

## A STUDY TO DETERMINE FERTILIZATION RATE AND WATER QUANTITY SUITABLE FOR GROWTH AND QUALITY OF TUBEROSE PLANTS CULTIVATED IN SOME SOIL TYPES

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### ABSTRACT

A study was consummated under the full sun at Orman Botanical Garden, Giza, Egypt during 2007 and 2008 seasons to find out the response of tuberose (*Polianthes tuberosa* L.) plants grown in 20-cm-diameter black polyethylene bags filled with 2.5 kg sandy, loamy or calcareous soils to the different quantities of irrigation water (100, 150 and 200 ml/plant), as well as different rates of kristalon (0, 2 and 4 g/plant) and their interactions.

The obtained results indicated that sprouting date (days) was not affected by kristalon treatments, but was greatly reduced with increasing water amount to reach the minimum period in plants grown in either loamy or calcareous soil and irrigated with 150 ml of water/plant, while for those grown in sandy soil, 200 ml/plant was the best. Vegetative and root growth [expressed as leaf No./plant, leaf length (cm), and fresh and dry weights (g) of the leaves and roots], flowering [as No. days from planting to first flower open, spike length (cm), rachis length (cm), No. flowers/spike, No. spikes/plant and vase life (days)], as well as bulbs productivity [No. bulblets/plant and the fresh and dry weights (g) of the replacement clump], were significantly improved in response to all individual treatments or their combinations applied in this study, with a notice that the best results in loamy and calcareous soils were obtained when the plants were irrigated with 150 ml of water/plant and fertilized with 2 g of kristalon/plant, while in the sandy soil, that was true when the plants received the highest rates of both watering and fertilization (200 ml and 4 g/plant, respectively). The superiority in all previous traits was for planting in the loamy soil, followed by planting in calcareous one, and then planting in the sandy soil that gave the least records. A similar trend was also gained with regard to leaves content of chlorophyll a, b and carotenoids (mg/g fresh weight), as well as the percentages of total carbohydrates, N, P and K.

Hence, it could be recommended to fertilize tuberose plants grown in sandy soil with 4 g kristalon/plant plus irrigation with 200 ml of water/plant, while in the loamy and calcareous soils, it is preferable to fertilize with 2 g/plant and irrigate with 150 ml/plant. It is also better to cultivate in loamy soil than cultivation in either sandy or calcareous ones.

### INTRODUCTION

*Polianthes tuberosa* L., tuberose, which belongs to Fam. Agavaceae (Amaryllidaceae) is widely cultivated in the tropics and sub-tropics where it is esteemed for the purity and powerful fragrance of its blooms as a cut-flower and in gardens (Huxley *et al.*, 1992).

Soil, water and nutrition are considered the most important elements in agriculture. So, the detection of water quantity and fertilization rate required for the healthy growth of plants when planted in special type of soil is regarded as one of the most vital points for which the scientific research sector exerts its utmost effort. In this regard, Auda *et al.* (2002) reported that

keeping the soil moisture at 75% of field capacity gave the best tuberose vegetative growth and flowering quality. Munikrishnappa *et al.* (2002) indicated that fertigation of *Polianthes tuberosa* cv. Single plants with 80% recommended water-soluble NPK fertilizer + 0.1 B or 0.5% Zn through sprinkler irrigation up to 75% of field capacity produced the greatest plant height, number of tillers, leaves and spikes/plant, leaf area, days to flowering, flowering duration, spike length, rachis length, floral diameter, number of florets/spike, fresh weight of spikes and flower yield. Sharma *et al.* (2003) revealed that irrigation of tuberose plants grown in sandy soil with sodic water significantly increased E. C. of the soil both with the addition of FYM and gypsum, while soil pH was decreased with the addition of gypsum only. The growth and flower yield were, however, significantly increased with the application of gypsum and FYM. Similarly, were those results recorded by Shahin *et al.* (2006) on sisal, Shahin *et al.* (2007) on *Agave americana* cv. Marginata and El Sayed *et al.* (2008) on *Dodonaea viscosa*.

Under water deficit conditions, plant growth is substantially reduced, while fertilization reduces the reverse effect, as it increases vegetative and root growth, flowers quality and improves the content of vital constituents (North and Nobel, 2000). This true was emphasized by Patel *et al.* (2006) who found that tuberose bulbs planted at 30x20 cm and fertilized with 400 kg N + 200 kg P/ha resulted the highest yield of spikes and bulb productivity. Application of N at 400 kg/ha recorded significantly the highest values of vegetative and floral characters. Number of days to first flowering was advanced at the same level of N. The effect of P was only significant on floral characters, viz. rachis length and number of florets/spike. Bulb yield in terms of clump weight (ton/ha) was also significant and 200 kg P/ha recorded higher values. Likewise, were those findings obtained by Padaganur *et al.* (2005), Sultana *et al.* (2006), Yadav (2007), Alan *et al.* (2007), Singh *et al.* (2007) and Muthoka and Muriithi (2008) on tuberose, Mahmoud (2007) on *Antholyza* and El-Sayed and El-Shal (2008) on *Schefflera*.

This trial, however aims to determine the optimum water quantity and fertilization rate with kristalon suitable for producing the best vegetative growth, flowering characteristics and bulbs productivity of tuberose plants grown in various soil textures.

## **MATERIALS AND METHODS**

The present investigation was conducted at Orman Botanical Garden, Giza, Egypt under the full sun during the two consecutive seasons of 2007 and 2008 to study the effect of water quantity, soil texture, fertilization rate with kristalon and their interactions on growth, flowering, bulbs productivity and chemical composition of tuberose (*Polianthes tuberosa* L.) plant.

Tuberose bulbs cv. Double were planted on March, 1<sup>st</sup> for both seasons in 20-cm-diameter black polyethylene bags filled with 2.5 kg of sandy, loamy or calcareous soils per bag at a depth of 5 cm. The physical and chemical properties of the three used soils in the two seasons are shown in Table (a). The bulbs were used as a clump, as each one consisted of the mother bulb (at a size of 2.7-2.9 cm diameter and about 31.0-33.5 g weight)

surrounded with 3-4 bulblets and dipped in a fungicide solution of orthocide for 15 minutes before planting. All bags were immediately irrigated after planting with 300 ml of fresh water, but after one week, they were subjected to the following amounts of irrigation water: 100, 150 and 200 ml/plant. The amount of irrigation water was not added as a percent of field capacity (F.C.) due to its variability for the different media used in this study, which makes the addition of irrigation water as a percent of F.C. more difficult and more subjected to fall in error. Irrigation was done once every week during March and April, and two times weekly throughout the period from May to October.

After one month from transplanting (on April, 1<sup>st</sup>), the plants received the first batch of kristalon fertilizer (19:19:19 + micronutrients, manufactured by DSM Agrospecialists, Holland) as a soil drench at the rates of 0, 2 and 4 g/plant. Two months later (on June, 1<sup>st</sup>), the second batch was added, while the third one was applied after flowering (on October, 1<sup>st</sup>).

**Table (a): Physical and chemical properties of the used soils**

Soil properties	Soil texture		
	Sandy	Loamy	Calcareous
Coarse sand (%)	89.03	10.18	8.63
Fine sand (%)	2.05	46.17	27.27
Silt (%)	0.40	19.53	34.70
Clay (%)	8.52	24.12	29.40
E. C. (dS/m)	3.71	3.29	2.16
pH	7.86	8.16	8.10
S. P.	21.33	35.00	29.76
O. M. (%)	0.12	0.57	0.38
Ca <sup>++</sup> (meq/l)	6.26	7.82	12.12
Mg <sup>++</sup> (meq/l)	1.74	2.12	4.75
K <sup>+</sup> (meq/l)	0.83	0.75	0.26
Na <sup>+</sup> (meq/l)	7.16	15.40	6.73
HCO <sub>3</sub> <sup>-</sup> (meq/l)	2.37	6.60	4.52
Cl <sup>-</sup> (meq/l)	3.50	8.20	9.38
SO <sub>4</sub> <sup>--</sup> (meq/l)	10.12	11.29	9.96

\* O. M.= Organic matter \* E. C. and soluble ions were determined in the soil paste extract

The split-split plot design was used with three replicates (Mead *et al.*, 1993), as each replicate contained 5 plants. The main plot was water quantity, while the sub- and sub-sub- plots were devoted to soil texture and kristalon rate, respectively.

Data were recorded as follows: sprouting date (number of days from planting to sprouting) was registered at the beginning of the experiment, while during flowering; No. days from planting to first flower open (days), spike length (cm), rachis length (cm), No. flowers/spike, No. spikes/plant and vase life of spike (days) were monitored. At the end of the experiment in each season (on October, 31<sup>st</sup>), the following parameters were measured: leaf No./plant, leaf length (cm), leaves and roots fresh and dry weights (g), No. bulblets/plant and the fresh and dry weights (g) of the replacement bulb. In fresh leaf samples taken from the middle part of the plants in the second

season only, chlorophyll a, b and carotenoids contents (mg/g fresh weight) were determined according to Moran (1982), while in dry samples, the percentages of total carbohydrates (Herbert *et al.*, 1971), N (Pregl, 1945), P (Luatanab and Olsen, 1965) and K (Jackson, 1973) were assessed.

Data were then tabulated and statistically analyzed according to SAS program (1994) using Duncan's Multiple Range Test (1955) to verify the significancy level among means of the different treatments and their interactions.

## RESULTS AND DISCUSSION

**Effect of water quantity, soil texture, kristalon level and their interactions on:**

### 1- Sprouting date

Data in Table (1) show that sprouting date (days) was not affected by fertilization treatments with kristalon (since these treatments have not been added yet), but was greatly affected by both water quantity and soil texture in the two seasons. In general, increasing water amount significantly decreased the sprouting date, especially at the level of 150 ml/plant for plants grown in loamy and calcareous soils in both seasons, while for those grown in sandy one, 200 ml/plant was the best. The least number of days to sprouting was, however, recorded by plants cultivated in loamy soil, followed by those cultivated in calcareous one, and then those cultivated in sandy soil, which took the longest period to sprouting. This may be due to the least holding capacity of water in sandy soil, whereas in loamy and calcareous ones, such capacity is better. In addition, the content of organic matter and nutrients in the loam are usually higher (Table, a).

**Table (1): Effect of soil texture, kristalon level, water quantity and their interactions on sprouting date of *Polianthes tuberosa* L. bulb during 2007 and 2008 seasons**

Soil texture	Kristalon level (g/bag)	First season: 2007				Second season: 2008			
		Water quantity (ml/bag)							
		100	150	200	Mean	100	150	200	Mean
Sandy	0.0	35.68 a	33.17 ab	30.00 b	32.95 a	32.85 a	30.54 b	27.61 b	30.33 a
	2.0	36.74 a	34.00 ab	30.67 b	33.80 a	34.00 a	31.30 ba	28.33 b	31.21 a
	4.0	36.70 a	33.46 ba	31.48 b	33.88 a	33.76 a	30.82 b	29.00 b	31.19 a
	Mean	36.37 a	33.54 b	30.72 c	33.54 a	33.54 a	30.89 b	28.31 c	30.91 a
Loamy	0.0	17.82 gf	13.50 i	15.00 h	15.44 c	16.40 e	12.83 g	13.91 f	14.38 c
	2.0	19.41 f	14.70 h	16.33 g	16.81 c	17.85 e	14.26 f	15.20 fe	15.77 c
	4.0	17.98 gf	14.13 hi	15.76 gh	15.96 c	16.56 e	13.02 g	15.11 fe	14.90 c
	Mean	18.40 f	14.11 h	15.70 g	16.07 c	16.94 f	13.37 h	14.74 g	15.02 c
Calcareous	0.0	29.70 b	22.30 e	25.00 d	25.67 b	28.33 b	21.00 d	23.31 c	24.21 b
	2.0	28.58 c	23.16 ed	26.10 dc	25.95 b	27.70 cb	21.76 d	24.03 c	24.50 b
	4.0	29.00 b	22.00 e	24.81 d	25.27 b	28.00 b	21.10 d	23.86 c	24.32 b
	Mean	29.09 c	22.49 e	25.30 d	25.63 b	28.01 c	21.29 e	23.73 d	24.34 b
<b>Water quantity mean</b>		27.95 a	23.38 b	23.91 b	-----	26.16 a	21.85 b	22.26 b	-----

\* Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5 % level.

## **2- Vegetative and root growth parameters**

Similarly, vegetative and root growth were improved in response to all treatments and interactions employed in this study as shown in Tables (2, 3 and 4). However, the best results in loamy and calcareous soils were obtained when plants were irrigated with 150 ml water/plant and fertilized with 2 g kristalon/plant, while in sandy soil, that was true when the plants were irrigated and fertilized with the highest rates of both water and kristalon (200 ml and 4 g per plant, respectively). The superiority in all vegetative and root growth parameters was for planting in loamy soil + irrigation with 150 ml water/plant + fertilization with kristalon at 2 g/plant, as this combination gave the highest number of leaves/plant, the longest leaf (Table, 2) and the heaviest fresh and dry weights of leaves and roots comparing with all other treatments and combinations in the two seasons (Tables, 3 and 4).

The aforementioned results, however, may indicate the role of suitable amount of water in preventing the synthesis of abscisic acid (ABA), which negatively affects root growth, induces defoliation and may inhibit plant growth (Hoffman *et al.*, 1999). Likewise, Dosmann *et al.* (1999) concluded that *Katsura* ornamental tree as a drought avoider that abscises its leaves to reduce transpirational water loss, is capable of quick refoliation after water becomes available due to having higher levels of acidic auxins, acidic and basic gibberellins and low levels of ABA, which might activate meristems and encourage cell division, elongation and enlargement that increase metabolites in the plant which is reflected on more growth and heavier plants. Stimulation of plant growth due to kristalon application would be reasonable since different nutrients usually activate vital processes, produce essential compounds as carbohydrates, proteins, hormones, enzymes and energy-reserve material (North and Nobel, 2000). Besides, the presence of loam granules may improve structure and texture of the medium, increase cation exchange capacity and water holding capacity, which lead finally to increase water and nutrients uptake by plants and consequently activate vital processes necessary for more growth and good quality (Yadav, 2007). These results are in accordance with those of Auda *et al.* (2002), Sharma *et al.* (2003), Padaganur *et al.* (2005) and Alan *et al.* (2007) on tuberose, Shahin *et al.* (2006) on sisal and El-Sayed *et al.* (2008) on *Dodonaea viscosa*.

## **3- Flowering parameters**

From data shown in Table (5), it is clear that number of days from planting to first flower open was progressively decreased with increasing of either water quantity or fertilization rate under the different used soil textures in the two seasons. However, the earliest flowering was noticed in plants grown in loamy soil compared to the other two ones, especially for plants irrigated with 150 ml of water/plant and dressed with kristalon at 2 g/plant level, as this combined treatment registered 76.43 days to flowering in the first season and 73.07 days in the second one. This may exhibit the role of both water and fertilizer when applied in optimum rate in accelerating vegetative growth and consequently precocity of flowering.









**Table (5): Effect of soil texture, kristalon level, water quantity and their interactions on number of days from planting to first flower open (days) of *Polianthes tuberosa* L. plant during 2007 and 2008 seasons**

Soil texture	Kristalon level (g/bag)	First season: 2007				Second season: 2008			
		Water quantity (ml/bag)							
		100	150	200	Mean	100	150	200	Mean
Sandy	0.0	124.00 a	122.50 a	122.00 a	122.83 a	118.76 a	115.90 a	114.76 a	116.47 a
	2.0	112.00 b	106.07 c	96.80 ed	104.96 c	106.40 b	101.16 c	93.69 e	100.42 b
	4.0	108.33 c	98.58 ed	85.33 f	97.41 d	102.91 c	93.10 e	81.85 h	92.59 c
	Mean	114.78 a	109.05 b	101.38 cd	108.40 a	109.36 a	103.39 b	96.73 c	103.16 a
Loamy	0.0	116.10 b	108.26 c	102.56 d	108.97 b	110.21 b	102.85 c	98.74 d	103.93 b
	2.0	97.50 ed	76.43 h	90.76 e	88.23 f	92.83 e	73.07 i	85.50 g	83.80 e
	4.0	98.00 ed	83.00 g	80.33 g	87.11 f	92.10 e	78.90 ih	81.33 h	84.11 e
	Mean	103.87 c	89.23 e	91.22 e	94.77 c	98.38 c	84.94 f	88.52 e	90.61 c
Calcareous	0.0	124.00 a	121.63 a	113.17 b	119.60 ab	117.21 a	114.00 a	107.54 b	112.92 ba
	2.0	99.00 ed	93.46 e	96.33 ed	96.26 d	95.05 ed	89.36 f	90.20 f	91.54 c
	4.0	99.33 ed	92.00 e	87.56 f	92.96 e	94.33 ed	87.40 fg	83.50 g	88.41 d
	Mean	107.44 b	102.36 c	99.02 d	102.94 b	102.20 b	96.92 c	93.75 d	97.62 b
Water quantity mean		108.70 a	100.21 b	97.21 c	-----	103.31 a	95.08 b	93.00 c	-----

\* Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5 % level.

A similar trend was also gained regarding spike length (cm), rachis length (cm), No. flowers/spike, No. spikes/plant and vase life of spikes in tap water (days) as shown in Tables (6, 7 and 8), where these characters were significantly improved by all treatments and combinations accomplished in such trial, with the prevalence of the combination between 150 ml/plant water level and 2 g/plant kristalon rate in the loamy soil, which gave the utmost high averages comparing with other treatments and their interactions in the two seasons.

These results could be interpreted and discussed as done before in case of vegetative and root growth parameters. Similar observations, however were also attained by Munikrishnappa *et al.* (2002), Sultana *et al.* (2006) and Singh *et al.* (2007) on tuberose.

#### 4- Bulbs productivity

Data in Tables (9 and 10) reveal that No. bulblets/plant and the fresh and dry weights (g) of the replacement bulb under the various soil textures used in the study were cumulatively increased with elevating of either water amount or fertilization rate. However, higher means in all previous measurements were gained from the combined treatments, especially at the highest levels of irrigation and fertilization in sandy and calcareous soils, while in the loam, that was true at the medium rates of both irrigation and fertilization. The highest records, on the other hand were obtained from planting in loamy soil plus irrigation and fertilization at the rates of 150 ml and 2 g per plant, respectively, as this combination scored the highest values over all other individual treatments and combinations in both seasons.







**Table (9): Effect of soil texture, kristalon level, water quantity and their interactions on number of bulblets of *Polianthes tuberosa* L. plant during 2007 and 2008 seasons**

Soil texture	Kristalon level (g/bag)	First season: 2007				Second season: 2008			
		Water quantity (ml/bag)							
		100	150	200	Mean	100	150	200	Mean
Sandy	0.0	5.33 g	6.50 fg	7.28 f	6.37 e	5.81 h	7.09 g	8.00 f	6.97 d
	2.0	8.00 e	8.91 ed	10.33dc	9.08 cd	7.33 g	8.76 fe	10.00 d	8.70 c
	4.0	9.90 d	11.00cd	11.33cd	10.74 b	8.56 fe	10.36 d	9.59 e	9.50 b
	Mean	7.74 e	8.80 d	9.65 ed	8.73 c	7.23 d	8.74 c	9.20 b	8.39 b
Loamy	0.0	7.44 f	9.33 de	11.35cd	9.37 c	7.00 g	9.00 e	10.47 d	8.82 c
	2.0	10.21dc	16.00 a	14.00 b	13.40 a	8.78 fe	14.79 a	13.50ba	12.36 a
	4.0	12.61cb	14.00 b	13.33bc	13.31 a	10.33 d	11.28 c	12.70 b	11.44ab
	Mean	10.09 c	13.11 a	12.89 a	12.03 a	8.70 c	11.69 a	12.22 a	10.87 a
Calcareous	0.0	7.00 f	8.17 e	11.00cd	8.72 d	7.00 g	8.33 f	10.00 d	8.44 c
	2.0	9.00 ed	14.00 b	14.50 b	12.50ab	8.76 fe	12.89 b	13.33ba	11.66ab
	4.0	12.00 c	13.10bc	12.67cb	12.59ab	10.00 d	12.10 b	11.86 c	11.32ba
	Mean	9.33 dc	11.76 b	12.72ab	11.27 b	8.59 c	11.11ab	11.73 a	10.47 a
<b>Water quantity mean</b>		9.05 b	11.22 a	11.75 a	-----	8.17 b	10.51 a	11.05 a	-----

\* Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5 % level.

These results may indicate the role of kristalon on supplying the growing buds with the required nutrients necessary for accelerating growth, and hence forming more bulblets. Moreover, kristalon as a complete fertilizer may promote the synthesis of more reserve foods stored in the new-formed bulbs and bulblets and make them relatively greater. On the same line, were those findings postulated by Auda *et al.* (2002) and Patel *et al.* (2006) on tuberose, Shahin *et al.* (2006) on sisal and Mahmoud (2007) on Antholyza.

### 5- Chemical composition

It is evident from data in Table (11) that leaf contents of chlorophyll a, b and carotenoids (mg/g fresh weight) were augmentatively increased with few exceptions, as water supply or kristalon rate were increased. All combinations induced also a marked improvement in pigments content in the leaves of treated plants. In sandy soil, the best content was noticed when the plants received the highest levels of both water and fertilization. In the loam, that was true when the plants treated with the medium levels of water and kristalon, whereas in the calcareous soil, the best records achieved in plants irrigated with the medium water level (150 ml/plant) and fertilized with the highest rate of kristalon (4 g/plant).

Similarly, the percentages of total carbohydrates, N, P and K in the leaves (Table,12) were augmented as a result of the various individual treatments or combinations applied in this work. However, the best results were recorded by plants grown in loamy soil, followed by these cultivated in calcareous one, and then those cultured in the sand.









Under sandy soil conditions, the highest values were registered by the highest levels of watering and fertilization, while under loamy soil conditions, the medium rates of irrigation and dressing scored the best means. In calcareous soil, the best means were found due to the medium and high levels of watering and fertilization, as they gave averages closely near together.

These results may be explained by the combined effect of both water and the complete fertilizer, irrespective of soil type, on supplying tuberose plants with their required water and nutrients necessary for accelerating biosynthesis processes which increase the content of vital constituents in plant tissues (North and Nobel, 2000). Similar observations were also obtained by Auda *et al.* (2002) on tuberose, Shahin *et al.* (2006) on sisal and El-Sayed and El-Shal (2008) on Schefflera.

According to the aforesaid results, it could be recommended to fertilize tuberose plants grown in sandy soil with 4 g of kristalon/plant and irrigation with 200 ml of water/plant, while in loamy and calcareous soils, it is preferable to fertilize with 2 g/plant and irrigate with 150 ml/plant.

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## دراسة لتحديد معدل التسميد وكمية المياه الملائمة لنمو وجودة نباتات التيبروز المنزرعة في بعض أنواع الأراضي

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أجريت هذه الدراسة تحت ظروف الشمس الساطعة بحديقة الأورمان النباتية- الجيزة - مصر خلال الموسمين ٢٠٠٧، ٢٠٠٨ وذلك للتعرف على إستجابة نباتات التيبروز (*Polianthes tuberosa* L.) المنزرعة في أكياس بلاستيك سوداء قطرها ٢٠ سم مليئت بحوالي ٢,٥ كجم تربة رملية، طميية أو جيرية للكميات المختلفة من مياه الري (١٠٠، ١٥٠، ٢٠٠ مل/نبات)، والمعدلات المختلفة من التسميد بالكريستالون (صفر، ٢، ٤ جم/نبات) والتفاعلات بينهم. ولقد أوضحت النتائج المتحصل عليها أن تاريخ الإنبات (يوم) لم يتأثر بمعاملات التسميد، لكنه إنخفض بوضوح بزيادة كمية مياه الري ليصل إلى أقل فترة في النباتات المنزرعة بالتربة الطميية والجيرية والتي رويت بمعدل ١٥٠ مل/نبات، بينما حدث ذلك للنباتات المنزرعة بالتربة الرملية عند ربيها بمعدل ٢٠٠ مل/نبات. ولقد تحسنت معنويا جميع قياسات النمو الخضري والجذري [عدد الأوراق/نبات، طول الورقة (سم) والوزن الطازج والجاف (جم) للأوراق والجذور]، وصفات التزهير [عدد الأيام من الزراعة وحتى تفتح أول زهرة (يوم)، طول الساق الزهري (سم)، طول الجزء الحامل للأزهار (سم)، عدد الأزهار/نورة، عدد النورات/نبات وعمر النورات في الزهرية (يوم)]، وكذلك إنتاجية الأبيصال [عدد البصيلات الناتجة/نبات، والوزن الطازج والجاف للأبيصال الجديدة المتكونة (جم)]، نتيجة للمعاملات الفردية أو التفاعلات بينها والتي طبقت بهذه الدراسة، مع ملاحظة أن أفضل النتائج في التربة الطميية والجيرية تم الحصول عليها عند التسميد بمعدل ٢ جم/نبات والري بمعدل ١٥٠ مل/نبات - بينما في التربة الرملية، كان ذلك صحيحا عندما عوملت النباتات بالمستويات المرتفعة من ماء الري والتسميد (٢٠٠ مل، ٤ جم/نبات على الترتيب). ولقد كان التفوق في جميع القياسات السابقة للزراعة في التربة الطميية، تلتها الزراعة في التربة الجيرية، ثم بعد ذلك الزراعة في التربة الرملية والتي أعطت أقل متوسطات على الإطلاق. هذا، ولقد تم الحصول على نفس الإتجاه فيما يتعلق بمحتوى الأوراق من كلوروفيللى ا، ب والكاروتينويدات، وكذلك محتواها من الكربوهيدرات الكلية، النيتروجين، الفوسفور والبوتاسيوم كنسبة مئوية. وعليه، يمكن التوصية بتسميد نباتات التيبروز المنزرعة في التربة الرملية بمعدل ٤ جم كريستالون/نبات مع الري بمعدل ٢٠٠ مل/نبات، بينما في التربة الطميية والجيرية فيفضل التسميد بمعدل ٢ جم/نبات والري بمعدل ١٥٠ مل/نبات. وبذلك تفضل الزراعة في التربة الطميية عن الزراعة في التربة الجيرية أو الرملية.





Table (2): Effect of soil texture, kristalon level, water quantity and their interactions on leaf number and length of *Polianthes tuberosa* L. plant during 2007 and 2008 seasons

Soil texture	Kristalon level (g/bag)	Leaf No./plant								Leaf length (cm)							
		First season: 2007				Second season: 2008				First season: 2007				Second season: 2008			
		Water quantity (ml/bag)															
		100	150	200	Mean	100	150	200	Mean	100	150	200	Mean	100	150	200	Mean
Sandy	0.0	21.83 l	25.79 k	28.12 j	25.25 e	23.10 l	26.50 j	29.70 ji	26.43 e	24.31 l	31.00 ih	33.91 ih	29.74 e	25.60 k	32.90 i	35.00 h	31.17 f
	2.0	23.90 lk	30.47 hi	36.00 f	30.12 d	25.33 k	32.00 hi	38.66 f	31.80 d	27.46 jk	36.85gh	40.10 f	34.80 d	28.76 kj	39.00 gf	40.33 f	36.03 e
	4.0	24.00 k	30.78 hi	37.18 fe	30.65 d	25.50 k	32.54 h	39.22 e	32.42 d	28.60 j	35.96 h	41.50 e	35.35 d	30.21 j	37.67 g	43.50ed	37.13 d
	Mean	23.24 f	29.01 e	33.77 d	28.67 c	24.64 f	30.35 e	35.66 d	30.22 c	26.79 f	34.60 e	38.50 c	33.30 c	28.19 e	36.52 d	39.61 c	34.78 c
Loamy	0.0	31.06 h	36.71 f	37.13 fe	34.97 c	33.00 h	38.90 fe	39.30 e	37.07 c	32.15 i	42.00 e	41.30 fe	38.48 c	33.26 i	43.70ed	43.78ed	40.25cd
	2.0	35.86 g	48.00 a	44.16 c	42.67 a	37.95 f	50.00 a	45.60 c	44.52 a	37.98 gf	53.00 a	48.76 b	46.58 a	39.30 gf	55.10 a	51.56 b	48.65 a
	4.0	36.90 f	46.20 b	47.69 a	43.60 a	40.00ed	47.70 b	48.76ab	45.49 a	38.50 gf	45.74 c	49.80ba	44.68ab	40.81 f	47.80 c	51.96 b	46.86ab
	Mean	34.61 c	43.64 a	42.99 a	40.41 a	36.98 c	45.53 a	44.55 a	42.36 a	36.21 d	46.91 a	46.62 a	43.25 a	37.79dc	48.87 a	49.10 a	45.25 a
Calcareous	0.0	30.29 i	36.72 f	37.00 fe	34.67 c	31.50 i	38.00 f	40.00ed	36.50 c	31.10 i	39.02 fg	40.33 f	36.82cd	32.00 ij	40.33 f	42.40 e	38.24 d
	2.0	35.67 g	41.33 d	39.02 de	38.67 b	36.10 g	42.40 d	40.76de	39.75 b	37.48 g	46.10 c	42.10 e	41.89 b	38.10 g	48.76 c	44.25 d	43.70 b
	4.0	36.10 f	38.26 e	38.50 ed	37.62 b	38.20 f	39.46 e	40.00ed	39.22 b	38.00 gf	43.50 d	40.76 f	40.75bc	38.00 g	45.00 d	41.88 fe	41.63 c
	Mean	34.02 c	38.77 b	38.17 b	36.99 b	35.27 d	39.95 b	40.25 b	38.49 b	35.53 d	42.87 b	41.06 b	39.82 b	36.03 d	44.70 b	42.84 b	41.19 b
Water quantity mean		30.62 b	37.14 a	38.31 a	-----	32.30 b	38.61 a	40.15 a	-----	32.84 b	41.46 a	42.06 a	-----	34.00 b	43.36 a	43.85 a	-----

\* Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5 % level.

Table (3): Effect of soil texture, kristalon level, water quantity and their interactions on fresh and dry weights of *Polianthes tuberosa* L. leaves during 2007 and 2008 seasons

Soil texture	Kristalon level (g/bag)	Leaves fresh weight (g)								Leaves dry weight (g)							
		First season: 2007				Second season: 2008				First season: 2007				Second season: 2008			
		Water quantity (ml/bag)															
		100	150	200	Mean	100	150	200	Mean	100	150	200	Mean	100	150	200	Mean
Sandy	0.0	36.50 g	40.00 g	47.28 f	41.26 g	39.60 h	42.80 h	50.61 g	44.34 f	6.52 f	7.25 fe	8.54 ed	7.44 f	6.96 g	7.88 fg	9.10 ef	7.95 e
	2.0	42.76 gf	50.82 f	66.18ed	53.25 f	45.76 g	54.36 f	70.33 e	56.80 e	7.00 f	8.16 e	10.50 d	8.55 e	7.50 fg	8.78 f	11.24ed	9.17 d
	4.0	48.50 f	55.30 fe	60.27 e	54.69 f	51.36 fg	58.90 f	64.50fe	58.25 e	7.76 fe	8.50 ed	8.90 de	8.39 e	8.25 f	9.00 ef	9.30 ef	8.85 de
	Mean	42.59 h	48.71 g	57.91 f	49.73 c	45.55 h	52.02 g	61.81 f	53.13 c	7.09 f	7.97 f	9.31 e	8.13 c	7.57 h	8.53 g	9.88 f	8.66 c
Loamy	0.0	61.58 e	79.10dc	86.20 c	75.63 d	64.13 fe	80.50 d	92.10 c	78.91cd	10.24 d	13.20dc	14.00 c	12.48 d	10.91 e	13.96 d	15.00 c	13.29 c
	2.0	92.15cb	120.33a	99.57 b	104.02a	96.41cb	129.00a	105.91b	110.44a	15.31cb	21.30 a	16.53 b	17.71 a	15.76 c	21.80 a	17.10 b	18.22 a
	4.0	85.00 c	103.56b	92.10cb	93.55 b	91.00 c	110.21b	98.50cb	99.90 b	13.88 c	16.81 b	15.10cb	15.26 b	14.33 c	17.21 b	16.03cb	15.86 b
	Mean	79.58 d	101.00a	92.62 b	91.07 a	83.85 d	106.57a	98.84 b	96.42 a	13.14dc	17.10 a	15.21 b	15.15 a	13.67 d	17.66 a	16.04 b	15.79 a
Calcareous	0.0	58.70 e	71.36 d	75.41dc	68.49 e	62.81 fe	76.40ed	80.67 d	73.29 d	10.43 d	12.67dc	13.41dc	12.17 d	10.58 e	13.50 d	14.36 c	12.81cd
	2.0	63.72ed	96.78 b	81.97cd	80.82 c	68.16 e	102.72b	90.00 c	86.96 c	11.30 d	17.22 b	14.50 c	14.34 c	12.10de	18.20 b	15.00 c	15.10 b
	4.0	71.31 d	87.03 c	80.33cd	79.56 c	76.10ed	93.07 c	85.95 d	85.04 c	12.70dc	15.46cb	14.30 c	14.15 c	13.50 d	16.00cb	15.33 c	14.94bc
	Mean	64.58 e	85.06 c	79.24 d	76.29 b	69.02 e	90.73 c	85.54 d	81.76 b	11.48 d	15.12 b	14.07 c	13.55 b	12.06 e	15.90 b	14.90 c	14.28 b
Water quantity mean		62.25 b	78.26 a	76.59 a	-----	66.14 b	83.11 a	82.06 a	-----	10.57 b	13.40 a	12.86 a	-----	11.10 b	14.03 a	13.61 a	-----

\* Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5 % level.

**Table (4): Effect of soil texture, kristalon level, water quantity and their interactions on fresh and dry weights of *Polianthes tuberosa* L. roots during 2007 and 2008 seasons**

Soil texture	Kristalon level (g/bag)	Roots fresh weight (g)								Roots dry weight (g)							
		First season: 2007				Second season: 2008				First season: 2007				Second season: 2008			
		Water quantity (ml/bag)															
		100	150	200	Mean	100	150	200	Mean	100	150	200	Mean	100	150	200	Mean
Sandy	0.0	8.54 i	9.18 ih	9.96 h	9.23 d	9.21 h	9.96 h	10.81 g	9.99 d	2.67 f	2.88 f	3.29 ef	2.95 d	2.81 f	3.03 fe	3.27 e	3.04 d
	2.0	9.33 h	10.08 h	10.53hg	9.98 d	9.87 h	10.91 g	11.40 gf	10.73 d	3.03 fe	3.75 e	3.94 e	3.57 cd	3.18 ef	4.00 ed	4.18 d	3.79 cd
	4.0	9.58 h	10.89hg	11.37 g	10.61 c	10.37hg	11.15 g	11.56 gf	11.01 c	3.00 fe	3.41 ef	4.36 ed	3.59 cd	3.25 e	3.52 e	4.65 d	3.81 cd
	Mean	9.15 f	10.05 e	10.62 e	9.94 b	9.82 d	10.66 c	11.26 c	10.58 b	2.90 d	3.35 c	3.86 c	3.37 b	3.08 d	3.52 c	4.03 c	3.55 b
Loamy	0.0	11.72 g	12.68 fe	13.71 e	12.70 b	12.64 f	13.61 e	14.80 d	13.68 b	4.96 de	5.37 d	5.80 dc	5.38 b	5.00 d	5.76 c	6.18 b	5.65 b
	2.0	12.50 f	22.38 a	16.12dc	17.00 a	13.46 e	19.76 a	17.39 c	16.87 a	5.36 d	8.55 a	6.20 c	6.70 a	5.79 c	7.28 a	6.70 b	6.59 a
	4.0	14.58 d	19.35 b	17.83 c	17.25 a	14.50 d	18.76 a	18.00 b	17.09 a	5.78 dc	7.66 b	7.00 bc	6.81 a	5.37 cd	7.10 a	7.06 a	6.51 a
	Mean	12.93 d	18.14 a	15.89 c	15.65 a	13.53 b	17.38 a	16.73 a	15.88 a	5.37 b	7.19 a	6.33 ba	6.30 a	5.39 b	6.71 a	6.65 a	6.25 a
Calcareous	0.0	11.55 g	11.78 g	12.80 fe	12.04 b	12.42 f	12.75 f	13.81ed	12.99 b	3.70 e	3.89 e	4.12 ed	3.90 c	3.98 ed	4.11 de	4.39 d	4.16 c
	2.0	12.46 f	20.75ab	16.90cd	16.70 a	13.43 e	18.47ab	17.82 c	16.57 a	5.42 d	8.31 a	7.33 b	7.02 a	5.51 cd	7.30 a	7.08 a	6.63 a
	4.0	13.87 e	18.40 b	17.24 c	16.50 a	14.00 d	17.90 b	17.36 c	16.42 a	5.67 dc	7.51 b	7.03 bc	6.74 a	5.70 c	7.21 a	6.87 b	6.59 a
	Mean	12.63 d	16.98 b	15.65 c	15.08 a	13.28 b	16.37 a	16.33 a	15.33 a	4.93 b	6.57 ab	6.16 ba	5.89 a	5.06 b	6.21 ab	6.11 ab	5.79 a
Water quantity mean		11.57 b	15.06 a	14.05 a	-----	12.21 b	14.80 a	14.77 a	-----	4.40 b	5.70 a	5.45 a	-----	4.51 b	5.48 a	5.60 a	-----

\* Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5 % level.



Table (6): Effect of soil texture, kristalon level, water quantity and their interactions on spike and rachis lengths of *Polianthes tuberosa* L. plant during 2007 and 2008 seasons

Soil texture	Kristalon level (g/bag)	Spike length (cm)								Rachis length (cm)							
		First season: 2007				Second season: 2008				First season: 2007				Second season: 2008			
		Water quantity (ml/bag)															
		100	150	200	Mean	100	150	200	Mean	100	150	200	Mean	100	150	200	Mean
Sandy	0.0	31.00 h	33.00gh	35.50 g	33.17 g	33.41 h	35.42hg	37.80 g	35.54 g	8.00 e	8.33 ed	8.76 d	8.36 c	8.00 d	8.00 d	8.67 dc	8.22 d
	2.0	31.80 h	34.10gh	37.33 gf	34.41 g	34.36 h	37.10 g	38.03 g	36.50 gf	8.64 d	8.90 d	9.33 c	8.96 c	8.50 dc	8.83 dc	9.36 c	8.90 d
	4.0	33.48gh	35.78 g	39.00 f	36.09 f	35.50hg	36.18hg	41.33 f	37.67 f	8.78 d	9.26 c	10.00cb	9.35 b	8.90 cd	9.33 c	10.21 b	9.48 c
	Mean	32.09 g	34.29 f	37.28 e	34.56 c	34.42 h	36.23 g	39.05 f	36.57 c	8.47 c	8.83 c	9.36 b	8.89 b	8.47 d	8.72 d	9.41 c	8.87 b
Loamy	0.0	38.14 f	40.81 fe	43.67 e	40.87 d	40.16 f	41.80 f	46.50 e	42.82 d	8.79 d	9.40 c	10.14 b	9.44 b	9.40 c	10.11 b	11.00ba	10.17 b
	2.0	47.72 d	70.00 a	50.00 c	55.91 a	48.70 d	64.50 a	54.00 c	55.73 a	9.31 c	14.00 a	13.10 a	12.14 a	10.03 b	12.78 a	12.46 a	11.76 a
	4.0	45.81 d	54.31 b	49.50cd	49.87 b	48.33 d	58.31 b	53.00 c	53.21 b	10.87 b	12.33 a	12.65 a	11.95 a	11.10ab	11.35 a	11.70 a	11.38 a
	Mean	43.89 c	55.04 a	47.72 b	48.88 a	45.73 d	54.87 a	51.17 b	50.59 a	9.66 b	11.91 a	11.96 a	11.18 a	10.18 b	11.41 a	11.72 a	11.10 a
Calcareous	0.0	36.12 g	38.70 f	41.60 ef	38.81 e	37.10 g	41.07 f	43.76 ef	40.64 e	8.51 d	9.20 c	10.00cb	9.24 b	9.00 cd	9.73 cb	9.96 bc	9.56 c
	2.0	39.00 f	51.28 c	47.35 d	45.88dc	43.00 ef	55.60 b	49.81 d	49.47 c	9.36 c	12.83 a	12.50 a	11.56 a	9.47 c	13.00 a	12.14 a	11.54 a
	4.0	44.51 e	50.33 c	46.76 d	47.20 c	46.10 e	51.00 c	49.00 d	48.70 c	10.67 b	11.28ba	12.00 a	11.32ab	10.81 b	11.50 a	11.78 a	11.36 a
	Mean	39.88 d	46.77 b	45.24 b	43.96 b	42.07 e	49.22 c	47.52dc	46.27 b	9.51 b	11.10ab	11.50 a	10.71 a	9.76 cb	11.41 a	11.29 a	10.82 a
Water quantity mean		38.62 c	45.37 a	43.41 b	-----	40.74 b	46,77 a	45.91 a	-----	9.21 b	10.61 a	10.94 a	-----	9.47 b	10.51 a	10.81a	-----

\* Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5 % level.

Table (7): Effect of soil texture, kristalon level, water quantity and their interactions on number of flowers per spike and number of spikes per *Polianthes tuberosa* L. plant during 2007 and 2008 seasons

Soil texture	Kristalon level (g/bag)	No. flowers/spike								No. spikes/plant							
		First season: 2007				Second season: 2008				First season: 2007				Second season: 2008			
		Water quantity (ml/bag)															
		100	150	200	Mean	100	150	200	Mean	100	150	200	Mean	100	150	200	Mean
Sandy	0.0	8.00 f	8.00 f	8.00 f	8.00 d	8.00 e	8.00 e	8.00 e	8.00 e	1.00 e	1.00 e	1.76 d	1.25 d	1.00 e	1.00 e	1.56 ed	1.19 e
	2.0	8.00 f	9.00 e	10.00 d	9.00 c	8.00 e	9.00 d	10.76 c	9.25 d	1.33 ed	2.00 c	2.46 cb	1.93 c	1.33 ed	2.00 d	2.26 dc	1.86 d
	4.0	8.00 f	9.00 e	12.00 c	9.67 c	8.00 e	10.98cb	12.00 b	10.33 c	1.76 d	2.00 c	3.00 b	2.25 bc	2.00 d	2.00 d	3.00 b	2.33 c
	Mean	8.00 d	8.67 dc	10.00 c	8.89 c	8.00 e	9.33 dc	10.25 c	9.19 c	1.36 c	1.67 cb	2.41 ba	1.81 c	1.44 d	1.67 c	2.27 cb	1.79 c
Loamy	0.0	8.00 f	9.00 e	10.00 d	9.00 c	8.00 e	9.76 cd	10.33 c	9.36 d	1.68 d	2.00 c	2.00 c	1.89 c	1.76 de	2.00 d	2.33 c	2.03 cd
	2.0	10.00 d	16.00 a	14.00 b	13.33 a	9.76 cd	14.00 a	14.00 a	12.59 a	2.33 cb	4.10 a	3.00 b	3.14 a	2.33 c	4.47 a	3.30 b	3.37 a
	4.0	12.00 c	14.00 b	14.00 b	13.33 a	12.00 b	13.00ba	13.00ba	12.67 a	3.00 b	3.00 b	2.67 bc	2.89 ab	3.00 b	3.33 b	3.67 ba	3.33 a
	Mean	10.00 c	13.00 a	12.67 a	11.89 a	9.92 c	12.25 a	12.44 a	11.54 a	2.34 ba	3.03 a	2.56 ab	2.64 a	2.36 bc	3.27 a	3.10 a	2.91 a
Calcareous	0.0	8.00 f	9.00 e	10.00 d	9.00 c	8.00 e	9.00 d	10.00 c	9.00 d	1.33 ed	1.67 d	1.67 d	1.56 cd	1.33 ed	1.33 ed	1.93 d	1.53 de
	2.0	9.00 e	13.00cb	12.00 c	11.33 b	9.00 d	12.00 b	11.78cb	10.93bc	1.76 d	3.00 b	3.00 b	2.59 b	1.76 de	3.38 b	3.26 b	2.80 b
	4.0	10.00 d	12.00 c	12.00 c	11.33 b	10.33 c	12.00 b	11.33cb	11.22 b	2.67 bc	3.00 b	3.00 b	2.89 ab	2.33 c	2.76 c	3.00 b	2.70 b
	Mean	9.00 cd	11.33 b	11.33 b	10.55 b	9.11 d	11.00 b	11.04 b	10.38 b	1.92 b	2.56 ab	2.56 ab	2.35 b	1.81 c	2.49 b	2.73 b	2.34 b
Water quantity mean		9.00 b	11.00 a	11.33 a	-----	9.01 b	10.86 a	11.24 a	-----	1.87 b	2.42 a	2.51 a	-----	1.87 b	2.48 a	2.70 a	-----

\* Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5 % level.

Table (8): Effect of soil texture, kristalon level, water quantity and their interactions on vase life (days) of *Polianthes tuberosa* L. spike during 2007 and 2008 seasons

Soil texture	Kristalon Level (g/bag)	First season: 2007				Second season: 2008			
		Water quantity (ml/bag)							
		100	150	200	Mean	100	150	200	Mean
Sandy	0.0	5.20 f	5.20 f	6.50 e	5.63 c	5.20 f	5.20 f	5.63 fe	5.34 e
	2.0	5.20 f	6.07 ef	6.93 ed	6.07 c	5.85 ef	6.50 e	6.93 ed	6.43 d
	4.0	6.93 ed	7.51 de	8.67 cd	7.70 b	7.80 d	7.80 d	9.10 c	8.23 c
	Mean	5.78 c	6.26 c	7.37 bc	6.47 b	6.28 d	6.50 d	7.22 ed	6.67 b
Loamy	0.0	6.50 e	6.50 e	7.80 d	6.93 b	7.15 de	7.38 de	8.50 cd	7.68 cd
	2.0	7.37 de	11.70 a	10.83 ba	9.97 a	8.16 dc	11.70 a	11.70 a	10.52 a
	4.0	9.53 cb	10.40 b	10.40 b	10.11 a	9.10 c	10.40 b	10.40 b	9.97 ba
	Mean	7.80 b	9.53 a	9.68 a	9.00 a	8.14 cb	9.83 a	10.20 a	9.39 a
Calcareous	0.0	6.50 e	6.50 e	7.80 d	6.93 b	6.93 ed	7.37 de	7.80 d	7.37 dc
	2.0	7.80 d	10.83 ba	10.40 b	9.68 a	7.37 de	10.40 b	10.40 b	9.39 b
	4.0	9.10 c	9.97 bc	10.40 b	9.82 a	8.79 cd	9.10 c	10.40 b	9.43 b
	Mean	7.80 b	9.10 a	9.53 a	8.81 a	7.70 c	8.96 b	9.53 a	8.73 a
Water quantity mean		7.13 b	8.30 a	8.86 a	-----	7.37 b	8.43 a	8.98 a	-----

\* Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5 % level.

**Table (10): Effect of soil texture, kristalon level, water quantity and their interactions on the replacement clump fresh and dry weights of *Polianthes tuberosa* L. plant during 2007 and 2008 seasons**

Soil texture	Kristalon level (g/bag)	The replacement clump fresh weight (g)								The replacement clump dry weight (g)							
		First season: 2007				Second season: 2008				First season: 2007				Second season: 2008			
		Water quantity (ml/bag)															
		100	150	200	Mean	100	150	200	Mean	100	150	200	Mean	100	150	200	Mean
Sandy	0.0	26.77 i	28.16 hi	30.45 h	28.46 e	25.17 k	26.50 k	28.62 j	26.76 d	8.43 h	8.90 h	9.60 gh	8.98 f	7.93 h	8.33 h	9.03 g	8.43 e
	2.0	33.10 g	41.15 ef	44.18 e	39.48 d	31.10 i	38.78 fg	41.53 ef	37.11 c	10.41 g	12.98 fe	13.95ed	12.45 e	9.50 g	12.20 e	13.12 d	11.61 d
	4.0	36.00 g	39.10 f	42.50 ef	39.20 d	33.80 h	39.76 f	40.00 f	37.85 c	11.33 f	12.24 fe	13.07 e	12.21 ef	10.70 f	11.76 ef	12.08 e	11.51 d
	Mean	31.96 f	36.14 e	39.04 d	35.71 c	30.02 e	34.99ed	36.72 d	33.91 c	10.06 f	11.37 fe	12.21 e	11.21 c	9.38 f	10.76 fe	11.41 e	10.52 c
Loamy	0.0	37.10 gf	40.83 fe	45.06 e	41.00 c	34.88 h	38.36 fg	43.10 e	38.78 c	13.28 e	14.60 d	16.12 c	14.67 d	12.20 e	13.72 d	15.10dc	13.67 c
	2.0	44.38 e	61.33 a	52.71 c	52.81 a	38.99 fg	62.18 a	57.67 b	52.95 a	16.90 c	23.35 a	20.06 b	20.07 a	15.89cd	21.90 a	20.31 a	19.37 a
	4.0	48.25 d	57.38 b	56.91 b	54.18 a	45.36 d	53.96 c	53.50 c	50.94 a	17.43 c	21.82ab	20.00 b	19.75 a	15.98cd	20.49 a	18.78 b	18.42 a
	Mean	43.24 c	53.18 a	51.56ab	49.33 a	39.74 c	51.50 a	51.42 a	47.56 a	15.87 c	19.89 a	18.73ab	18.16 a	14.69 c	18.70 a	18.06 a	17.15 a
Calcareous	0.0	33.59 g	38.90 f	43.28 e	38.59de	34.10 h	36.70 g	40.80 f	37.20 c	11.28 f	12.97 e	14.53 d	12.93 e	10.67 f	12.20 e	13.76 d	12.21dc
	2.0	41.67 ef	51.88 c	53.36 c	48.97 b	39.20 fg	50.78dc	50.21dc	46.73 b	14.00de	17.43 c	17.92 c	16.45 c	13.18 d	18.00 b	16.83 c	16.00 b
	4.0	47.40 d	56.00 b	58.42 b	53.94 a	44.70 d	52.80 c	56.73 b	51.41 a	15.93dc	18.78cb	19.60 b	18.10 b	14.87dc	17.56 b	17.94 b	16.79 b
	Mean	40.89 d	48.93 b	51.69ab	47.17 b	39.33 c	46.76 b	49.25ab	45.11 b	13.74 d	16.39cb	17.35 b	15.83 b	12.91 d	15.92 b	16.18 b	15.00 b
Water quantity mean		38.70 b	46.08 a	47.43 a	-----	36.36 b	44.42 a	45.80 a	-----	13.22 b	15.88 a	16.10 a	-----	12.33 b	15.13 a	15.22 a	-----

\* Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5 % level.

**Table (11): Effect of soil texture, kristalon level, water quantity and their interactions on pigments content (mg/g fresh weight) in the leaves of *Polianthes tuberosa* L. plant during 2008 season**

Soil texture	Kristalon level (g/bag)	Chlorophyll a				Chlorophyll b				Carotenoids			
		Water quantity (ml/bag)											
		100	150	200	Mean	100	150	200	Mean	100	150	200	Mean
Sandy	0.0	0.889	0.910	0.934	0.991	0.456	0.481	0.501	0.479	0.571	0.596	0.625	0.597
	2.0	0.943	1.004	0.986	0.978	0.468	0.523	0.547	0.513	0.583	0.671	0.698	0.651
	4.0	0.987	1.028	1.073	1.029	0.559	0.588	0.610	0.586	0.602	0.638	0.651	0.630
	Mean	0.940	0.981	0.998	0.973	0.494	0.531	0.553	0.526	0.585	0.635	0.658	0.626
Loamy	0.0	0.918	0.938	0.958	0.938	0.506	0.527	0.546	0.526	0.688	0.707	0.718	0.704
	2.0	0.990	1.112	1.095	1.066	0.551	0.733	0.598	0.627	0.697	0.756	0.731	0.728
	4.0	1.003	1.027	1.079	1.036	0.601	0.697	0.654	0.651	0.721	0.745	0.699	0.722
	Mean	0.970	1.026	1.044	1.013	0.553	0.652	0.599	0.601	0.702	0.736	0.716	0.718
Calcareous	0.0	0.907	0.928	0.961	0.932	0.476	0.495	0.511	0.494	0.596	0.620	0.648	0.621
	2.0	0.916	0.967	0.993	0.959	0.501	0.535	0.556	0.531	0.631	0.691	0.676	0.666
	4.0	0.952	1.015	0.984	0.984	0.541	0.697	0.658	0.632	0.661	0.687	0.697	0.681
	Mean	0.925	0.970	0.979	0.958	0.506	0.576	0.575	0.552	0.629	0.666	0.674	0.656
Water quantity mean		0.945	0.992	1.007	-----	0.518	0.586	0.576	-----	0.639	0.679	0.683	-----

Table (12): Effect of soil texture, kristalon level, water quantity and their interactions on total carbohydrates, N, P and K percentages in the leaves of *Polianthes tuberosa* L. plant during 2008 season

Soil texture	Kristalon level (g/bag)	Total carbohydrates				N				P				K			
		Water quantity (ml/bag)															
		100	150	200	Mean	100	150	200	Mean	100	150	200	Mean	100	150	200	Mean
Sandy	0.0	19.68	21.23	22.46	21.12	0.78	0.86	0.93	0.86	0.18	0.21	0.27	0.22	0.89	0.97	1.07	0.98
	2.0	20.90	22.85	25.17	22.97	0.82	0.97	1.04	0.94	0.20	0.28	0.29	0.26	1.02	1.28	1.36	1.22
	4.0	22.38	23.77	25.59	23.91	0.91	1.18	1.32	1.14	0.24	0.27	0.28	0.26	1.13	1.33	1.38	1.28
	Mean	20.99	22.62	24.41	22.67	0.84	1.00	1.10	0.98	0.21	0.25	0.28	0.25	1.01	1.19	1.27	1.16
Loamy	0.0	22.67	24.34	25.69	24.23	1.12	1.20	1.31	1.21	0.23	0.26	0.27	0.25	2.03	2.40	2.46	2.30
	2.0	23.56	28.41	27.37	26.45	1.38	1.86	1.52	1.59	0.26	0.31	0.30	0.29	2.12	2.91	2.73	2.59
	4.0	25.09	26.32	26.55	25.99	1.47	1.73	1.63	1.61	0.30	0.30	0.28	0.29	2.31	2.80	2.58	2.56
	Mean	23.77	26.36	26.54	25.56	1.32	1.60	1.49	1.47	0.26	0.29	0.28	0.28	2.15	2.70	2.59	2.48
Calcareous	0.0	20.85	22.34	24.10	22.43	1.10	1.30	1.43	1.28	0.20	0.23	0.25	0.23	1.46	1.76	1.92	1.71
	2.0	23.15	25.75	26.89	25.26	1.29	1.70	1.79	1.59	0.22	0.30	0.31	0.28	1.58	2.28	2.36	2.07
	4.0	25.68	27.74	26.10	26.51	1.50	1.75	1.81	1.69	0.25	0.27	0.30	0.27	1.73	2.33	2.17	2.08
	Mean	23.23	25.28	25.70	24.73	1.30	1.58	1.68	1.52	0.22	0.27	0.29	0.26	1.59	2.12	2.15	1.95
Water quantity mean		22.66	24.75	25.55	-----	1.15	1.39	1.42	-----	0.23	0.27	0.28	-----	1.58	2.00	2.00	-----

