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Early growth performance of advanced menthol mint (*Mentha arvensis* L.) mutants for salinity tolerance

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Abstract

Menthol mint (*Mentha arvensis* L.) is one of the most important aromatic plants producing essential oil. An experiment was carried out using Factorial Completely Randomized Design with 3 Replication along with ten advanced mutants' lines and two checks to study the effect of salinity on growth parameters of menthol mint at the department of Plantation, Spices, Medicinal and Aromatic crops, Kittur Rani Channamma College of Horticulture, Arabhavi during 2022 under open field condition. 4 levels of salinity solution containing 0, 50, 100 and 150 mmol NaCl was applied in irrigation. The results showed that salinity stress significantly affected plant height, number of branches, and plant spread, as salt level increased. Among the advanced mutant lines $CK_{20}P_{113}$ recorded maximum plant height (36.38 cm) and more number of branches (3.90) with uniform plant spread (20.96 cm) at 60 DAP. The highest values of growth parameters were observed under non-salinity condition (control). Also, $K_{20}P_{26}$ and $CK_{20}P_{79}$ showed better performance under salinity conditions appearing to be the most promising mutant lines in menthol mint.

Keywords: Menthol mint, mutants, NaCl, days after planting, millmolar

Introduction

Japanese mint, also known as menthol mint, is a perennial plant but cultivated as an annual herb belonging to the family Lamiaceae, well-known for essential oil-bearing plants all over the world (Kumar, 2014) [2]. In this Genera *Mentha*, Menthol mint, Spearmint (*Mentha spicata* L.), Bergamot mint (*Mentha citrata* L.) Peppermint (*Mentha piperita*) and Scotish mint (*Mentha cardiaca* L.) are some of the species cultivated commercially. Among them, menthol mint (*Mentha arvensis* L.) is widely grown for its aroma isolates such as menthol, carvone, linalyl acetate and linalool for several fields such as agroalimentary, perfumes, pharmaceutical industries and natural cosmetic products (Spencer *et al*., 1997) [7]. Currently india is facing various environmental stresses, which cause difficulties in the production of crops, among them salinity stress is one of the main factors in plant yield decrease, particularly in arid and semi-arid regions (Shaki *et al*., 2020) [8] As the threat of salinity in some parts of india is increasing, recent studies indicate that abiotic stress is directly affecting, an almost 70% reduction in agricultural output. Also, it is estimated, that at least 20% of all irrigated lands are salt- affected with this detrimental effect of high concentrations of salts cause the death of growing plants drastically (Pitman and Lauchli, 2002) [6] to overcome these challenges we need to identify genotypes having potential salt tolerance ability even in high saline levels. This has a effective approach for solving the problems of saline soils India.

Materials and Methods

The pot experiment was conducted following Factorial Complete Block Design (FCBD) with ten selected advanced mutant lines and two checks along with four salinity levels replicated thrice. The planting was taken up in February 2022 maintaining five plants per replication in polybags separately along with two checks *viz*., *cv*. Kosi and CIM Kranthi. The soil used for experiment was collected locally which was analysed as saline with higher EC (1.07) and alkaline pH (8.5). The mutant lines were selected from previous generation based on their growth habit. The observations were recorded at 60 DAP.

Observations recorded

Observations on various growth attributes like plant height, number of branches, and plant spread, were recorded on three randomly selected plants for each treatment in each replication

Average values were computed and the data were subjected to statistical analysed.

Treatment details
S_1 = 0 (control)
S_2 = 50 mM NaCl S_3 = 100 mM NaCl
S_4 = 150 mM NaCl

Table 1: Effect of salinity on Plant height of menthol mint advanced mutant lines at 60 DAP

Plant height					
Lines	60 DAP				
	S_1	S_2	S_3	S_4	Mean
$K_{20}P_{23}$	40.05	30.88	27.44	24.03	30.60
$K_{20}P_{41}$	41.20	30.61	25.21	20.99	29.50
$K_{20}P_{26}$	42.79	35.33	32.66	29.78	35.14
$K_{20}P_{33}$	30.53	22.83	20.05	16.64	22.51
$K_{20}P_{13}$	37.14	27.83	24.10	20.55	27.40
Kosi	25.91	19.83	18.10	17.88	20.43
$CK_{40}P_{17}$	34.96	27.04	22.77	19.60	26.09
$CK_{20}P_{113}$	39.00	37.00	36.19	35.23	36.85
$CK_{20}P_{43}$	35.06	27.06	23.54	19.50	26.29
$CK_{20}P_{22}$	28.54	21.43	21.00	14.95	21.48
$CK_{20}P_{79}$	35.97	38.58	37.03	25.32	34.22
Kranti	33.33	24.35	20.76	18.12	24.14
Mean	35.33	28.74	25.74	21.88	27.92
	Salt		lines	Lx S	
f-test	*		*	*	
SE m ±	0.65		0.37	1.29	
CD @ 5%	1.81		1.05	3.63	

Table 2: Effect of salinity on number of branches of menthol mint advanced mutant lines at 60 DAP

Number of branches					
Lines	60 DAP				
	S_1	S_2	S_3	S_4	Mean
$K_{20}P_{23}$	3.44	3.57	2.72	2.92	3.16
$K_{20}P_{41}$	4.62	3.62	3.19	2.76	3.55
$K_{20}P_{26}$	4.85	4.09	3.55	3.00	3.87
$K_{20}P_{33}$	4.26	3.80	3.41	3.40	3.69
$K_{20}P_{13}$	3.70	3.42	2.72	2.68	3.13
Kosi	4.06	3.22	2.75	2.31	3.09
$CK_{40}P_{17}$	4.37	3.36	2.84	2.23	3.20
$CK_{20}P_{113}$	5.28	4.03	3.40	2.88	3.90
$CK_{20}P_{43}$	3.95	3.00	3.07	2.62	3.16
$CK_{20}P_{22}$	3.54	3.38	2.82	3.30	3.26
$CK_{20}P_{79}$	4.28	4.13	3.40	3.30	3.78
Kranti	3.71	3.17	2.68	2.92	3.12
Mean	4.17	3.57	3.09	2.79	3.87
	Salt		lines	L×S	
f-test	*		*	*	
SE m ±	0.09		0.05	0.19	
CD @ 5%	0.26		0.15	0.53	

Table 3: Effect of salinity on Plant spread of menthol mint advanced mutant lines at 60 DAP

Plant spread					
Lines	60 DAP				
	S_1	S_2	S_3	S_4	Mean
$K_{20}P_{23}$	22.7	16.7	14.4	11.7	16.39
$K_{20}P_{41}$	21.6	16.5	14.0	10.9	15.73
$K_{20}P_{26}$	25.3	21.7	18.3	15.3	20.16
$K_{20}P_{33}$	20.6	15.9	13.3	10.7	15.12
$K_{20}P_{13}$	19.5	14.4	14.0	13.2	15.28
Kosi	15.9	16.6	14.0	12.9	14.86
$CK_{40}P_{17}$	21.3	17.0	13.8	12.6	16.18
$CK_{20}P_{113}$	21.6	21.4	20.7	20.1	20.96
$CK_{20}P_{43}$	18.1	13.9	14.9	12.9	14.94
$CK_{20}P_{22}$	21.3	14.4	14.3	11.5	15.37
$CK_{20}P_{79}$	21.7	16.4	14.3	13.5	16.47
Kranti	18.6	14.1	12.1	10.2	13.75
Mean	20.5	16.5	15.0	13.1	18.48
	Salt		lines		L×S

f-test	*	*	*
Sem ±	0.45	0.26	0.90
CD @ 5%	1.27	0.73	2.53

Results

Growth attributes

Plant height: The effect of salinity on plant height was recorded at 60 DAP in menthol mint advanced mutants and presented in Table 1.

The advanced mutants of menthol mint differed significantly in their height and were also influenced by salt levels. Among the advanced mutants studied, $CK_{20}P_{113}$ recorded taller plant height at 60 DAP (36.85 cm). Though initially, Kosi recorded the lesser plant height (20.43 cm). further $K_{20}P_{26}$ recorded higher values of (35.14 cm). Which was overtaken by $CK_{20}P_{79}$ at 60 DAP 34.22 cm.

Number of branches

The effect of salinity on number of branches was recorded at 60 DAP in menthol mint advanced mutants and presented in Table 2.

There was a significant difference between the advanced mutants for number of branches which was also influenced by salinity. Among all the advanced mutants studied, $CK_{20}P_{113}$ recorded more number of branches (3.90) at 60 DAP. Though initially $K_{20}P_{26}$ recorded (3.87) it was further over taken by $CK_{20}P_{79}$ (3.78) in later stages Kosi recorded lower values for number of branches

Plant spread

The effect of salinity on plant spread was recorded at 60 DAP in menthol mint advanced mutants and are presented in Table 3.

The advanced mutants of menthol mint displayed significant difference in their spread which was also influenced by salinity. Among the advanced mutant lines $CK_{20}P_{113}$ recorded wider spread at 60 DAP (20.96 cm) Which was overtaken by $K_{20}P_{26}$ (20.16 cm). further in later stages $CK_{20}P_{79}$ recorded 16.47 cm, respectively.

Discussion

The present study revealed that build-up of salinity in the growing stages adversely affected the growth attributes of the crop.

The results showed that salinity stress significantly affected growth parameter, such as plant height, number of branches, plant spread, as salinity increased drastically up to 150 mmol NaCl throughout the crop growth stages. The heights of the plants was reduced up to (56.79 %), with minimum number of branches (60.0%), and maximum plant spread (53.52 %), as compared to non saline irrigation water recorded at 60 DAP.

As demonstrated by Bernstein (1975) [1] it could be the resultant effect of salt toxicity of ions, low osmotic potential and decrease in wall extensibility the magnitude of which depends on salinity level affecting the growth of plant.

Also, the behavior of advanced mutant lines of menthol mint differed significantly at all stages of crop as the highest growth was observed at non saline irrigation.

As the concentration increased from 50 mM to 150 mM NaCl the plants of $CK_{20}P_{113}$ recorded taller plant height (36.85 cm), more number of branches (3.90), and uniform plant spread (20.96 cm), against the parental check cv. Kranti at 60 DAP. On contrary similarly the plant height increased with 50 mM NaCl treatment in $K_{20}P_{26}$ and $CK_{20}P_{79}$ (35.14 and 34.22 cm) against parental check cv. Kosi at 60 DAP. Thus, resulted difference among the advanced mutants could be attributed to their two diverse lineage *ie*. Kosi and Kranti as well as the pleotrophic effect of mutated genes as a result of irradiation which enhanced or altered the growth habit of plants as in pepper mint studies by Le Minh *et al*. (2015) [4], Lal *et al*. (1999) [3] and Padma *et al*. (2020) [5].

Conclusion

The experiment concluded that, detrimental effect of salt in the soil reduced the growth activity in menthol mint with different salinity levels. However, this serious impact of salinity had been overcome by identifying $CK_{20}P_{113}$ and $CK_{20}P_{79}$ in Kranti mutants and $K_{20}P_{26}$ in Kosi mutants as promising mutant lines for salinity tolerance.

Future Scope

Future studies with confirmed data of multilocation and farm trail, salinity tolerant mint varieties can be recommended to tackle the salinity issues prevalent in some tracts of Karnataka.

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