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PHYSICAL AND MECHANICAL PROPERTIES OF TABLE BEET AFFECTING THE DESIGN OF DIGGERS.

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ABSTRACT

This study was carried out to investigate some physical and mechanical properties of table beet plants, such as the root length, diameter of root, height of leaves, rosette width, diameter of leaf cluster, weight, volume, density, angle of friction between roots and both steel sheet, rubber, plastic and plywood. The positions of tablebeet in the soil. The pulling force required to pull up the table beet root by hand. The tensile force required to strip the top.

INTRODUCTION

Buyanov and Voronyuk (1985) concluded that the physical properties of table beet were: length of root 5.7-6.2 cm, diameter of roots 5.2-6.2 cm, mass of root 110-151 g and the length of top (leaf cluster) 17-27 cm, diameter of top (leaf cluster) 2.6-2.9 cm and mass of top (leaf cluster) 54-75g.

Zaalouk (1994) roperted that the physical properties of sugar beet were length of root 29.14 cm (c.v = 11%), diameter of 1o.82 cm (c.v = 10%), mass of root 1910.7 g (c.v=24%), and diameter of top (leaf cluster) 8.32cm (c.v. =12%), vegetative growth height of 43.61 cm (c.v.= 15%) and leaves mass 1033.2gr. (c.v = 39%). The pulling force required to pull up the sugar beet root by hand were ranging from 190.8 to 438.53 N with a mean value of 309.08N.

MATERIAL AND METHODS

This research was carried out in El-Ibrahimia village, Dasuq ,Kafr El-Sheikh Governorate during 2004 season.

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1-Table beet crop:

a- variety of table beet seeds:

The variety Detroit Dark Red was used in this study for manuol seeding. This variety is recommended for Egyptian condition.

b- Table beet plant description:

The table beet is considered as a perennial plant,and it consists of the following two main parts as shown in Fig. (1):

1) The root system which consists of a crown ,neck , cone shaped taproot and it is narrow extended taproot end .

2) The vegetative growth which consists of the leaves.

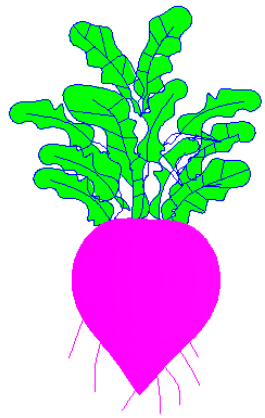

Fig . (1) Table beet plant

C-Specifications of beet plats:

A random sample of 100 plants were taken and cleaned from the soil clods and the following measurements were performed:

1- **Dimensions of table beet plants:**

The root length (L), root width (Wr), root thickness (T), diameter of root (Dr) (Dr = Wr + T/2), height of leaves (H), rosette width (w), width of leaf cluster (Wc), thickness of leaf cluster (tc) and diameter of leaf cluster (d) (d = Wc + tc/2), were measured and recored for random samples of beet plants.The root length, the height of the leaves and

rosette width were measured by a steel tape while the root width, root thickness, width of leaf cluster and the thickness of cluster were measured by a vernier calipers (-$^{+}$ 0.1 mm). Fig. (2) shows the measured dimensions.

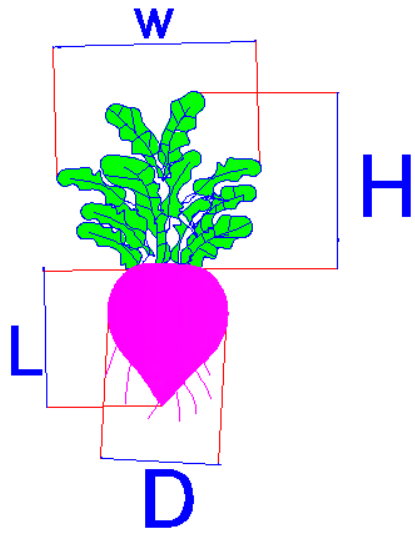

Fig. (2): Dimensions of beet plant.

2-Table beet location in soil:

The positions and sizes of table beet roots in the soil is dependent on there depth in the soil ,and on the diameter of roots. The depth of roots in the soil is measured from the soil surface (top of ridge) to the lowermost point of the root (narrow extended taproot end). To assign the locations of the roots relative in the ridge, the soil arround the roots were removed by an hand-hoe and the required measurements were taken. The measurements are made using a tap (--$^{+}$ 0.1 mm). These data were used in the design of the harvester digging share lifter.

3- Weight characteristics:

Weight of plant, weight of root and leaves were recorded separatel.

Ratio of they root mass to the plant mass was found

4- Root volume:

Root volume was calculated according to the following equation (assuming beet root is approxmately conical shape):

$$V = \Pi / 3\ r^2\ L$$

Where:

V = calculated volume of roots , cm^3.

r = radius of root , cm .

L = length of root , cm .

In addition to the root volume was measured also by using water displacement method in order to obtain actual volume .

5 –Hand pulling force for table beet uprooting (lifting):

Hand pulling force for the uprooting beet was measured by using the spring–weighing blance with a maximum reading of 50 kg and accuracy of 0.5 kg during the manual harvesting.

6 – Coefficients of friction:

Table beet friction angle was measured for table beet on plywood, plastic, rubber and metal surfaces according to [EL-Raie *et al*. (1996)]. The table beet samples was placed over the surface and by lifting up the surface around its side pivot, the angle of friction was diaplayed when 75% of the table beet reached the end of the surface. The friction angle of the table beet samples was taken as the average of five replicates.

7- Tensile force required to strip the tops by direct pulling:

The firmness of contact of tops (leaf cluster) with root is determined by there resistance to direct pull was measured by using the spring weighing blance with a maximum reading of 50 kg and accuracy of 0.5 kg.

2 – The soil:

The type of soil in the test plot was Clay loam with a mechanical composition of 34 % clay, 29.5 % silt, 36.5 % sand . The average bulk density, moisture content of the test plot were 1.42 g / $cm^3$and 26.13 %, respectively.

RESULTS AND DISCUSSIONS

The main goal of this work is to determine some physical and mechanical properties for table beet roots and beet location in ridge . These data were used in the design of the harvester share lifter.

A – Physical properties of table beet root :

1 – Table beet dimensions:

Table (1) shows the dimensions of table beet plants . The mean root length was 6.45 cm (C.V. = 22.32 %), mean root diameter was 5.25 cm (C.V. = 19.43 %), mean height of vegetative growth was 30.77 cm (C.V. = 14.23 %), mean rosettel width was 36.7 cm (C.V. = 15.98 %) and the mean leaf cluster diameter was 2.85 cm (C.V. = 19.82%). From table (2) it can be seen that most beets are located above the soil surface.

Table (1): Mean dimensions of table beet roots and leafs.

	Root Length (L),cm	Root diameter (D),cm	Leaf cluster diameter (d),cm	Vegetative growth height (H),cm	Rosettel width (w),cm
Maximam	9.00	8.00	4.05	39.00	
Minimum	4.30	3.50	2.10	21.00	
Mean (cm)	6.45	5.25	2.85	30.77	36.70
C.V. %	22.32	19.43	19.82	14.23	15.98

Table (2) : Position and depth of roots in the soil .

Parameters	**%**
1. Height of top relative to the soil surface:	
- above the soil surface	64
- at the soil surface .	26
- below the soil surface	10
2. Depth of root in the soil	**cm**
- Mean	4.34
- Maximum	6.70
- Minimum	1.80

2 – Table beet plant mass:

Table (3) represents the mean mass of parts of table beet plant. The total mass was 200.87 g (C. V = 45.54), the root mass was 101.23 g (C.V. = 48.29 %) ,the leaves mass was 99.60 g (C.V.= 47.50 %) and the ratio of root mass to the total mass 50.28 % with (C.V.= 14.85 %).

Table (3): The mean mass of table beet.

	Root mass,g	Leaves mass,g	Plant mass (total),g	Root/ total
Maximum	223	217	440	71.26
Minimum	38	39	75	38.08
Mean	101.23	99.60	200.87	50.28
C.V. %	48.29	47.50	45.54	14.85

3 – Root density:

The root density as estimated for the same samples the mean value of root density was 1.16 g/cm (C.V.= 18.93 %).

4 – Root volume:

The actual and calculated volume of table beet root are listed in table (4).

The relationship between actual and calculated volume of roots by using the mean values in table (4) follows:

$$V = 11.514\ Vc + 46.2 \qquad (R^2 = 0.8737)$$

Where:

Vc =Calculated volume of roots, cm^3.

Table (4): Actual and calculated volume of roots, cm^3

No. of samples	* Mean of roots size , cm^3	
	Actual volume	**Calculated volume
1	110	62.18
2	100	55.43
3	97	53.70
4	94	58.34
5	70	41.43
6	48	23.45

* Each indicated value in the above table is average of five replicates .

** Due to the equation of (1).

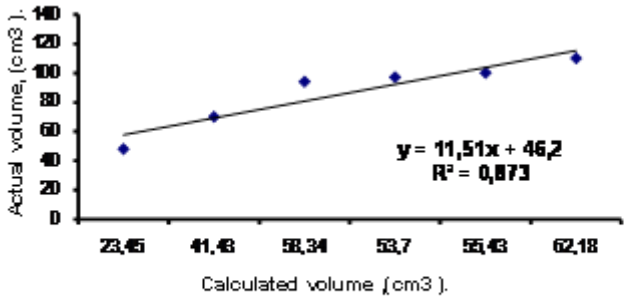

Fig.(1): The relationship between actual and calculated volume of roots.

4 – Pulling force:

The pulling force required to pull up the table beet root by hand . The pulling force was ranged form 35.32 to 109.87 N with a mean value of 62.20 N .The force was greatly affected by the number of the secondary roots.

5 – Roots coefficient of friction:

The values of the coefficient of fricition between roots and both steel sheet of the same material of the lifting shares, rubber, plastic and plywood. It was found that the coefficient of friction between roots and steel sheet ranged from 0.268 to 0.404 with a mean value of 0.3115 (C.V.= 20 %). The coefficient of friction between root and rubber ranged from 0.306 to 0.649 with a mean value of 0.411 (C.V. =29.04 %)

The coefficient of friction between root and plastic ranged from 0.445 to 0.675 with a mean value of 0.589 (C.V. =14.9 %). The coefficient of friction between root and plywood ranged from 0.268 to 0.364 with a mean value of 0.295 (C.V.= 16.10 %).

Tensile force rrequired to strip tops by direct pulling:

Table (5) shows tensile force required to strip tops by direct pulling. The meganitude of resistance to direct pull of the tops depends on their sectional dimensions at the base (at of rupture). The direct pulling force for table beet tops in much greater (35.32-109.87N).

Table (5): Tensile forces required to strip the tops by direct pulling.

No. of levers in top	Moisture content of leaves, %	Diameter of top, cm			Tensile force, N		
		Mean	Max	Min	Mean	Max	Min.
13.86	89	3.26	4.86	2.00	189.4	333.5	117.7

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الملخص العربى

بعض الخصائص الطبيعية والميكانيكية لبنجر المائدة المرتبطة بتصميم آلات التقليع

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معرفة الخصائص الطبيعية والميكاليكية لجذور بنجر المائدة ووضع الجذور فى التربة ذات أهمية كبيرة فى تصميم آلات تقليع جذور بنجر المائدة.

فى هذا البحث تم دراسة الخواص الطبيعية والميكانيكية مثل الطول والقطر والوزن والحجم والكثافة وزاوية الاحتكاك بين الجذور وكل من الصلب والمطاط والبلاستيك والخشب وكذلك تم دراسة وضع الجذور فى التربة من حيث نسبة عدد الجذور فوق سطح التربة وعند سطح التربة وتحت سطح التربة.

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وأوضحت النتائج:

١- يبلغ متوسط طول الجذور ٦,٤٥ سم ومتوسط قطر الجذر ٥,٢٥سم ومتوسط الحجم ٨٦,٥ سم٣ وكتلة الجذر ١١,٢٣جم وكثافته ١,١٦ جم/سم٣

٢- أقصى عمق للجذور فى التربة ٦,٧سم، بينما كانت نسبة الجذور فوق سطح التربة ٦٤٪ ونسبة الجذور عند مستوى سطح التربة ٢٦٪، ونسبة الجذور تخت سطح التربة ١٠٪.

٣- متوسط القوة اللازم لاقتلاع الجذور كانت ٦٢,٢٠ نيوتن. ومتوسط القوة اللازمة لفصل العرش عن طريق الشد المباشر كانت ١٨٩,٤ نيوتن.

٤- إزدياد معدل الاحتكاك بين الجذور وكل من الصلب والمطاط والبلاستيك والخشب بحوالى ٠,٣١١٥- ٠,٤١١- ٠,٥٨٩- ٠,٢٩٥- على التوالى.