Impact of different soil media on growth and chemical constituents of *Jatropha curca* L.seedlings grown under water regime

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Abstract: Two pot experiments were carried out at Research and Production Station, Nubaria of National Research Centre, Egypt, during 2008 and 2009 seasons. The purpose of this study is to investigate the influence of some soil media (sand, clay and sand + clay) under different water regimes (500, 1000, 1500 and 2000 cm^3/pot) on growth and chemical constituents of *Jatropha curcas* L. Results showed that, increasing water supply gradually increased significantly plant height, stem diameter, number of leaves/plant, leaf area, fresh and dry weight of leaves and stem. The same behavior was noticed concerning chlorophyll a, b, a+b, carotenoids content as well as N, P and k uptake in shoots. On the contrary, root length, fresh and dry weight of roots as well as N, P, K and proline content increased as water level decreased. Data also observed that all growth parameters, three pigments content, N, P, K and proline content tended to increase by using clay media followed by sand + clay media as compared with sand media. Clay media can be used to reduce the effect of water stress up to 500 cm^3/pot. These applications may be recommended for overcoming the harmful effect on growth and chemical constituents of *Jatropha curca* L. Seedlings under water stress. [Journal of American Science 2010; 6(8):549-556]. (ISSN: 1545-1003).

Keywords: soil media; *Jatropha curca* L; water regime; seedling

1. Introduction

Jatropha is a genus of approximately 175 succulent plants, shrubs and trees (same are deciduous, like *Jatropha curcas* L.*)*, from the family Euphorbiaceae. *Jatropha curcas* L. is a drought-resistant perennial, growing well in marginal/poor soil. It is easy to establish , grows relatively quickly and lives, producing seeds for 50 years. Jatropha the wonder plant produces seeds with an oil content of 37%. The oil can be combusted as fuel without being refined. It burns with clear smoke-free flame, tested successfully as fuel for simple diesel engine. The by-products are press cake a good organic fertilizer, oil contents also insecticide. Medically it is use for diseases like cancer, piles, snakebite, paralysis, dropsy etc.. Stress has been defined as any environmental factor capable of inducing a potentially injurious strain in plants. Water is a major constituent of tissue, a reagent in chemical reaction, a solvent for and mode of translocation for metabolites and minerals within plant and is essential for cell enlargement through increasing turgor pressure. With the occurrence of water deficits many of the physiological processes associated with growth are affected and under severe deficits, death of plants may result. Farahat (1990) in study on *Schinus molle, Schinus terbinthifolius* and *Myoporum ocminatum,*Metwally ***et al.*** (2002) on roselle Metwally and Azza ***et al.*** (2007) on *Bauhinia variegata* seedlings, found that plant height, stem diameter and fresh and dry weight of leaves, stem and root decreased with prolonging the water intervals. Shehata (1992) working on *Cupressus sempervirens* and *Eucalyptus camaldulensis,* El-Tantawy ***et al.*** (1993) on *Eucalyptus camaldulensis,* Azza ***et al.*** (2006) on *Melia azedarach* seedlings and Azza ***et al.*** (2006) on *Taxodium distichum,* supplied seedlings with three soil moisture content (40, 60 and 80% of water holding capacity. They observed that plant height, stem diameter, fresh and dry weight of leaves, stem and roots were increased by increasing soil moisture but root length and fresh and dry weight of roots were decreased. Also, Uday ***et al.*** (2001) studied the effect of irrigation at (field capacity 10.4% w/w) 0.2 F.C., 0.5 F.C. and 10 F.C. levels) on growth of *Simmondsia chinensis* and found that growth was increased with increasing irrigation levels. Sayed (2001) on *Khaya senegalensis* and Soad (2005) on *Simmondsia chinensis* , Azza ***et al.*** (2006) on *Taxodium distichum,* supplied seedling with three soil moisture content (40, 60 and 80% of water holding capacity. They observed that plant height, stem diameter, fresh and dry weight of leaves, stem and roots were increased by increasing soil moisture but root length and fresh and dry weight of roots were decreased. Also, Uday ***et al.*** (2001) studied the effect of irrigation at (field capacity 10.4% w/w) 0.2 F.C., 0.5 F.C. and 10 F.C. levels) on growth of *Simmondsia chinensis* and found that growth was increased with increasing irrigation levels. Sayed (2001) on *Khaya sensegalensis* and Soad (2005) on *Simmondsia chinensis*, Azza ***et al.*** (2006) on *Melia* *azedarach* and Azza *et al.* (2007) on *Bouhinia variegata*, irrigated seedling with different soil moisture content. They found that chlorophyll (a, b and carotenoid content) were increased as soil moisture content decreased. In addition to that total sugars, N, P and K concentration in the leaves were also stimulated gradually by decreasing water supply. While, leaf content of nitrogen, phosphorus and potassium were increased by increasing water supply. Azza *et al.*, (2006) on *Taxodium distichum* found that increasing water supply gradually increased N, P and k uptake in shoot. Data also revealed that proline tended to increase by decreasing water level.

Successful greenhouse and nursery production of container-grown plants is largely dependent on the chemical and physical properties of the growing media. An ideal potting medium should be free of weeds and diseases, heavy enough to avoid frequent tipping over and yet light enough to facilitate handling and shipping. The media should also be well drained and yet retain sufficient water to reduce the frequency of watering. Other parameters to consider include cost, availability, consistency between batches and stability in the media overtime. Selection of the proper media components is critical to the successful production of plants. (James and Michael, 2009).

Sandy soil: soils with a high proportion of sand drain easily, so water logging is not a problem unless a "pan" or impervious layer has formed below the surface. Their open structure means that they are easy to work and quick to warm up in the spring, allowing earlier sowing and plating. However sandy soils do dry out very quickly and nutrients are easily washed through the soil. Clay soil: These are heavy and difficult to work. They are slow to warm in the spring, sticky when wet and very hard when dry. Clay sails hold moisture and nutrients well and remain warm, in the autumn because they are slow to cool down. Mach of the water they contain will not be available to plants and in winter they are prone to water logging. (James and Michael, 2009). El-Sallami (2003) on *Leucaena leucocephala* seedlings, El-Khalifa (2003) on *Dalbergia melanoxylon*, Mohmood (2005) on *Caesalpinia pulcherrima* and *Thevetia peruviana* and Kathiravan *et al.* (2008) on *Jatropha curcas*, found that, clay soil was superior to sandy one in stimulating the morphological growth. Abd-El-Razek (2002) on *Gasteria verrucosa* and *Haworthia fasciata* plants and El-Sallami (2003) on *Lucaena leucocephala* seedlings, found that clay medium gave the highest chlorophyll (a and b), N, P, K percentages and total carbohydrates compared with sandy medium. Mahmood (2005) showed that N, P and K content in leaves exhibited maximum values under the clay + sand medium of *Caesalpinia pulcherrima* and *Thevetia peruviana.*

The aim of the present work is the evaluate the influence of different soils media (sand,clay and mix. soil) grown under several irrigation levels.

2. Material and Methods

This study was carried out at Research and Production Station, Nubaria of National Research Centre during two successive summer seasons of 2008-2009. The main objective of this study was to investigate the effect of different soil types under different water regimes on growth and chemical constituents of *Jatropha curcas.* The physical properties of the different media are shown in Tables (1a& 1b).

(1a)- Mechanical analysis

Soil sample	Coarse sand%	Fine sand %	Silt + Clay %
Clay	43.0	13.0	44.0
Sand	72.5	16.5	11.0

(1b) Chemical analysis:

Soil sample	E.C. m.mohs/cm^3	pH	SP%	Anion (meq/L.)			Cation (meq/L.)		
				HCO_3^-	Cl^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^++K^+
Clay	2.9	7.9	33.0	4	21	5	21	5	3
Sand	2.4	7.1	23.0	2	23	-	4	3	20

One year-old seedlings of *Jatropha curcas* L. were obtained from nursery of Forestry Department Horticulture Research Institute, Agriculture Research Centre. The seedlings were planted on 15th March in plastic pots 30 cm diameter (one plant/pot, the average height of seedlings were 12-15cm), each pot filed with three different soil media according to treatments i.e. sand, clay and the mixture of them 1: 1 (v/v). The irrigation schedule was four treatments (500, 1000, 1500 and 2000 cm^3/ pot). After one month from transplanting, the irrigation regime was started and was terminated in 15th November. The available commercially fertilizer used through this experimental work was kristalan (NRK 19: 19: 19) produced Phayzen campany, Halland. The fertilizer rates were 20.0gm/pot in four equal does after 4,8, 16 and 20 weeks from transplanting.

The following data were recorded: Plant height (cm), leaves number/ plant, root length (cm), stem diameter (mm), leaf area (cm^2), fresh and dry weight of leaves, stems and roots (gm). The experiment was sitting in completely Randomized experiment Design with four irrigation rates and three types of soil to give 12 treatments with 6 replicats. The obtained results was subjected to statistical analysis of variance according to the method described by Snedecor and Cochran (1980) and the combined analysis of the two seasons was calculated according to the method of Steel and Torrie (1980). The following chemical analysis was determined: Chlorophyll a, b and carotenoids contents were determined according to Saric *et al.,* (1967). The proline concentration was determined using fresh material according to Bates *et al.,* (1973). Nitrogen, phosphorus, potassium and sodium contents of leaves were determined according to the method described by Cottenie *et al.,* (1982). The physical and chemical properties of the soil were determined according to Chapman and Pratt (1961).

3. Results and Discussion

Vegetative growth: The results obtained in Tables (2-5) showed that the above-ground vegetative growth including plant height, leaves number/ plant, stem diameter, leaf area and fresh and dry weight of shoot were gradually increased as the level of water irrigation was sloping upward. The highest values for all these characters were obtained due to the use of the high irrigation level (2000cm^3).

The reduction in these growth parameters under low irrigation level (500cm^3) conditions may be attributed to losses of tissue water which inhibiting cell division and enlargement. El – Monayeri *et al.* (1985) reported that the vital roles of water supply at adequate amounts for different physiological processes such as photosynthesis respiration, transpiration translocation, enzyme reaction and cells turgidity occurs occurs simultaneously. Such reduction could be attributed to a decrease in the activity of meristemic tissues responsible for elongation, as well as the inhibition in photosynthetic efficiency under insufficient condition (Siddique *et al.,* 1999). Ali *et al.,* (1999) indicated that soil drying decreased leaf growth thereby reducing leaf water status in addition to accumulation of organic solutes to osmotic adjustment which in turn inhibit the incorporation of small substrate molecules into the polymers needed to grow new cell. On contarary, all water prementioned vegetative growth parameters root length and fresh and dry weight of roots took on opposite trend as they were gradually decreased with the irrigation levels was sloping upward. The lower water supply causes the root system to penetrate deeper and extending wider in the soil with higher root system researching for moisture in lower. This results were on line with those reported by Burman *et al.* (1991)on *Simmondsia chinensis* Uday *et al.* (2001) and Azza *et al.,* (2006) on *Taxodium distichum.*

Data in Tables (2-5) showed that clay and mix. media significantly increased all growth parameters in the two seasons compared with the sandy soil which gave the lowest values. Clay minimized this reductory effects ,while mix. medium gave a moderate values in this respect. This effect may be attributed to the physical properties of the soil. Sand soil is parous, the ions absorption is more easy while some of ions adhere on the clay soil particles. Also, sandy soils do dry out very quickly and nutrients are easily washed through the soil while, clay soils hold moisture and nutrients well.

These results were confirmed by El-Mesiry and Azza (2001) on *Melia azedarach* L., El-Sallami (2002) on *Chorisia speciosa, Leucaena leucocephala* and *Prosopis Juliflora,* El-Khalifa (2003) on *Dalbergia melanoxylon* plant and Kathiravan *et al.* (2008) on *Jatropha curcas* L.

The results presented in Tables (2-5) declared that clay and mix. media minimized the reductory effect of water irrigation levels compared with the sandy soil. Therefore,plant grown in clay media and irrigated with 2000 cm^3 treatment relatively increased the all morphological growth followed by mix. media compared with the sandy soil under irrigated with 500cm rate which produced the lowest values in the two seasons.

Chemical constituents:

Pigments content : From the given data in Table (6) it can be concluded that, increasing irrigation rates caused an increase in the content of photosynthetic pigments (chlorophyll a, b, a+b and carotenoids). Accordingly it can be stated that irrigation with 2000 cm^3 was the most effective irrigation treatment for promoting the synthesis and accumulation of the three photosynthetic pigments. In harmony with these results were those obtained by Soad (2005) on jojoba seedlings and Azza *et al.,* (2006) on *Taxodium distichum.*

Clay media tended to increase chlorophyll a, b, a+b and carotenoids as comparing with the sandy and mix.media in fresh leaves. These results are in accordance with those obtained by Sayed (2001) on khya and El-Sallami (2003) on *Leucaena leucocephala* plant .

Seedling grown in clay soil and irrigated with $2000cm^3$ rate produced the greatest photosynthetic pigments of fresh leaves . The increment effect on chlorophyll a ,b, a+b and carotenoids by 38.3,50.3,42.8 and 40.8% respectively compared with sand soil that was irrigated with $500cm^3$ rate which produced the lowest value.

Proline content: From the given data in Table (7) it can be concluded that decreasing irrigation level caused an increase of proline content. This may be due to the proline metobdism which is a typical mechanism of biochemical adaptation subjected to stress condition . The catabolism of proline involves its conversion to glutamic acids via. Pyrroline-s-carboxylate reduction and subsequent metabolism of glutamate by Kreb cycls veactin that release CO_2 as the end product (Armestrong, 1993). Obtained results were in harmony with the finding of Azza *et al.* (2006) on *Taxodium distichum.*

Soil media results on proline content had a similar trend as that in the photosynthetic pigments. Clay and mix.med increased the average proline content of leaves in both seasons compared with sandy soil. Seedlings grown in clay media which was irrigated with $500cm^3$ gave the highest proline content followed by mix.media + $500cm^3$ and sand +500 cm^3 respectively.

Minerals content : It is evident from the data in Tables (7 - 9) that minerals content under investigation (N,P and K)were gradually increase with decreasing the water supply. Regarding irrigation level from $2000cm^3$ and up to $500cm^3$ caused an increase in pervious minerals concentrations. This may be due to the leaching of the minerals from soil. In agreement with these results concerning irrigation were the results of Sayed (2001) on some woody trees, Soad (2005) on jojoba and Azza *et al.,* (2007) on *Bauhinia variegata.*

Furthermore, sodium content increased by increasing irrigation levels in plant, these results run parallel with those obtained by Farahat (1990) on *Scinus molle* L. *Myoprum acumination* and El-Tantawy *et al.,* (1993) on *Eucalyptus camaldulensis.*

Concerning the effect of soil media, it is evident from data that the previous minerals in plant in the tow growing seasons, were increased by using clay media, following by mix media. But, sodium content took an opposite menner, it decreased by using clay media. This effect was found in the two seasons and it may be attributed to the ability of such soil to supply the plant with its needs from nutrients. These results were confimed by El-Sallami (2003) on *Leucaena leucocephala.* Concerning ineraction between clay media + irrigation by 500 cm^3 showed that maximum values for each element.

On the contrary of N, P and K uptake as influenced by irrigation treatments, plant uptake of such four nutrients were gradually increased by increasing irrigation level. These results could be explained in high of the considerable increase in leave dry weight by the increase in irrigation level. In harmony with the prementioned results were finding of Soad (2005) on Jojoba seedlings and Azza *et al.,* (2007) on *Bauhinia variegata.*

Leaves uptake of each of nitrogen, phosphorus and potassium were increased due to the use of the clay soil than mix media and sand media. Similar results were obtained by El-Sallami (2003) on *Leucaena leucocephala.*

In the interaction between clay soil and irrigation by 2000 cm^3 showed the maximum uptake of each elements, except Na uptake, it obtaine the lowest uptake.

The results in this study indicated that clay soil media can be used to overcome the reduction effect of water regimes.

Table (2) Effect of soil types on plant height (cm), number of leaves/plant and root length (cm) of *Jatropha curcas.*L.plant grown under water regime condition (Average of two seasons 2008 and 2009).

Characters	Plant height (cm)					Number of leaves/plant					Root length (cm)				
Treatments	Water regime (cm^3/pot)					Water regime (cm^3/pot)					Water regime (cm^3/pot)				
Soil Types	500	1000	1500	2000	Mean	500	1000	1500	2000	Mean	500	1000	1500	2000	Mean
Sand	75.0	74.3	79.0	86.3	78.7	27.7	32.0	33.0	35.0	31.9	30.0	29.6	28.3	25.3	28.3
Clay	131.3	132.3	147.0	161.7	143.1	48.7	52.0	58.0	63.3	55.5	48.0	47.6	44.0	39.3	44.7
Sand+ Clay	86.7	89.7	94.0	96.3	91.6	36.7	39.6	41.7	46.0	40.8	37.7	36.6	32.6	31.0	34.5
Mean	97.6	98.7	106.6	114.7		37.3	41.0	44.2	48.1		38.5	37.9	34.9	31.8	
L.S.D at 5%															
Soil types (S)	7.3					4.7					1.8				
Water regime (W)	9.5					6.7					2.6				
(S)*(W)	12.11					7.3					3.1				

Table (3) Effect of soil types on leaves, stems and roots fresh weight (gm) of *Jatropha curcas* L. plant grown under water regime condition (Average of two seasons 2008 and 2009).

Characters	Leaves fresh weight (gm)					Stem fresh weight (gm)					Roots fresh weight (gm)				
Treatments	Water regime (cm^3/pot)					Water regime (cm^3/pot)					Water regime (cm^3/pot)				
Soil Types	500	1000	1500	2000	Mean	500	1000	1500	2000	Mean	500	1000	1500	2000	Mean
Sand	62.42	72.74	74.95	86.68	74.20	165.62	182.68	195.10	224.13	191.88	69.35	56.09	44.20	43.83	52.86
Clay	130.17	177.57	210.40	247.04	191.29	349.37	381.91	410.95	447.95	397.54	158.99	122.49	115.79	99.33	124.15
Sand+ Clay	80.88	89.23	103.67	117.32	97.77	237.47	261.25	285.96	315.05	274.93	93.11	73.12	70.22	69.35	76.45
Mean	91.16	113.18	129.67	150.34		250.82	275.28	297.33	329.04		106.48	83.90	76.73	70.83	
L.S.D at 5%															
Soil types(S)	7 13					11.62					7.35				
Water regime(W)	8.92					13.53					9.33				
(S)*(W)	11.31					15.71					11.93				

Table (4) Effect of soil types on leaves, stems and roots dry weight (gm) of *Jatropha curcas* L. plant grown under water regime condition (Average of two seasons 2008 and 2009).

Characters	Leaves dry weight (gm)					Stem dry weight (gm)					Roots dry weight (gm)				
Treatments	Water regime (cm^3/pot)					Water regime (cm^3/pot)					Water regime (cm^3/pot)				
Soil Types	500	1000	1500	2000	Mean	500	1000	1500	2000	Mean	500	1000	1500	2000	Mean
Sand	9.05	10.83	11.54	13.78	11.30	62.45	69.75	77.78	86.95	74.23	20.74	17.00	13.12	12.80	15.91
Clay	23.56	33.38	40.32	49.16	36.60	98.17	109.61	120.00	133.49	115.31	55.32	42.01	38.90	32.97	42.30
Sand+ Clay	13.10	14.99	17.86	20.64	16.64	72.45	79.75	87.78	96.95	84.23	30.45	23.69	22.18	21.56	24.47
Mean	15.23	19.73	23.24	27.86		77.69	86.37	95.19	105.80		35.50	27.56	24.73	22.49	
L.S.D at 5%															
Soil types(S)	2.60					4.35					2.86				
Water regime(W)	3.01					6.75					4.53				
(S)*(W)	4.63					7.88					6.12				

Table (5) Effect of soil types on stem diameter (mm) and leaf area (cm^2) of *Jatropha curcas* L. Plant grown under water regime condition (Average of two seasons 2008 and 2009).

Characters	Stem diameter (mm)					Leaf area (cm^2)				
Treatments	Water regime (cm^3/pot)					Water regime (cm^3/pot)				
Soil Types	500	1000	1500	2000	Mean	500	1000	1500	2000	Mean
Sand	2.60	2.60	3.00	3.20	2.85	37.32	41.05	41.99	42.48	40.78
Clay	3.70	3.80	4.20	4.50	4.05	53.29	58.42	60.38	68.60	60.18
Sand+ Clay	3.30	3.50	3.60	3.70	3.52	49.32	49.52	51.77	52.08	50.67
Mean	3.20	3.30	3.60	3.80		46.64	49.66	51.38	54.48	
L.S.D.at 5%										
Soil Typs(S)			0.04					1.31		
Water regime(W)			0.06					2.07		
(S)*(W)			0.10					2.71		

Table (6) Effect of soil types on photosynthetic pigments (mg/g F.W.) of *Jatropha curcas* L. plant grown under water regime condition (Average of two seasons 2008 and 2009).

Characters	Chlorophyll (a)					Chlorophyll (b)					Chlorophyll (a+b)					Carotenoids				
Treatments	Water regime (cm^3/pot)					Water regime (cm^3/pot)					Water regime (cm^3/pot)					Water regime (cm^3/pot)				
Soil Types	500	1000	1500	2000	Mean	500	1000	1500	2000	Mean	500	1000	1500	2000	Mean	500	1000	1500	2000	Mean
Sand	0.732	0.769	0.791	0.822	0.778	0.431	0.467	0.485	0.528	0.477	1.163	1.236	1.276	1.350	1.256	0.235	0.243	0.255	0.264	0.249
Clay	0.968	0.984	0.986	1.013	0.987	0.604	0.624	0.632	0.648	0.627	1.572	1.608	1.618	1.661	1.614	0.308	0.318	0.323	0.331	0.320
Sand+ Clay	0.841	0.891	0.934	0.959	0.906	0.534	0.549	0.585	0.596	0.566	1.375	1.440	1.519	1.555	1.472	0.270	0.278	0.285	0.297	0.282
Mean	0.847	0.881	0.903	0.931		0.523	0.546	0.567	0.590		1.370	1.428	1.471	1.522		0.271	0.279	0.287	0.297	

Table (7) Effect of soil types on prolin content, sodium percentage and uptake/plant leaves of *Jatropha curcas* L. plant grown under water regime condition (Average of two seasons 2008 and 2009).

Characters	Proline (µmg $^{-1}$)					Sodium %					Sodium – uptake mg/plant				
Treatments	Water regime (cm^3/pot)					Water regime(cm^3/pot)					Water regime (cm^3/pot)				
Soil Types	500	1000	1500	2000	Mean	500	1000	1500	2000	Mean	500	1000	1500	2000	Mean
Sand	5.7	4.59	3.73	2.91	4.23	1.92	1.76	1.69	1.49	1.72	17.38	19.06	19.50	20.53	19.12
Clay	8.31	7.12	5.32	4.42	6.29	1.49	1.39	1.33	1.15	1.34	45.23	46.40	53.63	56.53	50.45
Sand+ Clay	7.00	5.73	4.93	3.76	5.36	1.64	1.47	1.31	1.23	1.41	21.48	22.04	23.40	25.39	23.08
Mean	7.00	5.81	4.66	3.70		1.68	1.54	1.44	1.29		28.03	29.17	32.18	34.15	

Table (8) Effect of soil types on nitrogen, phosphorus and potassium percentage of *Jatropha curcas* L. plant grown under water regime condition (Average of two seasons 2008 and 2009).

Characters	Nitrogen %					Phosphorus %					Potassium %				
Treatments	Water regime (cm^3/pot)					Water regime (cm^3/pot)					Water regime (cm^3/pot)				
Soil Types	500	1000	1500	2000	Mean	500	1000	1500	2000	Mean	500	1000	1500	2000	Mean
Sand	0.94	0.90	0.82	0.76	0.83	0.45	0.44	0.38	0.32	0.40	0.85	0.78	0.59	0.53	0.69
Clay	1.23	1.19	1.12	0.99	1.13	0.79	0.71	0.64	0.60	0.69	1.35	1.26	1.20	1.14	1.24
Sand+ Clay	1.07	0.95	0.84	0.80	0.92	0.54	0.52	0.50	0.48	0.51	1.09	1.06	1.02	0.99	1.04
Mean	1.08	1.01	0.93	0.85		0.59	0.56	0.51	0.47		1.10	1.03	0.94	0.89	

Table (9) Effect of soil types on nitrogen, phosphorus and potassium uptake mg / plant leaves of *Jatropha curcas* L. plant grown under water regime condition (Average of two seasons 2008 and 2009).

Characters	Nitrogen –uptake mg/plant					Phosphorus –uptake mg/plant					Potassium –uptake mg/plant				
Treatments	Water regime (cm^3/pot)					Water regime (cm^3/pot)					Water regime (cm^3/pot)				
Soil Types	500	1000	1500	2000	Mean	500	1000	1500	2000	Mean	500	1000	1500	2000	Mean
Sand	85.1	97.5	94.6	104.7	93.8	281.0	306.9	295.6	278.2	296.9	108.8	102.3	100.3	109.9	109.8
Clay	289.8	397.2	451.6	486.7	413.6	775.5	778.2	768.0	800.9	795.6	445.1	490.1	504.1	630.6	524.5
Sand+ Clay	140.2	142.4	150.0	165.1	153.1	391.2	414.7	476.0	507.8	429.6	235.0	235.1	241.6	301.5	254.5
Mean	164.5	199.3	216.1	236.8		458.4	483.7	485.5	497.3		247.4	254.7	259.1	316.0	

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