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Adansonia digitata L.Natural variation in fruit, leaves characteristics، seed germination and seedling growth in Sudan.

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Abstract: This study is devoted to the Baobab trees, from the Blue Nile and North Kordofan States,Sudan.The objective of this study was to characterize and assess morphological variations fruits, leaves, and study seed germination and seedling growth variations between two location. In each state five populations of baobab trees naturally distributed were randomly sampled as a group, based on the presence of well-established baobab fruit bearing. Five to twenty individual trees were randomly sampled within each baobab population for the morphometric measurements at different distances. The seeds were planted in polythene bags filled with river sand using completely randomized design (CRD) with 20 replications and seedling variations assessed. The data was analyzed using SPSS version 16. ANOVA was applied to detect the significant variations. Results revealed that there were significant differences in tree morphological charaters as well as differences in pulp and seed weight. The findings showed that there were significant differences in seedling growth characteristics between the study areas. In conclusion great phenotypic variability in organ characters within and between baobab populations were detected. For recommended further studies on baobab, environmental and genetic factors should be considered as important factors to support domestication and conservation of baobab tree species.

Keywords: Baobab**,** Phenotype, domestication, Variation, Genetic factors.

الاختلافات الطبيعية في صفات ثمار، أوراق، إنبات ونمو شتلات التبلدى (*Adansonia digitata* L.) في السودان

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المختصر: كرست هذه الدراسة علي اشجار التبلدى في ولايتى النيل الازرق وشمال كردفان، السودان. أجريت هذه الدراسة بهدف توصيف وتقدير الاختلافات المظهرية لشجرة التبلدى ارتباطا بالموقع وتقدير اختلافات انبات البذور ونمو البادرات. في كل ولاية تم اختيار خمس مجموعات نباتية من اشجار التبلدى عشوائيا و موزعة طبيعيا بناءا علي الاثمار الجيد.اخذت من كل مجموعة ما بين 5 – 20 عينة من الاوراق والثمار عشوائيا ومن مواقع مختلفة من اجزاء الشجرة. زرعت البذور في اكياس من البوليثين معبئة بتربة رملية نيلية ، استخدمت القطاعات العشوائية الكاملة بمكررات قدرها 20 مكررة،تم تقييم الاختلافات في البادرات. حللت المعلومات بواسطة برنامج الحزم الاحصائية للدراسات الاجتماعية (SPSS)و تحليل لمعرفة الفروقات المعنوية في العينات. دلت نتائج الدراسة على ان هنالك فروق معنوية (ANOVA)التباين في الصفات الظاهرية بالاضافة الي الاختلافات في وزن اللب والبذور. اوضحت الدراسة أن هنالك فروق معنوية في نمو البادرات بين مناطق الدراسة المختلفة. خلصت الدراسة الى ان هنالك اختلافات كبيرة في صفات اعضاء اشجار التبلدى بين و خلال المجموعات. اوصت الدراسة بإجراء مزيد من الدراسات في مجال البيئة والوراثة و التي يمكن ان تلعب دورا في تأنيس والمحافظة على اشجار التبلدى.

1. INTRODUCTION

The well-known African baobab (*Adansonia digitata*L.),is widespread and common. It belongs to the family Malvaceae, which includes 30 genera, six tribes and about 250 species. The genus *Adansonia* includes seven other species. One species is restricted to North-Western Australia (*A. gibbosa*), and the remaining six species(*A. grandidieri* Baill., *A. suarezensis* H. Perrier, *A. rubrostipa* Jum. & H. Perrier, *A. za* Baill., *A. madagascariensis* Baill. and *A. perrieri* Capuron) are endemic to Madagascar (Baum *et al*., 1998). A new diploid African species in adansonia has been identified named *A. kilima* Pettigrew *et al* (2012).It is a very important species for the rural livelihood, providing food, fodder, medicine and income and sustainable use of natural resources in the tropics, which has been intensified in the past decades (Akinnifesi*et al*., 2008). The baobab occurs throughout the drier parts of Africa. It has been identified as one of the most important edible forest trees to be conserved and domesticated in Africa. It is generally accepted that the origin of the African baobab is tropical Africa (SCUC, 2006). Baobab trees are classified as an endangered species by the International Union for Conservation of Nature (IUCN) from 1996 to 2012, IUCN Red List version 2012.2. At the same time, the sustainability of baobab trees is threatened in their natural savannah ecosystem because of cattle grazing, more intensive agricultural practices, and pronounced drought situations (Wickens and Lowe, 2008).Tree viability is seriously affected by destructive practices associated with leaf harvesting whereby over harvesting can lead to reduced fruit production (Dhillion and Gustad, 2004).

Domestication of the baobab tree, presented in this study, looked at characterization of morphological variation, in fruits, leaves and seed germination and seedling growth. Information obtained may help to protect the species, and

screen more material to get super-trees as well as enhance the food security and income generation for the local population.

Little information is available on baobab tree phenotypic variations, however, within the species there is evidence indicating the existence of a number of local types, differing in habit, vigour, size, quality of the fruits and vitamin content of the leaves (Gebauer*et al*., 2002). Moreover, information about the ecology and morphological variations within and between populations is lacking (Sidibé and Williams, 2002).

The objectives of this study were to characterize and study morphological, seed germination and seedling growth variations between two locations with combinations of morphometric characteristics.

2. MATERIALS AND METHODS

2.1 Study Areas

The study was performed on baobab (*Adansonia digitata*L.).Ten populations were selected, five from each location(NorthKordofan and Blue Nile states) in Sudan. 38500km²(**Fig.1&Table1**).

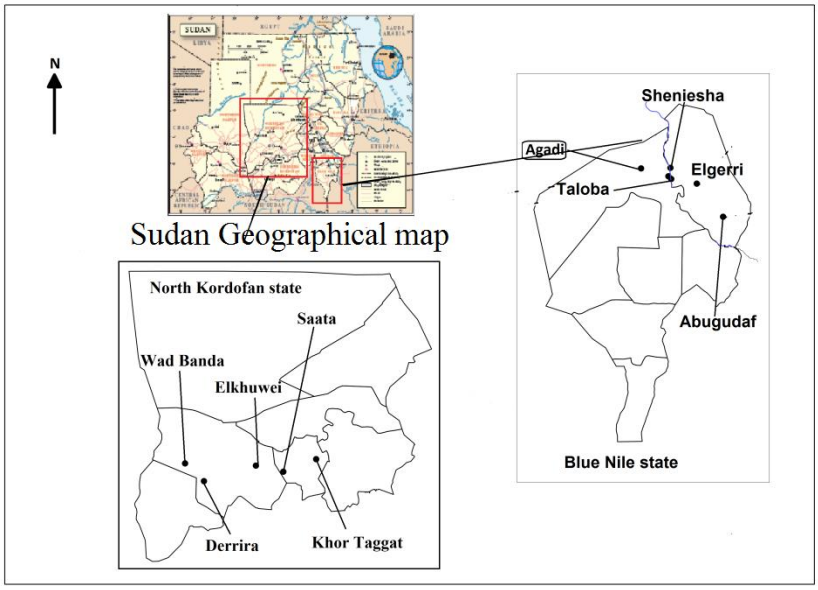


Figure 1: Study Areas (Blue Nile State and North Kordofan State)

(GIS database and GPS coordinate taken by the author during the field survey)

*source: Sudan geographical map (2014)

Table 1: Details of the selected locations

State	**Altitudes (m)**	**Soil type**	**Lat. (N˚)**	**Long. (E˚)**	**Average rainfall (mm)**
Blue Nile (BN)	492	Stony hill side	9˚ 30′	33˚ 5′	700
North Kordofan (NK)	482	Sandy loam	14˚ 22′	29˚ 32′	350

Sources: Ministry of Agriculture of North Kordofan (2013)
: Ministry of Agriculture of Blue Nile States (2013)

2.2 Fruits, leaves and seedlings growth morphological characteristics measurements

From each sampled tree, six dry fruits and six fresh leaves without any damage were selected from different positions of the tree crown and kept in labeled plastic bags. This correspond to a total of 390 fruits and leaves sampled in each State for assessing and analyzing morphometric data for baobab populations.

For each fruit capsule weights were measured using a Dial Scale to determine the pulp productivity. The capsule shell was opened and separated from shell content (pulp plus seeds) (Figure 2) and weighted. Fruits pulp and seeds were separated by dissolving the dry powdery pulp in water for five minutes and then the seeds were weighted and the pulp weight was calculated by subtraction (pulp + seed - seeds weight). The individual seeds were weighted and seed length was measured, according to the method described by De Smedt *et al*. (2011). For leaf medial leaflet length, medial leaflet width were calculated, as well as medial leaflet length to broadest parts (ratio), to estimate leaf shape.In addition the leaflets, stalk length were measured using ruler and vernier caliper. All reported weights are from fresh samples, as baobab fruit pulp is consumed without drying (De Caluwé*et al*. 2009).

Figure 2: Baobab fruit inner content

2.3 Seedling growth variations assessment

Fruits were cracked and washed to remove the dry powder and the seeds were dried for 2 hours under direct sun light, for this experiment, seeds with similar weight were selected. To facilitate and speed the germination, the seeds were soaked in hot water for 24 hours. (Cass 1995). Seeds were planted in polythene bags with river sand using a completely randomized design (CRD) with 20 replicates, one seed per replicate per treatment in the Nursery of the Faculty of Natural Resources and Environmental Studies, Elsuki Campus, University of Sinnar, for 18 weeks of follow up. The seedlings were irrigated twice a week. Six healthy seedlings were selected per treatment and growth parameters (stem-epicotyl and hypocotyl, tap root and total roots length, stem length and taproot diameter at largest width)were measures using ruler and using dial caliper as well as number of leaves was recorded at different times intervals (week 1, week 3, week 6, week 10, week 14 and week 18) (Figure 3 and 4).

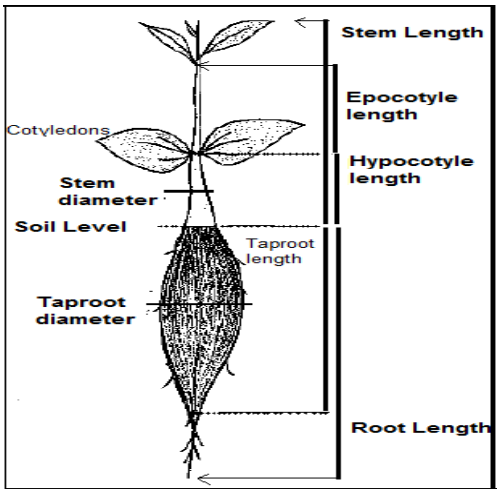


Figure 3: Seedling of *A. digitata*Figure 4: Characteristics recorded from each seedlingCuni (2010)

2.4 Statistical analysis

The data was analyzed using Statistical Package for Social Sciences (SPSS)version16. To detected the significant variations of Fruits, leaves and seedlings growth parameters. Duncan analysis was applied to compare the means.

3. RESULTS AND DISCUSSION

3.1 Variations in fruits characteristics

Generally the study results indicated that there were significant differences ($P \leq 0.05$) between the two locations in relation to fruit weight, pulp weight and seeds weight. Fruits from Blue Nile were significantly heavier than those from North kordofan state. (Table 2). The seeds number per fruits from Blue Nile state were higher than those from North Kordofan state (Table 2).

Table 2: The variation of baobab fruit characteristics between the two locations

Characters / location	Stalk Length (cm)	Fruit weight (g)	Epicarp thickness (mm)	Seeds weight (g)/ capsule	Pulp weight (g)/ capsule	Number of seeds/ capsule
Blue Nile	10.83 ± 3.06 a	209.22± 84.32 a	5.09 ± 1.17 a	90.25± 48.8 a	30.8± 14.09 a	192.3 ± 43.2 a
North Kordofan	11.44± 3.04 a	153.18± 78.45 b	4.77± 0.91 a	61.23± 39.08 b	24.54± 10.47 b	133 ± 34.2 b

Means followed by the same letter within a column are not significantly different at $P \leq 0.05$.

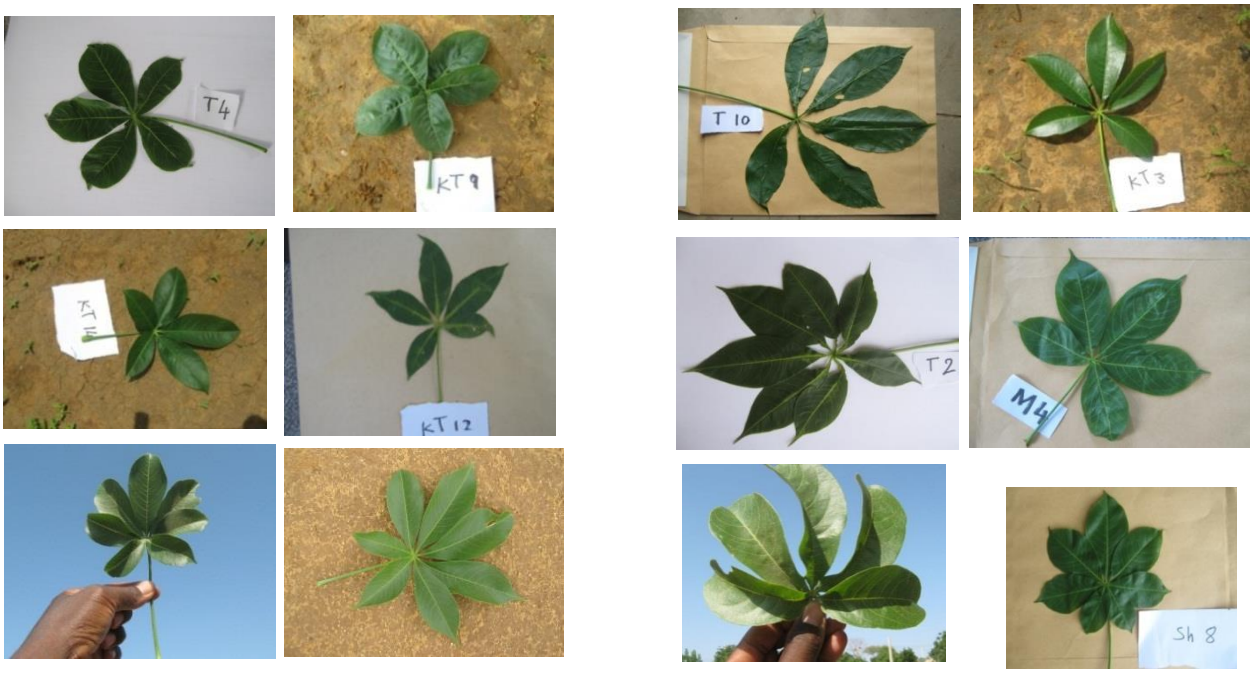
Fruits from the Blue Nile (wetter areas) were larger and had more pulp than that from the North Kordofan (drier area). Assuming that fruit characteristics are under relative environmental and strong genetic control, however, more areas where baobab is found should be sampled to identify locations with useful fruit characteristics for cultivar development. Population characteristics give an indication of overall baobab population properties, these values give information about the properties of individual trees, population containing different morphotypes differing in fruits, leaves, bark, and color.This agreed with Gebauer *et al*. (2002) who reported that the existence of different ecotypes with different fruits in terms of size, shape and sweetness. The differences in climatic factors may lead to differences in fruit and leaves parameters observed, as the mean weight of fruits pulp (30.8 ± 14.09 g) in Blue Nile state having higher rainfall (700mm

average) was greater than those from North Kordofan state having low rainfall (350 mm) (24.54±10.47 g). Moreover, Katsvanga *et al*. (2007) reported that weight of pulp is influenced by environmental factors largely by the amount of rainfall.

This suggests that selection of superior trees to improve pulp production should be done following several seasons of data collection on pulp productivity.

3.2 Variations in leaves morphology of baobab

The results indicated that leaves morphology was significantly different ($p \leq 0.05$) between the studied locations(Figure 5).



(A)(B)

Figure 5: Variation in leaf morphology of (*A. digitata*L.) from(A) North Kordofan and (B) Blue Nile.

In general, leaves from North Kordofan state were smaller than those from Blue Nile state in all studied characters except the stomata density which is significantly higher in North Kordofan (Table 3).

Table 3: Leaf morphological characteristics and stomata density of *A. digitata* from studied areas

Parameters	***Blue Nile state***	***North Kordofan state***
Petiole length cm	10.66 ± 1.68 a	8.45 ± 1.56 b
Number of leaflet	5.57 ± 0.63 a	5.1 ± 0.32 b
Medial leaflet length cm	9.20 ± 1.32 a	7.75 ± 1.43 b
leaflet width cm	3.80 ± 0.52 a	2.98 ± 0.58 b
Medial leaflet thickness mm	0.24 ± 0.03 a	0.20 ± 0.02 b
Number of stomata mm^2	83.36 ± 12.95 b	101.36 ± 14.77 a

Means followed by the same letter within rows are not significantly different at $P \leq 0.05$.

There was a clear pattern in leaf morphological character differences by visual examination. This finding may be due to the fact that environmental variables (annual precipitation and mean annual temperature) have impacts on tree leaves morphology. This is in agreement with Abrams *et al*. (1990) who reported that plants from drier environments tend to be shorter or smaller overall, compared with those of wetter environments.

When compared with other countries leaves from Malawi were, in general, larger (Medial leaflet length 13.99 ± 2.72 cm, pedicel length 11.74±2.47cm) than those from Benin (Medial leaflet length7.65 ± 1.88 cm, pedicel length6.41 ± 2.35cm), whereas leaves from Malawi were thinner (0.24 ± 0.02 mm) than those from Benin (0.26 ± 0.05 mm) these were reported by Cuni (2010). Leaves from Malawi and Benin were, larger in pedicel length and thinner inML thickness than those from Sudan.Regarding the stomata density, from this study the stomata density is low (83.36 and 101.36) compared to Malawi and Benin. Cuni, (2010) reported that stomata density were different in west Africa and it is higher in Malawi 226.5 ± 28.0 mm^2than in Benin which was112.12± 32.62mm^2.

The differences in leaves morphology and stomata characteristics depend on climatic differences between the study states, Blue Nile state (situated in a wetter area) had the lowest stomata densities while the highest stomata densities were found in the driest North Kordofan state. The stomata density had relationship between climatic characteristics observed in the two states is in accordance with the literature: Variability in leaf size has also been reported with plants from xerophitic environments having smaller and thicker leaves than those in this study. As Abrams *et al*. (1990) decided that xerophytes often have a higher stomata density than mesophytes from wetter environments. The highest temperature, the highest the stomata density, the lowest precipitation, the highest stomata density (Burns 1969, Sutcliffe 1979, Ristic and Cass 1991).Stomata density being significantly higher on a biaxial surface was adaxial in the studied area. A few stomata were found close to the nerves of the medial leaflet on the adaxial impressions. Possibly, the observed low stomata densities in this study site are related to low quality stomata imprints taken in this site.

3.3 Variation in seedling growth and morphology

The results indicated that there were significant differences ($P \leq 0.05$)between the location in seedlings cotyledon length and width from Blue Nile and North Kordofan state. The study findings also illustrated that seedlings from Blue Nile (wetter sites) had larger cotyledon length (6.74±1.19cm) and width (4.73±0.86cm),compared to North Kordofan which was shorter with the length (5.51±1.23cm) and width (4.42±0.69cm)(Figure 6). These results were due to the fact that differences in cotyledon morphology may be related to drier area adaptation (Fujita & Humphreys 1992 and Fisher 2008). Similarly, Pock Tsy *et al*.(2009) reported that seedlings from Mali have their cotyledons at a lower height than those from Malawi.

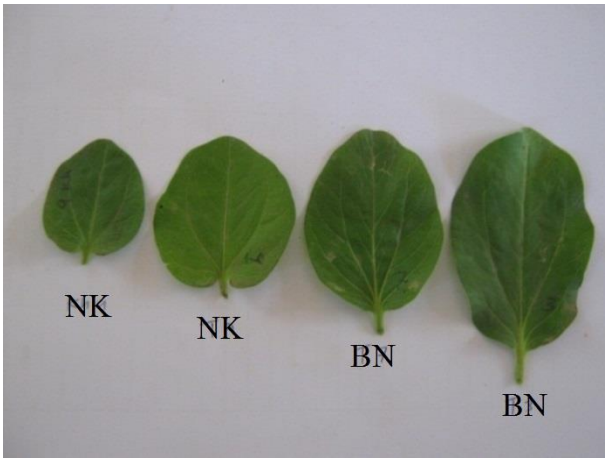


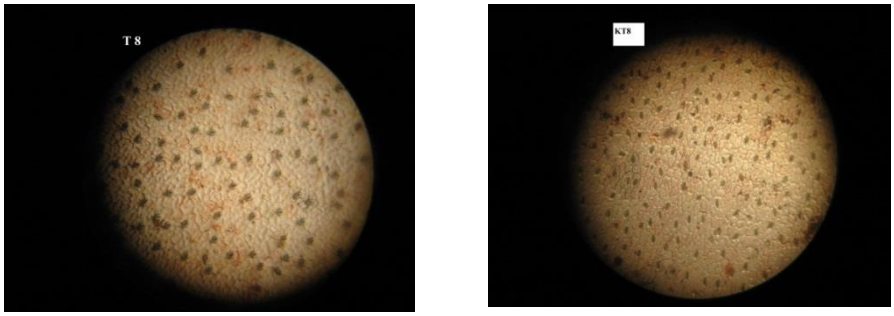
Figure 6: Cotyledon leaf variation of Blue Nile (BN) and North Kordofan(NK)

After 6 weeks, it was observed that there were significant differences between seedlings medial leaf thickness, taproot length, taproot diameter and root length. Seedling from the Blue Nile state have thicker leaves than those from North Kordofan state. Whereas taproot length, taproot diameter and root length from Blue Nile were longer than those from North Kordofan in 6 weeks (Table 4).

After 10,14, and 18 weeks, seedling stem and taproot lengths from Blue Nile states (wetter areas) were found to be longer than those from North Kordofan state (drier area). Also the number of leaves from Blue Nile State after 10, 14 and 18 weeks were found to be higher than those from North Kordofan state. After 14 and 18 weeks, (taproot length/taproot width) ratio,from Blue Nile state were found to be higher than those from North Kordofan state (Table 4).These findings agreed with the results of Pock-Tsy *et al*. (2009) who reported that the differences in seedling morphology may support the genetic differences between baobab populations from West Africa and south-eastern Africa. In Malawi, Cuni, (2010) also reported significant differences between study sites regarding leaf and fruit characteristics. Similarly, Assogbadjo *et al*. (2010) argued that there were differences between study sites within the same country. The results were attributed to the fact that the

climatic conditions have influences on seedling growth characteristics (e.g. stem height, diameter and number of leaves) within and between geographical locations. Additionally, differences in seedlings growth are related to variation in seeds size which is ultimately affected by geographical locations. In their study, Parker *et al*. (2006) observed a positive influence of large seed size on seedlings establishment and early growth.

The findings revealed that there was significant differences ($P \leq 0.05$) in stomata density after 3 weeks between the studied locations (Table 4). Stoma density was found to be lower ($93.94 \pm 21.6 mm^2$) in Blue Nile state than those from North kordofan state ($110 \pm 13.5 mm^2$) (figure 7). This result may be due to the fact that baobab seedlings are adapted for drought in order to accumulate more water as well as avoiding water loss. These results agreed with Cuni (2010) who reported that high stomata density with small size is thought to be a characteristic of drier area adaptation.



Blue Nile state *North Kordofan state*

Figure 7: Stomata density variation on the abaxial surface of baobab seedlings. Picture taken under a light microscope at x100 magnification.

Table 4: Seedling characteristics of *A. digitata* at 6, 10, 14 and 18 weeks after germination

	6Week		10Week		14Week		18 week	
Characteristics recorded	BN	NK	BN	NK	BN	NK	BN	NK
Stem length (cm)	34.7± 6.39 a	32.57± 5.65 a	40.67± 7.19 a	35.75± 8 b	42.67± 9.36 a	34.05± 7.71 b	46.36± 8.37 a	35.76± 9.14 b
Stem diameter (mm)	5.4± 2.46 a	5.82± 0.94 a	8.65± 1.54 a	7.56± 1.1 b	9.32± 1.8 a	9.7± 10.9 a	10.03± 1.72 a	8.69± 1.37 b
Hypocoty length(cm)	2.7± 0.62 a	2.69± 0.64 a	2.86± 0.55	2.76± 0.66 a	3.38± 0.77 a	2.71± 0.42 b	4.01± 1.19 a	3.44± 1.97 a
Epocotyl length (cm)	4.76± 1.31 a	4.69± 0.87 a	4.61± 0.9 a	4.53± 1.03 a	4.5± 1.21 a	5± 0.67 a	3.97± 1.08 a	3.39± 0.73 a
Number of leaves	12.77± 2.87 a	11.79± 2.15 a	18.71± 3.82 a	12.85± 3.26 b	19.49± 5.21 a	13.28± 2.95 b	21.13± 4.6 a	13.09± 3.82 b
Medial leaf length(cm)	10.73± 1.52 a	11.15± 1.66 a	10.9± 1.82 a	11.9± 1.99 a	11.98± 1.71 a	11.56± 1.83 a	11.13± 2.1 a	12.91± 3.13 a
Medial leaf width(cm)	4± 0.76 a	4.06± 0.62 a	4.09± 0.57 a	4.28± 0.82 a	4.23± 0.72 a	4.12± 0.88 a	4.02± 0.53 a	4.5± 1.25 a
Medial leaf Thickness (mm)	0.26± 0.18 a	0.13± 0.08 b	0.16± 0.13 a	0.13± 0.13 a	0.11± 0.02 a	0.1± 0.01 a	0.1± 0.01 a	0.1± 0.01 a
Taproot length (cm)	6.37± 2.54 a	4.56± 1.01 b	9.73± 2.73 a	8.92± 2.18 b	13.9± 2.89 a	11.43± 2.11 b	16.93± 2.89 a	14.07± 3.84 b
Taproot diameter(cm)	0.995± 2.5 a	0.82± 1.13 b	1.81± 0.48 a	1.89± 0.67 a	2.42± 0.32 a	2.37± 0.38 a	2.46± 0.27 a	2.46± 0.27 a
Ratio L/D	6.32± 1.42 a	5.55± 0.89 a	5.59± 1.53 a	8.33± 14.1 a	5.74± 1.13 a	4.91± 1.05 b	6.93± 1.44 a	5.78± 1.6 b
Root length (cm)	18.06± 3.38 a	14.52± 5.23 b	20.91± 5.11 a	22.73± 4.7 a	23.46± 4.87 a	23.2± 3.44 a	31.66± 5.98 a	27.2± 6.09 a

Mean with the same letters in arrow are not significantly different using (SD Duncan) at ($P \leq 0.05$)

4. CONCLUSIONS

This study provides data on the morphological variation of baobab tree, across Sudan and shows how the research findings help in filling the knowledge gaps highlighted by the literature review. This study reveals that there are many evidences indicating the existence of a number of local eco-types, variations in fruits, leaves and seedling growth.Variation between and within baobab population in fruit and leaf shape may suggest different genetic orgins of baobab which should be taken into a consideration in domestication programs and conservation aspects. It will help in the assessment of variability which will facilitate selection for breeding of better quality, higher yielding cultivars, germplasm characterization and exchange. This may help to protect the species and screen more material to get super-trees as well as enhance the food supply and income generation for the local population. It is recommended that more studies on genetic variation of baobab be performed as a necessity prerequisite to selection and conservation programs.

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Vegetative growth of some grapefruit cultivars, grafted on sour orange and grown in the heavy clay soils of Gezira State, Sudan

Mohammed H. Mekki, Osman M. Elamin and Mohamed E. Elkashif

ABSTRACT

The grapefruit (*Citrus paradisi* Macf.) is one of the most important citrus fruits in the Sudan. The traditional grapefruit cultivar in the Sudan is "Foster" which is a pigmented cultivar, but very seedy. The commercial importance of "Foster" around the world has declined because of its seediness. This experiment was conducted to evaluate the vegetative growth of grapefruit cultivars (as a source of scions) namely: Star Ruby, Rio Red, Frost Marsh, Flame, Little River, Red Blush, Davis, Wheeny, Pink Ruby, Sweetie and Ray Ruby. The cultivars were grafted on sour orange (*Citrus aurantium* L.), then they were grown on heavy clay soils in the horticultural nursery, Faculty of Agricultural Sciences, University of Gezira, Sudan. Planting date was 22 February, 2014. A randomized complete block design with three replicates was used with two seedlings in each plot. The measured parameters were plant height, number of branches/plant, length of branch, thickness of branch and thickness of scion and were recorded from February to December 2015. Results showed that Star Ruby recorded the longest plants, the longest branches, thickest scion and the largest number of branches/plant. Little River cultivar recorded the least vegetative growth. The most vigorous vegetative growth was recorded by Star Ruby cultivar grafted on sour orange in the heavy clay soils of Gezira State, Sudan. It is recommended to grow Star Ruby cultivar in the heavy clay soils as a source of scion.

INTRODUCTION

Grapefruit culture has developed principally in hot tropical and subtropical countries. The tree needs high heat requirements for fruit maturity and requires hot arid climate with fairly high temperatures during most of the year and mild winter. Under such conditions, the fruits attain large size and develop an excellent fruit quality (Sidahmed and Geneif, 1984).

The grapefruit is one of the most important citrus fruit in the Sudan. It can be successfully grown throughout the country where there are suitable soils and sufficient water to sustain tree growth (Babiker *et al.,* 2006). Climatic conditions of the Sudan are suited for grapefruit culture and offer good opportunities for export. The traditionally grown grapefruit cultivars in the Sudan are Foster and Duncan. They are seedy and do not compete well in international markets (Babiker *et al.,* 2006). Growth, flowering, production efficiency and fruit quality of 13 grapefruit cultivars grafted on sour orange

rootstock were evaluated for over a 15- year- period at Sennar Horticultural Research Station, Sudan. The newly introduced cultivars showed vigorous vegetative growth, compared to the locally adapted cultivars (Sidahmed and Khalil, 1997).

Most of today's commercial grapefruit cultivars are selections or mutations from earlier ones, which were replaced gradually with new ones. Consumers prefer large red- fleshed seedless fruits. Red Blush and Ruby Red are red-fleshed grapefruit cultivars with almost identical fruit and tree characteristics and were selected in Texas. Other cultivars include Henderson, Ray Ruby and Rio Red. Henderson has deeper red flesh and peel color than Ruby Red. Ray Ruby has even deeper red flesh than Henderson. Ray Ruby is a mutation of Ruby Red. Rio Red is a seedling selection from Ruby Red. Flesh color of Rio Red is deeper than that of Ray Ruby with higher yields. Flame cultivar originated from Henderson as a seedling. Peel color is similar to Ray Ruby and internal color is similar to Star Ruby. Ray Ruby, Flame and Rio Red, develop red color on the rind and flesh even in tropical warm climates. Star Ruby fruits have very deep red flesh with reddish blush on the peel (Ladaniya, 2008).

The major rootstock of citrus in the Sudan is sour orange (*Citrus aurantium* L.) which has many advantages compared to other rootstocks. It is tolerant to *phytophtora* disease and has a strong root system to penetrate clay soils and give vigorous growth, good fruit size and very good fruit quality. The major disadvantage of sour orange is its susceptibility to trestiza virus (Davies and Albrigo, 1998).

This experiment was aimed to evaluate vegetative growth (as source of scion) of 11 grapefruit cultivars grafted on sour orange and grown in the heavy clay soils of Gezira State, Sudan.

MATERIALS AND METHODS

Eleven grapefruit cultivars (Star Ruby, Rio Red, Frost Marsh, Flame, Little River, Red blush, Davis, Wheeny, Pink Ruby, Sweetie and Ray Ruby) were grafted on sour orange (one year old) and grown on heavy clay soils (after 12 months of grafting) in the horticultural nursery, Faculty of Agricultural Sciences, University of Gezira, Sudan (14^0 24′ N, 33^0 29′ E, and 407 masl). Planting date was 22 February, 2014. A randomized complete block design with 3 replicates and 2 seedlings/plot was used. The measured parameters were pant height (cm), number of branches/plant, length of branches (cm), thickness of branches (cm) and thickness of scion (cm) and were recorded from February to December 2015.

The data were statistically analyzed using MSTAT program. Means were separated using Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Table 1 shows plant height of 11 grapefruit cultivars grafted on sour orange and grown in heavy clay soil of Gezira State, Sudan. Differences were significant between cultivars during the months of evaluation. Star Ruby cultivar recorded the most vigorous vegetative growth. This result is in agreement with that reported by Sidahmed and Khalil (1997) who found significant differences in plant height of 13 grapefruit cultivars grafted on sour orange under central Sudan conditions. Khan *et al.* (2015) also found significant differences in plant height of twelve orange cultivars grafted on sour orange under Pakistan conditions. Nabi *et al.* (2004) recorded significant growth differences among grapefruit genotypes grafted on sour orange under climatic conditions of Peshawar. Becerra-Rodriguez *et al.* (2007), Ali-Akbar and Alierzanezhad (2005) referred the significant differences in growth of grapefruit and pummelo cultivars, grafted on sour orange, to genetic characters of cultivars.

Table 1. Plant height (cm) of 11 grapefruit cultivars grafted on sour orange.

Cultivars	Plant height (cm)					
	February	April	July	August	October	December
Davis	97.8 bc	121.2 b	129.0 b	132.3 b	134.7 b	136.3 b
Flame	89.3 c	105.8 c	114.8 c	117.5 c	119.7 c	121.0 c
Frost Marsh	98.2 bc	122.0 b	126.7 b	128.7 b	130.7 b	132.5 bc
Little River	86.0 c	102.5 c	107.8 c	109.5 d	111.5 c	113.2 c
Pink Ruby	100.0 bc	113.5 b	118.7 bc	122.3 bc	124.5 bc	132.0 bc
Ray Ruby	93.3 bc	104.8 c	111.8 c	115.0 c	117.0 c	118.7 c
Red Blush	98.2 bc	112.7 bc	117.7 bc	119.8 c	122.0 c	123.7 c
Rio Red	107.2 b	122.5 b	125.8 b	129.2 b	131.2 b	133.0 bc
Star Ruby	126.3 a	149.8 a	154.7 a	157.3 a	159.3 a	161.0 a
Sweetie	107.8 b	119.7 b	123.0 b	126.8 b	129.2 bc	130.8 bc
Wheeny	78.3 c	83.2 d	86.5 d	88.5 e	89.8 d	91.3 d
Sig. level	*	*	*	*	*	*
SE±	11.71	11.98	11.63	11.59	11.66	11.47
CV(%)	20.96	18.45	17.11	16.67	16.49	15.94

* Significant at the $P \leq 0.05$ level.

Means followed by different letters in columns are significantly different according to Duncan's Multiple range Test.

Table 2 shows length of branches of 11 grapefruit cultivars grafted on sour orange and grown in heavy clay soil of Gezira State, Sudan. Differences were significant among cultivars during the months of

evaluation. Also, Star Ruby cultivar recorded the highest length of branches. This result is in agreement with Sidahmed and Khalil (1997) who found significant differences in length of branches of 13 grapefruit cultivars when grafted on sour orange under conditions of central Sudan. Also, Khan *et al.* (2015) found significant differences in internodes length among twelve orange cultivars when grafted on sour orange under Haripur conditions in Pakistan. Nabi *et al.* (2004) recorded significant growth differences among grapefruit cultivars grafted on sour orange under climatic conditions of Peshawar.

Table 2. Length of branches (cm) of 11 grapefruit cultivars grafted on sour orange.

Cultivars	Length of branches (cm)					
	February	April	July	August	October	December
Davis	44.5 b	61.1 b	69.1 b	70.3 b	71.5 b	73.2 b
Flame	37.7 cd	53.1 cd	61.6 cd	63.2 c	64.8 cd	65.9 c
Frost Marsh	38.7 c	52.1 d	58.5 d	59.6 cd	61.1 d	62.7 c
Little River	45.3 b	57.6 c	62.4 cd	64.0 c	65.1 cd	66.7 c
Pink Ruby	45.7 b	55.8 cd	65.0 bc	68.4 bc	69.2 bc	71.1 bc
Ray Ruby	48.6 b	63.4 b	69.0 b	70.7 b	72.9 b	73.2 b
Red Blush	48.7 b	60.9 b	69.7 b	71.2 b	72.8 b	74.2 b
Rio Red	47.9 b	70.1 a	68.3 b	70.5 b	72.1 b	73.5 b
Star Ruby	57.4 a	68.8 a	80.1 a	81.7 a	84.5 a	85.6 a
Sweetie	44.5 b	59.8 bc	68.6 b	71.0 b	72.4 b	73.9 b
Wheeny	33.2 d	54.6 cd	57.0 d	58.7 d	59.9 d	61.6 c
Sig. level	*	*	*	*	*	*
SE±	4.71	5.91	5.14	5.14	5.00	5.10
CV(%)	18.55	17.42	13.67	13.30	12.62	12.61

* Significant at the $P \leq 0.05$ level.

Means followed by different letters in columns are significantly different according to Duncan's Multiple range Test.

Table 3 shows thickness of scion of 11 grapefruit cultivars grafted on sour orange and grown in heavy clay soil of Gezira State, Sudan. Differences were significant among cultivars during the twelve months of evaluation. Star Ruby recorded the highest scion thickness during months of evaluation. There were no significant differences between Star Ruby and Davis during July, August, October and December. This result is in agreement with those of Sidahmed and Khalil (1997) who found significant differences in scion thickness of 13 grapefruit cultivars when grafted on sour orange under central Sudan conditions. Also, Khan *et al.* (2015) found significant differences in shoot thickness among twelve orange cultivars when grafted on sour orange and evaluated under Pakistan conditions. Nabi *et al.* (2004) recorded significant growth differences among grapefruit cultivars grafted on sour orange under climatic conditions of Peshawar.

Table 3. Thickness of scion (cm) of 11 grapefruit cultivars grafted on sour orange.

Cultivars	Thickness of scion (cm)					
	February	April	July	August	October	December
Davis	1.5 b	1.8 b	2.1 a	2.2 a	2.3 a	2.5 a
Flame	1.4 b	1.7 bc	1.8 b	2.0 b	2.1 b	2.3 b
Frost Marsh	1.3 c	1.6 c	1.8b	2.0 b	2.1 b	2.3 b
Little River	1.2 c	1.4 d	1.6 c	1.7 c	1.8 c	2.0 c
Pink Ruby	1.3 c	1.5 cd	1.8 b	1.9 bc	2.0 bc	2.2 bc
Ray Ruby	1.5 b	1.7 bc	1.9 b	2.0 b	2.1 b	2.3 b
Red Blush	1.4 bc	1.6 c	1.8 b	1.9 bc	2.0 bc	2.2 bc
Rio Red	1.4 bc	1.6 c	1.8 b	2.0 b	2.1 b	2.3 b
Star Ruby	1.8 a	2.1 a	2.2 a	2.3 a	2.4 a	2.6 a
Sweetie	1.3 c	1.5 cd	1.6 c	1.8 c	1.9 c	2.1 c
Wheeny	1.2 c	1.5 cd	1.6 c	1.7 c	1.9 c	2.0 c
Sig. level	*	*	*	*	*	*
SE±	0.14	0.16	0.18	0.19	0.18	0.19
CV(%)	18.25	17.8	17.73	16.76	15.66	14.64

* Significant at the $P \leq 0.05$ level.

Means followed by different letters in columns are significantly different according to Duncan's Multiple range Test.

Table 4 shows thickness of branches of 11 grapefruit cultivars grafted on sour orange and grown in heavy clay soil of Gezira State, Sudan. Differences were significant during the months of evaluation. However, Star Ruby recorded the highest thickness of branches. There were no significant differences between Star Ruby and Davis during the months of evaluation. This result is in agreement with those of Nabi *et al.* (2004) who found significant growth differences among grapefruit cultivars when grafted on sour orange and evaluated under Peshawar conditions.

Table 4. Thickness of branches (cm) of 11 grapefruit cultivars grafted on sour orange.

Cultivars	Thickness of branches (cm)					
	February	April	July	August	October	December
Davis	1.5 a	2.2 a	2.6 a	2.9 a	3.1 a	3.3 a
Flame	1.4 b	2.1 b	2.3 c	2.5 c	2.7 b	2.9 b
Frost Marsh	1.6 a	2.1 b	2.4 bc	2.6 bc	2.9 ab	3.2 a
Little River	1.3 b	2.0 b	2.3 c	2.5 c	2.7 b	3.0 b
Pink Ruby	1.3 b	2.0 b	2.4 bc	2.6 bc	2.8 b	3.1 b
Ray Ruby	1.4 b	2.1 b	2.2 c	2.4 c	2.7 b	2.9 b
Red Blush	1.5 a	2.1 b	2.5 b	2.6 bc	2.8 b	3.1 b
Rio Red	1.4 b	2.1 b	2.6 a	2.8 a	3.1 a	3.4 a
Star Ruby	1.5 a	2.3 a	2.7 a	2.9 a	3.2 a	3.4 a
Sweetie	1.5 a	2.1 b	2.4 bc	2.7 b	2.9 ab	3.1 b
Wheeny	1.1 c	1.6 c	1.8 d	1.9 d	2.0 c	2.2 c
Sig. level	*	*	*	*	*	*
SE±	0.11	0.14	0.18	0.19	0.21	0.22
CV(%)	13.54	12.03	12.96	13.42	13.27	12.68

* significant at the $P \leq 0.05$.

Means followed by different letters in columns are significantly different according to Duncan's Multiple range Test.

Table 5 shows no significant differences among grapefruit cultivars on number of branches/plant during the first six months of evaluation and differences appeared on the last six months. These results agree with those of Sidahmed and Khalil (1997), Khan *et al.* (2015), Nabi *et al.* (2004) and Becerra-Rodriguez *et al.* (2007) who found significant growth differences among grapefruit, orange and pummelo cultivars when grafted on sour orange and evaluated under different conditions.

Table 5. Number of branches/plant of 11 grapefruit cultivars grafted on sour orange.

Cultivars	Number of branches/plant					
	February	April	July	August	October	December
Davis	4.0	5.3	6.3	7.2 a	7.3 b	8.0 a
Flame	3.5	4.3	5.5	6.3 b	6.8 bc	7.5 b
Frost Marsh	4.3	4.8	5.5	5.7 c	6.7 c	7.0 bc
Little River	3.3	4.2	5.0	6.0 b	6.2 d	7.0 bc
Pink Ruby	3.0	4.7	5.5	5.7 c	6.5 c	6.7 c
Ray Ruby	3.2	4.2	5.0	5.8 bc	6.3 cd	7.0 bc
Red Blush	2.2	3.5	4.5	5.3 c	5.8 d	6.5 c
Rio Red	3.2	4.2	5.0	6.2 b	6.7 c	7.5 d
Star Ruby	5.0	5.8	6.8	7.5 a	8.3 a	8.5 a
Sweetie	3.0	3.8	4.7	5.3 c	5.7 d	6.5 c
Wheeny	2.3	2.8	3.3	3.5 d	4.0 e	4.5 d
Sig. level	NS	NS	NS	*	*	*
SE±	0.58	0.56	0.65	0.59	0.61	0.58
CV(%)	30.13	22.74	22.02	17.69	16.68	14.74

* and NS, significant at the P≤0.05 and not significant, respectively.

Means followed by different letters in columns are significantly different according to Duncan's Multiple range Test.

CONCLUSIONS

The performance of 11 grapefruit cultivars grafted on sour orange rootstock and grown in heavy clay soils of Gezira State, Sudan conditions was good. Star Ruby cultivar recorded the most vigorous vegetative growth.

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تقويم النمو الخضري لبعض أصناف القريب فروت المطعومة على النارنج والمزروعة في الأراضي الطينية الثقيلة بولاية الجزيرة، السودان

محمد حامد مكي وعثمان محمد الأمين و محمد الحاج الكاشف

الخلاصة

واحد من أهم الفاكهة في السودان. الصنف التقليدي المزروع في السودان هو (*Citrus paradisi* Macf.) يعتبر القريب فروت حول العالم تناقصت بسبب أنه صنف بذري. تهدف هذه "Foster" الذي يتصف بأنه بذري وملون. الأهمية التجارية للصنف "Foster" و Frost Marsh و Rio Red و Star Ruby(كمصدر للطعوم) وتشمل: التجربة إلى تقويم النمو الخضري لأصناف القريب فروت . تم تطعيم هذه الأصناف Ray Ruby و Sweetie و Pink Ruby و Wheeny و Davis و Red Blush و Little River و Flame ومن ثم تمت زراعتها على التربة الطينية الثقيلة في مشتل البساتين ، كلية العلوم الزراعية ، (*Citrus aurantium* L.)على النارنج جامعة الجزيرة ، السودان. كان تاريخ الزراعة في يوم 22 فبراير 2014م. القطاعات العشوائية الكاملة تم إستخدامها بثلاث مكررات و2 شجرة/الوحدة. الصفات التي تم قياسها شملت طول النبات وعدد الأفرع في النبات وطول الفرع وسمك الفرع وسمك الطعمة وتم اخذ سجل أفضل طول نبات وأفضل طول الأفرع Star Rubyالقراءات في الفترة من فبراير إلى ديسمبر 2015م. أظهرت النتائج أن الصنف المطعوم على النارنج Star Ruby أعطى أقل نمو خضري. الصنف Little Riverوأفضل سمك للطعم وأكبر عدد فروع/النبات. الصنف أعطى أفضل نمو خضري(كمصدر للطعمه) في الأراضي الطينية الثقيلة بولاية الجزيرة السودان.

بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

Effect of parathyroid gland disorders on uncontrolled hypertension in hemodialysis patients

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ABSTRACT

Uncontrolled hypertension is a common problem in the patients of end stage kidney disease. Upgrading of anti-hypertensive medication using different classes of anti-hypertensive drugs is the usual method of decreasing high blood pressure ((Foley et al 1996). The aim of this study is to look for the role of Parathyroid gland in the management of resistant hypertension. The study had been carried out in the period from august 2013 to February 2014 in Sinner Dialysis Center. The data was collected from 80 hypertensive cases, with, or without parathyroid disorder, and under regular hemodialysis. All patients were adult age. Patients not compliant to anti-hypertensive medication, normotensive are excluded. All data is collected using questionnaire including personal data. The study showed that 59% of study group suffering uncontrolled hypertension, 81% of them have hyperparathyroidism, regarding parathyroid function 71% of all patients have hyperparathyroidism, 66% of them have uncontrolled hypertension, only 4% of all patients have hypoparathyroidism, in spite this weak positive relationship observed, so any uncontrolled hypertensive patient should had investigate his parathyroid function, in addition to regular interval follow up, finding of this study is in agreement with Anthonye from Oxford University, England he found that Systolic, diastolic and mean blood pressure were higher in the 17 hyperparathyroidism patients than in the 10 patients with normal PTH(Anthony).

Keys words uncontrolled hypertension, parathyroidism, hemodialysis.

INTRODUCTION:

Uncontrolled Hypertension

It is defined as persistence of unusual above 140/90 mm Hg despite treatment with full dose of three or more different classes of medications including diuretic in rational combination (Dennis et al 2008).

The most common pattern of BP in dialysis patients is systolic hypertension associated with a wide pulse pressure due to atherosclerotic arterial stiffness (Locatelli et al 2004). Extracellular fluid overload is the most common feature in hypertensive dialysis patients. Indeed, insufficient volume removal is often the major factor responsible for dialysis-refractory hypertension Extracellular volume overload, Dysregulation of the renin-angiotensin-aldosterone system, Sympathetic over activity, Imbalance in endothelium-derived vasoactive substances, Erythropoietin replacement therapy, Secondary hyperparathyroidism, and Nocturnal hypoxemia and sleep disturbances, (Parfrey 1996) (Fishbane et al 1996).

Parathyroid Glands

The parathyroid glands are four pea sized glands located on the thyroid gland in the neck.

The parathyroid glands secrete parathyroid hormone (PTH), secondary hyper parathyroidism (SHPT) to chronic kidneys disease is over production of PTH caused by several changes that occur in bone and mineral metabolism as a result of decreased kidney function . The first changes that usually occur with declining kidney function involve the deficiency of activated vitamin D and an increase in phosphorus excretion by the remaining functional nephrons. Both of these changes stimulate an increase in PTH

Synthesis and secretion (Friedman 2005), (Qunibi 2004), (Hernandez et al 2005), (Cozzolino et al 2005), (Horl 2004), (Coen 2005), (Goodman et al 2000).

THE PROBLEM:

Uncontrolled hypertension is a great problem facing staff in renal units and dialysis centers. It is a hard stone to overcome in spite of using a wide range of anti-hypertensive medication, and adjust dry weight.

Persistent hypertension increased risk of stroke, in addition to increase after load upon the tired, illheart, leading to more ischemia, myocardial infarctions and their subsequences.

This study tried to find out the relation between uncontrolled hypertension and parathyroid disorder opening a new way in treatment of uncontrolled hypertension.

OBJECTIVE:

The general objective is to study the relation between uncontrolled hypertension and parathyroid disorder in hemodialysis patients.

MATERIALS AND METHODS.

This study had been carried out in the period from August 2013 to February 2014 in Sinner Dialysis Center, . The data were collected from 80hypertensive cases, with, or without parathyroid disorder, and under regular hemodialysis for 1 year or more, twice per week, through A-V fistula in most cases, the residual by venous catheters.. All patients were adult and more than 15 year old. Patients not compliant to anti-hypertensive medication, normotensive were excluded. Serum parathyroid hormone level was done by Tosoh AIA-360 analyzer, All data were collected using a questionnaire including personal data +reading of blood pressure + number and type of anti-hypertensive medication.

RESULTS

Table *(*1) Age Distribution and Frequency of respondents

Age	15-30	30-45	45-60	60<	total
Frequency	20	36	19	5	80
Percentage	25 %	45 %	24 %	6 %	100%

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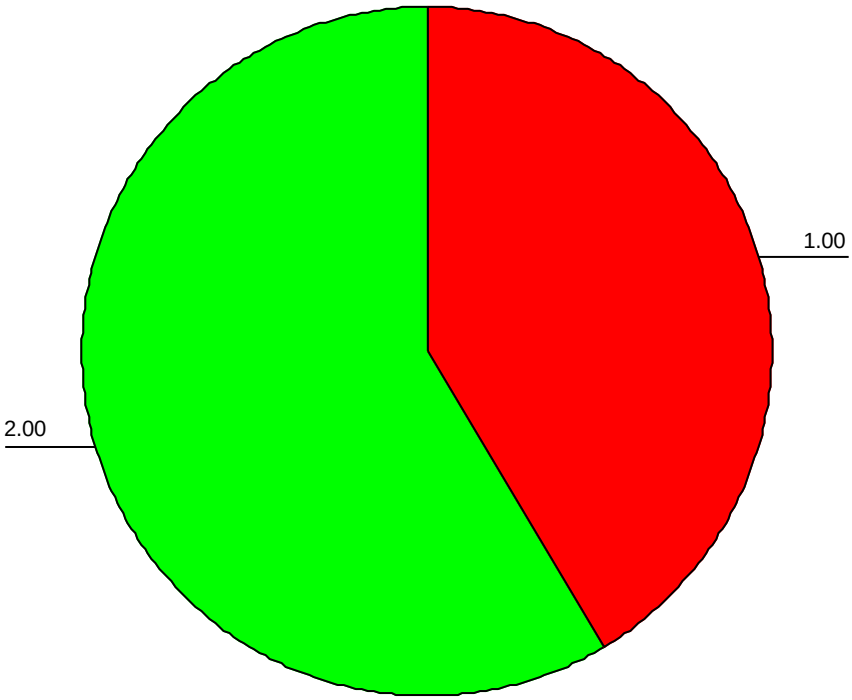
Figure (1) Controlled and Uncontrolled hypertension percentage



Keys words

1 Controlled 41%.

2 Uncontrolled 59%

Table (2) Parathyroid Hormone Disorders Frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Hypo	3	4	4	3.8
	Normal	20	25	25	28.8
	Hyper	57	71	71	100.0
	Total	80	100.0	100.0	

Table (3) Parathyroid Hormone * Blood Pressure Cross Tabulation

	blood pressure		Total
Parathyroid hormone	Controlled	Uncontrolled	
hypo	2	1	3
normal	11	8	19
hyper	20	38	58
Total	33	47	80

Table (4) Relation Between Hyper Parathyroidism and Blood Pressure

Parathyroid hormone	Controlled hypertension	Uncontrolled hypertension	Total
Frequency	20	38	58
percentage	34%	66%	100%

Table (5) Relation between Uncontrolled Hypertension andParathyroid Hormone Disorder

Uncontrolled hypertension	Hyper parathrodism	Normal parathyroid	Hypo parathrodism	Total
frequency	38	8	1	47
percentage	81%	17%	2%	100%

Table (6) Correlation Test Between Parathyroid Disorders and Blood Pressure Disorders

blood pressure	parathyroid hormone	Correlation test	
.221(*)	1	Pearson Correlation	parathyroid hormone
.049	.	Sig. (2-tailed)	
80	80	N	
1	.221(*)	Pearson Correlation	blood pressure
.	.049	Sig. (2-tailed)	
80	80	N	

* Correlation is significant at the 0.05 level (2-tailed).

DISCUSSION

The study showed that 80 cases under regular hemodialysis25% of them their age between 15-30 and 45% between 30-45 and 24% between 45-60 and 6% above 60(table 1). Regarding blood pressure 59% suffer uncontrolled hypertension, and 41% have controlled hypertension (figure 1). On the other hand had 25% of all cases have normal parathyroid function, and 71% have hyperparathyroidism, and only 4% have hypoparathyroidism(table2). The study showedthat 66%of the hyperparathyroidism patientshave uncontrolled hypertension(table 4), and 81% of uncontrolled hypertension patients suffer hyperparathyroidism (table 5).

Correlation test between parathyroid hormone and blood pressure disturbance is significant at the 0.05level (2-tailed) it is found 0.49, and the P value is .221(*). So the variable has week positive relationship (table 6).

In spite of high percentage of both groups in each other in cross tabulation in tables 3, 4, 5, there is weak positive relationship in correlation test in table 6, this is can be explained by that renal failure and its effect on calcium metabolism, and fluid balance generate both conditions with little effect of parathyroid gland disorders on blood pressure because of interference of calcium metabolism.

This was in line with Heyliger et al 2009, they concluded that parathyroidctomy in hypertensive patients seems to reduce both systolic and diastolic blood pressure (Heyliger et al 2009), Also the study agree with Franek et al 1997 who concluded that sub-acute administration of physiological doses of parathyroid hormone under hyperinsulinaemic conditions significantly affects intracellular calcium and blood pressure in healthy subjects, but does not affect the action of insulin(Franek E et al 1997), .

RECOMMENDATIONS:

After the enumeration of the results that are related to the following the study, there are some ideas which could help further in the field of the research and are better to be recommended as follows:

- Close monitoring of parathyroid function is very important in management of hemodialysis patients especially those suffering from uncontrolled hypertension.
- Medical and interventional studies in management of uncontrolled hypertension, like parathyroidctomy should be put in mind.

CONCLUSIONS:

This study was done in Sudan at Sinnar Teaching Hospital on 80 end stage kidney disease patients on hemodilysis. Their ages were 15 years old or more, Patient not compliant to anti-hypertensive medication, or normotensivewere excluded.

The goal of this research is to study relation between uncontrolled hypertension and parathyroid disorder in hemodialysis patients.

The study showed that 59% of study group suffering uncontrolled hypertension, 81% of them have hyperparathyroidism.

In respect of parathyroid function 71% of all patients have hyperparathyroidism, 66% of them have uncontrolled hypertension, only 4% of all patients have hypoparathyroidism, in spite of this weak positive relationship is observed.

Regular follow up to the parathyroid function is mandatory in management of hemodialysis patients.

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الملخص

ارتفاع ضغط الدم الشرياني المقاوم للعقاقير واحد من المشاكل الشائعه في وسط مرضي الفشل الكلوي النهائي. التدرج في العقاقير الخافضه لارتفاع الضغط باستعمال ادويه مختلفه من تصنيفات مختلفه وسيله متبعه في تخفيض ارتفاع الضغط ، هدفت هذه الدراسه لبحث علاقة هرمون الغده جار الدرقيه في علاج ارتفاع ضغط الدم المقاوم للعقاقير، تمت الدراسه في الفتره من اغسطس من العام 2013 الي فبراير ااعام 2014 في مركز سنار لغسيل الكلي . جمعت البيانات من 80 مريض بارتفاع الضغط بالاضافه لخلل بوظائف الغده جار الدرقيه او عدمه، مداومين علي الاستصفاء الدموي . كل المرضي بالغين، المرضي غير المنتظمين بالعلاج او لا يعانون ارتفاع الضغط ابعدوا عن الدراسه. جمعت كل البيانات باستخدام استبيان يحوي المعلومات الشخصيه، اظهرت الدراسه ان 80مريض مدوامين علي الاستصفاء الدموي 59% منهم يعانون ارتفاع ضغط الدم الشرياني غير المستجيب للعقاقير حيث ان 81% منهم مصابون بارتفاع نسبه هرمون الغده جار الدرقيه. اما فيما يخص وظائف الغده جار الدرقيه 71% من جملة المرضي يعانون من ارتفاع وظائفها 66% منهم مصابون بارتفاع ضغط الدم الشرياني الغير مستجيب للعقاقير، فقط 4% من كل المرضي مصابون بهبوط وظائف الغده جار الدرقيه، بالرغم من هذا لوحظت علاقيه ايجابيه ضعيفه بينهما، لذا يجب ان يخضع مريض ارتفاع ضغط الدم الشرياني غير المستجيب للعقاقير لفحص وظائف الغده جارالدرقيه، بالاضافه للمتابعه الدوريه المنتظمه، اتفقت هذه الدراسه مع انتوني من جامعة اوكسفورد في بريطانيا حيث انه وجد ان الضغط الشرياني الانبساطي والانقباضي والمتوسط مرتفع عند 17مريض يعانون من ارتفاع هرمون الغده جار الدرقيه عن 10 اشخاص لديهم هرمون الغده الجار الدرقيه في المستوي الطبيعي

Evaluation of a pneumatic precision planter Performance for direct seeding of onion (*Allium cepa* L) on raised beds under Gezira conditions, Sudan

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ABSTRACT

This experiment was conducted at the Experimental Farm of the Faculty of Agricultural Science, University of Gezira (latitude $14^0\ 25'39.43"$ N, longitude $33^0\ 29'\ 21.39"$ E) to investigate the possibility of direct seeding of onion on raised beds of the Gezira clay soil. Four main direct seeding methods of onion were tested, using a pneumatic precision planter and compared with the traditional transplanting method. The treatments were seeding at 4km/hr (S_4) with covering device, seeding at 4km/hr without covering device, seeding at 7km/hr (S_7) with covering device, planting at 7km/hr without covering device and control (transplanting). A randomized complete block design (RCBD) was used with four replications. Results showed that onion seeds could be directly sown by the pneumatic precision planter on raised beds using 7km/hr speed. Although all the methods gave plant population far below the recommended, no significant differences were found among treatments. With regard to bulb diameter, yield and number of bulbs, the direct seeding methods gave the best results compared with the conventional method. Plant population was not significantly different between the conventional method and S_7 treatment.

INTRODUCTION

Onion is the most important and popular vegetable crop in the Sudan. It is grown in most States of the Sudan as a winter crop during the period from October to February (Ali,2009)

Soil structure is important for onion establishment. An ideal soil structure is a mixture of small granules mixed with enough fine-textured soil particles to provide a firm, smooth planting surface. Extremely fine soil particles work well if the beds do not become crusted by rainfall or flooding of the beds before germination (Cogran*et al*, 2000). However, the crusts that form on a powdery soil tend to be tougher than crusts that form on soils with more granular structure. Larger size granules (clods) may interfere with precision seed placement, and if the large granules are not mixed with fine textured particles, seeds may settle to greater than desirable depths. At optimum conditions, seeds planted in cloddy soils tend to have uneven and erratic germination.

A desirable planting surface requires pre-irrigation on most soils. The sequence of operations in soil preparation starts with plowing, followed by disk harrowing leveling, ridging, pre-irrigation, rotary cultivation, shaping, and applying pre-plant fertilizer (Corgan*et al*, 2000). The

pre-plant fertilizer is most effective if applied after pre-irrigation. If the fertilizer is to be banded, then it can be done by mounting the fertilizer applicator with the bed shaper. Fertilizer broadcasting is applied following rotary cultivation and incorporated by running the rotary cultivators for a second time.

For salad onions, a bed system with several rows at a narrow spacing is used. For bulb production, beds can also be used or machinery can be adapted to other systems, like ridges, furrows, or on the flat, using precision seeders. Bracy and Parish (1998) stated that different planters gave different overall uniformity and percentage of misses that ranged from 15% in the Stanhay belt-type seeder in comparison to 5% for the Carraro vacuum-type model.

Ideally, under direct seeding, the soil should be kept damp until the seedlings emerge. Drying out at the establishment stage can lead to uneven emergence, which reduces uniformity of development throughout the life cycle of the crop. A well worked but dense layer of soil is needed below the seeds so that water can reach the seeds by capillarity. A press wheel or a roller is used to firm the soil around the seed, as close contact of the seed with the soil improves water uptake, a factor that enhances more even germination and allows good primary root development. Under seedbeds with a risk of crust formation, flat profiles must be avoided. Under such conditions, concave bed profiles above the seed are preferred. If stagnant water is a problem, a convex profile is recommended (Kretschmer, 1994).

Whalley*et al*. (1999) showed that mechanical compaction from 0.19 to 0.75 MPa of mean penetrometer pressure reduced the rate and extent of onion shoot development, but affected roots less than shoots.

The development of agricultural machinery and chemical weed control provided opportunities for direct seeding of onion in the Sudan, considering the high wages of manual labor for transplanting. Several experiments were conducted in this regard in the last three years in Sulait Project east of Khartoum State and some special projects in the River Nile State. Tests proved to be successful in reducing production cost by about 30% compared to the traditional method (manual transplanting). In addition, it doubled the yield and resulted in early harvest (Ali, 2009)

McRobie (1990) reported that precision planters resulted in the correct seeding depth, high germination percentages and reduced amount of seeds required. They also allowed easier weeding and drilling of fertilizers.

Traditional method:

Seeds are sown in the nursery using a seed rate of about 4.8 kg per ha. The nursery usually established during the period from mid-August to September and the seedlings transplanted to the field after about six weeks from sowing in the nursery. Irrigation of seedlings should be stopped a week before uprooting of the transplants. A light irrigation recommended for help in uprooting of seedlings without injuring the roots. The soil is plowed and super-phosphate is added at the rate of 96 kg/ha, and the soil is refined and leveled when sowing in light loam soil and ridged into 70 cm furrows in case of heavy clay soil. There are usually four lines of transplants on the ridge. When transplanting in flat, the lines should be 20 cm apart and the distance between plants is 5-10 cm. The field must be irrigated immediately after transplanting. Transplanting is preferably practiced early in the morning or late in the afternoon. A month after transplanting, urea fertilizer at rate of 100 kg /ha will be added and the same dose repeated one month after the first dose (Ali, 2009).

The objective of this work was to investigate the performance of a pneumatic precision planter for direct seeding of onion seeds.

MATERIALS AND METHODS

The experimental site:

The experiment was conducted at the Experimental Farm of the Faculty of Agricultural Sciences, University of Gezira, Wad Madani, Sudan, the winter season of the year 2015. The Farm is located at latitude $14^0\,25'39.43"$ N, longitude $33^0\,29'\,21.39"$ E. The soil is heavy cracking clay; characterized by high water-holding capacity and poor internal drainage (Metrological Station, 2012).

layout:

Four main direct seeding methods of onion were tested and compared with the traditional transplanting method. The treatments were as follows:

1. Direct seeding on raised beds using a pneumatic precision planter at the speeds of:
    a. Seeding at 4km/hr (S_4) with covering device (S_4WCD)
    b. Seeding at 4km/hr without covering device (S_4WOCD)
    c. Seeding at 7km/hr (S_7) with covering device (S_7WCD)
    d. Seeding at 7km/hr without covering device (S_7WOCD)
2. Control (manual transplanting).

Raised bed shaping:

The bed dimensions were 150 cm wide (from furrow centers) the top furrow width was 55cm and about 20cm deep. The randomized complete block design (RCBD) was used with four replications. The plots were rectangular in shape (42m×3.2m). The following parameters for the planter and the crop were tested:

1. Planter parameters:
    a. Field capacity.
    b. Field efficiency.
    c. Fuel consumption.
2. The crop parameters:
    a. Plant population.
    b. Onion bulb yield.
    c. Bulb diameter.

Materials:

Mahindra tractor (80HP) was used to power the implements,chisel plow for primary tillage, ridger, ditcher to open water ditches, bed shaper to establish the beds and a pneumatic precision planter. Onion seeds (Baftaim cultivar) was used. Other materials included Petri dishes, stop watch, measuring tape, granulated and soluble fertilizers, Imidacloprid 17.8 % SLPymetrozine (Chess 50WG) pesticides, Knapsack sprayer,*Najjama* for weed control, a square meter frame, plastic bags, digital balance, a vernier to measure the diameter of the bulb and a 100 m measuring tape.

Pneumatic planter:

Description	**Value**
Model	ORIETTA CS
Working width	1.5-2.0 m
Number of planting units	6

No. of rows per unit	2
Maximum required tractor pump pressure	180 bar
Recommended working speed range	3-5 (km/h)

Pattern of sowing:

The pneumatic precision planter was used for direct planting of onion seeds. The planter air vacuum was set to 20 mille-bars, the twin rows are seven cm spaced. Between units spacing was set to 11cm, while the spacing between seeds within row was adjusted to 10 cm. The seed plates used have 48 cells arranged into two rows; the cell is 1.1mm in diameter. Sowing depth was adjusted to 2 cm.

Experimental Methods:

Tractor forward speed:

For measuring the actual speed of the tractor in the field, a distance of 50 m was measured and fixed by two flags using a 100 m measuring tape. The planter was hitched to the tractor and put into operation depth and gauge pressure. Two speeds were tested. The second gear was used for the first speed (S_4) (4 km/hr), while the fourth gear was used for speed (S_7) (7km/hr). Time taken to cover this distance and the corresponding engine rpm for each speed were recorded. Each speed was replicated four times. The means were taken and then the actual average speed was calculated by the following formula;

$$\text{Actual operation speed } \left(\frac{\text{km}}{\text{hr}}\right) = \frac{\text{covered distance(m)}}{\text{elapsed time (min)}} \times \frac{60 \text{ min} \times 1\text{km}}{1000 \text{ m} \times 1\text{hr}} \quad \text{.....(1)}$$

Fuel consumption:

The tractor fuel tank was topped at the starting point of planting 4.2 ha area. After the completion of planting the area, the tractor engine which was stopped and the fuel tank was refilled using a measuring cylinder. Then the fuel consumption was calculated by the formula;

$$\text{Fuel consumption } \left(\frac{\text{L}}{\text{ha}}\right) = \frac{\text{Consumed fuel (L)}}{\text{4.2 (ha)}}. \quad \text{.....(2)}$$

Operating time:

A distance of 50 meters was marked by two flags fixed outside the boundaries of the experimental plots in order to determine the speeds of planting. The time required to cover the distance was recorded using the stopwatch.

Machine field efficiency:

The theoretical field capacity was calculated using the formula:

$$C_T = \frac{sw}{c}$$

Where:

C_T is the theoretical field capacity (ha/hr), s is the forward speed (km/hr), w is the implement width (m) and c is a constant (10). The actual field capacity was obtained by recording the time required to cover 0.1 ha (hr/ha), then dividing one by that number gives the actual field capacity in (ha/hr). Machine field efficiency was calculated by the following formula;

$$\text{Machine field efficiency(Ef)\%} = \frac{\text{Actual field capacity } \left(\frac{\text{ha}}{\text{hr}}\right)}{\text{Theoratical field capacity } \left(\frac{\text{ha}}{\text{hr}}\right)} \times 100\% \quad \text{.....(3)}$$

The two tested speeds of 4 and 7km/hr were estimated from the tractor gear-speed range and accordingly the theoretical calculated field capacities of 0.6 ha/hr for speed 4km/hr and 1.05 ha/hr for speed 7km/hr were calculated based on 1.5m effective width of the planter as shown in Table 1.

Plant population:

A square meter metal frame was used for the determination of plant population.

Onion yield:

Yield of onion was obtained using a square meter frame of metal rod. It was laid on the mature onion randomly, and the onion from the determined area (meter square) was collected for each plot. Plastic bags were used to take samples of the onion. The collected material was weighed using a digital balance.

Seed germination test:

Alaboratory germination test for seeds carried out two weeks before executing the experiment. Five replications in five Petri dishes, the base of each Petri dish was covered with wet filter paper. A sample of 100 random seeds was placed in each dish. Germination count was recorded daily until a fixed number of germinated seeds per dish were obtained.

Statistical analysis:

Data were subjected to standard analysis of variance procedures. The Duncan's Multiple Range Test was used for means separation. The SPSS was used for analysis of the data.

RESULTS AND DISCUSSION

Thousand seed weight and germination test:

The 1000 seed weight was found to be 4.02g and the germination test was 80.2%. The recommended seed rate was divided by the germination percentage. Accordingly, the seed rate was more than the recommended by 20%.

Machine field efficiency:

Table 1 shows that the actual field capacities were 0.6 and 1.07 ha/hr for S_4 and S_7 respectively, with time efficiency of 0.97 and 0.98 for S_4 and S_7 respectively when compared to the theoretical. The result indicated uniform and steady speed at S_4, but some acceleration and deceleration at speed S_7. This may be attributed to the fact that there was no need to slow down at the cross ridges or depressions for (S_4) while (S_7) necessitates slowing down and speeding up. The covering devices were not expected to affect plant population, rather than straightness of planting rows. Comparing the actual field capacity of the two speeds (S_4) and ($S_{7)}$, (S_7) resulted in 47% increase in actual field capacity while the calculated was 43% only.

Table 1 Estimated and actual field output

Item	Estimated	Actual
Estimated capacity (ha/hr) @ 4km/hr	0.60	0.58
Estimated capacity (ha/hr) @ 7km/hr	1.05	1.07
Actual Field efficiency (%) @ 4km/hr	97	97
Actual Field efficiency (%) @ 7km/hr	98	98
Fuel consumption (L/ha) @ 7km/hr	-	8.5
Seed consumption (kg/ha)	-	1.79

Effect of treatments on plant population:

The effect of treatments on plant population was significant ($P \leq 0.05$). Fig 1 shows the results of plant population for the five treatments. The control (C), S_7WCD and S_7WOCD resulted in a significantly higher plant population of 24 plants/ m^2 for each. While treatments S_4WCD

andS_4WOCD resulted in a significantly lower plant population of 16 plant/ m^2 and 14 plants/ m^2, respectively. The low plant population under direct seeding of (S_4) might be due to the destruction of some seedlings during hand weeding which was estimated to be about 15% of the established seedlings. However, plant population for all treatments was far below the recommended 67 plants/ m^2 for direct seeding and 40 plants/ m^2 for transplanting. The overall average field results showed a deviation from the recommended of aboutb35%, 36% and 60%, for S_4, S_7 and C respectively. Fig.1 shows that the covering devices had no effect on plant population for all treatments.

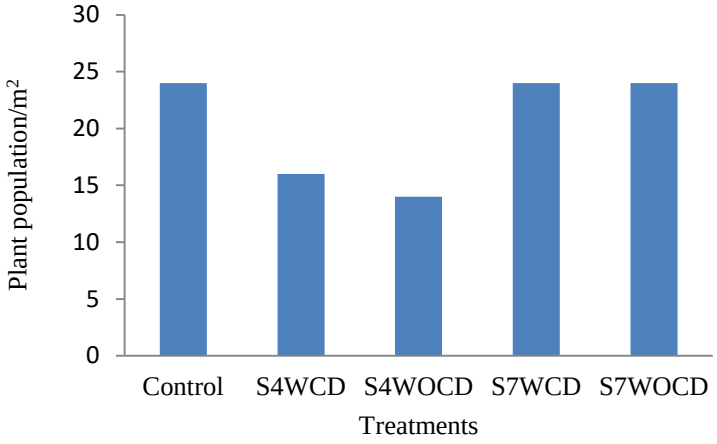

Fig 1. Effect of treatments on plant population

Number of bulbs per square meter:

Figure 2 shows the effect of treatments on the number of bulbs per square meter. The difference was found to be significant for treatments S_7WOCD, S_7WCD and C resulted in 20, 17 and 17 bulbs per m^2, respectively, without a significant difference between them. Treatments S_4WOCD and S_4WCD resulted in 14 and 13 bulbs/m^2, respectively. This difference was considerable when estimated in sacks of onion per ha. The difference was found to be 107.7 sacks per hectare (3.5 ton/ha on average basis of 650 bulbs per sack).

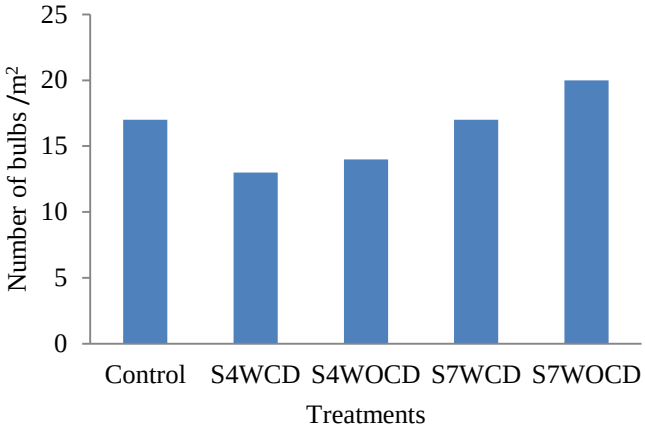

Fig 2 Effect of treatments on number of bulbs

Bulb yield:

Figure3. Shows that the effects of treatments on bulb yield were not significant. Treatments S_4WCD gave the highest yield (1.12 kg/m^2) followed by treatment C (1.09 kg/m^2). Treatments S_7WOCD and S_7WCD resulted in the least yield (0.86 and 0.77 kg/m^2, respectively).

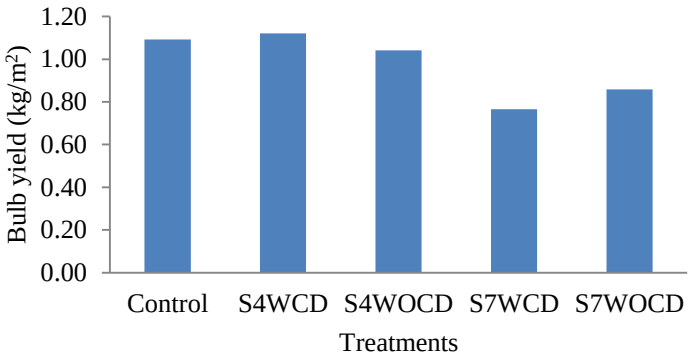

Fig 3 Effect of treatments on bulb yield

Bulb diameter (cm):

Fig 4 shows the effects of treatments on bulb diameter. There were no significant differences among treatments in bulb diameter. Bulbs from different treatments had round shape. Treatments S_7WCD and S_4WOCD resulted in 5.3 cm and 4.6 cm as largest and smallest bulb diameter,respectively.

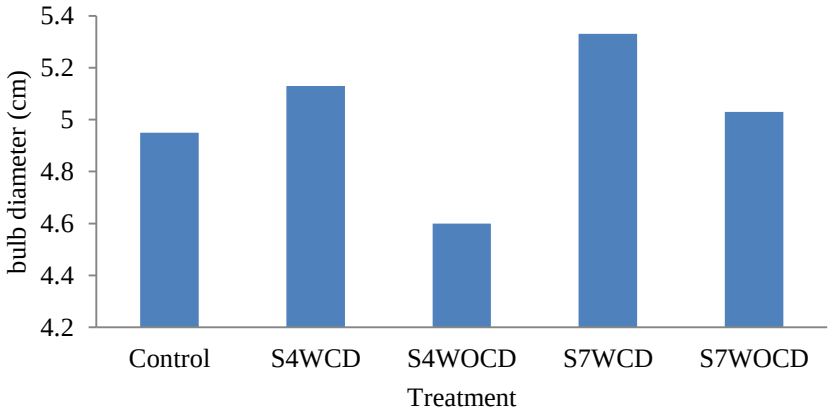

Fig 4 Effect of treatments on bulb diameter

It was found that bulbs near the furrow are larger in size than those in the inner position of the bed. Although this difference is not significant, this may be attributed to the availability of water due to lateral and capillary movement. Plants on the lower side might have received more water and less ventilation while on the higher side received adequate water and good ventilation.

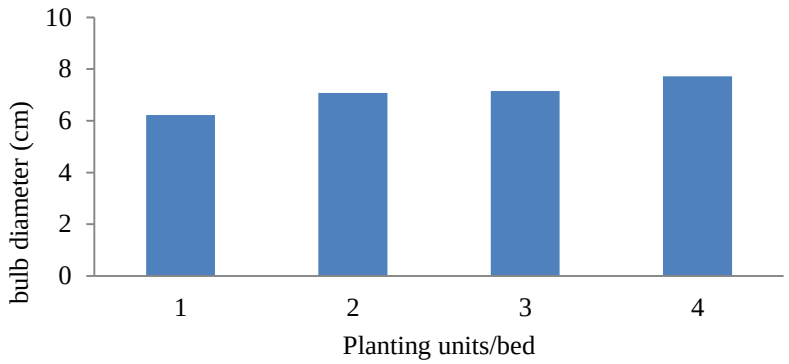

Fig 5 bulb diameter

Conclusions and Recommendations:

1. Direct seeding of onion on raised beds under Gezira conditions was successful.
2. Planting speed of 7 km/hr should be maintained to maximize tractor output, time efficiency and minimize fuel consumption.
3. Adoption of direct seeding is recommended when high value and expensive seeds are used because it cuts down the required seeds by about one third.
4. Use of S_7WOCD planting speed should be maintained to maximize tractor output, time efficiency and minimize fuel consumption.

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الخلاصة

تقييم أداء الزراعة الدقيقة في الزراعة المباشرة لبذور البصل على مساطب في ظروف الجزيرة، السودان

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تم اجراء هذه التجربة بالمزرعة التجريبية بكلية العلوم الزراعية جامعة الجزيرة (latitude 14^0 25′39.43" N, longitude 33^0 29′ 21.39" E)لتحديد امكانية زراعة بذور البصل مباشرة في تربة الجزيرة الطينية. تم اختبار اربعة طرق زراعة مباشرة والطريقة التقليدية لزراعة البصل. كانت المعاملات هي الزراعة بسرعة 4 كم/الساعة بدون جهاز تغطية للبذور ومع جهاز تغطية للبذور، زراعة بسرعة 7كم/الساعة بجهاز تغطية للبذور وبدون جهاز تغطية للبذور بالإضافة للطريقة التقليدية. تم استخدام التصميم العشوائي الكامل باربعة تكرارات. اتضح من التجربة امكانية الزراعة المباشرة لبذور البصل بسرعة 7 كم /الساعة. بالرغم من ان كل الطرق المستخدمة اعطت عدد نباتات قليل مقارنة بالموصى به، إلا انه لا توجد فروقات معنوية بين المعاملات المختلفة. بالنسبة لقطر البصلة و الإنتاجيةوعدد البصلات فإن الزراعة المباشرة اعطت نتائج افضل من الطريقة التقليدية. عدد النباتات في المتر المربع كان متساويا بين الطريقة التقليدية والزراعة بسرعة 7 كم/ الساعة.