Research Article
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Effect of bed-type and seasonal variation on growth parameters, yield and oil content of mint plants

Abstract

An experiment was conducted for three successive seasons (winter, summer and autumn), at the University of Khartoum Top Farm, Shambat, Sudan. The study was aimed to evaluate the effect of bed-type on growth parameters, yield and oil yield of mint during three successive seasons. The bed types are sowing on flat and sowing on ridges. Sowing in flats resulted in the highest growth parameters; plant height, number of leaves, number of bramches and herb yield but most of which are non significant except under 90 days harvest, while in contrast, flat sowing decreased the oil content and the sinficant difference just during simmer season between flat and ridges. Summer season proved to be the best for growth with a significant difference in herb production and oil yield of mint plants followed by autumn and winter.

Keywords: spearmint, bed type, essential oil, season

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Introduction

Sudan contains more than 300 aromatic plants; one of the most important aromatic oil yielded plants is mint group. Mint plants are widely used in the world. They can be used with diet, folk medicines and confectioneries and other uses.[1] Administration of spearmint tea to rats causes dose-dependent, temporary or permanent negative effects on the reproductive system of the male rat and leads to lipid peroxidation, that results in histopathologies in the kidney, liver, and uterine tissues.[2] Due both to its antioxidant activity and its common use to season lamb in South Asian cuisine, it has been studied as an additive to radiation-processed lamb meat, and was found effective in delaying oxidation of fats and reducing formation of harmful substances, which can be detected using thiobarbituric acid as a reagent.[3] It has been studied as an additive to radiation-processed lamb meat, and was found effective in delaying oxidation of fats and reducing formation of harmful thiobarbituric acids.[4]

In Sudan, spearmint production is still very low or even negligible, its marketability is limited to local markets and its use is only for flavoring and folk medicine, this because limited basic information on cultural practices, improper handling technique and fields. Environmental conditions change according to seasons. Environmental factors, such as temperature, relative humidity, photoperiod and light intensity, affect mint oil content, composition and quality.[1,5–8] Cultural practices affected the plant productivity and oil content. Beds are important for the growing of mint plants; bed types are associated with irrigation and other agronomic factors. The physical conditions of the soil were affected by land preparation. Flat beds are differing from ridge beds, which lead to chemical effect, concentration and distribution of minerals in the sides of ridges, and hence affected the plant growth. The aim of this study was to investigate the effect of two bed-types namely; sowing in flat vz sowing on ridges of two mint cultivars *Mentha spicata* (Spearmint) and *Mentha arvensis* (Japanese mint) under three seasons on growth parameters; plant height, number of leaves, number of branches, yield parameters and oil content.

Materials and methods

Experimental site and period

A field experiment was conducted for three successive seasons (Winter, Summer& Autumn) in the Top Farm, University of Khartoum, Shambat, Sudan (latitude 15,40 N, longitude 32, 32 E). The climate of the location is considered as semi–arid. The rainy season is from July to September and 90% of the rainfall is concentrated during this period. The annual precipitation ranges between 150–180 mm. The lowest temperature reaches 5°C during Jan. and the highest temperature high as 48°C during April–May.[9] The soil of the experimental site is classified as fine mixed Isohyperthermic entices chromuster clay i.e.: Montmorillonite clay. The experiment was conducted at the end of December to the beginning of March for winter season, from March to beginning of June for hot summer season and from the beginning of June to the beginning of September for rainy season.

Source of the plant

The source of spearmint (*Mentha spicata* var. viridis L.) was Kuku area, Khartoum North, Sudan. Japanese mint (*Mentha arvensis*) obtained from Horticultural Administration, Ministry of Agriculture, Sudan.

Land preparation and cultivation

Soil was ploughed, harrowed, leveled, and splitted into plots (5x5 m each). Mint underground rhizomes were cut into segment 5-8 cm each and containing at least three nodes. The segmented rhizomes were placed in holes of 5 cm depth in the soil and immediately watered, then Watering every 7 days. Basal application of urea fertilizer (40 kg/fed) was done after the third week from planting and after each harvest thereafter.

Growth parameters parameter

The measured parameters for growth 10 plants are plant height (cm) from tip of the plant to the soil surface measured, number of leaves per

the main stem counted, number of branches per the main stem counted and recorded every 30 and weight (g) of one square meter was taken every 90 days. Collected herb for oil content determined every 30 days from 50 g of dried herb.

Herb preparation and oil distillation

Harvested herbs were dried (open shed drying) and stored in dark cold store until distillation.

Oil content determination

Distillation of volatile oils was conducted using Clevenger apparatus according to British Pharmacopeia Protocol .[10] Fifty grams of dried samples were taken and placed in a 2000 ml round–bottomed flask. One liter of water was added; so that the sample was completely immersed. The flask was adjusted to Clevenger apparatus equipped with a condenser. Flask contents were brought to boiling for two hours using electric heating mantle. The mixture of water and volatile oil vapor were affected to condense and collected as two layers in the distillation apparatus. After distillation was completed, the whole system was left undisturbed for about half an hour so that a good separation was obtained. The volume of the oil was determined and expressed in ml per 50 g dry weight.

Experimental design

The experiment was laid in a factorial randomized complete block design of two treatments; t_1 (ridges) and t_2 (flat) and four replicates.

Results and discussion

Growth parameters

Effect of bed-type on plant height showed in Table 1. Plant height was grew highest in flat during the three seasons, these results were due to that flat plots well irrigated than ridges, and save high amount and well distributed water in the plots. The soil moisture was good than on ridges and consequently affected the biological process for growth and development. The plants were dense in flat and leads to elongation of the stem and under ground spread of the roots. This agree with El-Gamacy et al.[11] and Teito-ago and Gardner mentioned that dense population affected the plant to grow high; because the competition between plants.[12] Furthermore the plant height increased with plant age from 30 days towards 90 days due to plant growth. Table 2 illustrated the effect of bed- type on number of leaves during three seasons. The numbers of leaves were increased by the increasing of the plant height; due to what mentioned before. The branching was high in flat (Table 3), this result was in accordance with what happened with plant height and number of leaves. Because as the plant grow tall more nodes and branches were appear.

Herb yield

Yield of herb per sugared meter Table 4 was high in flat compared to ridge, this due to growth condition in flat plots than ridges. Because the flat promotes the spread of underground runners (rhizome like) and consequently give great opportunity for area shoots to grow from the underground nodes of the runners. Herbal production and oil content are also affected by humidity, so that warm dry season result in higher production and oil content, compared to wet autumn and cool winter seasons.[1,13]

Oil yield

The oil content obtained from the two species are illustrated in Table 5. Summer season produced higher oil content compared to other seasons. The results showed a significant difference in oil content between the three seasons in ridge; but the significant difference between the two beds in oil content occurred just between winter and summer in flat. Mustyatoe explained that summer warm dry conditions increased oil yield per unit area.[14] These differences in oil content were due to climatic factors such as temperature, rainfall and light. The highest oil content obtained from summer due to that the season conditions activate the physiological process, which lead to oil formation and collection in oil glands. And agree with Abu-Zid who mentioned that oil glands increased in summer and decreased during autumn and winter.[15] Moreover autumn season decreased because the presence of clouds and humidity.[15]

Table 1 Effect of bed-type on plant height (cm) during three seasons

Bed-type/ bed-type		Ridge	Flat	LSD at 5 %	STDEV
Winter	After 30 days	4.2	4.51	0.7	0.219203
	After 60 days	14.2	15.93	1.06	1.223295
	After 90 days	22.35	23.03	1.19	0.480833
Summer	After 30 days	8.9	9.6	1.396	0.494975
	After 60 days	31.62	32.57	1.33	0.671751
	After 90 days	50.34	48.92	2.4	1.004092
Autumn	After 30 days	9.38	9.6	1.36	0.155563
	After 60 days	27.83	28.05	1.36	0.155563
	After 90 days	32.9	33.4	3.34	0.353553

Table 2 Effect of bed-type on number of leaves during three seasons

Seasons/ bed-type		Ridge	Flat	LSD at 5 %	STDEV
Winter	After 30 days	9.82	9.98	0.353	0.113137
	After 60 days	23.29	23.76	0.53	0.33234
	After 90 days	30	30.69	0.67	0.487904
Summer	After 30 days	11.54	17.59	0.76	4.277996
	After 60 days	36.42	37.92	0.562	1.06066
	After 90 days	43.39	44.64	0.66	0.883883
Autumn	After 30 days	18.98	19.96	1.58	0.692965
	After 60 days	29.63	30.03	0.7	0.282843
	After 90 days	35.02	36.29	1.91	0.898026

Table 3 Effect of bed-type on number of branches during three seasons

Seasons/ bed-type		Ridge	Flat	LSD at 5 %	STDEV
Winter	After 30 days	2.75	3.41	0.199	0.46669
	After 60 days	14.8	15.32	0.782	0.367696
	After 90 days	19.42	19.77	0.99	0.247487
Summer	After 30 days	7.5	7.9	0.955	0.282843
	After 60 days	27.35	27.92	1.463	0.403051
	After 90 days	30.8	31.73	3.588	0.657609
Autumn	After 30 days	8.32	9.33	0.5	0.714178
	After 60 days	18.57	20.72	3.376	1.52028
	After 90 days	33.13	33.13	0.59	0

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Table 4 Effect of bed-type on yield (g/square meter) during three seasons

Bed-type/ Seasons	Winter	Summer	Autumn	STDEV
Ridge	296.18	707.1	1445.3	290.5643
Flat	296.35	864.73	1974.79	401.9054
LSD at 5 %	31.6498	283.405	124.447	

Table 5 Effect of bed-type on oil content (ml 50g) meter during three seasons

Bed-type/ Seasons	Winter	Summer	Autumn	STDEV
Ridge	0.49	0.7	0.63	0.148492
Flat	0.46	0.67	0.63	0.148492
LSD at 5 %	0.05	0.013	0.041	

Conclusion

We can come to conclude that highest growth parameters such as stem height, number of leaves, number of branches and herb yield obtained from sowing on flat sowing due to well spread of underground rhizome which lead to an increased in shoot system and consequently growth and yield parameters. In contrast highest oil content obtained from sowing on ridge. Summer season proved to be the best for growth, herb production and oil yield of mint plants followed by autumn and winter.

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None.

Conflicts of interest

Author declares that there is no conflict of interest.

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