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Study of the Morphological Variations among some *Ocimum* Species and Subspecies Grown in Sudan[1]

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Abstract: This study was conducted to differentiate among *Ocimum* species and subspecies grown in Sudan on basis of growth analysis. Seven different plant materials were used in this experiment. The layout of the experiment was Randomized Complete Block Design with three replicates; treatments were the Ocimum species and subspecies. Growth parameters were evaluated in terms of plant height, number of branches per plant, fresh biomass per plant (g) & productivity (ton / hectare), moisture content of leaves, Number of days to start of flowering and Number of weeks from sowing to maturity. Data collected were statistically analyzed The highest plant height (115.1cm) was obtained from *O. basilicum* L. (Baladi), while the lowest plant height (64.7 cm) was obtained from *O. americanum* L. (Wild). The highest number of branches per plant (859) was obtained from *O. americanum* L. (Wild), while the lowest number of branches per plant (386) was obtained from *O. basilicum* L. (Green). There were no significant differences among spp. for the fresh biomass per plant and productivity of fresh biomass (ton/ hectare); the highest values 1349 g / plant and 48.1 ton / hectare were recorded from *O. basilicum* L. (Baladi) and the lowest values 494 g/plant and 17.6 ton / hectare were recorded from *O. americanum* L. (Lime). The highest moisture content of leaves (86%) was obtained from *O. basilicum* L. (Green), while the lowest moisture content (78%) was obtained from *O. tenuiflorum* L. (Clove). The shortest number of days to start of

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flowering (39 days) and the shortest number of weeks to maturity (21.5 weeks) were obtained from *O. americanum* L. (Wild), while the latest start of flowering (113 days) and the latest maturity (53.7 weeks) was obtained from *O. basilicum* var. *thyrsiflorum* L. (White).

Key words: *Ocimum*; Sudan; basil

INTRODUCTION

The genus *Ocimum* which belongs to the family Lamiaceae, collectively called, basil comprises annual and perennial herbs and shrubs. Because of the popularity of basil, the plant is often referred to as the "king of the herbs". The geographical distribution of the genus *Ocimum* shows three main centers of biodiversity *i.e.* (a) Tropical and subtropical regions of Africa (b) Tropical Asia and (c) Tropical parts of America (Brazil) (Gulati and Sinha 1994).

Ocimum is known by the vernacular names: basil (English), basilica (French), rihan (Arabic), basilicum, basilienkraut (German), tulsi (Indian), basilica (Italian). The genus is characterized by great variability including morphology, growth habit, the color of flowers, leaves, stems and chemical composition (Svecova and Neugebauerov 2010). Flowers appear to be uniform in the appearance throughout the group but they are of great taxonomic importance for the demarcation of species. Different basil species can be identified by morphological characterizations such as leaf shape and its colour, flower structures and its colour, seed structures and its characteristics. However, extensive cultivation, inter and intra-specific cross hybridization have led to polyploidy and consequently different species, subspecies, and varieties that are not significantly different in their appearances (Chowdhury *et al*. 2017).

The most popular species are *O. basilicum* L., *O. americanum* L. (*syn. O. canum*), *O. gratissimum* L., *O. kilimandscharicum* L., *O. tenuiflorum* L. (syn. *O. sanctum*) (Moghaddam *et al.* 2011; Rewers and Jędrzejczyk 2016).

The plant is propagated through seeds, but direct sowing of seeds in the field is not advisable. Seedlings are first raised in the nursery and then transplanted

to the field (Smith *et al.* 2014). Number of days to flowering is very variable through *Ocimum* spp. It depends on weather conditions and the variety, and it amounted from 44 to 126 days (Nurzyńska-Wierdak 2007). The crop should be cut at 15-20 cm above the ground level. An average yield of 3-4 tons of flowers and 13-14 tons of herbage can be obtained per hectare. Post harvest processing is usually the most critical stage in determining the end quality of the aromatic plant material (Smitha *et al.* 2014). When basil is grown for its dried leaves, it is harvested just prior to the appearance of flowers. For essential oil, it is harvested during full bloom (Keita *et al.* 2001). Product quality is determined by appearance (color and absence of decay or insect damage), flavor, moisture content for the fresh market, volatile oil content and total insoluble ash content for the processing market (Hamasaki *et al.*1994). *Ocimum* species have many uses, but the most common is for culinary purposes. As a fresh herb, they are used to flavor foods such as vegetables, poultry and fish, jelly, honey, tea, and liquor. The flowers are edible and can make an attractive addition to salads and other dishes (Grieve 1999). Green parts of basil can provide additional amount of several minerals in human nutrition, particularly micronutrients which play a critical role in some protein synthesis and essential enzyme system which can improve resistance to diseases in people (Fraga 2005; Leal *et al.* 2008).

Basil is grows in Sudan as a wild plant and is also cultivated for ornamental purposes. It has also limited folk medicinal applications in Sudan *e.g*., use as anti-malarial by Southern Sudanese, or insecticidal use in Western Sudan (Abduelrahman *et al*. 2009). In traditional medicine, *Ocimum basilicum* has been used as an antiseptic, preservative, sedative, digestive regulator and diuretic (Effraim *et al.* 2003). Basil is also recognized as a febrifuge, infusion of the plant is used for gouty joints, cephalalgia and gargle for foul breath. Relief of earache is also well known property of basil extracts (Aladekoyi and Orungbemi 2016). Basil has been occasionally used for mild nervous disorders and for the alleviation of wandering rheumatic pains. The dried leaves, in the form of snuff, are said to be a cure for nervous headaches and indeed, research has provided some evidence for a direct effect of basil constituents on the central neural system (Waldstein 2006).

Characterization of *Ocimum* is difficult, due to the interference of Man with selection, cultivation and hybridization within the genus and also due to considerable morphological variations among the different species (Labra *et al.* 2004). Hence the objective of this research was to study the differences in growth characteristics for different species and subspecies of basil grown in Sudan, under different local names.

MATERIALS AND METHODS

Experimental Site

A field experiment was conducted at the Demonstration Farm of the Department of Horticulture, Faculty of Agriculture, University of Khartoum at Shambat from June 18th 2017 to April 26th 2018.

Soil type is clay loam with relatively high clay content and pH 7.91 – 8.

Plant Materials

Seven different plant materials were used in the study, namely *Ocimum basilicum* L. (Baladi), *Ocimum basilicum* L. (Egyptian), *Ocimum basilicum* L. (Green), *Ocimum basilicum* var. *thyrsiflorum* L. (White), *Ocimum americanum* L. (Lime), *Ocimum americanum* L. (Wild) and *Ocimum tenuiflorum* L. (synonym: *Ocimum sanctum*) (Clove). These species were used to investigate the differences among them regarding growth parameters, under Shambat environment. The seeds source was the Medicinal and Aromatic plants Research Institute (6) and one was collected from a wildly grown species in the Faculty of Agriculture University of Khartoum, Demonstration farm, and was classified as *O.americanum*.

Experimental Design

The layout of the experiment was Randomized Complete Block Design with three replicates. Treatments were the 7 *Ocimum* Spp. Data recorded were statistically analyzed using the procedure described by Gomez and Gomez (1984). Means separation was performed using the Least Significance Difference (LSD) test.

Cultural methods

Before the initiation of the experiment, the land was ploughed, harrowed,

leveled and divided into three blocks each one contained 7 experimental units (plots) each plot contained 3 ridges 3m long & 0.7m wide. Seeds were planted in the nursery on May till June, when they reached transplanting size. The plants were transplanted in the field on June18th, 2017. Pre-transplanting irrigation was applied, followed by the first irrigation immediately after transplanting. The plants were transplanted on the shoulders of the ridges. There were seven plants per ridge at 40 cm spacing, the direction of the ridges were North to South. Irrigation was carried out every 5 days during summer and every 7 days during winter, weeding was done when needed.

Vegetative growth parameters

Data on vegetative growth components were collected using destructive sampling of three plants per treatment per replication were chosen randomly, by pulling up the whole plant, 15 weeks after transplanting; the following data were recorded:

Plant height (cm)

Measured from the base of the main stem to the highest tip at the plant using measuring tape.

Number of branches per plant

All the types of branches were counted (primary, secondary and tertiary).

Fresh biomass per plant (g)

Measured by weighing the entire plant directly after pulling up from the field. At 15 weeks after transplanting *O. americanum* L. (Wild) had shed most of its leaves, so it was excluded from this parameter.

Moisture content of leaves (M.C.$_{f.b.}$%)

The moisture content on fresh weight basis was measured by taking (10 g) leaves sample from each treatment/ replication and drying it in an electric oven at 70°C for 48 hours. The moisture content was calculated using to the following equation:

$$MC_{f.b}\ \% = \frac{W_f - W_d}{W_f} \times 100$$

Where: $MC_{f.b}$ = Moisture content, fresh weight basis %, W_f = weight of fresh sample (g) and W_d = weight of dry Sample (g)

Number of days to start of flowering

Measured by counting the number of days from sowing of seeds to start of flowering.

Number of weeks from sowing to maturity

Were measured as number of weeks from sowing of seeds to stage of seeds maturity (from seed to seed).

RESULTS AND DISCUSSION

Plant height measurements

There was a highly significant difference in plant height among the *Ocimum*

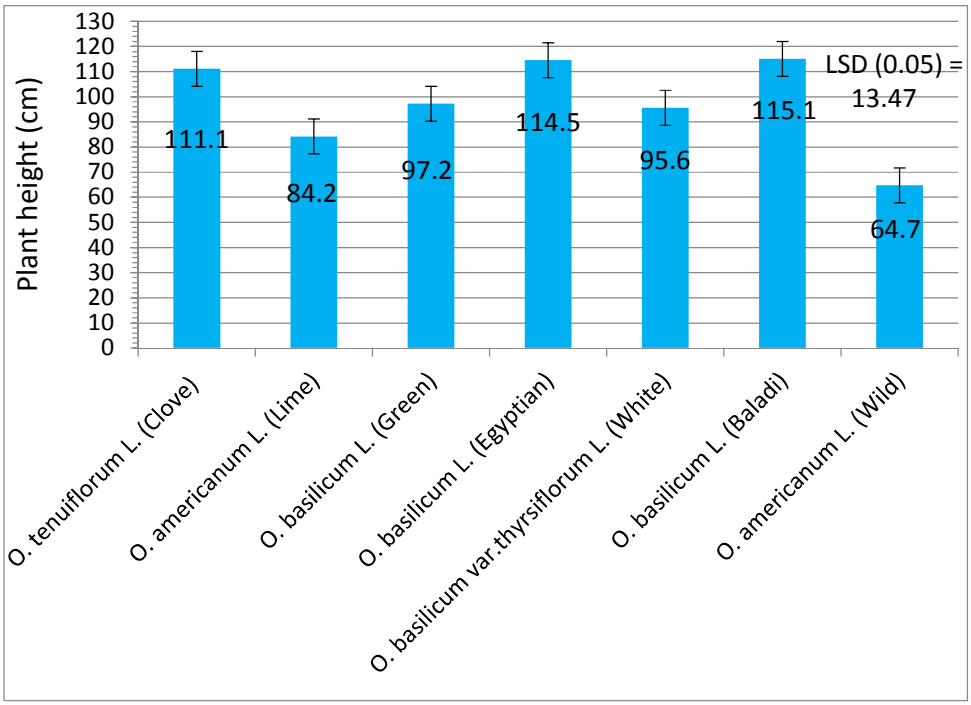

Fig. 1. Plant height (cm) of seven *Ocimum* spp. 15 weeks after transplanting.

The longest plant was recorded from *O. basilicum* L. (Baladi) (115.1cm), it was not significantly different from *O. basilicum* L. (Egyptian) (114.5 cm) and *O. tenuiflorum* L. (Clove) (111.1 cm), but was significantly higher than the other species. The shortest plant was from *O. americanum* L. (Wild) (64.7 cm). It was significantly lower than all the other species.
There were no significant differences among *O. basilicum* L. (Green) (97.2 cm), *O. basilicum* var. *thyrsiflorum* L. (White) (95.6 cm) and *O. americanum* L. (Lime) (84.2 cm).

This result is in agreement with that of Tangpao *et al.* (2018) who reported that, *O. basilicum* var. *thyrsiflorum* (Thai basil) was 45–100 cm tall and *Ocimum tenuiflorum* L. (red holy basil) (syn: *O. sanctum* L.) was70- 150 cm tall. Also results are in conformity with Abd El-Aziz *et al.* (2007) who reported that, the plant height of *O. americanum* L. was 65.90 cm.

In a study of six varities of *O. basilicum* L., Rawat *et al.* (2016) reported that the plant height varied from 51.68 to 101.72 cm. The shortest plants were from *O. basilicum* var. *thyrsiflorum* L. (51.68 cm) and the tallest plants were from *O. basilicum* var. *difforme* (101.72 cm). *O. basilicum* var. *basilicum* varied from 80.5 to 97.5 cm. *O. basilicum* var. *glabratum* varied from 91.88-94.7 cm and *O. basilicum* var. *purpurascens* varied from 73.76 – 88.04 cm. However, results reported above are not in line with those of Kandil *et al.* (2009) and Nurzyńska-Wierdak *et al.* (2012) who indicated that *O. basilicum* cultivars had significant mean plant height of 78.6 cm.

There were broad variations in the plant height among *Ocimum* spp. This may be attributed to the different varieties, environmental conditions, nutritional situation, cultivation region, method of cultivation and plant density.

Number of branches per plant(total of primary, secondary and tertiary)
There was significant difference in the number of branches per plant among the *Ocimum* spp. 15 weeks after transplanting (Table 1).

Table 1. Number of branches per plant for seven *Ocimum* spp. 15 weeks after transplanting.

Treatments	**No of branches per plant**
O. tenuiflorum L. (clove)	729
O. americanum L. (Lime)	559
O. basilicum L. (Green)	386
O. basilicum L. (Egyptian)	478
O. basilicum var. *thyrsiflorum* L. (White)	417
O. basilicum L. (Baladi)	672
O. americanum L. (Wild)	859
Overall mean	585.8
LSD (0.05)	248.5

The highest number of branches per plant was obtained from *O. americanum* L. (Wild) (859), it was not significantly different from *O. tenuiflorum* L. (Clove) (729) and *O. basilicum* L. (Baladi) (672), but was significantly higher than the other species.

On the other hand, the lowest number of branches per plant (386) was obtained from *O. basilicum* L. (Green), it was not significantly different from *O. basilicum* var. *thyrsiflorum* L. (White) (417), *O. basilicum* L. (Egyptian) (478) and *O. americanum* L. (Lime) (559), but it was significantly lower than *O. basilicum* L. (Baladi) (672), *O. tenuiflorum* L. (clove) (729) and *O. americanum* L. (Wild) (859).

Nurzyńska-Wierdak (2013) reported that *O. basilicum* L. cultivars (Lemon, Lettuce leaf, Sweet, var. minimum "bush" and var. purpurascens) have number of branches per plant respectively of 13.3, 15.6, 16.5, 15.5 and 14.2.

Omer *et al.* (2008) reported that *O. basilicum.* var. siam queen and *O. tenuiflorum* were superior in number of branches per plant than the other species.
The number of branches per plant of *O. americanum* was 14.55 (Abd El-Aziz *et al.* 2007). Plants of 'Sweet' cv. were characterized by the side shoot number of 16 (Nurzyńska-Wierdak 2007).

The numbers of basil plant branchings were on average 12.5 per plant and significantly depended upon the cultivar and dose of applied nitrogen (Nurzyńska-Wierdak *et al*. 2012). The basil plants had different numbers of branchings of 5.2–45.5 per plant, which was related to their height and growth habit (Kandil *et al.* 2009; Said- Al Ahl and Mahmoud 2010; Nurzyńska-Wierdak and Borowski 2011).

It seems that these values represent primary branches. Results of this research, however, represent secondary and tertiary branching and hence were generally different than the literature findings. The observed differences were probably due to different varieties, different environmental and genetic factors, and the nutritional status of the plants as well as other factors that can influence the number of branches per plant in reported literature.

Fresh biomass and productivity

Table 2. Fresh biomass/ plant (g) and Productivity (ton/ hectare) of six *Ocimum* spp. 15 weeks after transplanting.

Treatments	**Fresh biomass per plant**	**Productivity of fresh biomass**
O. tenuiflorum L. (Clove)	793	28.3
O. americanum L. (Lime)	494	17.6
O. basilicum L. (Green)	792	28.2
O. basilicum L. (Egyptian)	873	31.1
O. basilicum var. *thyrsiflorum* L. (White)	1048	37.4
O. basilicum L. (Baladi)	1349	48.1
Overall mean	891.7	31.8
LSD (0.05)	NS	NS

As shown in Table 2. there were neither significant differences among the fresh biomass per plant nor among productivity (ton / hectare) of *Ocimum* spp. The highest fresh biomass per plant and Productivity (1349 g and 48.1 ton/ hectare respectively) were obtained from *O. basilicum* L. (Baladi). The lowest fresh biomass per plant and Productivity (494 g and 17.6 ton/hectare respectively) were obtained from *O. americanum* L. (Lime).

Smitha *et al.* (2014) reported that an average yield of 13-14 tons of herbage could be obtained per hectare of *O. basilicum*. About 5 tonnes of fresh herbage per hectare could be obtained by two to three harvests in a year of *O. sanctum*.

Rawat *et al.* (2016) reported that, the fresh herbage yield / plant (g) were 429.17 for *O. basilicum* var. *basilicum*, 353.17 for *O. basilicum* var. *pilosum*, 351.35 for *O. basilicum* var. *glabratum*, 276.42 for *O. basilicum* var. *purpurascens* and 192.31 for *O. basilicum* var. *thyrsiflorum*. Abd El-Aziz *et al.* (2007) reported that, plant fresh weight and leaves fresh yield of *O. americanum* were 752.3 (g/ plant) and 3.053 (ton/ fed) respectively. Nurzyńska-Wierdak (2007) reported that the plant weight and yield of fresh herb of *O. basilicum* L. varieties were as follow respectively, 98.2 (g) and 10.4 (kg/ 100 m^2) for New Guinea variety, 156.4 (g) and 16.7 (kg/ 100 m^2) for Napoletano variety, 141.3 (g) and 15 (kg/ 100 m^2) for Bush variety, 202.9 (g) and 21.6 (kg/ 100 m^2) for var. *piperita*, 183.1 (g) and 19.5 (kg/ 100 m^2) for var. *lactucoefolium*. Nurzyńska-Wierdak (2013) reported that, the plant fresh weight of *O. basilicum* L. cultivars as follow: Kardinal 454.1 g, Lime 135.8 g, Licorice 174.5 g, Lemon 127.3 g, Lettuce Leaf 266.7 g, Purple Ruffles 301.5 g, Rubra 413.5 g, Sweet 158.4 g, var. citriodorum 229.3 g and var. purpurascens 254.4 g. The mean fresh basil herb weight equaled 165.2 g (Nurzyńska-Wierdak *et al.* 2012) and was comparable with that presented by Dzida (2010).

Results of this research were higher than findings reported in literature above; the differences might probably be due to differences in variety, soil, nutritional conditions and weather conditions among research sites.

Moisture content of leaves

There was highly significant difference in moisture content of leaves among the *Ocimum* spp. 15 weeks after transplanting (Fig. 2)

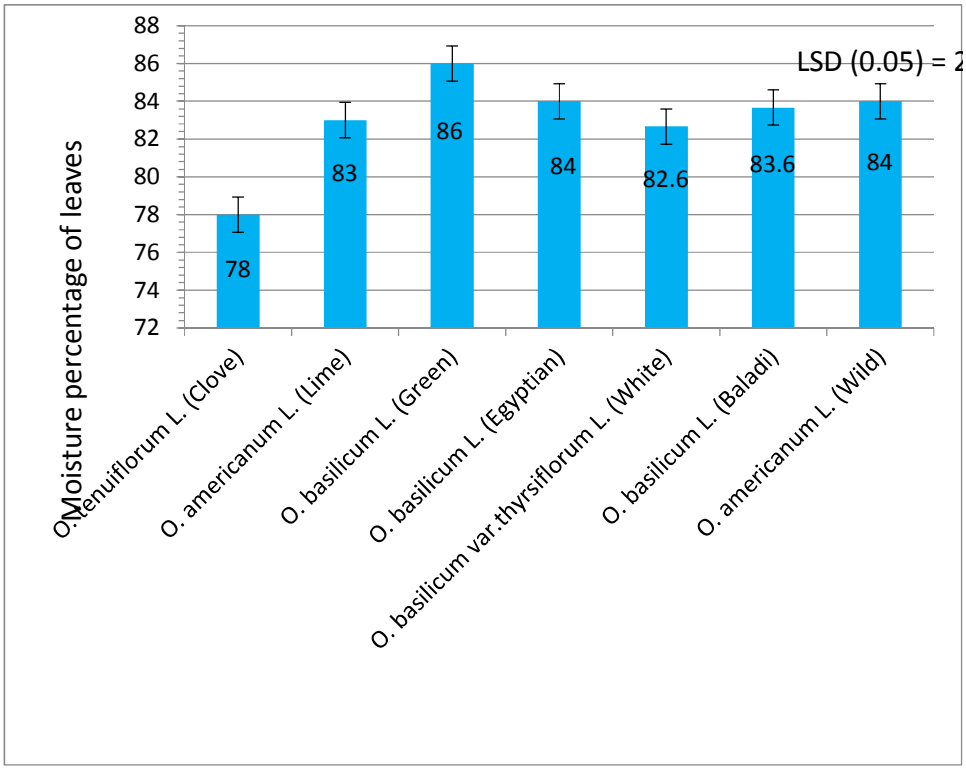

Fig.2. Moisture percentage of leaves of seven *Ocimum* spp. 15 weeks after transplanting.

The highest moisture content of leaves was obtained from *O. basilicum* L. (Green) (86 %), it was significantly higher than all species. The lowest moisture content was obtained from *O. tenuiflorum* L. (Clove) (78 %), it was significantly lower than all the other species.

These results are almost in line with the finding by Parmar *et al.* (2018) who reported that the range of moisture content varied from 81 - 83 % (wet weight basis), which shows that the basil leaves can be considered under highly perishable group. The moisture content on wet basis of fresh basil leaves was

84.28±0.1%, (Khiewnavawonsga *et al.* 2018), and 91.20% ± 0.96 (Danso-Boateng 2013).

The differences among our results and the findings reported in literature above may be due to the dependence of moisture content of leaves on the variety, age, physiological status of the plant, nutritional status, soil conditions, irrigation and weather conditions.

Number of days to start of flowering

There was significant difference in number of days to start of flowering among the *Ocimum spp*. (Fig. 3).

The shortest number of days to start of flowering *i.e*. earliest (39 days) was recorded s from *O. americanum* L. (Wild) followed by (45 days) from *O. americanum* L. (Lime); yet, there were no significant differences among *O. americanum* L. (Wild) and *O. americanum* L. (Lime), but they were significantly earlier to start flowering than the other *Ocimum spp.* On the other hand the latest start of flowering (113 days) was recorded from *O. basilicum* var. *thyrsiflorum* L. (White) followed by *O. basilicum* L. (Egyptian) and *O. tenuiflorum* L. (Clove) (100 days). There were no significant differences in number of days to start of flowering among *O. basilicum* var. *thyrsiflorum* L. (White), *O. basilicum* L. (Egyptian) and *O. tenuiflorum* L. (Clove), but *O. basilicum* var. *thyrsiflorum* L. (White) was significantly the latest to start flowering than the other *Ocimum spp.* Also there were no significant differences among *O. basilicum* L. (Egyptian), *O. tenuiflorum* L. (Clove), *O. basilicum* L. (Green) and *O. basilicum* L. (Baladi).

Such variation in number of days to start of flowering was also reported by França *et al.*(2017) who indicated that 'Grecco a Palla' cultivar bloomed 40 days after sowing, whereas 'Thai Basil' developed inflorescences 48 days after sowing, Alfavaca Basilicão Vermelho' displayed inflorescences 55 days after sowing.

Result of this research is in conformity with Simon *et al.* (1999) who reported that the days to flowering of *O. tenuiflorum* L. was 99 days.

Furthermore, Orwa *et al.* (2009) reported that Flowering started in *O. gratissimum* after 136 days and continued until 195 days.

In a study of six varieties of *O. basilicum* L., Rawat *et al.* (2016) showed that the beginning of flowering varied from 64 to 93 days after planting. The earliest flowering (64 days) accessions were *O. basilicum* var. *pilosum* and *O. basilicum* var. *thyrsiflora*. Late flowering was in *O. basilicum* var. *difforme* (94 days), where as *O. basilicum* var. *basilicum*, *O. basilicum* var. *glabratum* and *O. basilicum* var. *purpurascens* flowered after 85, 87 and 74 days respectively.

Nurzyńska-Wierdak (2007) reported that, days to flowering after sowing for *O. basilicum* L. cultivar as follow, "Lemon" 44-72 days, "Sweet" 50- 94 days, "New Guinea" 48- 72 days, "Bush" 49- 61 days, "Purple Ruffles" 48-126 days, "Piperita" 44- 67 days and "Lactucoefolium" 50- 58 days.

Accelerated transition from vegetative to generative stage may be a result of low temperatures at the beginning of plant growth (Nurzyńska-Wierdak 2007). This phenomenon happened in our experiment in *O. americanum* L. (Wild) and *O. americanum* L. (Lime).

There were high variations in number of days till flowering, as it depends on climatic conditions, variety and cultivation region.

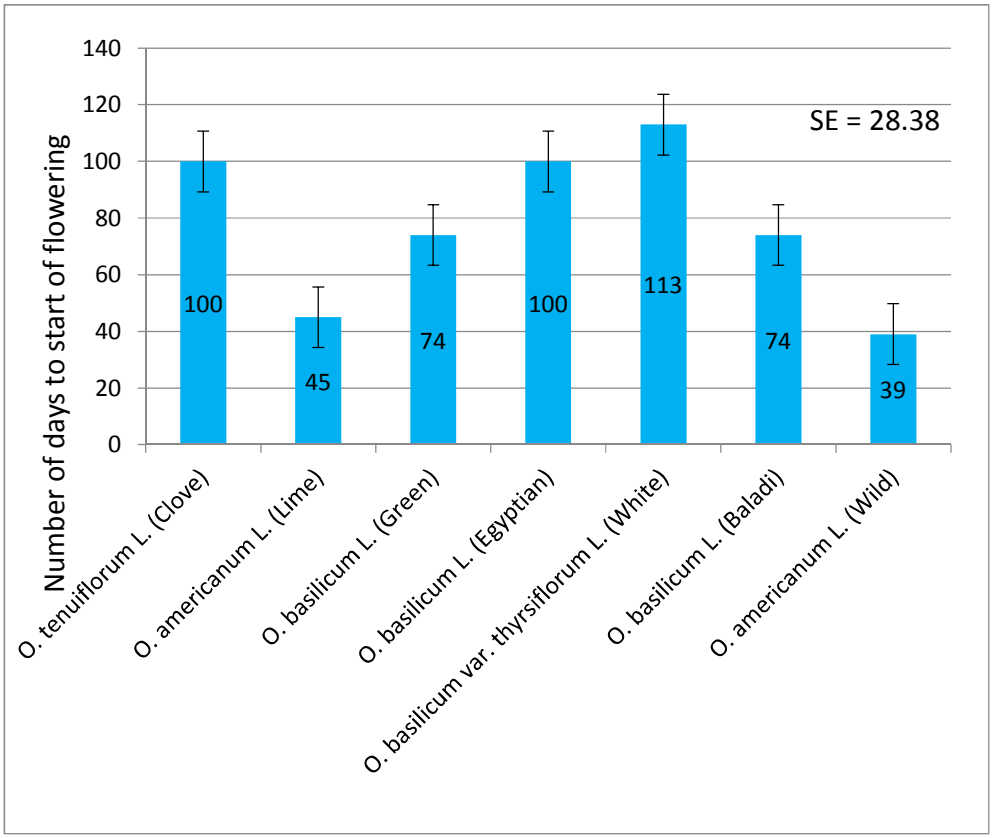

Fig.3. Number of days to start of flowering of seven *Ocimum* spp.

Number of weeks from sowing to maturity

Number of weeks to maturity was highly significantly different among *Ocimum spp.* (Fig. 4).

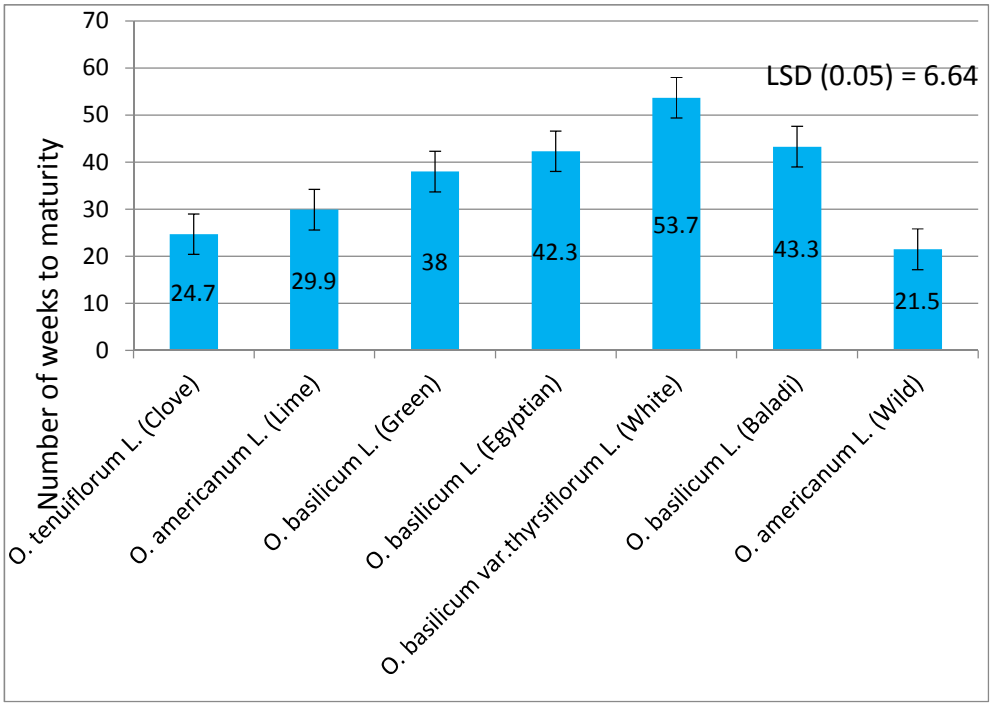

Fig. 4. Number of weeks from sowing to maturity of seven *Ocimum* spp.

As shown in (Fig.4), there were marked differences in the number of weeks to maturity for *Ocimum spp.*

The shortest number of weeks to maturity (earliest) was obtained from *O. americanum* L. (Wild) (21.5 weeks) followed by *O. tenuiflorum* L. (Clove) (24.7 weeks), so there were no significant differences between them, but *O. americanum* L. (Wild) was significantly the earliest to maturity than the other *Ocimum spp.* There were significant differences between *O. americanum* L. (Lime) (29.9 weeks) and all the *Ocimum spp.* except *O. tenuiflorum* L. (Clove) (24.7 weeks).

The longest time period to maturity (latest) was recorded from *O. basilicum* var. *thyrsiflorum* L. (White) (53.7 weeks) followed by *O. basilicum* L. (Baladi) (43.3 weeks) and *O. basilicum* L. (Egyptian) (42.3 weeks). There

were no significant differences between *O. basilicum* L. (Baladi), (Egyptian) and (Green).

Rawat *et al.* (2016) reported that, the maturity period for *O. basilicum* L. varities varied from 123- 150 days. Early maturity was recorded in *O. basilicum* var. *pilosum* (123 days). On the other hand late maturity was noted in *O. basilicum* var. *differme* (150 days). Maturity periods of *O. basilicum* var. *basilicum*, *O. basilicum* var. *glabratum*, *O. b*asilicum var. *purpurascens* and *O. basilicum* var. *thyrsiflora* were 132, 141, 137 and 127 days, respectively. Orwa *et al.* (2009) reported that, seed matured in *O. gratissimum* after 259 days. Both results of this research and reported findings clearly reflect differences in maturity among *Ocimum spp.*, which could be attributed to the variety, plant physiological status, environmental conditions, latitude and altitude and nutritional status.

CONCLUSIONS

From the results of this study the following conclusions can be made:

- Great morphological and developmental variability are found among the studied *Ocimum* plants.
- *O. basilicum* L. (Baladi) has the highest plant height, fresh biomass per plant and productivity of fresh biomass.
- *O. basilicum* L. (Green) has the highest moisture content of leaves and the lowest number of branches per plant.
- *O. tenuiflorum* L. (Clove) has the lowest moisture content of leaves.
- *O. americanum* L. (Lime) has the lowest fresh biomass per plant and Productivity of fresh biomass.
- *O. americanum* L. (Wild) has the highest number of branches per plant, shortest plant height, earliest start of flowering and earliest maturity.
- *O. basilicum* var. *thyrsiflorum* L. (White) has the latest start of flowering and latest maturity.
- Finally, DNA genotyping offers the unique capacity to classify basil plants regardless of environmental conditions, plant growth

stage, biotic and abiotic factors which effect on the morphological characters. The best classification results can be by combining morphological characters, chemotaxonomy together with DNA molecular markers technology.

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دراسة التباين الظاهري لبعض أنواع و أصناف الريحان التي تزرع في السودان[٢]

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المستخلص: أجري هذا البحث لدراسة النمو ومكوناته في انواع وأصناف الريحان التي تزرع في السودان.أستخدم في التجربة سبعة انواع وأصناف من الريحان. مثلت المعاملات انواع وأصناف الريحان. كان تصميم التجربة القطاعات العشوائية الكاملة بثلاثة مكررات. البيانات التي جُمعت كانت طول النبات ، عدد الفروع في النبات ، الكتلة الحيوية الرطبة للنبات (جم) و الإنتاجية (طن/ هكتار)، محتوي الرطوبة في الأوراق ، عدد الأيام حتي بداية الإزهار و عدد الاسابيع من زراعة البذور و حتي إكتمال النضج. تم تحليل البيانات إحصائياً. أعلي طول نبات (115.1سم) رصد في (البلدي) *Ocimum basilicum* L. و أقصر طول نبات (64.7 سم) رصد في (البري) *O. americanum* L. . أكبر عدد فروع (٨٥٩) رصد في (البري) *O. americanum* L. وأقل عدد فروع (386) رصد في (الأخضر) *O. basilicum* L. . لم توجد فروق معنوية في الكتلة الحيوية الرطبة للنبات و الإنتاجية و لكن أعلي قيمة كانت 1349جم/ نبات ، ٤٨.١ طن/هكتار التي رصدت في (البلدي) *Ocimum basilicum* L. و أقل قيمة 494 جم/نبات ، ١٧.٦ طن/هكتار رصدت في (الليموني) *O. americanum* L. . أعلي محتوي رطوبة في الأوراق كان 86% رصدت في (الأخضر) *O. basilicum* L. و أقل محتوي رطوبة كان ٧٨% رصد في (القرنفلي) *O. tenuiflorum* L. . أقل عدد أيام حتي بداية الإزهار و أقل عدد أسابيع من الزراعة حتي النضج رصدا في (البري) *O. americanum* L. و كانا ٣٩ يوم ، 21.5 اسبوع علي التوالي. أكثر عدد أيام حتي بداية الإزهار و أكثر عدد أسابيع من الزراعة حتي النضج رصدا في (الأبيض) *O.basilicum* var. *thyrsiflorum* L. و كانا ١١٣ يوم ، 53.7 اسبوع علي التوالي.

[2] الورقة مستلة من اطروحة الماجستير للمؤلف الاول