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Research Article

Efficiency of Various Fertilizer Applications on Some Morphological and Pomological Characteristics of Banana(Dwarf Cavendishi L. Var. Şimşek)

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2. Keywords

Banana; Fertilizer applications; Soil pH, Pomology

1. Abstract

In this study, it was aimed to determineefficiacy of six different fertilizer application some morphological, pomological and fruit yieldcaharacteristics such as bunch weight (g), number of hands (unit), weight of hand (g), number of the fingers in cluster (unit), finger weight in hand (g), circumference of finger (cm) and length of finger (cm) of Simsek (Dwarf cavendish)banana variety. Fort his purpose, 6 various commercial fertilizers such as Actagro, 5K (certified organic leaf fertilizer), Crop Set (leaf fertilizer) and Agrisul 90 (Sulfur ability to reduce soil pH) and their combinations were compared. According to the obtained results, the highest values obtained from the fifth application, containing the combination of Actagro and Crop Set fertilizers. However, the highest plant height (m) values obtained from the combination of Actagro, Agrisul90 and Crop Set fertilizers. This indicates that Crop Set plant growth activator has created a positive impact on vegetative development and fruit yield.

3. Introduction

Banana (Musa Cavendishii) is derived from the word "banan = finger" in Arabic [1]. The banana plant is an annual forage herbaceous and rhizomatous plant and its actual sten is under the ground. Banana belongs to Musa (L) genera of Musaceae family and it is one of the biggest flowering herbaceous plant and also its heightmay reach up to 10m. (Heslop-Harrison ve Schwarzacher, 2007). Among the cultivated bananas there are several groups and 41% of them are Cavendish, 24 % are them are cooked and eaten, 14% of them are Gros Michel, and 21% are plantain groups bananas [2,3].

The homeland of the banana plant is the islands between the South China, India and Australia. Banana plant was first observed in Turkey in the middle of the 18th century. It was brought to district of Alanya from Egypt as an ornamental plant and thenit was realized that it could also be eaten, it was brought to Anamur and cultivation started commercially [4].

Banana fruit is good for human health and nutrition and has a high energy value. 100 g banana contains 360 mg potassium, 33 mg magnesium, 7 mg calcium, 0.2 mg zinc, 0.5 mg iron, 1 ug iodine, 1 ug selenium, 0.2 mg vitamin E, 0.5 ug vitamin K, 12 mg vitamin C, 0.05 mg riboflavin, 0.05 mg vitamin B1 and 29.7 ug of carotenoid [5]. Furthermore, 100g banana contains 90-100 kcal energy [6,7]. It is a very good blood pressure regulator because of its potassium content at high levels. It is beneficial for people, who has hypertension and high blood pressure problems [8].

Banana can be consumed as row or cooked and it can also be used for producing many fruits such as beer, fruit juice and wine [6-10]. The plant part of the banana, which is under the ground, is a source of starch. It has been consumed as a source of nourishment for many years in Africa and Asia in the times of famine [11]. Banana is the most important and consumed fruit after rice, wheat and corn in developing countries. Thousands of small-scale farmers in Africa, South Asia and North Latin America cultivate bananas for their own consumption or for local markets [12]. Banana fruit has an important place for the Pacific Regions and was used in areas such as food, beverage, pharmaceutical products, compost, perfumery, manufacture, clothing, fermentable sugar, smoking material [13]. It has been found that banana peel has antibiotic properties. It is used for medical purposes in the Pacific

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region especially against skin wart and mouth inflammation [14].

Banana is one of the most traded fruits all across the globe. According to the FAO (2016) data, India has the top place with 29.124.000 tons production, followed by China with 13.324.337 tons, followed by Brazil with 6.764.324 tons in banana cultivation.

Banana cultivation in Turkey is intensively carried in Anamur and Bozyazı districts of Mersin, Alanya and Gazipasa districts of Antalya in the Mediterranean region. In recent years, due to the possible the harvest fruit same year as banana planting and being lower labor costs than many other cultivation have resulted in expanding production areas and consequently becoming widespread of greenhouse cultivation [15]. According to FAO (2016) data, Turkey has 305.926 tons of banana production. In addition, 209.369 tons of banana were imported from the foreign countries. The optimum pH range for the banana plant is between 5.5-7.5 [16]. However, pH value above 6.5 is not desirable due to difficulties in obtaining trace elements [17]. While in banana growing areas soil pH is extremely high (8-8.5). The places where the greenhouse cultivation is made in our country generally use different commercial fertilizer combinations. Banana cultivators in this region usually use commercial fertilizers. It is thought that the most important reason for this situation is derived from the fact that plant nutrients cannot be taken up by the plants due to high pH value of soil in the mentioned area. In this study, it was aimed to determine the effects of different commercial preparations and their different combinations and efficiency on the yield and some morphological and pomological properties of "Simsek" (Dwarf Cavendishi L) banana clone which is intensively cultivated in the Limonlu town of Erdemli district of Mersin province in Turkey.

4. Materıals and Methods

This study was carried out in Limonlu town at Erdemli district of Mersin provinces in Turkey. Banana plants belonging to 'Simsek' type of Dwarf Cavendish, which were produced in vitro conditions by Toros Fide Inc. used as a material. In September 2012, 90 banana plants were planted with a distance of 2 m row spacing in a high plastic greenhouse (height of 7 m). In this research, six different applications, each application including five replicates and three plants for each replicate was established according to completely randomized block design. In this study, Actagro which is commercially and mostly applied by the banana growers were used as fundamental fertilizer. Agrisul 90, 5K Mineral (certified organic leaf fertilizer) and cropset and their various combinations were compared. These applications are given as below;

Application 1:Actagro

Application 2: Actagro + 5K mineral

Application 3: Actagro + Agrisul 90

Application 4: Actagro + Agrisul90 + 5K mineral

Application 5: Actagro + Cropset

Application 6: Actagro + Agrisul90 + Cropset

Actagro fertilizer applied every ten days until harvesting time.

5K Mineral is a CO2 fertilizer that can be used both in open-field and greenhouse. Owing to its CO2 content, this fertilizer enhances photosynthesis activity of plants when applied via humidification system. Moreover, it regulates the health of the plants and productivity by increasing enzyme activity and immune system. 5K Mineral fertilizer was applied four times.

1. When pseudostem height was reached about 2 meters
2. A month before the birth of plant
3. When hands started to form in plants
4. When fruits were clearly visible

Agrisul 90 is a type of commercial fertilizer used to decrease the pH level of soil.This fertilizer contains around 90% sulfur and 10% bentonite. Whereas Cropset fertilizer is an organic and natural plant activator and increases the activation of bacteria population.The weight of bunch, number of hands, weight of hands, finger per bunch, height of plant, circumference of trunk, number of leaves, Total Soluble Content (TSS%) were compared based on the fertilizer applications.

5. Results and Dıscussıon

The results of weight of bunch (g), number of hands, weight of hands (g), finger per bunch (number) from six different fertilizer applications of Şimsek banana cultivar were given in **Table 1**. In terms of number of hands, the result shows that there is no statistically differences among the applications. Even though these differences were insignificant, the highest average number of hands obtained from application no-5 (Actagro + Crop set) as 12.40. This was followed by 12 on application no-4 (Actagro + Agrisul 90 + 5K Mineral) and application no-6 (Actagro + Agrisul90 + Crop set). The lowest value was obtained from application no-2 (Actagro + 5K Mineral) with 11.40 [18]. Compared the efficiacy of different levels (0.5%, 1%, 1.5%) of potassium sulfate applications and detected the number of hands as 12.33, 13.00, 13.00, respectively. In other study, [19] reported as 9.00-11.67, while reported 9.37-9.87 in the Jahaji banana varieties [20-22]. Determined as 9.87 while [23] detected 11.17-13.43 in the Williams banana varieties. Furthermore, the study of [24]. Reported as 8.33 in Grand Naine varieties and more recently, [25,26] detected as between 8.58 and 11.75. In our study, hand numbers were de-

termined in the range of 11.40-12.40. These results are similar to result of [27,28]. The results of [29,30]. Were found to be slighly lower than ours. The difference may be due to the using different types of fertilizers used by researchers along with different ecological conditions where studies are carried out.

Results of fingers per bunch are given in Table 1. As seen in Table 1, differences were found to be atistically significant among the fertilizer types. The highest value was obtained from application no-5 (Actagro + Cropset) with 237.4. This was followed by application no-6 (Actagro + Agrisul 90 + Cropset), application no-4 (Actagro + Agrisul 90 + 5K Mineral) and application no-3 (Actagro + Agrisul 90) with 236.60, 225.40, 212.40 values respectively. The lowest value detected as application no-2 (Actagro + 5K Mineral) that showed 208.80 fingers per bunch [31]. Detected as fingers per bunch number in the range of 161.00-199.67. Moreover [19,20], reported as 154.00-169.25 [32]. Determined fingers per bunch as 124.7-151.7. When the results of our study and previous studies are evaluated, finger numbers were found in the range of 208.80-237.40in our study that is rather high compared to results of [33,34]. It is thought that these differences are caused due to the applying various cultivation techniques and ecological conditions. The results of bunch weight values are given in the **Table 1**.

Table 1. Average hand number, finger number, bunch weight and hand weight of bananas with different fertilizer application.

App. No:	Number of Hands	Number of Fingers	Bunch weight (kg)	Weight of hand (kg)
1	11.80	209.20 b	38.70	3.41
2	11.40	208.80 b	38.00	3.10
3	11.80	212.40 b	41.55	3.49
4	12.00	225.40 ab	43.03	3.52
5	12.40	237.40 a	50.32	4.00
6	12.00	236.60 a	46.54	3.66
LSD	N.S	20.04 *	N.S	N.S

(1): Differences in means were indicated in different letters
(2): N.S: nonsignificant * :p<0.05

No difference was found to be statistically significant among the applications based on their bunch weights. The maximum bunch weight was obtained from application no-5 (Actagro + Cropset) with 50.32 kg. This was followed by application no-6 (Actagro+Agrisul90+Cropset) with 46.54, application no-4 (Actagro + Agrisul 90 + 5K Mineral) with 43.03 kg and application no-3 (Actagro + Agrisul 90) with 42.55 kg bunch weight. The minimum bunch weight was obtained from application no-2 (Actagro + 5K Mineral) with 38 kg. In a previous study reported by Kumar (2007) as 10.80 kg in control group while 11.53 kg, 12.63 kg and 14.27 kg in the plants treated with 0.5 %, 1.0 % and 1.5 % of potassium sulfaterespectively [35]. Detectedas 17.0-25.3 kg in the Maghrabi banana clones. Moreover, Chaudhuri and Baruah (2010) determined in the range of 12.50-18.50 kg. in Jahaji banana species. Obtained the highest bunch weight as 15.29 kg on the Grand Naine banana clones. The study of carried out in India determined the bunch weight as 19.7 kg on Grand Naine banana clones. The study on Williams banana clones by [18] showed that bunch weight was in the range of 22.50-28.50 kg. Moreover, [35] determined the bunch weight between 15.37-18.11 kg. More recently, Ganapathi and Dharmatti (2018) reported the bunch weightbetween 11.55 to 26.94 kg. Our results are quite high when compared with the related studies. It is thought that these differences may be caused by various maintenance conditions and application of different fertilizers in variable amounts.

The results of hand weights of bananas at various applications are given in Table 1. The effects of applications on hand weights were not found statistically significant among the applications while the highest value was obtained from application no-5(Actagro + Cropset) with 4 kg. This was followed by application no-6 (Actagro + Agrisul 90 + Cropset) with 3.66 kg, application no-4 (Actagro+Agrisul90+5K Mineral) with 3.52 kg and application no-3 (Actagro + Agrisul 90) with 3.49. The lowest value was obtained from applicationno- 2 (Actagro + 5K Mineral) with 3.10 kg. Moreover [30], conducted in India on Grand Naine banana clones, as the range of 1.64-2.20 kg. When the previous reports results were compared bunch weight varied between 3.10-4.00 kg that is higher than the values obtained by [30].

(1): Differences in means were indicated in different letters

(2): N.S: nonsignificant * :p<0.05

The total soluble solid content (TSS) of the unripe fruits derived from the plants subjected to different fertilizer application of Dwarf Cavendish L banana clones are given in Table 2. When TSS values of raw fruits were examined, the difference between applications was found to be statistically significant. The highest TSS was obtained from application no-1 (Actagro) as 7.41 % . This value was followed by application no-6 (Actagro + Agrisul 90 + Cropset) with 7.04 % and application no-2 (Actagro + 5K Mineral) and application no-4(Actagro + Agrisul 90 + Cropset) with 6.67 %. The lowest value detected applicationno-3 with 5.07 %. The TSS of ripe fruits are given in Table 2. Results show that the TSS values of ripe fruits change according to the application type and this difference was found to be significant. The highest TSS content was obtained from application

no-1 (Actagro) with 24.7 %. This was followed by application no-4 (Actagro + Agrisul 90 + 5K Mineral) with 23.23 %, application no-3 with 22.23 % and application no-2 (Actagro + 5K Mineral) with 21.90 % respectively. The lowest TSS content was 21.33% belonging to application no-6 (Actagro + Agrisul90 + Cropset).

(1): Differences in means were indicated in different letters

(2): N.S: nonsignificant **:p<0.01

Table 2. The Total Soluble Solid contents of unripe and ripen fruits of banana.

App. No:	TSS (%)	
	UNRIPE	RIPE
1	7.41a	24.70a
2	6.67c	21.90c
3	5.07d	22.23c
4	6.67c	23.23b
5	5.09d	21.37d
6	7.04b	21.33d
LSD	0.13**	0.47**

(1): Differences in means were indicated in different letters

(2): N.S: nonsignificant **:p<0.01

Ada and Gloria (2005) detected unripe TSS value (Phase 1) as 1.26% in the study performed on Prata banana clones that are highly consumed in Brazil. Reported avarage TSS values as 21.9 % andthey reported TSS content in the range of 16.30-24.50% in Spanish and Latin American (Grand Enana) clones'of ripe bananas [11]. Determined TSS ripe bananas between the range of 17.3-22.8%. Additionally, detected TSS as 19.26% in Grand Naine banana clones. Remarked that TSS content of banana fruit is related with high sucrose content. Kumar (2007) determined the TSS content in the range of 27.9-28.9% in fruits treated with potassium sulfate [26]. Obtained highest TSS content as 25% and the same authors implied that the lowest TSS content (14.57%) obtained by when bio fertilizer applied. The study on Williams banana clones by [32]. Showed that the highest TSS ranged 19.73-19.77% and lowest TSS value in the range of 18.33-18.53% in ripen fruits of Williams banana clones. Ganapathi and Dharmatti (2018) reported TSS content as 23.52%in the study that they performed with different fertilizer types on Nendran Grand Neine of ripen banana fruits. When TSScontents are evaluated; the TSS values of unripe fruits were found in the range of 5.07-7.41%. These values are very high when compared with the unripe TSS values determined by Adao and Gloria (2005). It is thought that the difference is caused by determination of TSS values at different stages of fruits maturation. Fruits at stage 3 are less green than stage 1 fruits and they start to have a green-yellow color at this stage. Moreover, during the ripening progress starch in the fruits begins to turn into sugar. As [33] presented in their work, TSS value increases at ripe phase due to the fact that starch turns into sugar. In this study, TSS values were determined in between 21.33-24.70% in ripe fruits (Phase 7) that were similar to results of [9,10]. Ganapathi and Dharmatti (2018) and control group of Kumar (2007)'s previously published papers. However, our results showed lower TSS values than some previous reports such as Kumar (2007). However, TSS values obtained from this study is relatively high than the results of [4,32,25].

Values of stem perimeter, pseudostem height and number of leaves of banana plants subjected to six different fertilizer applications are given in **Table 3.**

Table 3. Average stem perimeter, pseudostem height and leaf number in banana plants subjected to different fertilizer applications.

Application No	Stem perimeter(cm)	Pseudostem height(m)	Leaf number(number)
1	78.00	4.22	13.00
2	78.40	4.12	12.80
3	77.20	4.06	13.00
4	75.40	4.24	13.20
5	78.80	4.13	13.60
6	77.80	4.27	13.20
LSD	N.S	N.S	N.S

(1): N.S: nonsignificant

Results indicate that differences of values obtained from different applications are statistically insignificant. In this research, the highest stem perimeter was found as 78.8 cm from application no-5 (Actagro + Cropset). Furthermore, 78.4 cm was obtained from application no-2(Actagro + 5K Mineral), 78 cm from application no-1(Actagro), 77.8 cm from application no-6 (Actagro + Agrisul 90 + Cropset) and 77.2 cm from application no-3(Actagro + Agrisul 90). The lowest stem perimeter was obtained from the application no-4 (Actagro + Agrisul 90 +5K Mineral) with 75.4 cm [4]. Conducted in Egypt showed stem perimeter values in the range of 75.67-85.00 in the Maghrabi banana clones. Chaudhuri and Baruah (2010) detected stem perimeter as 65.00-75.85 cm in the Jahaji banana clones [3]. Reported stem perimeter values in the range of 55-73 cm in the three local banana types of Bangladesh; Sabri, Bari KALA-1 and ITC-1441. Moreover [26], carried out in India reported stem perimeter values between the range of 57.05-58.54 in Grand Naine banana clones. When our results were compared with previous studies on similar subject, they were similar to the results of [4], and Chaudhuri and Baruah (2010). Compared to the results of [3,26], our results were found as higher. It is thought that this situation was caused by different

fertilizer applications, different cultivation and maintenance conditions in different regions and as well as use of different clones in the researches.

(1): N.S: nonsignificant

When pseduostem heights were analyzed, no significant difference among applications was observed. The highest value was 4.27 m obtained from application no-6 (Actagro + Agrisul90 + Cropset). Rest of the results were found to be 4.24 m in application no-4 (Actagro+Agrisul90+5K Mineral), 4.22 m in application no-1 (Actagro), 4.13 m in application no-5 (Actagro+Cropset), 4.12 m in application no-2 (Actagro+5K Mineral) and 4.06 m in application no-3 (Actagro+Agrisul90) respectively [4]. Conducted in Egypt, reported pseudostem height of Maghrabi type banana in between 2.71-3.48 m. Chaudhuri and Baruah (2010) determined the pseudostem height of Jahaji type banana in between 1.60-1.85 m [3]. Reported that Sabri type had the highest value with 3.1 m and Bari KALA-1 had the lowest value with 1.8 m among all three Bangladesh local banana types which are Sabri, Bari KALA-1 and ITC-1441. The study on Williams banana types by [32]. Reported that Williams type banana pseudostem height was found to be between 2.66-2.78 m [26]. Found the pseudostem height of Grand Naine type banana in the range of 1.99-2.10 m in India. Ganapathi and Dharmatti (2018) detected the pseudostem height of plant in between 1.71-2.05 m. When the results of this study (4.06-4.27m) were compared with previous studies, the pseudostem heights of plants were found to be rather high. It is thought that this difference is originated from the difference in clones of banana used, features of clones, conditions of maintenance, applications and different ecological conditions.

There were no statistically significant difference in terms of number of leaves among different applications. The highest number of leaves was found to be 13.6 in application no-5 (Actagro+Cropset) among other applications The order was followed by application no-4 (Actagro+Agrisul90+5K Mineral) and application no-6 (Actagro+Agrisul90+Cropset) with 13.2, application no-1 (Actagro) and application no-3 (Actagro+Agrisul90) with 13.0. The lowest number of leaves were found as 12.8 from application no-2 (Actagro+5K Mineral). Kumar (2007) reported that while number of leaves of Neypoovan type banana was 8 in control group, the number of leaves in plants which were subjected to 0.5%, 1.0% and 1.5% potassium sulfate were found to be 8.4, 8.2 and 10.2 respectively [4]. Reported that the number of leaves of Maghrabi type banana was in between 9.33-13. Chaudhuri and Baruah (2010) determined the number of leaves in Jahaji type banana in the range of 12.50-14.20 [3]. Observed that the number of leaves in Bangladesh local banana types (Sabri, Bari KALA-1 and ITC-1441) were 14.6 in October, 13.9 in November, 12.7 in September, 10.56 in February, 10.33 in March and 8.78 in April. The study on Williams banana clones by [32]. Reported that this number in Williams type banana was between 12.33-13.27. Moreover [26], Found the number of leaves in Grand Naine type banana in between 13.68-15.55. Ganapathi and Dharmatti (2018) stated the number of leaves values in between 13.24-16.00. When results were evaluated, we determined the number of leaves between the range of 12.8-13.6 in our study. These values are similar to number of leaves found in other studies except [4]. This difference between our study and [4] were thought to be derived from that number of leaves were counted in different periods.

6. Conclusıon

According to results, even though weight of bunch (38.00-50.32 g), number of hand (11.40-12.40 piece), weight of finger (156.71-190.00 g) and weight of hand (3.10-4.00 kg) was determined to be insignificant, best results were obtained from application no-5 (Actagro+Crop Set). While values of TSS within quality criteria were found to be statistically significant, the best results on unripe fruit (5.07-7.41%) and ripe fruit (21.33-24.70%) were obtained from application no-1 (Actagro). The differences of vitamin C content of unripe fruits values (2.4-6.6 mg/100g) were found to be statistically significant and best results on unripe fruits were obtained from application no-1 (Actagro). Although, there were no statistically significant difference in vitamin C content of ripe fruits (8.00-11.20 mg/100g), best results were obtained from application no-1 (Actagro). Inspite of insignificant difference in stem perimeter, pseudostem height and number of leaves, best results for stem perimeter values (75.40-78.80) were derived from application no-5, best results for height of plant values (4.06-4.27) were derived from application no-6 and lastly, best results for number of leaves values (12.80-13.60) were also obtained from application no-5. It is recommended cultivators to use Simsek type banana, to apply macro and micro nutrients which plants need without neglecting analysis of soil and leaves during cultivation, to use combination of Actagro and Crop Set fertilizers which give best yields and to try combination of different doses of those fertilizers to produce high quality bananas for domestic and foreign markets. In addition to those, it is recommended that cultivators to use combination of liquid fertilizers containing Thiomax-S sulfur found in Actagro and Agrisul 90 annually when high pH in Mediterranean region is considered as a problem.

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