

Phenotypic recurrent selection on herb growth yield of citronella grass (*Cymbopogon nardus*) grown in Egypt

MOHAMED M. IBRAHIM^{1,*}, KHALID A. KHALID²

¹Department of Genetics and Cytology, National Research Centre, El Buhouth St., Dokki 12311, Giza, Cairo, Egypt. Tel. +202-3371615.

*email: mohamed_mostafa480@yahoo.com

²Department of Medicinal and Aromatic Plants, National Research Centre, El Buhouth St., Dokki 12311, Giza, Cairo, Egypt.

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Abstract. Ibrahim MM, Khalid KA. 2013. Phenotypic recurrent selection on herb growth yield of citronella grass (*Cymbopogon nardus*) grown in Egypt. *Nusantara Bioscience* 5: 70-74. This investigation was conducted in four generations: base population (G0, G1, G2) and G3 (clone selection generation) to evaluate the genetic variability of citronella clones. Thirteen clones were selected from base population to study the herb growth yield characters and oil production as well as genetic parameters, correlation, and regression. Results were recorded for herb growth characters (i.e., plant high (PH), no. of tillers (NOT), dry yield (DY), viability percentage (VP) and oil production. Significant variation was observed among citronella clones in base population for most studied traits. Wide range of mean values was observed among the characters for generations and cuts in most traits. High heritability values (0.95, 0.93, 0.89 and 0.72) were estimated in NOT, LG, HY, and VP., respectively. Clone code no. 39/3, 17/4 and 8/1 gave highest values of dry weight, oil yield, and viability percentage. Selected clones showed significant positive regression and correlation between dry weight and each of number of tillers and linear growth. On the contrary, viability percentage had significant negative correlation and regression with other characters. These results revealed high yielding selected citronella clones will be utilized in medicinal plant breeding program.

Key words: citronella, essential oil, heritability, selection

Abstrak. Ibrahim MM, Khalid KA. 2013. Seleksi fenotipik berulang pada pertumbuhan herba rumput serai (*Cymbopogon nardus*) yang ditanam di Mesir. *Nusantara Bioscience* 5: 70-74. Penelitian ini dilakukan dalam empat generasi: populasi dasar (G0, G1, G2) dan G3 (generasi pilihan klon) untuk mengevaluasi keragaman genetik klon-klon serai (sereh wangi). Tiga belas klon dipilih dari populasi dasar untuk mempelajari karakter hasil pertumbuhan herba dan produksi minyak serta parameter genetik, dengan korelasi dan regresi. Hasil yang dicatat berupa karakter hasil pertumbuhan herba (yaitu: tinggi tanaman (PH), jumlah anakan (NOT), hasil berat kering (DY), persentase viabilitas (VP) dan produksi minyak. Variasi yang signifikan teramati diantara klon-klon serai dalam populasi dasar untuk sebagian besar sifat-sifat yang dipelajari. Nilai rata-rata yang berjangkauan luas teramati diantara sifat-sifat untuk generasi dan pemotongan di sebagian besar sifat. Nilai heritabilitas tinggi (0,95, 0,93, 0,89 dan 0,72) diperkirakan secara berturut-turut pada NOT, LG, HY dan VP. Kode klon no. 39/3, 17/4 dan 8/1 memiliki nilai tertinggi dalam berat kering, hasil minyak dan persentase viabilitas. Klon terpilih menunjukkan regresi dan korelasi positif yang signifikan antara berat kering dan jumlah anakan serta pertumbuhan linear. Sebaliknya, persentase viabilitas memiliki korelasi dan regresi negatif yang signifikan dengan karakter lain. Hasil ini memberikan klon-klon serai terseleksi dengan hasil panen yang tinggi yang akan digunakan pada program pemuliaan tanaman obat.

Kata kunci: serai, minyak esensial, heritabilitas, seleksi

INTRODUCTION

Citronella, *Cymbopogon nardus* L. is a tufted perennial grass with long narrow leaves and numerous stems arising from short rhizome roots (Figure 1) which are indigenous to India (Weiss 1997). The importance of citronella grass is related to widely used in perfumes, soaps, insect repellent. It is also used in Chinese medicine and traditional medicine for the treatment of rheumatism, digestive problems, fever, and intestinal problems and in aromatherapy to treat colds, flu, and headaches (Akhila 2010).

Few efforts had been carried out on the crop improvement through the clone selection of herb and essential oil yield. Plant breeders primarily estimate variability in initial population of its importance in

choosing the most efficient breeding procedures. Kulkarni (1994) studied the herb growth characters, oil yield and variability in lemongrass though phenotypic recurrent selection, found that realized gains from selection were slightly smaller or smaller to predicted gains. Kole and Sen (1986) studied the selection strategy of yield and yield component in lemongrass clones in base population and selected clones. Selection is more efficient to improve essential oil and yield component. The importance of clone selection in genus *Cymbopogon* and genetic variability were studied by many researchers (Patra et al. 1991; Rao and Sobti 1991; Singh and Pathak 1994). They found recently a few clonal varieties have been developed to overcome wide fluctuation in quantity production of genus *Cymbopogon*.



Figure 1. *Cymbopogon nardus* L. (citronella grass)

Information on genetic variability, heritability estimates and interclass correlations for important characters are essential for plant breeding program. The present work aims to study genetic variability in population of citronella grass and then attempt to select some characterized and improved clones in herb growth yield and essential oil production.

MATERIALS AND METHODS

Cultivation method

This work was carried out in the Experimental farm of Nation Research Centre (NRC) in El Nobaria, Egypt, during four successive seasons 2008 - 2011 seasons or generations. Clones of citronella grass (*Cymbopogon nardus* L.) were obtained from the groups of genetics and breeding of medicinal plants, Nation Research Centre (NRC), Egypt. All tented clones were cultivated using tillers which separated from mother plants. On the 1st of May in base population and selected clones over two trials. Randomized complete block design with 3 replications was used. Each replicate had one line of 3m long and 60 cm in between. Each line had six ridges with 50 cm space. All cultural practices were followed. The first cut was taken after six months after planting, while the second cut was taken three months later. The plants of base population and selection experiment were carried out through four generations. The plant records included linear growth, number of tillers, herb dry yield and viability percentages of 13 clones were cultivated.

Statistical analysis

Statistical analysis of data was computed according to Steel and Torrie (1965). Heritability estimates were according to Robinson et al. (1951). Correlation and regression analysis estimated according to Mode and Robinson (1959).

Extraction of essential oils

The essential oils were extracted by harvesting the plants of selected clone's basis on dry weight. 30 grams of dried leaves from each of three replications for each selected clone were hydro distilled using Clevenger apparatus (Gunter 1962) for three hours. The obtained oil was measured and then computed as percentage value.

RESULTS AND DISCUSSION

Rang, mean values, coefficient of variation. (%) analysis of variance, heritability, and L.S.D. of four herb growth characters (no. of tillers, linear growth, herb dry yield, and viability percentage) at three generations (G0, G1 and G2) of citronella clones population are presented in Table 1. Significant differences were showed in all studied characters. Wide rang observed in all studied traits among three generations. Mean values ranged from (8.3±0.6) to (87.3±0.6), (43.4±0.9) to (108.5±5.1), (32.3±2.7) to (165.9±2.48), (77.0±1.9) to (98±0.07) % of numbers of tillers, linear growth, herb dry yield, and viability percentage respectively. Coefficient of variation (C.V. %) varied in all generations and all studied characters. Heritability estimate revealed highest values (0.9528, 0.9303, 0.8935 and 0.725) in no. of tillers, linear growth, herb dry yield, and viability percentage, respectively, while the values 0.4253, 0.1589, 0.372 and 0.1986 were the lowest in the same characters, respectively. Moreover, the first cut had higher heritability values comparing with the second cut values for all studied characters.

Evaluation of selected citronella clones

Thirteen clones of citronella were selected from earlier population to study clonal variation parameters and evaluate herb growth characters and yield components

Analysis of variance

Highly significant differences were shown among generations in all studied characters and only related to linear growth among clones

Covariance analysis

Average values, coefficient of variation and parent-progeny regression of 13 selected clones over four different generations presented in Table (3). Clonal variations were found for herb growth yield characters in the four

generations. Average values of clones cod no. 39/3, 15/4, 17/4, 1/2 and 14/3 had the highest values of herb dry character. Linear growth had the highest spatial regression (bij) in case of clone 25/1 followed by clone 39/3 in dry weight and no. of tillers

Interclass correlation and regression

Interclass correlation and regression among four growth herb yield in the mean of 13 citronella clones were presented in Table 4. Viability percentage showed high negative correlation with each of linear growth, no. of tillers and herb dry yield. One the other hand herb dry yield was high positive correlation with linear growth and no. of tillers. Viability percentage with each of no. of tillers, linear growth, and herb dry yield revealed negative regression values (-0.52, -1.01, -13.25) respectively. Herb dry yield with each of linear growth and no. of tillers had high (25.23, 18.66) and positive values of regression respectively.

Variation in oil production in selected citronella clones

Data presented in Table 5 showed variation in the oil content variation and oil yield of the thirteen selected clones basis on dry weight. Oil percentage ranged from 2.00 to 2.66 for clones (24/4, 14/3) and 36/3 respectively. Clones no. 15/4, 17/4 and 1/2 had highest values of oil yield. Oil yield ranged from 2.96 in clone 34/3 to 11.99 in case of clone 15/4 respectively.

DISCUSSION

Cymbopogon species display wide variation in morphological attributes and essential oil composition at inter- and intraspecific levels. Germplasm diversity is important for plant conservation and improvement, therefore there is interest in determining the genetic diversity in *Cymbopogon* germplasm. Although, morphological traits can be used to assess genetic diversity they are

Table 1. Biometrical genetic parameters of four major herb yield component in citronella grass under clone selection

Items	Range	Mean	C.V. ANOVA		σ^2e	h^2b	LSD		no
			%	σ^2g			0.05	0.01	
Number of tillers									
1st gen (G0)	5.5-11.3	8.3±0.6	25	24.43**	33.64	0.4253	4.36	5.74	41
2nd gen (G1)	11.4-17.7	14.9±0.6	14	226.38**	11.33	0.9528	1.71	2.25	37
1st Cut	5.1-13.0	8.3±0.6	25	77.15**	10.15	0.8828	2.29	3.01	37
2nd Cut	16.0-28.5	21.1±0.8	14	143.48**	39.48	0.7837	4.6	6.06	37
3rd gen(G2)	42.5-119.3	75.7±1.2	24	1289.07**	105.44	0.5508	44.94	59.16	16
Linear growth (cm)									
1st gen (G0)	39.6-49.0	43.4±0.9	7	29.78*	157.69	0.1589	8.99	0.0	41
2nd gen (G1)	51.0-63.1	57.0±0.6	8	216.92**	52.6	0.7574	3.7	4.9	37
1st Cut	37.5-52.5	46.4±1.7	12	147.22**	105.35	0.5829	7.6	10	37
2nd Cut	62.3-74.5	63.6±1.3	6	46.04*	121.92	0.2741	7.9	10.4	37
3rd gen (G2)	77.5-127.5	108.5±5.1	15	435.26**	32.63	0.9303	7.9	10.4	16
Herb dry yield (g/plant)									
1 st gen (G0)	18.4-95.0	35.3±1.2	56	1328.92**	678.41	0.662	20	26.4	41
2 nd gen (G1)	30.0-78.1	56.0±3.6	23	2021.91*	1197.83	0.372	17.9	23.5	37
1 st Cut	18.9-52.7	32.3±2.7	30	1083.82**	596.35	0.6451	17.8	23.4	37
2 nd Cut	32.5-121.7	80.0±1.3	28	1048.57**	1799.3	0.3682	30.9	40.7	37
3 rd gen (G2)	420.344	1659±248	54	8.79**	0.26	0.8935	70.7	930	16
Parentage viability									
1 st gen (G0)	75-100	98±0.7	7						
2 nd gen (G1)	42-100	79±4.2	19	429.59**	164.99	0.725	20.6	27.1	41
3 rd gen (G2)	68-89	77±1.9	9	75.23**	315.57	0.1986	22	29	41

Table 2. Analysis of variance of 13 citronella clones grown in four generations under clone selection

S.O.V.A	DF	No. of tillers	DF	Linear growth	DF	Herb dry yield	Viability %
Clones	12	117.93	10	140.57**	12	203566.21	82.57
Generations	3	13435.49***	3	9822.34 ***	3	8423104.3**	1187.16***
Error	36	101.13	36	51.07	36	199424.21	123.467

Table 3. Average values, coefficient of variation and regression on the median index of 13 citronella clones grown in four generations

bij	Viability %		Herb dry yield (gm.)		Linear growth (cm.)		Number of tillers			Code no.		
	C.V. %	Average	bij	C.V. %	Average	bij	C.V. %	Average				
1.02	16	87	2.10	18.7	905	1.26	52	75	1.62	13.1	40	39/3
1.22	20	83	0.98	18.7	424	1.28	57	68	0.79	5.6	27	54/4
0.98	16	85	1.84	18.7	794	00	00	000	0.92	12.1	25	15/4
1.72	40	74	1.54	18.4	673	1.09	46	72	1.04	10.4	32	17/4
1.16	19	86	0.63	16.4	309	1.27	49	74	1.09	12.2	29	24/1
1.16	25	73	0.94	17.0	443	0.75	35	64	0.92	12.1	25	22/1
0.91	14	88	0.75	17.8	341	5.85	32	56	1.04	12.6	27	25/1
1.01	19	88	1.01	17.9	455	1.26	51	74	0.61	8.9	23	14/3
0.69	11	92	0.24	13.9	137	0.83	43	59	0.47	7.4	21	34/3
0.74	11	90	0.58	15.4	293	0.73	33	66	0.05	11.5	32	8/1
1.30	12	88	0.42	15.1	245	00	00	00	0.87	10.1	24	36/3
1.20	17	84	1.29	18.6	560	1.03	52	64	1.36	12.7	35	1/2
0.04	12	77	0.63	17.7	287	1.01	49	62	1.05	12.4	28	18/2
		84.23±1.66		451±62.53			66.59±1494			28.0±15.94		Mean
		7.42		49.97			44.57			11.3.85		CV%

strongly influenced by environmental conditions and show little variation at the intra-specific level (Dhar et al. 1981; Kulkarni and Rajagopol 1986; Kulkarni 1997). The fluctuation of viability percentage of citronella clones population from generation to other due to compensation among yield component, fitness characters, and genotype-environment interaction Adams and Grafius (1971). The analysis of variance and covariance in the actual and predicted selection in base population and selected top 30% of citronella clones were studied in herb growth characters and oil yield production. Highly significant differences were shown among generations in three characters only (number of tillers, linear growth, and viability percentage). This finding revealed that clones carried genes with different additive effects. Meanwhile, in citronella clones revealed highly significant differences between clones in case of linear growth character, these results have reflected the role of gene type–environment interaction and seasonal variations (Western and Lawrence 1970). The result of clonal variation for herb growth yield characters in the three generations is in agreement with the investigation of Omokokhafa and Alike (2004) and Jezowski (2008).

Table 4. Estimates of interclass correlation (above) and regression (down) coefficients among four herb growth yield components.

Characters	X1	X2	X3	X4
No. of tillers (X1)	1.000	0.3368*	0.5911**	-0.5202**
Linear growth (X2)	0.360	1.000	0.4699**	-0.85414**
Herb dry yield (X3)	25.23	18.66	1.0000	-0.3706**
Viability% (X4)	-0.52	-1.01	-13.25	1.0000

Table 5. Average values, coefficient of variation in oil production for selected citronella clones at two generations.

Code no.	Oil percent %		Oil yield ml/plant	
	Average	C.V.%	Average	C.V.%
39/3	2.05	17.02	6.33	24.22
24/4	2.00	13.20	8.02	67.21
15/4	2.05	4.80	11.99	61.12
17/4	2.10	7.20	10.43	50.93
24/1	2.46	14.30	7.43	39.04
22/1	2.03	28.70	8.43	56.50
25/1	2.08	16.23	7.09	40.30
14/3	2.00	16.06	9.12	60.12
34/3	2.16	11.03	2.96	53.61
8/1	2.14	10.25	6.22	24.30
36/3	2.66	16.22	7.33	40.15
1/2	2.12	12.80	10.40	61.30
18/2	2.16	10.30	6.22	25.26
Mean	2.16 ± 0.053		7.85 ± 0.645	
C.V.%	13.70		46.47	

In citronella studied clones the correlation analysis confirms the role of clones x environment interaction Viability percentage showed high negative correlation with each of linear growth, no. of tillers and herb dry yield. One the other hand herb dry yield was high positive correlation with linear growth and no. of tillers. These results reflected compensation in yield components and variation in

excretion. That is confirmed clear homeostasis of genetic background and differential expression in these characters expression (El-Ballal et al. 1983).

Comparison of oil content and yield of the selected clones in the four seasons revealed apparent interaction (Harridy et al. 2001). Herb dry yield express of growth activity and essential oil production in grasses. Variations in oil production and accumulation (oil/yield ml/plant) due to many factors, such as growth stage, elongation of tillers and dry matter production were influenced. This finding is in agreement with Misra and Srivastava (2000) and Behura et al. (1991).

CONCLUSION

The results from this study lead to the conclusion that there is significant genetic variability among citronella clones has been made through phenotypic recurrent selection for studied traits. Wide rang were shown in all studied characters among three generations. Heritability estimates revealed highest values in no. of tillers, linear growth, and herb dry yield and viability percentage. Coefficient of variation (C.V. %) varied in all generations and all studied characters. One the other hand herb dry yield was high positive correlation with linear growth and no. of tillers. Highly significant differences were shown among generations in three characters only (number of tillers, linear growth, and viability percentage). This finding revealed that clones carried genes with different additive effects. Meanwhile, in citronella clones revealed highly significant differences between clones in case of linear growth character, these results have reflected the role of gene type–environment interaction and seasonal variations

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