996). In the modern orchard facility, obtaining high quality and high amount of fruit by the saplings as soon as possible depends on the nutrition of the plant. Because there are very close and important relationships between pear nutrition and product quantity and quality as in other soft seed species (Başar, 2001).

In Yozgat and similar conditions, in fruit trees and especially in saplings grafted on clonal rootstocks, the formation of the side branch and consequently the crown structure takes longer than other temperate regions, which delays the time of the saplings to lay on the fruit. Despite regular cultural practices in the pear garden, which was established in 2012, tree development and yield remained low. It is thought that this situation is caused by the soil health below a certain level and low soil quality in the cultivated garden. Soil quality or health is a product of genetics such as parent material, climate and topography, and human-induced interactions such as tillage and crop rotation. Soil quality can be evaluated by determining the changes in soil properties affected by management (Aziz et al., 2009). Since organic matter affects the physical, chemical and biological properties of the soil, it has been the top priority in almost every study on soil quality. In addition to organic matter, soil properties such as soil pH, salinity, bulk weight, and resistance to penetration have also been accepted as indicators of the dynamic quality of the soil (Wienhold et al., 2009; Ding et al., 2011). The aims of this study are to determine the farm manure to be applied in different three doses to the soil of the research area which has some problems in terms of horticultural crop cultivation; (i) to determine the effect on some chemical properties, which are indicators of soil health, (ii) to determine the effect on some physical properties, which are indicators of soil quality, and (iii) to determine the relationship between the contribution of improved soil health and quality to the vegetative growth and yield of pear trees.

MATERIALS and METHODS

Plant and soil materials

This study was carried out in the pear garden established with Etryoshka pear variety grafted to the rootstock of OHF333 were planted at 4 m x 5 m in-row and row spacing in 2012, in Gedikhasanlı Research and Application Center, located in Sorgun district, Yozgat between 2018 and 2020. The general characteristics of the soil in the land where the pear orchard is located are as follows: it is a sandy clayey loam (clay, slt and sand contents are 299,89 g kg^{-1} and 612 g kg^{-1}, respectively), it has sufficient exchangeable K content (215 µg g^{-1}), its total N content is 0.05% and available P content is 5.76 µg g^{-1}. It has no salt and slihtly alkaline. Its organic matter content level is very low (0.99%) and total $CaCO_3$ content is 5.76% (Yakupoğlu, 2018). By applying different doses of farm manure, its effectiveness on the vegetative growth and yield of the tree was investigated by improving the health and quality of the soil. Gedikhasanlı village is connected to Sorgun district and has an altitude of 1050 m and is located at 39°58′69″ N - 35°15′95″ E coordinates (Figure 1).

The average monthly temperature and precipitation values determined throughout the study were obtained from the Yozgat Meteorology Provincial Directorate (Figure 2 and Figure 3).

Methods

In this study, three different doses of farm manure (control, full dose: 10 kg $tree^{-1}$ and half dose: 5 kg $tree^{-1}$) were applied to the crown projection of the trees by being mixed into the soil after being left in circular canals to be opened in 15 cm width and 15 cm depth (Kacar and Katkat, 1998). Organic N concentration of the manure is 6.60%, and its NH_4^+-N and NO_3^--N contens are 170 µg g^{-1} and 2100 µg g^{-1}, respectively. The P and K contents of manure, which can be considered as rich in phosphorus and potassium, are 2.86% and 3.55%, respectively. 10 kg of farm manure was given in full dose application per tree. The reason for choosing half dose is that routine chemical fertilizer applications will be performed.

Before the vegetation started, pruning of pear saplings was carried out in March 2019 and 2020. Chemical fertilization, which is carried out every year, was made with Ammonium sulphate (21% N) at a rate of 200 g per tree in 2019 and 2020, and the fertilizer was mixed with the soil. Chemical fertilizers were not preferred for phosphorus fertilization because phosphorus supplementation from farm manure was taken into account. Also, no chemical potassium fertilization was done because the soil has a sufficient exchangeable K content.

Figure 1. The Gedikhasanlı Research and Application Center
Şekil 1. Gedikhasanlı Araştırma ve Uygulama Merkezinin konumu

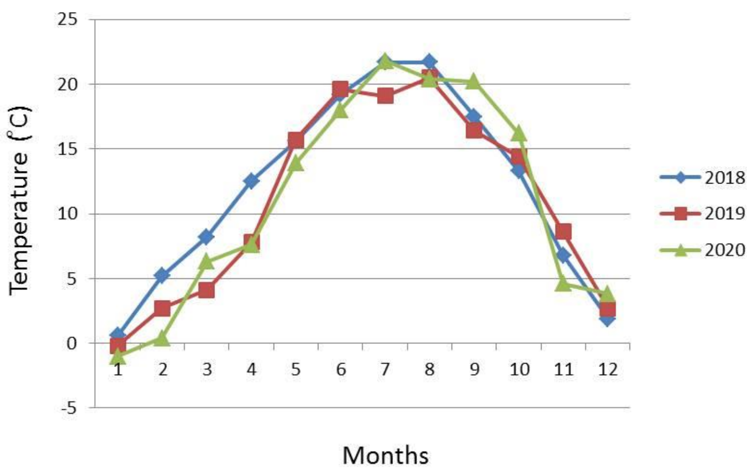

Figure 2. Monthly average air temperature values of the trial area for the years 2018-2020.
Şekil 2. 2018-2020 yılları için deneme alanına ait aylık ortalama hava sıcaklık değerleri.

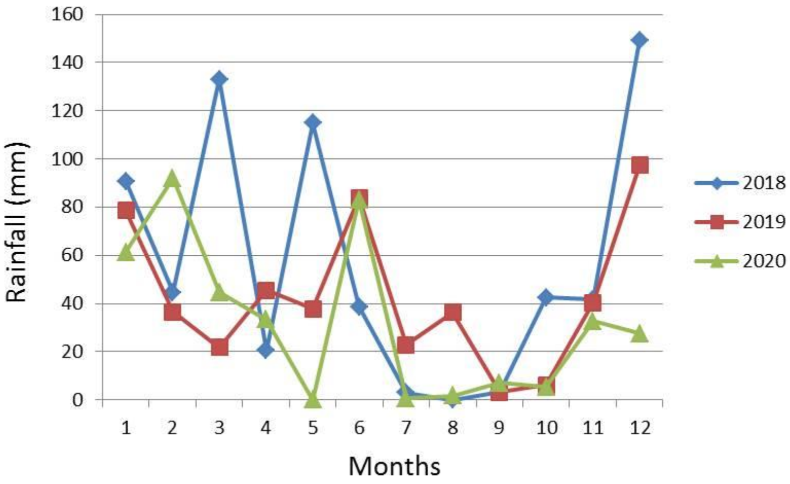

Figure 3. Monthly average precipitation values of the trial site for the years 2018-2020
Şekil 3. 2018-2020 yılları için deneme alanına ait aylık ortalama yağış değerleri.

The following measurements were made on plants for 2 years to determine the effect of farm manure applications on the vegetative growth of trees: Average tree height (cm), average trunk diameter (mm), average tree crown width (cm), average number of annual shoots, average annual shoot length (cm), average annual shoot diameter (mm), leaf chlorophyll content readings (measured using the Konica Minolta SPAD-502 Plus Brand Chlorophyll Meter), leaf anthocyanin amount (measured by (Opti Science ACM–200 Plus Anthocyanin Meter), leaf area determination (determined by ADC Bio Scientific Area Meter AM300 device, cm^2). In fruit measurements, 15 fruits in 3 replications were used in fruit measurements. Fruit weight (g), total soluble solids (brix,%), total acidity (g / 100 ml), fruit firmness (kg/cm^2), and yield (g) were measured.

The following variables were measured to determine farm manure applications on selected soil properties: Soil organic matter (OM): This variable was determined by using the Walkley-Black method (Kacar, 1994). Soil reaction (pH): It was determined by pH-meter with glass electrode in saturation sludge (Kacar, 1994). Total salt: In the saturation paste, the electrical conductivity was determined with a glass electrode Hanna EC-meter and the salt content was calculated (Bayraklı, 1987). Bulk density (BD): In the undisturbed soil samples taken with standard steel cylinders of 100 cm^3, and calculations were based on oven dry weight (Demiralay, 1993). Infiltration ratio rate (IR): Measured according to the double-cylinder infiltrometer method (Soil quality Ins. Staff., 1999). Penetration resistance (PNTR): Penetration measurements in the field were carried out according to Herrick and Jones (2002) by using hand penetration with 30° peak angle at 0-15 cm soil depth with 5 replications. PNTR results have been standardized using Equation 2 as reported in Aksakal and Öztaş (2010).

PNTR=M/A [Equation 1]

PNTR: Penetration resistance, M: Manometer reading, A: Base area of the conical tip used

$$Y_c = Y_0 e^{\left(\frac{X-0.1}{0.132}\right)} \quad \text{[Equation 2]}$$

Yc: Corrected penetration resistance (kPa), Y0: Measured penetration resistance (kPa)

X: Soil moisture at the time of measurement (kg kg-1), 0.1: Moisture value selected for standardization (kg kg-1)

Statistical analysis

The experiment was set up in a randomized block design, with 3 doses (control, 5 kg tree^{-1} and 10 kg tree^{-1}), with 3 replications and using 3 trees in each replication. Effects of subjects on measured variables Comparison of subject averages with ANOVA was performed with Duncan (α = 0.05) and the comparison of two breeding years over measured variables was performed with t test. These statistical evaluations were made using IBM SPSS 20.0 package program and the means were separated according to Duncan's Multiple Range Test.

RESULTS and DISCUSSION

Changes in Plant Characteristics

Fertilization and fertilizer application play a vital role in the growth and yield of fruit trees. A well-nourished fruit tree not only provides good yields but also improves the quality and stays in a healthy and fertile state longer. Nitrogen and farm manure are important for the normal growth of plants. Nitrogen is the basic element of amino acid structure and plays an important role in protein synthesis, increasing chlorophyll content and speed of photosynthesis. Vegetative growth mainly depends on the nitrogen supply and helps the root system to develop better. Nitrogen, which enhances the assimilation process through glycolysis and fatty acid synthesis, greatly increases the effectiveness of inorganic fertilizers when applied with farm manure, because it helps to keep organic matter in the root zone of urea and to make phosphate and potash suitable for the plant (Khan and Sharma, 2018).

Tree height, crown width, trunk diameter, shoot number, shoot length and shoot diameter were measured in November 2018, 2019, and 2020 in trees in the resting period in order to determine the effect of farm manure applications on the vegetative growth of trees (Table 1).

Table 1. The effect of manure application on some vegetative growth characteristics of pear trees.
Çizelge 1. Armut ağaçlarında çiftlik gübresi uygulamasının bazı vejetatif büyüme özelliklerine etkisi

Features	Applications	Mean ± Std. Deviation		
		2018	2019	2020
Tree Height (cm)	Control	229.44±43.45 NS	235.17 ± 43.62 NS	231.50±39.03 b*
	5 kg tree^{-1}	250.89±33.78	255.86 ± 38.11	292.75±25.21 a
	10 kg tree^{-1}	240.22±32.47	258.89 ± 48.65	263.75±20.69 ab
	Mean	237.5±38.73	246.00 ± 44.00	262.67±37.26
Crown Width (cm)	Control	109.33±37.64 NS	109.00 ± 31,63 NS	116.75±23.20 NS
	5 kg tree^{-1}	117.00±43.39	112.63 ± 40.05	142.50±45.86
	10 kg tree^{-1}	99.00±20.30	108.89 ± 16.21	125.50±13.53
	Mean	108.67±35.42	109.8 ± 29.92	128.25±29.92
Trunk Diameter (mm)	Control	52.93±9.01 NS	60.89 ± 5.90 NS	61.82±6.27 NS
	5 kg tree^{-1}	52.90±10.03	62.99 ± 7.08	67.84±3.61
	10 kg tree^{-1}	56.80±5.37	64.48 ± 4.88	66.44±3.83
	Mean	53.89±8.48	62.29 ± 5.98	65.36±5.05
Number of Shoots (Piece)	Control	17.78±10.36 NS	18.06 ± 9.69 NS	15.00±2.16 b*
	5 kg tree^{-1}	18.67±6.96	19.13 ± 6.56	20.50±7.94 ab
	10 kg tree^{-1}	16.11±7.11	20.00 ± 14.28	23.25±7.09 a
	Mean	17.58±8.70	18.09 ± 10.61	19.25±6.97
Shoot length (cm)	Control	28.50±13.59 NS	19.64 ± 11.69 b*	23.55±11.70 b*
	5 kg tree^{-1}	26.18±8.84	28.63 ± 10.40 a	29.25±13.32 ab
	10 kg tree^{-1}	27.62±13.76	27.78 ± 13.14 a	32.55±19.19 a
	Mean	27.69±12.58	22.73 ± 12.40	22.84±13.95
Shoot diameter (mm)	Control	7.35±1.47ab*	8.55 ± 0.83 b*	8.67±0.41 c*
	5 kg tree^{-1}	7.00±1.10 b	9.08 ± 0.58 a	9.97±0.41 a
	10 kg tree^{-1}	7.68±2.30 a	8.88 ± 0.80 ab	9.03± 0.83 b
	Mean	7.35±1.65	8.71 ± 0.81	8.89±1.21

NS. The difference between the applications is not significant.
* There is no statistically difference between the averages indicated with the same letter (P <0.05)

While there was no statistical difference between applications in 2018 and 2019 measurements in tree height measurements, half-dose, and full-dose farm manure applications were found to be significant compared to the control in 2020 measurements.

Crown width and trunk diameter were not found statistically different in the measurements made in three years. When the number of shoots was examined, there was no statistical difference in the year of application (2018) and one year after (2019), while in 2020, half-dose and full-dose farm manure applications were found to be higher than control. While there was no difference between trees in the measurements of shoot length in the year of application (2018), a statistically significant difference was found in half-dose and full-dose applications one year later (2019) and the following year (2020) compared to the control.

Shoot diameter was determined in the trees with the lowest half dose in the year of application, while the shoot diameter was found to be statistically different in trees selected as full dose and control. In the following first year (2019), the shoot diameter of the trees that were applied half dose and full dose increased, while the second year (2020) was the highest in the trees that were applied half dose. Cheng et al. (2001) found that leaf and shoot development in pear trees in spring was closely related to reserve nitrogen from seedlings. Finding and using nitrogen reserves in trees is as important as taking nitrogen from the soil (Titus and Kang, 1982; Tromp, 1983). With the development of spring, nitrogen is extracted from tree reserves in pears and only a small part of the nitrogen applied before flowering grows into the newly formed tissues.

Nitrogen application from the soil towards the end of summer is recommended to create a reserve for the following development period (Hart et al., 1997).

Most of the nitrogen required for flowering and fruit formation comes from the reserves stored in the tree from the previous development period. For this reason, it should be noted that for a good nutrition, a good nutrition is needed from the previous year. In some regions, nitrogen applications are made after harvest to meet the needs of the next season. However, the application must be done after the product is collected, otherwise the nitrogen application made close to the harvest in the summer period will negatively affect the fruit quality and storage life (Bright, 2005).

Kumar et al. (2013) reported that the application of NPK (600: 400: 400 g) + 20 kg farm fertilizer / plant in the Gola pear variety significantly increased the percentage of plant growth, plant spread and fruit set compared to control. Khan et al. (2016) observed that the application of 800 grams of nitrogen and 90 kg of farmyard manure per plant in pear varieties significantly improved shoot length, number of leaves per branch, fruit set and fruit retention.

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In other measurements made on leaves in 2019 and 2020 (leaf chlorophyll content (Spad value), anthocyanin and leaf area), a statistically significant difference was found between applications (Table 2). Leaf chlorophyll content was higher in half-dose and full-dose applications compared to the control. Leaf anthocyanin content was found to be higher in full dose application compared to the other two applications. While there was a statistically significant difference between applications in terms of leaf area in 2019, there is no difference in 2020. In the measurements made in 2019, half dose and full dose applications were found to be higher than control.

Table 2. Leaf chlorophyll content (Spad value), anthocyanin measurement and leaf area values
Çizelge 2. Yaprak klorofil içeriği (Spad değeri), antosiyanin ölçümü ve yaprak alanı değerleri

Applications	Leaf chlorophyll content (Spad value)*		Leaf anthocyanin content (LAC) *		Leaf area (cm²)*	
	2019	2020	2019	2020	2019	2020
Control	42.6±6.5 b	41.2 ± 5.1 b	7.4 ± 1.8 b	6.8±1.2 b	30.7 ± 7.5 b	28.3 ± 6.7 NS
5 kg tree^{-1}	44.5 ±4.5 a	47.2 ± 3.6 a	7.8 ±1.5 b	6.7 ± 0.8 b	32.2 ± 8.1 ab	28.7 ± 5.6
10 kg tree^{-1}	44.0 ± 4.9 ab	46.4 ± 1.9 ab	8.8 ± 5.9 a	7.2 ± 0.9 a	33.9 ± 7.7 a	28.5 ± 4.4
Mean	43.4 ± 5.7	44.9 ± 4.3	7.9 ± 3.4	6.9 ± 0.9	31.9 ± 7.8	28.2 ± 5.6

* There is no statistically difference between the averages indicated with the same letter (P <0.05) NS. The difference between the applications is not significant

Measurements and analyzes were made on the yield and fruit characteristics of the trees where half and full dose applications of farm manure were applied (Table 3). While there was no statistically significant difference between the applications in 2019 in terms of efficiency values, half and full dose applications were found to be significant in 2020 compared to the control. Fruit weight and fruit firmness properties were not statistically significant in both years.

According to Özbek (1981), nitrogen deficiency is seen more in soft stone fruit types due to their high nitrogen needs. In nitrogen deficiency, fruits remain small, ripen early and at the same time early fruit drop occurs and as a result, the fruit amount is significantly reduced. According to the same researcher, despite the continuous development of strong shoots in young apple and pear trees with nitrogen excess, flower bud formation decreases very much and the amount of product decreases. In addition, low nitrogen level affects fruit yield negatively (Kacar and Katkat, 1998).

In terms of fruit weight, Kumar and Chandel (2004) measured the maximum fruit weight of Red Bartlett pear variety with the application of NPK (700: 300: 600 g / tree). Kumar et al. (2013) reported that the application of NPK (600: 400: 400 g) + 20 kg farm fertilizer / plant significantly increased fruit weight, number of fruits per tree and fruit yield in pear compared to control. Khan et al. (2016) observed that 600 g of nitrogen treatment combined with 90 kg of farm manure significantly improved fruit set (6.95%), fruit yield (25.14%), fruit weight (113.87 g) and fruit count. Arba et al. (2017), in their study investigating the effects of different nitrogen and phosphorus levels on pears, found that nitrogenous mineral fertilization increased fruit yield, especially fruit size (weight and size).

Table 3. Measurement values of fruit yield and characteristics
Çizelge 3. Meyve verimi ve meyve özelliklerinin ölçüm değerleri

Features	Applications	Mean ± Std. Deviation 2019	Mean ± Std. Deviation 2020
Fruit Yield (g/tree)	Control	4659.7 ± 1443.9 NS	5696.1 ± 855.9 b*
	5 kg tree^{-1}	6250.0 ± 1117.9	8996.7 ± 2983.4 a
	10 kg tree^{-1}	6318.0 ± 1675.5	8221.7 ± 2831.9 a
	Mean	5742.6 ± 1481.9	7607.3 ± 2720.4
Fruit Weight (g)	Control	139.9± 22.4 NS	139.7±18.7 NS
	5 kg tree^{-1}	125.8 ± 19.7	130.6±29.4
	10 kg tree^{-1}	141.7 ± 9.2	139.8±25.9
	Mean	135.8 ±17.3	136.7±25.2
Total Soluble Solids (brix, %)	Control	14.7 ± 0.12 b*	11.7±1.24 b*
	5 kg tree^{-1}	15.2 ± 0.06 a	15.7±1.23 ab
	10 kg tree^{-1}	13.9 ± 0.12 c	17.6±1.20 a
	Mean	14.6 ± 0.57	15.0±3.2
Titratable acidity (g/100 ml)	Control	0.22 ± 0.05 NS	0.17±0.02 a*
	5 kg tree^{-1}	0.20 ± 0.00	0.08±0.01 b
	10 kg tree^{-1}	0.19 ± 0.02	0.10±0.00 b
	Mean	0.20 ± 0.03	0.12±0.04
Fruit Firmness (kg/cm^2)	Control	7.1 ± 0.2 NS	5.3±0.8 NS
	5 kg tree^{-1}	6.6 ± 1.5	3.9±0.7
	10 kg tree^{-1}	7.8 ± 0.6	3.5±0.7
	Mean	7.2 ± 0.9	4.2±1.4

NS. The difference between the applications is not significant
* There is no statistically difference between the averages indicated with the same letter (P <0.05)

According to the pomological analysis results made on fruits in 2019 and 2020, while there was a significant difference between applications in Total Soluble Solids (TSS) measurements, titratable acidity (TA) values were found to be statistically significant only in 2019. The TSS value was determined to be the highest in half-dose administration in 2019, half and full-dose administration in 2020. Control application was found to be statistically significant in both years. While TA was not statistically different in 2019, it was higher in the control application in the 2020 analysis. There was no statistical difference between the applications in both years in terms of flesh firmness. Akçay et al. (2009) In a pear cultivar trial conducted with a total of 13 varieties including Deveci cultivar between 1995 and 2002 under Yalova conditions, the TSS. They determined the value as 13.50%. Kappel et al. (1995) determined for the ideal pear, TSS reports that their values are between 13.6 and 17.2%. Kingston (1992) reported that lower titratable acidity values in pears were associated with increased nitrogen applications. Nava et al. (2008) stated in the study they carried out in Brazil by applying nitrogen from 0 to 200 kg per hectare in apples and that there was no change in titratable acidity values with increasing nitrogen doses.

In the Bagugosha pear variety, Yadav and Bist (2003) observed that increasing nitrogen levels did not have a significant effect on the soluble solids content (TSS) of fruits. However, the acidity of the fruits was significantly reduced in fruits obtained from trees given 60 g / tree / year and 90 g / tree / year of nitrogen. Kumar and Chandel (2004) observed that different nitrogen levels did not affect solubility and acidity in pear. It gives the acidity taste of the fruits in reasonable limits and the lack of optimum concentration causes an unpleasant taste. However, excess can make fruits tasteless even if other ingredients are optimal. In the Bagugosha pear variety, Yadav and Bist (2003) noticed that nitrogen had no significant effect on total sugar. Similar results were noted by Kumar and Chandel (2004) for the Red Bartlett pear variety, TSS and sugars, the highest at 800 g nitrogen and 90 kg farm fertilizer / plant application, and the minimum at control. Khan et al. (2017) applied different levels of nitrogen and farm manure on pears and it was observed that 600 g of nitrogen and 90 kg of farm manure increased the sugar content of fruits.

Changes in Soil Properties

Some descriptive statistics related to soil properties determined in Etryoshka pear garden are given in Table 4. According to the aforementioned table, the pH values of the soils varied between 7.35 and 8.45 in the first year, while this variable varied between 7.33 and 7.99 in the second year. While the average organic matter value was 1.90% in the first year, this value decreased to 1.43% in the second year. Bulk density values of soils in the first year varied between 1.06-1.44 g cm^{-3}, and in the second year between 1.20-1.44 g cm^{-3}.The average penetration value was measured as 2.01 MPa for the first year, and the average infiltration rate value was measured as a very low value such as 3.68 mm h^{-1} for the first year. The average penetration value increased to 2.06 MPa in the second year, and the average infiltration rate decreased further and decreased to 3.36 mm h^{-1} compared to the first year.

Table 4. Descriptive statistics for measured soil variables
Çizelge 4. Ölçülen toprak değişkenleri için tanımlayıcı istatistikler

	Variables	N	Lowest	Highest	Mean	Std. Deviation
2019	pH	36	7.35	8.45	8.02	0.253
	Salt (%)	36	0.06	0.37	0.13	0.063
	OM (%)	36	0.72	3.30	1.90	0.917
	BD (g cm^{-3})	36	1.06	1.44	1.24	0.110
	PNTR (MPa)	36	1.06	2.75	2.01	0.519
	IR (mm h^{-1})	36	2.50	4.90	3.68	0.661
2020	pH	36	7.33	7.99	7.66	0.150
	Salt (%)	36	0.10	0.32	0.18	0.045
	OM (%)	36	0.92	2.38	1.43	0.470
	BD (g cm^{-3})	36	1.20	1.44	1.30	0.055
	PNTR (MPa)	36	1.56	2.63	2.06	0.349
	IR (mm h^{-1})	36	2.20	4.70	3.36	0.464

OM: Soil organic matter, BD: Dry bulk weight, PNTR: Penetration resistance, IR: Infiltration rate

ANOVA results showing the effects of farm manure application on measured soil variables are given in Table 5. As it can be understood from the examination of the table, first year farm manure application affected the salt variable at the level of $P < 0.01$, while the effects of the applications on the other measured variables in the first year were found to be significant at the level of $P < 0.001$. Second year applications did not affect salt and IR variables, its effect on pH was found to be $P < 0.05$, and its effects on other variables were found to be significant at $P < 0.001$.

The results of Duncan test comparing the average of soil variables over farm manure application doses are presented in Table 6. When the first year is examined in the Table 6, the average pH value in the soil of pear trees selected as control was 7.84c, this value increased to 8.08b with 5 kg $tree^{-1}$ dose of farm manure and 8.32a with 10 kg $tree^{-1}$ dose application. These values are statistically different from each other.

While the 5 kg dose of $tree^{-1}$ of the farm manure applications did not change the salt content of the soil statistically, the 10 kg dose of $tree^{-1}$ reduced the salt concentration to 0.08b% and the difference is statistically significant. The highest organic matter content was achieved with high dose administration (3.03a), followed by low dose administration (2.54b). The organic matter value measured for the control is at the lowest level (1.02c). As can be seen, all the averages determined for the organic matter variable are statistically different from each other.

The volume weight and penetration resistance variables changed to reflect this change in organic matter, and as the organic matter content increased, these values decreased, and the differences between the averages were found to be statistically significant. In terms of IR, there was no difference between control and 10 kg $tree^{-1}$ dose administration, while the highest value for this variable was measured for 5 kg $tree^{-1}$ dose administration and it is statistically different from the others (4.70a mm h^{-1}).

Table 5. ANOVA results showing the effects of farm manure application on measured soil variables
Çizelge 5. Çiftlik gübresi uygulamasının ölçülen toprak değişkenleri üzerindeki etkilerini gösteren ANOVA sonuçları

	Variables and significance levels					
	pH	Salt	OM	BD	PNTR	IR
2019	***	**	***	***	***	***
2020	*	NS	***	***	***	NS

OM: Soil organic matter, BD: Dry bulk density, PNTR: Penetration resistance, IR: Infiltration ratio. ^{NS}The difference between the applications is not significant

Table 6. Comparison of the means of soil variables over the farm manure application doses with Duncan test (α = 0.05)

Çizelge 6. Duncan testi ile çiftlik gübresi uygulama dozları üzerinden toprak değişkenlerinin ortalamalarının karşılaştırılması (α = 0.05)

Years	Application	Variable means					
		pH	Salt (%)	OM (%)	BD (g cm^{-3})	PNTR (MPa)	IR (mm h^{-1})
2019	Control	7.84c	0.16a	1.02c	1.34a	2.49a	3.28b
	5 kg tree^{-1}	8.08b	0.15a	2.54b	1.22b	1.78b	4.70a
	10 kg tree^{-1}	8.32a	0.08b	3.03a	1.09c	1.32c	3.47b
2020	Control	7.60b	0.18	1.06c	1.34a	2.34a	3.23
	5 kg tree^{-1}	7.68ab	0.17	1.45b	1.28b	1.86b	3.63
	10 kg tree^{-1}	7.76a	0.16	2.14a	1.24c	1.69c	3.55

OM: Soil organic matter, BD: Dry bulk density, PNTR: Penetration resistance, IR: Infiltration ratio

When Table 6 is analyzed over the second year values, it is seen that the applications made lose their power to change the salt concentration and infiltration rate. Both application doses showed similar effects on soil reaction. Although there were various changes in the averages of the other measured variables compared to the first year, the direction of the effects of the applications on the variables and the statistical significance of the differences between them were similar to the first year. The fact that the effectiveness of organic fertilizer application on the IR variable disappeared in the second year can be attributed to the fact that the applied manure lost its role on aggregation together with decomposition in the soil. In this case, since the pore continuity in the soil will change, the IR values in the manure applied plots were also measured similar to those of the control plot.

According to the results of this study, where different doses of farm manure were applied in order to improve some physical and chemical soil properties, which are also used as soil quality indicators in the Etryoshka variety pear garden, improvements were observed in the measured soil properties, especially at the end of the first year. The application of 10 kg of farm manure per tree contributed more to the positive effects obtained than the application of 5 kg. Both doses increased the pH value of the soils. The ability of farm manure to affect pH depends on the amount of various substances in it (Uçgun et al., 2019). Alagöz et al. (2006), statistically significant increases in soil pH were achieved with organic wastes of different origin. The comparison of the means of soil variables belonging to the first year and the second year with the t test is given in Table 7.

Table 7. Comparison of the means of soil variables of the first year and the second year with the t test

Çizelge 7. İlk yıl ve ikinci yıl toprak değişkenlerinin ortalamalarının t testi ile karşılaştırılması

pH	Salt	OM	BD	PNTR	IR
***	**	**	**	NS	*

OM: Soil organic matter, BD: Dry bulk density, PNTR: Penetration resistance, IR: Infiltration ratio
NS. The difference between the applications is not significant

Accordingly, first year and second year pH averages are different from each other and this difference is statistically significant at P <0.001 level. The first year and the second year are also different from each other in terms of total salt concentration, total organic matter content and bulk density, and all of these differences were statistically significant at the P <0.01 level. While there was no statistically significant difference in penetration resistance between the two years of the trial, the infiltration ratio differences between the two years were significant at the P >0.05 level. The differences between years can be attributed to the possibility that the applied organic fertilizer may have decomposed in the soil.

At the Etryoshka pear garden, salt content of the soils was reduced with a dose of 10 kg tree^{--1} at the end of the first year, but the farm manure applied in the second year lost its effectiveness on this variable. This can be attributed to the fact that the organic material may have decomposed substantially by the end of the first year and that chemical fertilizer supplementation on each tree may have increased salinity in the environment. Applied wastes of organic origin may affect the salt concentration of soils in different directions and levels depending on environmental factors, the properties of the organic regulator and anthropogenic applications. In this study, the organic matter content of the soil was increased from "low" level (1.02%) to "medium" level (3.03%) at the end of the first year with the application of 10 kg of farm manure per tree. A similar situation is valid for 5 kg tree^{-1} dose application, although the increase in the amount of organic matter is lower (2.45%). At the end of the second year, while the level of organic matter in soils where high dose application was applied was preserved as "medium" (2.14%), the low dose application lost its effectiveness and the level of organic matter fell back to the "low" class (1.45%). These results show that high dose application can be successful in maintaining the organic matter level of the soil subject to the study in the second breeding year. The effects of organic-based regulators in increasing soil organic matter content have been known for a long time. In another study conducted on the subject (Yakupoğlu and Özdemir, 2007), it was reported that various organic wastes applied to eroded soils increased the organic matter contents of soils after a certain incubation period depending on the application dose and this increase had a positive effect on the useful microelement contents of soils. In this study carried out in Etryoshka pear garden, it was observed that one-year incubation was suitable for the application of 5 and 10 kg tree^{-1} dose of farm manure, but when the time increased to two years, the low dose lost its effectiveness.

The effects of farm manure applications on pH, total salt and organic matter, which are chemical soil quality indicators, were examined above and changes in chemical soil fertility were discussed. However, the physical productivity of soils is as important as their chemical efficiency in terms of their productivity and sustainable use (Yakupoğlu and Özdemir, 2012). At the end of the first harvest season, a 16% decrease in bulk density compared to the control was achieved with the application of 10 kg tree^{-1} dose of farm manure in the Etryoshka pear garden. This decrease remained at approximately 9% in 5 kg tree^{-1} dose application. After the second harvest season, an increase in the weight of the soil of the trees treated with farm manure was observed, but it was found that the effectiveness of the applications continued depending on the application dose. The decrease in the volume weight reduction effect of farm manure at the end of the second year can be explained by the decomposition of organic material as a result of microorganism activities. By increasing the organic matter level of the soil, soil physical properties can be improved (Barzegar et al., 2002; Anikwe et al., 2003). Depending on the type and characteristics of the organic stabilizer applied to the soil, different levels of reduction in the volume weight of the soil can be achieved or sometimes the volume weight may not change depending on the application dose insufficiency or soil properties. For example, Alagöz et al. (2006), while the application of litter compost and processed chicken manure did not affect the volume weight of the soil, the researchers found that the effect of leonardite on the volume weight was significant at the level of $P < 0.05$.

The penetration value of the soils was reduced from 2.49 MPa to 1.32 MPa with a dose of 10 kg per tree at the end of the first year and it was reduced to 1.78 MPa with 5 kg dose application. At the end of the second year, although the dose effects were the same as the first year, there were increases in the average penetration resistance values. Penetration limit value for ideal cultivation in agricultural land is 2 MPa (Gupta et al., 1990). When the penetration resistance exceeds this value, various problems arise, and when this value exceeds 3, root growth is limited in different rates depending on other factors (Busscher and Sojka, 1987; Yakupoğlu et al., 2013). With farm manure applications, the volume weight could be reduced below the limit value of 2 MPa in the Etryoshka pear garden. This situation can be explained by the decrease in the volume weight of farm manure application. At the end of the first year, the dose of 10 kg tree^{-1}, which was evaluated as a full dose application, was not successful in increasing the infiltration rate of the soil, while the dose of 5 kg tree^{-1} farm manure, which was a half dose application, slightly increased the infiltration rate of the soil and this increase was found to be statistically significant. This complex result actually indicates that the applications do not affect the infiltration rate, but that the change is caused by other factors, and the results of the infiltration measurements made at the end of the second harvest season show that this variable is not affected by the farm manure application.

It is thought that soil compaction is the leading cause of the other factors. In a study carried out in a berry fruits orchard with an Etryoshka pear garden (Balcı and Yakupoğlu, 2018), a serious soil compaction is pointed out, although it is divided in area. Agricultural activities are an important factor in top soil compaction. Especially one of the biggest effects of agricultural traffic and processing tools on soil is soil compaction. The data of this study carried out in the Etryoshka pear garden also show a serious middle depth compression in the field.

CONCLUSIONS

As a result, when the literature is examined, it shows that farm manure and nitrogenous fertilization rate are the most important agricultural inputs that largely define pear yield and quality. When applied together with farm manure, the effectiveness of inorganic fertilizers increases greatly. Farmyard manure is a valuable soil improver that heals and restores a number of natural properties, including soil fertility. Nitrogen application is extremely important at a certain level and excessive nitrogen application reduces the tolerance of pear to pests and diseases. It was concluded that the most successful manure application in reducing the bulk density and penetration resistance, which is used as the evaluation criteria of soil compaction, was 10kg tree^{-1} for both years. The applied manure lost its effect on increasing the infiltration rate in the second year.

In the light of the results of this study carried out in Etryoshka pear garden and in the light of the discussions above, in the pear garden in the semi-arid climate zone in the Gedikhasanlı region, the application of at least 10 kg of farm manure per tree every year to improve the physical and chemical properties of the soil physical and chemical will improve its properties. Even increasing the application dose to 12-14 kg per tree may increase the infiltration rate.

Acknowledgments and Funding

This study was financially supported by Yozgat Bozok University Scientific Reseach Projects Division (Project number: 6602b-ZF/18-161). I thank Yozgat Bozok University Scientific Reseach Projects Division for its additions.

Authorship Contribution Statements

The contribution of the authors is equal.

Conflict of Interest

The authors have declared no conflict of interest.

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