GENETIC VARIABILITY IN CLONAL POPULATIONS OF JAVA CITRONELLA *Cymbopogon winterianus* JOWITT

K. K. Singh and N. K. Gupta

Scientist and Garden Superintendent, Regional Research Laboratory, Jorhat, Assam, India.

ABSTRACT

The nature and extent of variability and heritability were estimated in clonal populations of Java citronella, *Cymbopogon winterianus* Jowitt. A wide range of variability was observed. Genotypic variability varied between 0.02 for oil content and 10519.17 for yield of green herb. High genotypic variability was usually associated with high genotypic coefficient of variability, indicating a high latent potential for advancement by selection. Heritability estimates were high for height (85.45), leaf area (92.56), yield of green herb (86.17) and oil yield (88.97); medium for number of leaves (42.50) and oil content (41.10); and low for number of tillers (18.55). Genetic advance varied between 0.19 for oil content and 196.13 for yield of green herb. The value of genetic advance as per cent of mean was highest for oil yield (48.03) and lowest for number of tillers (3.13). High heritability values were usually associated with high genetic advance, indicating that clonal selection could be an effective method in improving plant characters such as height, leaf area, yields of green herb and oil.

Ann. Trop. Res. 5: 23-28.

KEY WORDS: *Cymbopogon winterianus* J. Genotypic variance. Phenotypic variance. Heritability. Genetic advance. Coefficients of variability.

INTRODUCTION

Oil produced from Java citronella *(Cymbopogon winterianus* Jowitt) is a rich source of perfumery chemicals such as geraniol, citronellal, citronellol and hydroxy citronellol, and is widely used by the industries. The annual international trade of the oil is 2000 to 2500 tons (Robbins, 1983). Hence, a number of countries have been cultivating the crop on large scale basis to meet the industrial needs. However, despite its economic importance, investigation on genetic improvement to further increase the yield per unit area has so far been neglected. Although studies on clonal selection and induction of mutations have been carried out (Chauhan et al. 1976; Ganguly et

al, 1979), knowledge on genetic parameters which are extremely essential for designing effective improvement programs is still lacking. The present investigation was therefore undertaken to determine the nature and extent of variability in the clonal populations of Java citronella and to estimate heritability and expected gain for various characters.

MATERIALS AND METHODS

Eight promising clones of Java citronella were selected from the population based on marked differences in various morphological characters. These clones were vegetatively propagated and slips obtained were planted in randomized complete block design, replicated 5 times. Individual plots measured 12 m^2, spacing was 80 cm and 60 cm between and within rows, respectively. Phosphorus and potassium fertilizers were each applied basally at 80 kg/ha. Nitrogen was applied at 120 kg/ha, half of which was applied basally and the rest in 2 equally split doses at 3 months interval. Other intercultural operations were kept uniform.

Based on 9 plants located at the center of each plot, the following plant characters were observed and recorded at the end of the year:

1. Height
2. Number of tillers
3. Number of leaves
4. Leaf area based on 10 selected leaves/plant (Watson, 1937)
5. Per cent oil content produced by distilling representative leaf samples
6. Total yield of green herb
7. Total oil yield (yield of green herb x % oil content).

Data were averaged and used for statistical analysis. Total variance was partitioned into genotypic ($\sigma^2 g$) and phenotypic ($\sigma^2 p$) variances, and heritability ($\beta^2 p$) in broad sense was calculated following the method of Burton and de Vane (1953).

Genetic advance (GA) and GA as per cent of mean was calculated as follows (Burton and de Vane, 1953):

$$GA = \frac{SV_G}{\sqrt{* V_r}} \quad \text{; where,}$$

$$V_r = V_G + \frac{V_e}{N}$$

V_e = Error mean sum of square,

V_G = Total genetic variance

S = 2.06

N = Number of replications

$$\text{GA as per cent of mean} = GA \times \frac{100}{\overline{X}}$$

where:

GA = Genetic advance

$\overline{X}$ = Mean

Genotypic and phenotypic coefficients of variability were calculated using the method of Burton and de Vane, as cited by Osman and Khidir (1974).

RESULTS AND DISCUSSION

The data for different characters of Java citronella are presented in Table 1. Analysis of variance showed significant differences in height, leaf area, yield of green herb and oil yield.

The estimates of genotypic ($\sigma^2 g$) and phenotypic variance ($\sigma^2 p$), heritability ($h^2\beta$), genetic advance (GA), genetic advance as per cent of mean and genotypic (GCV) and phenotypic (PCV) coefficients of variability for different characters are shown in Table 2. The results of this study revealed the presence of sufficiently large variability. Values of genotypic variance for different characters varied between 0.02 for oil content and 10519.17 for yield of green herb. High $\sigma^2 g$ was also associated with high $\sigma^2 p$. However, the range in genetic variance values is not as useful as when unit of measurement and mean are known (Burton and de Vane, 1953). The GCV takes these variables into consideration and presents in one statistic an index of potential advance latent within the population (Burton and de Vane, 1953). The GCV values in this study ranged from 3.66 for number of tillers to 24.73 for oil yield. It may also be noted that high $\sigma^2 g$ values were coupled with high GCV, indicating that the population under study had high latent potential for advancement by selection.

The $h^2\beta$ estimates were high for height (85.45), leaf area (92.56), yield of green herb (86.17) and oil yield (88.97); medium for number of leaves (42.50) and oil content (41.10); and low for number of tillers (18.55). The GA values varied between 0.19 for oil content and 196.13 for herbage yield. The GA expressed as per cent of mean ranged from 3.13 for number of tillers to 48.03 for total oil yield.

The purpose of partitioning total variance and estimating $h^2\beta$ is to

Table 1. Range, mean and standard error (S.E.) for different characters of Java citronella.

Character	Range	Mean ± S.E.
Height (cm)	67.2 - 143.7	97.62 ± 3.44
Number of tillers	47.0 - 104.0	69.95 ± 5.61
Number of leaves	258.0 - 526.0	391.48 ± 29.77
Leaf area (cm^2)	4.16- 11.54	7.70 ± 0.32
Yield of green herb (g/plant)	250.00-1200.00	486.56 ± 41.09
Oil content (%)	1.22- 1.52	1.33 ± 0.17
Oil yield (cc)	2.55- 10.20	6.48 ± 0.56

Table 2. Estimates of genotypic and phenotypic variance, heritability, genetic advance, genetic advance as per cent of mean, and genotypic and phenotypic coefficients of variability in Java citronella.

Character	Genotypic variance	Phenotypic variance	Heritability (%)	Genetic advance	Genetic advance as per cent of mean	Genotypic coefficient of variability	Phenotypic coefficient of variability
Height (cm)	69.41	128.50	85.45	15.87	16.25	8.53	11.61
Number of tillers.	6.56	167.15	18.55	2.19	3.13	3.66	18.48
Number of leaves	655.41	5086.96	42.50	34.39	8.78	6.54	18.22
Leaf area (cm^2)	1.28	1.79	92.56	2.24	29.06	14.66	17.36
Yield of green herb (g/plant)	10519.17	18959.14	86.17	196.13	40.31	21.08	28.29
Oil content (%)	0.02	0.17	41.10	0.19	14.23	10.76	30.72
Oil yield (cc)	2.57	4.16	88.97	3.11	48.03	24.72	31.47

assess the genetic worth of the material and to determine whether selection is an effective method of improvement. The estimated $h^2\beta$ measures the efficiency of selection system in separating genotypes (Burton and de Vane, 1953). Johnson et al. (1955), however, suggested that h^2B estimates along with GA will be more useful than $h^2\beta$ alone in selecting best genotypes. In the present study, high $h^2\beta$ values were generally associated with high GA values as well as with GA expressed as per cent of mean. This indicates that phenotypic selection could improve the plant characters of Java citronella like height, leaf area, yields of green herb and oil.

High $h^2\beta$ values coupled with high GA are indicative of predominance of additive genetic variance (Panse, 1957), which would consequently bring about high genetic gain (Osman and Khidir, 1974). Genetic variance as calculated following Burton and de Vane (1953), may still contain variance due to dominance deviations and epistasis in addition to additive fraction. Hence, genetic variance could give considerable upward bias to gain by selection estimates based upon it, especially if sexually propagated (Burton and de Vane, 1953). Since genetic variance may contain variance due to dominance and epistatic effects, genetic advance values will be strictly applicable if vegetative propagation of plants is assumed. Java citronella is a vegetatively propagated crop, therefore, the estimates presented and the observations made would remain applicable. Clonal selections or selections based on phenotypes would be an effective method for rapid gain for characters with high $h^2\beta$ and high GA, i.e., characters like height, leaf area, yields of green herb and oil.

ACKNOWLEDGMENT

The authors are thankful to Dr. G. Thyagarajan and Dr. D. Ganguly, former Director and Head, respectively, Medicinal and Aromatic Plants Division, RRL, Jorhat, Assam, India, for providing the facilities and encouragement.

LITERATURE CITED

BURTON, G.W. and DE VANE, E.H. 1953. Estimating heritability in tall fescue *(Festuca arundinacea)* from replicated clonal material. Agron. J. 45: 478-481.

CHAUHAN, Y.S., SINGH, K.K. and GANGULY, D. 1976. Improvement of Java citronella *(Cymbopogon winterianus* Jowitt) by chemical mutagenesis. Ind. Perf. XX (1): 73-77.

GANGULY, D., SINGH, K.K., BHAGAT, S.D., UPADHYAY, D.N., CHAUHAN, Y.S., GUPTA, N.K. and SINGH, H.S. 1979. RRLJOR-3-1970- an improved strain of Java citronella *(Cymbopogon winterianus* Jowitt). Ind. Perf. XXIII (2): 107-111.

JOHNSON, H.W., ROBINSON, H.F. and COMSTOCK, R.F. 1955. Estimates of genetic and environmental variability in soybeans. Agron. J. 47: 314-318.

OSMAN, H. EL GIZOULI and KHIDIR, M. OSMAN. 1974. Estimates of genetic and environmental variability in sesame. Expt. Agric. 10: 105-112.

PANSE, V.C. 1957. Genetics of quantitative characters in relation to plant breeding. Ind. J. Genetics. 17: 318-328.

ROBBINS, S.R.J. 1983. Selected markets for the essential oils of lemongrass, citronella and eucalyptus. Rep. Trop. Prod. Inst., London, vii + 91 pp.

WATSON, D.J. 1937. The estimation of leaf area in field crops. J. Agric. Sci. 27: 474-483.