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Influence of the regulation of underground water level on some of qualitative and productivity characters of Golden delicious apple cultivar

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Abstract : The present research was Carried out in Sweida Governorate, Syria in the area where apple trees widely distributed which characterized with heavy clay soil, during the growing season 2014-2015, in order to study the effect of the regulation of the subsurface free water level on the productivity and qualitative characters of apples , where Mole trenches were made using a tractor and plow by fixing a drill or a screw driver on the tractor. The experiment was carried out using four considered Treatments which differ in the distance between the tracks.

The results showed that the treatment (1m distance between tracks) significantly improved the vegetative growth (Shoot length and diameter) of apple trees in the comparison with other treatments, the average length of shoots was 65 cm with significant increasing of 32.9 cm than the Control and the average diameter 6.33 mm which increased significantly of 2.23 mm than the Control. On the other hand, the treatment (1m distance between tracks) revealed the highest productivity (60.25 kg/tree) in significant with the other treatments, which increased about 99.8% more than the control.

The results of the chemical analysis of apple fruits showed the highest percentage of soluble solids and total sugar in the treatment (1m between tracks) which were 15.73 % and 14.3%, respectively, with an increasing of 1.77 % and 1.12 % respectively than the Control.

Key words: apple, total soluble solids, sugars, clay soil, drainage.

Introduction:

Apple Tree is one of the most important fruit trees in Syria, where it occupies the first rank in the production of deciduous trees, The amount of production reached 397.857 thousand tons in 2014[1]. Apple fruits are characterized by very high quality which led to export this fruit to the Arab and som foreign markets

Apple trees prefer light clay, good drainage, ventilation and with sufficient organic matter soils, but Sweida soils are heavy clay soils[2], which need to add sufficient amounts of organic fertilizers, to improve soil physical and chemical properties. Also, it is preferable to establishe drainage system in addition to avoid waterlogging because of its negative role on apple trees .

Flooded soils exposed to the lack of oxygen which lead to the change in the pH, specific conductance , sorption, desorption, ion exchange and exchange equilibria, which in turn greatly influence the availability of plant nutrients , uptake and utilization by the plant[3] .The main electrochemical changes that influence the

chemistry and fertility of submerged soils and growing of crops such as wetland rice include. A decrease in Redox potential (Eh) or reduction of the soil. An increase in pH of acid and a decrease in pH of alkaline soils, and changes in flooding may take up to several weeks, depending on the soil type, OM levels, microbial population, and other soil chemical properties. Changes in organic matter and availability of plant nutrients in soils following their submergence under water could be as follow: i) Favours convergence to neutral pH, ii) Favours accumulation of organic carbon and nitrogen, and iii) Improve Si[4].

So, to regulate the subsurface free water level which can be used in different drainage forms (open , covered drainage, and Mole drainge). Mole drainage are cylindrical tracks on a certain depth of soil prepared by plows beneath the soil surface with a certain diameter and at appropriate moisture[5]. On the other hand, the nature of Ground water and its contents and the concentration of different elements affect the pH and the final use of water[6].

It has been thought about using the Mole drainge technique, because of the Low cost (30-130$/Ha) in the comparison with covered drainage (3000$)[7]. This kind of drainage is considered as a new technique to get rid of excess water in the spread area of the root zone in clay soil[8], Mole leads to improving the physical properties of the soil and increases crop productivity[9].

Mole drainage is performed well in clay soils, the proportion of clay must be more than 35% [10], and it can range between 30-45% [11], and the increase proportion of clay for 45% increases the quality of tunnels and prolongs its validity[12].

The determination of soil moisture before the experiment is crucial, soils must contain the soft clay to remain cohesive and elastic enough (Fabric: clay Or soft clay) and that the moisture content is at the plastic limit of the soil (50% of field capacity) or above[13]. However soil moisture content is possible to range between 20-25% in the mole depth[14].

Operations that involve machinery traffic and soil engaging tools, such as tillage and planting, on agricultural soil is considered tractable if it can develop adequate shear resistance to minimize tire slippage and soil damage[15]. The soil in the study area is characterized as relatively heavy structure, where the proportion of clay is between 30-50% of the granular composition of the soil, and it has been noted that the increase in the proportion of clay in some subsurface profiles, may due to the migration of the clay and the formation of stacked layer, especially in the open clay soil, as a result of different conditions such as the lack of soluble salts such as calcium carbonate or gypsum salts, high rainfall level, the presence swollen and scatter metals like Smectite metals, and the applied weight to soil as a result of the weight of the mechanisms and plow machine pressure which lead to the lack of access to water and nutrients due to subsurface runoff or exposing some flat areas to the high ground- water level. Therefore the present investigation aimed to evaluate the efficiency of mole tracks to drainage the exceeded water and its effect on the growth and productivity of apple trees.

Materials and Methods:

The research was achieved in the Agricultural Research Center in Sweida- Syria, which is located at an altitude of 1525 m and enjoys a mountainous atmosphere (cold winter and relative mild summer), which helps to keep mild temperatures and reduces evaporation amount. Apple trees are planted under rainfed conditions, the annually rainfall is about 550mm.

The soil belongs to Mollisols rank [16], and it was classified based on the American system of classification, depending on the presence of diagnostic horizons (horizon molar) TypicHaploxerolls.It is a heavy clay soil that is characterized by a high content of Smectite , good content of organic matter, it has the homogeneity of the soil profile, and it has high cationic exchange capacity [17].

- **Plant material :** Apple trees of Golden Delicious cultivars were used , which characterized as a vigor tree, big size of fruits and have yellow color , the maturity time in October and can stored for 8 months[18].

- **Research methods**:

- **soil Characterization:** the area was divided into experimental sectors, each 60 m2 per treatment , (15 m long by 4 meters wide), samples were taken at different depths (0-20sm, 20-40sm, 40-60sm) using metal cylinders at a rate of 3 Repetition per depth.

Service operations prior to the implementation of the research : Fermented compost (cow dung) has been added at a rate of 6 m3 / acres, according to the results of soil analysis where It can be concluded that application of compost (In these soils) improved yield, soil properties and nutrients availability[19], it has been distributed uniformly on the surface soil and it has been mixed well with the soil during the cultivating process, then the soil was leveled (this is important to avoid errors that can occur due to the accumulation of water in one place, or more depending on the topography of the heterogeneous surface).

- **Implementation of Mole tracks:**

Trench was dug at a depth of 80 cm and a width of 60 cm to collect water and its drainage out of the field, and then Mole trenches were made using a plow tractor by fixing a drill on the tractor, where processing Mole trenches starts with an assembly trench with the inclination angle of 5% and lowering the drill gradually until we reach the depth of 60 cm within the trench , the rear of the tractor with drill has been placed perpendicular to the trench and fixed in this position , the trench diameter 10 cm= cylinder diameter that is used to dig the trench . The four Treatments were identified as the following:

- Treatment (1) : the distance between tracks 1m .
- Treatment (2) : the distance between tracks 1.5 m .
- Treatment (3) : the distance between tracks 2.5 m .
- Treatment (4) : without tracks(the Control Treatment) .

Studied indicators:

1- average length of shoots:

The length of five shoots was measured of each tree in each replicate and each Treatment that represents all others by measurement meter.

2- Shoots diameter:

Measured by caliper (Electric Digital Caliper, Model Z22855F, ± 0,02mm, UK) to measure the diameter of the shoot between fifth and seventh leaves on the shoot.

3-Chemical analysis : 10 fruits of each replicate were taken in each Treatment to conduct quality tests :

3-1- Total Soluble Solids (TSS %): it was directly estimated as a percentage by Digital refractometer device (RL. Atago, model pocket PAL-1, 0-53, Germany). After squeezing of the fruit and extracting juice fruiting each repeater separately.

3-2- Total sugars (%) : total sugars were calculated in each Treatment and each replicate according to Lane and Enon way [20].

3-3-Titratable Acidity (TA%): through the calibration of 5 ml of juice with a solution of sodium hydroxide (0.1n), until reaching the degree of pH = 8.1 on the basis of prevailing acid which malic acid (a equivalent weight of 67) and calculated the total acidity by the equation [21]**:**

Total acidity (g / 100 g) = (volume of been consumed NaOH X100X0.1X67) / sample size X1000

4. Productivity: The productivity has been accounted for each replicate in each Treatment on the basis of kg / tree.

- **Statistical analysis:**

Experiment has been carried out as a factorial experiment in simple randomized plot design where the number of experimental treatments were 12 (4 * 3), data was analyzed using MSTAT-C program and depending on the Duncan test at the Significance level of 0.05 .

Results and discussion:

- **Effect of mole drainage in shoots length:**

Results in Table (1) showed that the two treatments (1) and (2) Significantly Excelled in terms of the shoot length in the comparison with the control, while the treatment (3) did not show any significant difference from the view treatment, treatment (1) has excelled Significantly on treatment (2), treatment (3) and control shoots at an increase of 10.6 cm, 28.7 cm and 32.9 cm respectively. Also, treatment (2) Significantly revealed higher shoot length average than the treatment (3) and control with an increase of 18.1 cm and 22.3 cm, respectively . However, the highest average length of the shoot average was (65 cm) in treatment (1), while it was 32.1 cm in the control.

Depending on the results, treatment (1) was the best in positively effecting of the length of the shoots , and this is due to the improved soil physical and hydrophysical properties and provide an appropriate environment (water + air) of the plant because of the drainage process and its effect positively in increasing the capacity of photosynthesis and the food manufacturing in the plant and ,thereby, increasing vegetative growth, strength and length of the shoots in trees ,which was in agreement with [22].

- **effect of Mole drainage in shoot diameter :**

Table 1 showed the effect of distance between mole tracks in shoot diameter in Apple trees , where all treatments Significantly revealed higher average than the control with an increasing 2.23 mm, 1.6 mm, and 0.34 mm for treatments (1), (2) and (3), respectively, and the significantly increased Reached. Likewise, treatment (1) Significantly showed high average diameter in the comparison with the treatments (2) and (3) with an increase of 0.63 mm and 1.8 mm respectively , and treatment (2) outperformed significantly (3) an increase of 1.17 mm . The treatment (1) wasthe best , due to the reflection of increasing the number of drainage lines to improve the physical properties of the soil, and provide ventilation conditions , thereby increasing the plant 's ability to absorb nutrients and provide nutrients for plants Which will reflect positively on the vegetative growth [23] , leading to increase shoot diameter.

Table (1):The average of shoot length and diameter in apple trees Golden delicious cultivar

Average of shoot diameter (mm)	Average of shoot length (cm)	Treatment
4.1^{d}	32.1^{c}	control
6.33^{a}	65^{a}	treatment(1)
5.7^{b}	54.4^{b}	treatment(2)
4.53^{c}	36.27^{c}	treatment(3)
0.38	5.71	**LSD 5%**

Means separation was done by Duncan Test at $p \leq 0.05$.

Total soluble solids percentage:

Soil management of apple orchards can affect fruit quality [24] .Results showed that the two treatments (1) and (2) Significantly revealed high content of total soluble solids in the comparison with the treatment (3) and control. On the other hand, treatment (3) significantly revealed higher content than the control. However, the highest content of total soluble solids was in the treatment (1) which was 15.73 % with an increase 1.77 % than the control. Thus the treatment (1) was the best by raising the percentage of total soluble solids in the fruits of apple tree cultivar Golden delicious due to excess of water drainage that the tree does not need and provide ventilation and convenient environment to deepening roots and getting the sufficient amount of mineral nutrient from the soil shoots which lead to improve qualitative traits of fruits and raise the percentage of total soluble solids, literature studies stated that the total soluble solids in Golden delicious apple cultivar can arise to 21.4% at consuming maturity time[25]. On the other hand, The total soluble solids content differs depending on apple

varieties, 9 found that the TSS in Idared apple fruits ranged between 11.7-12.4%, and in Milrose fruits were 12.3-13% depending on fertilization treatment[26].

- **Total Sugars (%):**

Sugars are the main component of total soluble solids [27], and the sugar content is influenced with the applied treatments [28]. As shown in total soluble solids the two treatments (1) and (2) significantly contained the higher total sugar than the treatment (3) and control, and treatment (3) revealed higher content than the control with significant variance. Likewise, the highest percentage of total sugar was found in the treatment (1) 14.13% with an increase of 1.12% over the control.

Thus, treatment (1) was the best in terms of its effect of raising the percentage of total sugar in the fruit of Golden delicious apple cultivar, for the reflection of increasing the number of drainage lines in the pilot widget on soil properties improvement and providing the necessary oxygen for the roots which improving the growth and fruit quality due to increase the proportion of sugars in fruits.

Titratable Acidity(%) :

Titratable acidity considerably decreased during the ripening of fruits and malic acid is used as respiratory substrates in apple as other fruits like Mango[29] and Pomegranate[30]. It can be seen from Table (2) that there is significantly low titratable acidity in all treatments, compared with the control, and there is no significant difference in titratable acidity between treatments (1) , (2) and (3) studied . So the distance between the drainage lines had no significant effect on reducing the proportion of titratable acidity in the apples cultivar .Our result was in agreement with previous study under the same conditions [25].

Table 5 : Percentage of total soluble solids, total sugars, and titratable acidity in the fruits of Golden delicious apple cultivar.

Titratable acidity(%)	total sugars (%)	Total soluble solids (%)	Treatment
0.43[a]	13.01 [c]	13.96 [c]	control
0.39 [b]	14.13[a]	15.73[a]	treatment(1)
0.39[b]	14.03 [a]	15.7[a]	treatment(2)
0.40[b]	13.43 [b]	14.57[b]	treatment(3)
0.02	0.24	0.16	**LSD 5%**

Means separation was done by Duncan Test at $p \leq 0.05$.

- **Effect of Mole drainage on productivity**:

Table (3) showed that the Mole drainage significantly increased the productivity in all treatments in the comparison with the control with an increase of% 99.8 for treatment (1), 53.17% in the treatment (2) and 16.27% in the treatment (3). productivity reached 60.25 kg / tree in treatment (1) , 46.18 kg / tree in treatment (2) and 35.05 kg / tree in treatment (3) while the productivity in the control was 30.17 kg / tree. This is consistent with [31] and [9] that the Vestibular drainage increases the productivity of crops: onions, tomatoes, wheat 40%, 10%, 19%,respectively. All treatments also increased Significantly among themselves and the treatment (1) was the best. The least significant difference value was 7.3.

Table 6 : the effect of Mole drainage on apple trees productivity

productivity%	**productivity**(kg/tree)	**productivity**(kg/ Ha)	Treatment
100[d]	30.17	6033.3[d]	control
199.8[a]	60.25	12050[a]	treatment(1)
153.17[b]	46.18	9236.7[b]	treatment(2)
116.27[c]	35.05	7010[c]	treatment(3)
7.3		23.63	**LSD 5%**

Means separation was done by Duncan Test at $p \leq 0.05$.

Conclusion:

The application of mole drainage was able to improve the vegetative growth and fruit quality traits, and the treatment 1 m distance between tracks was the efficient treatment. We recommend to apply mole drainage as an efficient technique in apple orchards.

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