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Response of Fodder Beet Plants Grown in a Sandy Soil to Different Plowing Conditions

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Abstract : The objectives of this research are to studying the effect of different soil moisture, soil depth at plowing, and different plowing speeds on growth, yield and quality of the fodder beet crop in new lands.. The field experiments were conducted during two successive seasons 2014 and 2015 in the experimental farm of National Research Centre at El-Nubaria area, El-Buhaira Governorate, Egypt. Three levels of soil moisture at plowing (ϴ1=6.68, ϴ2=7.88, ϴ3=8.86%w/w), two plowing speeds (Speed 1 = 1.78 km/hr and Speed 2 = 9.6 km /hr) and three plowing depth's (10, 20; 30 cm) were used. Data could be summarized as follows: The effect of soil moisture content at plowing, plowing speed, and plowing depth on growth, yield and quality of the fodder beet crop could be put in the following descending order: (ϴ1>ϴ2>ϴ3), (Speed2>Speed1) and (depth30>depth20>depth10 cm). The interaction among factors as follows: the maximum and minimum values of growth, yield and quality of the fodder beet crop were (significantly at 0.05 levels) recorded at ϴ1 x Speed2 x depth30, and ϴ3 x Speed1 x depth10, respectively. It could be concluded that use the conditions of moisture content at plowing ϴ1=6.68%, plowing speed SP2= 9.6 km/hr and plowing D3=10cm were positive effects on fodder beet growth, yield and quality parameters. So it could be expected to maximize the productivity of fodder beet in further seasons and save consumptive fuel, driver salary, time and money by using soil moisture content 6.68% at plowing, speed plowing 9.6km/h and plowing depth 30 cm.
Key words: Speed, Moisture, Plowing, Depth, growth, yield, quality, fodder beet.

1. Introduction

Soil tillage is carried out by many different implements and it's the one of the most determined of operations agricultural product. The success or failure of crop production is primarily determined by tillage practice. In addition Tillage operations alter soil physical properties attributing the effect of structural properties of soil in the process of farming or breaking down of aggregates; these physical properties are of great importance to crop growth, **FAO**[1]. During recent years, soil depletion was observed and that was due to the intensive tillage with heavy tractor drawn implements **Cook etl**[2]**.**

Lal[3] mentioned that some of soil management problems uncounted with conventional tillage systems are the degradation of soil structure, soil erosion, and decreased in soil organic matter. **Culpin**[4] reported that there were many experiences which showed that if it is possible to control weeds with chemicals effectively, then it is better to grow arable crops without any cultivation.

All these functions and objectives of tillage can be summarized in the concept of better soil structure and hence a good soil tilth, which stands to produce a high crop yield.

As a matter of fact the actual objectives and methods used for tillage vary widely from one part of the world to another, as while in some parts tillage practices include sub soiling or deep ploughing and various other operations.

Tillage methods are considered to be the most important operations for crop production. Since, upon them depends proper management of soil moisture content and crop residues, crop establishment, weed control, improvement of soil tilth, erosion control, temperature control for seeding, insect control, the incorporation of fertilizers and preparation of the land surface for other operations. **Kepner et al[5].** Despite the various advantages of tillage operations there are many problems encountered through time due to the use of heavy machinery.

Omerand Elamin[6] reported tillage significantly affected the plant height, and that the sorghum plants were shorter on no tilled then on tilled plots. Soil structure has a great influence on seedling emergence. Tillage will cause the surface layer above the implement working depth to be drier and the zone below to contain more moisture than a tilled soil.

Alem[7] stated that seedling emergence was significantly influenced by the different seed- beds due to variation in soil moisture. On soils with poor physical conditions caused by erosion or extensive row cropping, crop yield associated with moldboard plowing was generally better than yields associated with other forms of tillage. **Abdelmageed[8].**

Ahmed and Maurrya[9] stated that the un-compacted soils gave higher yields than compacted ones in silt loamy soils, but in the loamy sandy soils, the Influence on yield changed towards more with years.

SAS Institute[10] reported that after three to four years of crop cultivation under normal conventional tillage, the useful effects of deep tillage vanished, and that was due to the increasing impact of infiltration and water and nutrient losses from the root zone resulting in the dilution of the soil fertility.

The aim of this paper to investigate the effect of different soil moisture, soil depth at plowing, and different plowing speeds on growth, yield and quality of the fodder beet crop in new lands.

2. Materials and Methods

The field experiments were conducted during two successive seasons 2014 and 2015 in the experimental farm of National Research Centre at El Nubaria area, El-Behera Governorate, Egypt to study the response of fodder beet plants to plowing conditions (soil moisture content, tractor speed and plowing depth) under sandy soil condition. Some physical properties of the studied soil are presented in Table (1). The previous crop in selected site was Common Been; *Phasolus Vulgaris*.Sprinkler irrigation system was used.

A completely randomized and split – split plot design was applied. Three soil moisture content θ (6.68, 7.88 and 8.86% w/w), two plowing speeds (1.88 and 9.6 km/h) and three plowing depth (10, 20 and 30cm) were used at blowing. Plowing process was conducted using Chisel plow with 7 fixed tines.

Table (1): Some physical properties of the soil.

Depth (cm)	Particle Size distribution, %				Texture Class	θ_S % on weight basis			HC (cm/h)	BD (g/cm³)
	C. Sand	F. Sand	Silt	Clay		F.C.	P.W.P	A.W		
0-15	8.4	78.6	7.5	5.5	Sand	12	4.1	7.9	6.68	1.56
15-30	8.6	78.7	7.3	5.4	Sand	12	4.1	7.9	6.84	1.58
30-45	8.5	78.5	7.8	5.2	Sand	12	4.1	7.9	6.91	1.63
45-60	8.8	78.7	7.6	5.9	Sand	12	4.1	7.9	6.17	1.62

The seeds of fodder beet (*Beta Vulgaris, L.*), (*Beta Yorosphenger cultivar*) were sown on $10^{th}$of December 2014.The plants were 30 cm apart in each row. The mineral fertilizers were applied uniformly as follows: 200kg/fed calcium superphosphate (15.5% P2O5) was added during soil preparation, 50 kg potassium sulphate (48% K2O) +100 kg/fed Urea (46 % N) after one month from sowing and 100kg potassium sulphate+ 100 kg/fed Urea after 3 months of sowing time. Regarding the determination of vegetative growth parameters, at 180 days old, five plants from each plot was picked up randomly as representative samples for measuring and calculating the following characteristics: length of roots, root diameter and green yield of leaves and roots in t/fed.

The Least Significant Differences (L.S.D) between the means were computed at 5 % level of significance and used to make paired comparisons between the treatment means. The obtained data (two seasons) were statistically analyzed according to SAS[10].

3. Results and Discussions

3.1. Vegetative growth:

Tables (2 and 3) show the effect of three different soil moisture (Θ1=6.68, Θ2=7.88, Θ3=8.86%), two tractor speed's (Speed 1 = 1.78 and Speed 2 = 9.60 km/h) and three plowing depth (D1=10, D2=20, D3=30cm) on fresh weight of leaves/plant (g), dry weight of leaves/plant (g), leaves yield (kg/fed), root length (cm), and root diameter (cm). For study the effect of individual factors, regardless the different plowing speeds and moisture content, the obtained of all vegetative growth parameters under study, plowing depths could be ranked in the following descending orders: D3>D2 >D1.Based on these results, increasing soil depth has positive effects on all vegetative growth parameters of fodder beet plant and vice versa. While the effect of moisture content on all fodder beet vegetative growth parameters took the inverse rank of plowing depth, soil moisture content could be arranged in the following descending order Θ1> Θ2> Θ3. One can notice that there is inverse relationship between all fodder beet vegetative growth and values of moisture content under study. On the other hand the effect of plowing speeds and depth on all fodder beet vegetative growth parameters took the inverse ranke of soil moisture content. Plowing speeds could be ranked on the following descending order SP2 > SP1. The highest and lowest values of all fodder beet vegetative growth parameters were achieved under plowing depth (30 and 10cm), moisture content (Θ1 and Θ3), and plowing speed (SP2 and SP1), respectively. At Θ1 treatments increased all growth parameters (fresh weight of leaves/plant, dry weight of leaves/plant, leaves yield, root length and root diameter of 94.1, 84.4, 94.1, 15.3 and 29.7%higher than that ofΘ3 treatments respectively. Relevant increases for PS2 treatments were 4.5, 4.8, 4.5, 5.7 and 2.8% compared to PS1 and for D3 were56.4, 44.1, 56.4, 22.9 and 23.9% compared to D1, in sequence.

Table (2) Effect of soil moisture content, plowing speed and plowing depth on fodder beet growth.

Moisture (θ) % I	Plow Speed (km/h)II	Plow Depth (cm)III	Fresh weight of leaves/plant (g)	Dry weight of leaves/plant (g)	Leaves yield (kg/fed)	Roots length (cm)	Roots diameter (cm)
θ1 6.68%	**PS1 1.78**	**10**	277.27	37.13	6144.60	31.17	8.60
		20	321.05	54.05	7114.80	31.50	9.58
		30	425.53	58.34	9430.05	36.33	9.73
	PS2 9.6	**10**	265.33	37.21	5880.00	30.67	8.02
		20	297.84	38.95	6600.30	35.42	9.47
		30	426.19	61.46	9444.75	40.17	10.50
θ2 7.88%	**PS1 1.78**	**10**	214.92	35.40	4762.80	28.17	6.93
		20	240.79	36.59	5336.10	30.17	7.77
		30	302.81	42.76	6710.55	30.33	8.60
	PS2 9.6	**10**	164.18	32.48	3638.25	25.58	6.15
		20	254.06	34.05	5630.10	32.67	7.88
		30	287.89	51.78	6379.80	33.33	7.90
θ3 8.86%	**PS1 1.78**	**10**	98.84	19.54	2190.30	24.00	6.14
		20	147.92	22.62	3278.10	30.33	6.43
		30	178.77	23.67	3961.65	32.00	7.32
	PS2 9.6	**10**	173.46	25.78	3844.05	27.67	7.05
		20	191.70	31.91	4248.30	30.67	7.07
		30	246.43	32.20	5461.05	33.33	9.08
LSD 5% Interactions							
I X II			**75.69**	**2.45**	**524.36**	**0.45**	**0.15**
I X III			**54.58**	**1.25**	**478.96**	**0.16**	**0.36**
II X III			**62.36**	**0.89**	**378.69**	**0.47**	**0.08**
I X IIXIII			**64.21**	**1.53**	**460.67**	**0.36**	**20.00**

Differences in the studied parameters of all vegetative growth between means were significant at the 5 % level. While the lowest and highest values of fuel consumption and wheel slippage were achieved under depths10cm and 30cm, respectively. These data supported by **Riley**[12], **Riley et al**[13], **Poss et al**[14], **Tayel et al**[15] and **Berresen and Njes**[16]**.**

Tables (2) shown that the interaction between the studied factors as following: The maximum and minimum values of all fodder beet growth parameters were obtained in ϴ1 x Speed2 x depth30, and ϴ3 x Speed1 x depth10, respectively, differences in the obtained data among interactions were significant at the 5% level.

Table (3): Effect of means factors of soil moisture content, plowing speed and plowing depth on fodder beet growth.

Factors or treatments	Fresh weight of leaves/plant (g)	Dry weight of leaves/plant (g)	Leaves yield kg/fed	Root length cm	Root diameter cm
θ1	335.54 a	47.86 a	7435.75 a	34.21 a	9.32 a
θ2	244.11 b	38.84 b	5409.60 b	30.04 b	7.54 b
θ3	172.85 c	25.95 c	3830.58 c	29.67 c	7.18 c
PS1	245.32 b	36.68 b	5436.55 b	30.44 b	7.90 b
PS2	256.34 a	38.42 a	5680.73 a	32.17 a	8.12 a
D1	199.00 c	31.26 c	4410.00 c	27.88 c	7.15 c
D2	242.23 b	36.36 b	5367.95 b	31.79 b	8.03 b
D3	311.27 a	45.04 a	6897.98 a	34.25 a	8.86 a
LSD 0.05	2.56	0.08	12.46	0.17	0.04

3.2. Roots yield:

Tables (4 and 5) show the effect of three different soil moisture (ϴ1=8.68, ϴ2=7.88, ϴ3=8.86%), two tractor speed's (Speed 1 = 1.78; Speed 2 = 9.60 km/h) and three plowing depth (D1=10, D2=20, D3=30cm) on root fresh weight/plant (g), root dry weight/plant (g) and roots yield (kg/fed). Factors under study could be ranked in the following orders: ϴ1> ϴ2> ϴ3, SP2 > SP1, and D3 > D2 > D1. The three parameters of roots fodder beet yield took the same trend.

The highest and lowest values of root fresh weight/plant (g), root dry weight/plant (g) and roots yield (kg/fed) were obtained under the moisture content (ϴ1 and ϴ3), plowing speed (SP2 and SP1) and plowing depth (30 and 10 cm), respectively.

Increase percentage for yield parameters (fresh weight/plant, root dry weight/plant and roots yield) according ϴ1compared by ϴ3 were88.2, 28.3 and 88.2%;increasing percentage in plowing speeds SP2 comparing SP1 were 3.8, 9.0 and 3.8%;increasing percentage in plowing depth D3 comparing with D1 were 68.9, 80.5 and 68.9, respectively.

Differences in the mean values studied of fodder beet roots yield were significant at the 5 % level. While the lowest and highest values of fuel consumption and wheel slippage were achieved under depths10cm and 30cm, respectively. Taking into consideration that excess consumption of fuel as a result of the use depth of 30 cm can be offset by the increase in yield production. These results are in harmony with those obtained by **Berresen and Njes**[16] **and Mansour et al**[17]

Table (4) Effect of soil moisture content, plowing speed and plowing depth on roots yield of fodder beet

Moisture θ(%) I	Plow Speed (km/h) II	Plow depth (cm) III	Fresh weight of roots /plant (g)	Dry weight of roots/plant (g)	Roots yield (kg/fed)
θ1	**PS1**	**10**	1780.9	66.5	39171.2
6.68%	**1.78**	**20**	2170.4	74.5	47738.1
		30	3115.7	102.5	68528.6
	PS2	**10**	1926.6	49.7	42375.1
	9.6	**20**	2056.8	90.1	45237.7
		30	3017.2	133.5	66362.5
θ2	**PS1**	**10**	1179.3	54.8	25937.7
7.88%	**1.78**	**20**	1341.1	65.8	29496.8
		30	1473.5	97.0	32408.1
	PS2	**10**	743.2	64.1	16346.9
	9.6	**20**	1337.6	72.6	29420.2
		30	1554.2	73.9	34184.2
θ3	**PS1**	**10**	850.3	45.2	18701
8.86%	**1.78**	**20**	1029.2	64.3	22636.3
		30	1374.7	74.2	30235.1
	PS2	**10**	1015.2	48.2	22329.8
	9.6	**20**	1078.3	59.0	23715.8
		30	2127.7	112.0	46797.8
LSD 5% Interactions					
I X II			104.36	0.23	35.45
I X III			88.47	0.16	26.78
II X III			69.34	0.06	18.63
I X IIXIII			87.39	0.15	26.95

Tables (4) show that the interaction between the studied factors as follows: The maximum and minimum values of root, fresh weight/plant (g), root dry weight/plant (g) and roots yield (kg/fed) were obtained in (Ɵ1 x Speed2 x depth30), and (Ɵ3 x Speed1 x depth10), respectively, differences among the values of the obtained data interactions were significant at the 5% level.

3.3. Crude protein and total carbohydrate percent in root and foliage of fodder beet yield:

Tables (6 and 7) show the effect of three different soil moisture (Ɵ1=8.68, Ɵ2=7.88, Ɵ3=8.86%), two tractor speed's (Speed 1 = 1.78; Speed 2 = 9.60 km/h) and three plowing depth (D1=10, D2=20, D3=30cm) on the crude protein percent in root and foliage of fodder beet yield. Factors under study could be ranked in the following orders: Ɵ1 > Ɵ2 > Ɵ3, SP2 > SP1, and D3> D2 >D1. The percentage of crude protein percent in root and foliage of fodder beet yield took the same trend.

Table (5): Effect of means factors of soil moisture content, plowing speed and plowing depth on roots yield of fodder beet.

Factors or treatments	Fresh weight of roots /plant (g)	Dry weight of roots /plant (g)	Roots yield (kg/fed)
θ1	2344.60 a	86.13 a	51568.87 a
θ2	1271.48 b	71.37 b	27965.65 b
θ3	1245.90 c	67.15 c	27402.63 c
PS1	1590.57 b	71.64 b	34983.66 b
PS2	1650.76 a	78.12 a	36307.78 a
D1	1249.25 c	54.75 c	27476.95 c
D2	1502.23 b	71.05 b	33040.82 b
D3	2110.50 a	98.85 a	46419.38 a
LSD 0.05	15.4	0.08	124.56

Table (6) Effect of soil moisture content, plowing speed and plowing depth on total carbohydrate and the crude protein percent in root and foliage of fodder beet yield.

Moisture θ % I	Plow Speed (km/h) II	Plow Depth (cm) III	Total carbohydrate %		Crude protein %	
			Root	Foliage	Root	Foliage
θ1 6.68%	PS1 1.78	10	59.44	26.11	10.23	12.14
		20	54.44	27.22	11.41	12.36
		30	47.78	16.66	13.67	15.86
	PS2 9.6	10	55.56	20.55	11.34	12.09
		20	44.44	16.11	12.78	14.98
		30	52.78	20.55	11.65	13.75
θ2 7.88%	PS1 1.78	10	61.11	17.22	9.84	10.31
		20	58.33	14.44	10.20	10.88
		30	61.67	25.55	9.75	10.87
	PS2 9.6	10	67.22	14.44	7.18	9.38
		20	57.22	22.22	10.97	11.86
		30	58.89	21.11	11.47	12.02
θ3 8.86%	PS1 1.78	10	60.19	18.33	10.57	11.48
		20	58.94	22.03	11.39	12.04
		30	62.15	21.46	10.27	11.19
	PS2 9.6	10	61.19	19.33	10.83	11.36
		20	55.56	22.78	11.99	12.39
		30	63.01	20.43	9.17	10.75
LSD 0.05			0.65	0.52	0.23	0.15

Table (6) shown that the interaction between the studied factors as followoing: The maximum and minimum values of crude protein percent in root and foliage of fodder beet yield were obtained in (Θ1 x Speed2 x depth30), and (Θ3 x Speed1 x depth10), respectively, differences among the values of the obtained data interactions were significant at the 5% level.

The highest and lowest values of crude protein percent in root and foliage of fodder beet yield were obtained under moisture content (Θ1 and Θ3), plowing speed (SP2 and SP1)and plowing depth (30 and 10 cm), respectively.

Table (7): Effect of mean factors of soil moisture content, plow speed and plow depth on total carbohydrate and crude protein

Factors or treatments	Total carbohydrate %		Crude protein %	
	Root	Foliage	Root	Foliage
θ1	52.41	21.20	11.85	13.53
θ2	60.74	19.16	9.90	10.89
θ3	60.17	20.73	10.70	11.54
PS1	58.23	21.00	10.81	11.90
PS2	57.32	19.72	10.82	12.06
D1	60.79	19.33	10.00	11.13
D2	54.82	20.80	11.46	12.42
D3	57.71	20.96	11.00	12.41

At Θ1 treatments increased the percentage of crude protein by 10.7 and 17.3%higher than that of Θ3 treatment for root and foliage, respectively. Relevant increases slightly for PS2 treatments were 0.05 and 1.4% compared to PS1 and for D3 were 10.0 and 11.5% compared to D1, in sequence. Data agreed with **Mansour etl**[17], **Canada Soil Survey Committee**[18]**, and Camrell and Hawes**[19]

On the other hand the percentage values of total carbohydrate took the same trend as regards plowing depth in foliage only where increased the percentage of carbohydrate for D3 by8.4%higher than that of D1 treatment, while its decreased in root by 5.1% compared that of D1 treatments. Also the percentage values of total carbohydrate took the opposite trend in plowing speed where decreased at SP2 treatments by 1.6 and 6.5 in root and foliage compared that of SP1 treatments, respectively.

4. Conclusion

The effect of soil moisture content at plowing, plowing speed, and plowing depth on growth, yield and quality of the fodder beet crop could be put in the following descending orders: (θ1>θ2>θ3), (Speed2> Speed1) and (depth30> depth20> depth10 cm). The interaction among factors as follows: the maximum and minimum values of growth, yield and crude protein percent in root and foliage of the fodder beet crop were (significantly at 0.05 level) recorded at θ1 x Speed2 x depth30, and θ3 x Speed1 x depth10, respectively.

It could be conclude that use the conditions of moisture content at plowing Θ1=6.86, plowing speed SP2=9.6km/h and plowing D3= 30cm were positive effects on fodder beet growth, yield and quality parameters.

So it could be expected to maximize the productivity of fodder beet in further seasons by using soil moisture content 6.68% at plowing, speed plowing 9.6km/h and plowing depth 30 cm.

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