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RESEARCH PAPER

Assessment of genetic variability and association among yield traits in M_1 population of menthol mint *cv.* Kosi

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Abstract : For plant genetic improvement, it is of paramount significance to determine genetic components for selecting desirable traits and their interrelationship for enhanced selection efficiency. Menthol mint, a perennial herbaceous aromatic plant cultivated as an annual herb for its commercial valued essential oil. Mint is highly heterozygous in its genetic constitution and vegetatively propagated by stolons, making it a promising material for inducing mutation and creation of desired variability.Mint cultivar Kosi was subjected to gamma irradiation (20 Gy and 40 Gy) and each M_1plant was analysed for variability and desired characteristics. 42 promising putative mutants selected from M_1 generation based on growth and yield parameters were forwarded to M_2. Study revealed that the exposure of stolons to gamma rays created significant variability in the plant height, plant spread, number of branches, leaf area, fresh and shade dried herb yield per plant.Further, fresh herb yield was found to have significantly and positively correlated with leaf area, number of branches, plant spread and plant height. Path co-efficient analysis revealed that leaf area and plant spread exhibited positive direct effect on yield. Hence, selection for this character could bring improvement in yield and yield components in menthol mint.

Key Words : Correlation, *Menthaarvensis* L., Heritability, Path analysis, Genetic advance

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INTRODUCTION

Japanese mint or menthol mint (*Mentha arvensis* L.) belongs to the family Lamiaceae, a vast group of herbs with notable economic value (Srivastava *et al*., 2001). This plant is not only considered as aromatic but also medicinal due to its analgesic, anaesthetic, antiseptic, astringent, carminative, expectorant, nervine, stimulant and stomachic properties which is used to treat inflammatory diseases, ulcer and stomach problems (Cowan, 1999 and Iscan *et al*., 2002). The Japanese mint essential oil is the primary source of natural menthol, which is used in personal care products like moisturizers, lip balms, hair oil, talcum powder and bathing products (Kumar *et al.,* 2019).

All the mint species available in India are introductions and varieties are developed through selection and hybridization based breeding programmes. Being highly heterozygous vegetatively propagated plant, mint offer good scope for mutation breeding. However, research in India has been focussed to North Indian

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conditions and the developed varieties perform better there. So, there is a need to create and develop varieties or chemotypes for South Indian conditions. In this direction, creation of variability through induced mutations in this vegetatively propagated crop can contribute immensely through genetic manipulation (Gustafsson, 1947) in terms of both quantitative and qualitative traits within a shorter period of time. With this background *cv*. Kosi, the ruling variety of North India due to its desirable traits like high herbage yield, oil yield and short duration was used for inducing mutation.

MATERIAL AND METHODS

The M_1 generation was obtained by treating 120 stolons of menthol mint *cv*. Kosi of 10.0-12.0 cm length with each of 20 Gy and 40 Gy gamma irradiation at BARC, Trombay, Mumbai. They were evaluated at the department of Plantation, Medicinal, Aromatic and Spice crops, Kittur Rani Channamma College of Horticulture, Arabhavi, during *Rabi* 2018-19 along with untreated check planted after every three rows of M_1 plants by following 120 cm X 120 cm spacing. The experimental site is located in the northern dry zone (Zone-III) of Karnataka at a latitude of 16°15' N, longitude 74°45' E and at an altitude of 612 meters above mean sea level. During the experimental period, the maximum and minimum temperatures were 38.00º C and 18.05º C, respectively. Growth parameters *viz.,* plant height (PH), plant spread (PS), number of branches (NB), leaf area (LA), number of days taken for flowering (NDF) and leaf to stem ratio (LS); and yield parameters like fresh and shade dried herb yield (FHY and SDHY) were recorded in all the M_1 plants individually and compared with check cultivar at the time of harvest. Survival was recorded in M_1 generation at 30 days after planting and expressed in percentage. Essential oil content was estimated by taking known weight of three hour shade withered herbage from each plant in M_1 using Clevenger's apparatus and expressed in percentage. Observed data on each individual M_1 plant was considered for statistical analysis. The chi square test was done to know the dose effect of gamma irradiation on growth and yield traits and the mean from all mutant population was calculated in M_1 generation (Table 1 and 2). Genetic variability parameters *viz*., genotypic variability (Vg), phenotypic variability (Vp), genotypic co-efficient of variability (GCV), phenotypic co-efficient of variability (PCV), broad sense heritability (H_{BS}), genetic advance as per cent of mean (Mahmud and Kramer, 1951; Comstock and Robinson, 1952; Burton and Devane, 1953 and Johnson *et al.,* 1955) in M_1 generation. Mean and range were estimated from all mutant population and check in M_1 generation (Table 2). Phenotypic and genotypic correlation co-efficients were worked out (Panse and Sukhatme, 1967) and they were partitioned into direct and indirect effect of the yield-related traits on fresh herbage yield in M_1, using the path co-efficient analysis (Dewey and Lu, 1959).

RESULTS AND DISCUSSION

Gamma irradiation at 20 Gy and 40 Gy reduced the field survival of stolons (41.67 and41.53%, respectively) greatly as compared to control (80.00%). The reduction in survival following mutagen exposure is attributed to the possibility of lethal mutations, as well as reduced auxin concentration affecting cell division and resulting in poor establishment, as previously reported in glory lily by Anandhi and Rajamani (2017). Chi square test indicated significant changes in plant height, spread, number of branches, leaf area, fresh and shade dried herb yield per plant due to irradiation treatment (Table 1) showed were significantly altered by gamma irradiation through mutation (Lal *et al*., 2018).

Co-efficients of variation are more useful indices for comparing characters with different measurement units. Even though the phenotypic co-efficient of variation (PCV) was higher than the corresponding genotypic co-efficient of variation (GCV) for all of the characters in this study, there was only a slight difference between them (Table 2). This revealed greater stability of the characters against environmental fluctuation, thus the selection based on phenotypic performance will be reliable. A major portion of PCV was contributed by GCV for most of the characters suggesting that the observed variation was mainly due to genetic factors. This similarity between PCV and GCV was reported earlier by Nair and Shiva 2003. Higher estimates of phenotypic and genotypic co-efficient of variability (PCV and GCV) were observed for essential oil yield per plant (52.23% and 41.76%), number of branches (42.41% and 38.31%), shade dried herb yield per plant (37.70% and 34.39%) and fresh herbage yield per plant (36.10% and 32.54%), respectively. The genotypic co-efficient of variation does not provide enough information to estimate heritable variation, so heritability estimation is required.The knowledge of heritability along with genetic advance aid in drawing valuable conclusions for effective selection based on phenotypic performance. Very high heritability coupled with high GAM was observed for leaf area (96.75% and 34.70%), shade dried herb yield (84.03% and 65.23%), number of branches (82.39% and 71.98%), fresh herb yield per plant (82.05% and 61.02%) and plant spread (79.99% and 34.72%), respectively (Table 2). High value of heritability indicates that phenotype of the trait strongly reflects the genotype and suggests the major role of genotypic constitution in the expression of the character. Therefore, reliable selection could be made for these traits on the basis of phenotypic expression. This is in agreement with the findings of Nair and Shiva 2003.

Yield of mint is decided by the interactions of a number of interconnected characters. Selection will be more rewarding when it is based on yield components for a rational approach to yield improvement.The efficiency of selection for yield mainly depends on the direction and magnitude of association between yield and its components and among themselves. The fresh herb yield per plant (Table 3) was significantly and positively

Table 1 : Effect of gamma irradiation on growth and yield parameters of *cv.* Kosi during M_1 generation

Traits	Mean	Range	$\chi 2$
Plant height (cm)	39.45±5.25	19.00-52.00	92.81*
Plant spread (cm)	47.22±9.95	12.50-73.00	313.28*
Number of branches	22.45±9.52	4.00-52.00	496.03*
Leaf to stem ratio	2.74±0.73	1.31-4.83	NS
Leaf area (cm^2)	5920.98±1030.96	2102.60-13984.70	17194.82*
Number of days taken for flowering	113.92±3.28	108.00-127.00	NS
Fresh herbage yield (g $plant^{-1}$)	243.98±88.08	50.00-620.00	3269.81*
Shade dried herbage yield (g $plant^{-1}$)	226.31±85.32	42.00-598.00	3328.43*

* indicate significance of value at P=0.05 NS=Non-significant Table χ^2 value @ 0.05 = 80.58

Table 2: Estimates of mean, range, parameter of variability, heritability (h^2 %) and genetic advance over mean (GAM) in mutant populations of *cv.* Kosi in M_1 generation

Traits	Mean (Check)	Mean (Mutants)	Range	PCV (%)	GCV (%)	h^2 (%)	GAM (%)
Plant height (cm)	40.79	39.45±5.25	19.00-52.00	13.30	9.43	50.75	13.90
Plant spread (cm)	42.39	47.22±9.95	12.50-73.00	21.07	18.75	79.99	34.72
Number of branches	20.37	22.45±9.52	4.00-52.00	42.41	38.31	82.39	71.98
Leaf to stem ratio	3.45	2.74±0.73	1.31-4.83	26.49	16.27	38.08	20.78
Leaf area (cm^2)	5915.14	5920.98±1030.96	2102.60-13984.70	17.41	17.04	96.75	34.70
Days taken for flowering	116.47	113.92±3.28	108.00-127.00	2.88	2.48	74.88	4.44
Fresh herbage yield (g $plant^{-1}$)	216.84	243.98±88.08	50.00-620.00	36.10	32.54	82.05	61.02
Shade dried herbage yield (g $plant^{-1}$)	197.95	226.31±85.32	42.00-598.00	37.70	34.39	84.03	65.23
Essential oil yield (g $plant^{-1}$)	1.47	1.66±0.87	0.61-4.52	52.23	41.76	65.49	70.46

Table 3. Estimates of phenotypic correlation coefficients in gamma irradiated populationof *cv.* Kosi in M_1 generation

	PH	PS	NB	LS	LA	NDF	FHY
PH	1	0.615**	0.514**	-0.254**	0.469**	-0.258**	0.479**
PS		1	0.795**	-0.290**	0.576**	-0.168	0.684**
NB			1	-0.338**	0.590**	-0.209*	0.700**
LS				1	-0.264**	0.209*	-0.424**
LA					1	-0.144	0.787**
NDF						1	-0.189

PH: Plant height LS: Leaf to stem ratio PS: Plant spread LA: Leaf area NB: Number of branches NDF: Number of days taken for flowering
FHY: Fresh herbage yield per plant * and ** indicates significance of values at P=0.05 and 0.01, respectively
r value at 5% = 0.192 and 1% = 0.251

Table 4 : Estimates of phenotypic path co-efficients analysis in gamma treated population of *cv*. Kosi in M_1 generation

	PH	PS	NB	LS	LA	NDF	FHY
PH	-0.035	0.123	0.094	0.042	0.250	0.003	0.479
PS	-0.022	0.201	0.146	0.048	0.307	0.002	0.684
NB	-0.018	0.160	0.184	0.057	0.314	0.003	0.700
LS	0.009	-0.058	-0.062	-0.168	-0.140	-0.003	-0.424
LA	-0.016	0.116	0.108	0.044	0.532	0.002	0.787
NDF	0.009	-0.033	-0.003	-0.038	-0.035	-0.076	-0.189

PH: Plant height LS: Leaf to stem ratio PS: Plant spread LA: Leaf area NB: Number of branches
NDF: Number of days taken for flowering FHY : Fresh herbage yield per plant
Residual effect= 0.507 Bold: Direct effect Above and belw diagonal: indirect effect

associated with leaf area (0.787), number of branches (0.700), plant spread (0.684) and plant height (0.479). While, the association was significant but negative with leaf to stem ratio (-0.424). This is in agreement with the findings of Venkatesha *et al*., 2020. Correlation studies give an idea about the positive and negative associations of different characters with yield and also among themselves. However, the nature and extent of contribution of these characters towards yield is not obtained. Path co-efficient analysis can provide a more realistic picture of relationships between different traits, as it takes into consideration direct as well as indirect effects of the different yield components. Determination of interrelationships between and among yield components and yield helps a plant breeder to easily identify traits that make the most significant contribution to yield. Path analysis revealed highly significant and positive direct effect of leaf area (0.532) on fresh herbage yield per plant followed by plant spread (0.201) and number of branches (0.184). While, the leaf to stem ratio negatively and directly influenced the fresh herbage yield (-0.168). Further, plant height, plant spread, number of branches, leaf to stem ratio influenced the fresh herbage yield through leaf area (0.250, 0.307, 0.314 and -0.140, respectively), leaf area influenced through plant spread (0.116) and number of days to maturity through leaf to stem ratio (-0.038). Similar results were noticed by Singh *et al*., 2000.

Conclusion:

Fresh herbage yield per plant had a highly significant positive relationship with leaf area, number of branches, plant spread and plant height. As a result, selecting these traits aids in increasing fresh herbage per plant in this crop. Selected 42 putative mutant lines are forwarded to M_2 generations for further evaluation, selection and stabilisation.

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