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Nature of Gene Action for Yield and Yield Components in Sugarcane (*Saccharum spp.*)

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ABSTRACT

Moderate to high estimates of phenotypic and genotypic coefficients of variation (PCV and GCV) were recorded for shoot population at 120 DAP, stalk population at 240 DAP, plant height at 240 DAP, number of millable canes, cane yield, sugar yield while the estimates of PCV and GCV were low for single cane weight, per cent juice sucrose and diameter of cane. Estimates of heritability and genetic advance over mean were moderate to high for plant height at 240 DAP, shoot population at 120 DAP, stalk population at 240 DAP, single cane weight, number of millable canes, cane yield and sugar yield suggested the importance of additive gene action for the inheritance of the characters. Moderate to high heritability and low to moderate estimates of genetic advance over mean for length of millable cane per cent juice sucrose and diameter of cane indicated the operation of non-additive gene action for length of millable cane, diameter of cane and per cent juice sucrose.

Key words : Gene Action, Sugarcane Genetic Parameters.

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Knowledge on the nature of gene action and inheritance of characters is essential so as to adopt a suitable breeding methodology in crop improvement. Sugarcane is a polyploid and highly heterozygous in nature. It is a vegetatively propagated, long duration crop with numerous chromosomes (2n=80-120). Hence, adoption of Mendelian principles in sugarcane is difficult. The information available on the inheritance of characters is scanty. The present study was carried out in sugarcane to assess the variability for yield components, cane and sugar yield and to study the nature of gene action through the estimation of genetic parameters.

MATERIAL AND METHODS

The experiment was conducted with 14 pre-release sugarcane clones in main yield trial stage at Sugarcane Research Station, Vuyyur during 2006-07. The design adopted was RBD with three replications. Each clone was grown in eight rows of five meters length and 80 cm. spacing between rows. The soil are of clay loam with low in available nitrogen and high in available phosphorus and potassium. Organic carbon content of the soils is medium with neutral pH. The crop was raised under irrigated conditions following all the recommended package of practices and fertilizer application (168 kg N + 80 kg P_2O_5 + 100 kg K_2O ha^{-1}). Data were recorded on plant height at 240 (DAP), shoot population at 120 DAP, stalk population at 240 DAP, length of millable cane, diameter of cane, single cane weight, number of millable canes and cane yield. Per cent sucrose in juice and estimated CCS yield (sugar yield) were determined as per the procedure of Meade and Chen (1977) and Srivastava et al., (1988).

Analysis of variance for all the characters studied was carried out following the procedure of Panse and Sukhatme (1978). Mean sum of squares obtained from analysis of variance were utilized to estimate phenotypic and genotypic variances as per the method suggested by Lush (1949).

The phenotypic and genotypic coefficients of variation were estimated by using the formulae given by Burton (1952). Heritability in broad sense (Hanson, 1963) and genetic advance over mean (Allard, 1960) were determined as per the standard procedures. Estimates of coefficients of variation, heritability and genetic advance over mean were grouped in to different categories as per the suggestions of Sivasubramanian and Menon (1973), Stansfield (1969) and Johnson et al., (1955), respectively.

RESULTS AND DISCUSSION

Results on mean, phenotypic and genotypic variances, coefficients of variation, heritability, genetic advance over mean for yield components, cane and sugar yield are presented in Table 1.

The range of variation observed was high for shoot population at 120 DAP followed by cane yield, stalk population at 240 DAP, plant height at 240 DAP, sugar yield, length of millable cane and number of millable canes while it was low for single cane weight and per cent juice sucrose and diameter of cane. Among the clones studied 2000 V 59, 2000 V 220, 2002 V 2, 2002 V 3, 2002 V 5 and 2000 V 106 were found superior for cane and sugar yields. These clones have also recorded higher mean values for yield components and CCS yield.

Moderate to high phenotypic and genotypic coefficients of variation were recorded for plant height at 240 DAP (10.68 and 10.06), shoot population at 120 DAP (25.93 and 24.47), stalk population at 240 DAP (14.97 and 13.39), single cane weight (22.07 and 21.59), number of millable canes (12.43 and 10.26), cane yield (21.06 and 19.36) and sugar yield (23.67 and 21.66). Higher estimates of coefficients of variation and mean values recorded for the above characters indicate the scope for operation of selection. Singh et al., (1995) and Rajabapa Rao (2002) for single cane weight; Rao (1999) and Bakshi Ram (2005) for number of millable canes and sugar yield; Milligan et al., (1996) for cane yield have also reported higher phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) values in sugarcane.

Low estimates of variances and phenotypic and genotypic coefficients of variation observed for length of millable cane (9.44, 8.56), diameter of cane (10.23, 8.64) and per cent sucrose (6.24, 5.79) suggests the scope for selection for these characters is low due to narrow range of variability. Similar results of narrow range of variability were also reported in sugarcane for length of millable cane and diameter of cane (Nair et al., 1980 and Nair and Srinivasan,1989) and per cent juice sucrose (Singh et al., 1981 and Rajabapa Rao, 2002).

Johnson et al., (1955) suggested that heritability alone will not give any idea about the gene action but heritability along with genetic advance over would be useful in assessing the nature of inheritance of the characters.

Moderate to higher estimates of heritability in broad sense and genetic advance over mean were noted for plant height at 240 DAP (88.80 and 19.54), shoot population at 120 DAP (89.00 and 47.56), stalk population at 240 DAP (80.00 and 24.67), single cane weight (95.30 and 43.49), number of millable canes (67.30 and 17.39), cane yield (84.50 and 36.60) and sugar yield (83.70 and 40.83). Higher estimates of heritability and genetic advance over mean or moderate estimates of heritability and genetic advance over mean recorded in the present study for plant height, shoot population, stalk population, single cane weight, cane yield, sugar yield and number of millable canes suggests the operation of additive gene action in these characters. Similar results of moderate to higher estimates of heritability and genetic advance over mean were reported in sugarcane for plant height (Kumar, 2004); shoot population at 120 DAP (Singh et al., 1983); single cane weight (Tyagi and Singh, 1998 and Kumar, 2004); number of millable canes, cane yield and sugar yield (Kumar, 2004).

Low to moderate estimates of heritability along with low to moderate values of genetic advance over mean were recorded for length of millable cane (82.20 and 15.98), diameter of cane (71.30 and 15.04), per cent juice sucrose (86.00 and 11.06). The low to moderate estimates of heritability coupled with low to moderate estimates of genetic advance over mean indicates the importance of non-additive gene action for the inheritance of these characters. The results obtained in the present study are in agreement with the previous findings for length of millable cane (Tyagi and Singh, 2000), diameter of cane (Tyagi and Singh 1998) and per cent juice sucrose (Tyagi and Singh, 2000 and Kumar, 2004).

Based on mean values, variances, phenotypic and genotypic coefficients of variation, heritability and genetic advance over mean it is concluded that plant height, shoot population, stalk population, single cane weight, number of millable canes, cane yield and sugar yield are governed by additive gene action while length of millable cane, diameter of cane and per cent juice sucrose are conditioned by non-additive gene action.

LITERATURE CITED

Allard R W 1960. Principles of plant breeding. John Wiley and Sons Inc New York pp : 485

Bakshi Ram 2005. Estimation of genetic parameters in different environments and their implications in sugarcane breeding. Indian Journal of Genetics and Plant Breeding 63 (3) : 219-220

Burton G W 1952. Quantitative inheritance in grasses. Proceedings of International Grassland Congress 6 : 277-283

Hanson W D 1963. Statistical genetics and plant breeding NAS-NRC publication 982 : 125-139

Table 1. Mean, range of variation, phenotypic and genotypic coefficients of variation, heritability and genetic advance over mean for yield components, cane and sugar yield

Characters	Mean	Range	Genotypic variance	Phenotypic variance	Genotypic coefficient of variation	Phenotypic coefficient of variation	Heritability (broad sense)	Genetic advance over mean
Plant height (cm)	196.20	167.80-225.20	389.94	439.13	10.06	10.68	88.80	19.54
Shoot population plot^{-1}	375.64	189.33-511.33	8448.27	9487.54	24.47	25.93	89.00	47.56
Stalk population plot^{-1}	313.95	232.67-375.33	1750.19	2187.82	13.39	14.97	80.00	24.67
Length of millable cane (cm)	252.97	220.33-293.33	468.53	570.09	8.56	9.44	82.20	15.98
Single cane weight (kg)	1.56	0.91-2.01	0.11	0.12	21.59	22.07	95.30	43.49
Diameter of cane (cm)	262 00	2.26-3.08	0.05	0.07	8.64	10.23	71.30	15.04
Number of millable canes plot^{-1}	289.12	224.00-334.33	890.15	1315.99	10.26	12.43	67.60	17.39
Juice sucrose (%)	17.17	16.01-18.96	0.99	1.15	5.79	6.24	86.00	11.06
Cane yield (kg plot^{-1})	405.40	274.33-492.00	6161.62	7292.97	19.36	21.06	84.50	36.66
Sugar yield (kg plot^{-1})	49.87	35.87-66.02	117.18	139.96	21.66	23.67	83.70	40.83

Johnson H W, Robinson H F and Comstock R E 1955. Estimates of genetic and environmental variability in soybeans Agronomy Journal 47 : 314 – 318

Kumar C K 2004. Genetic variability and correlation studies in sugarcane (*Saccharum officinarum* L.). M.Sc. (Ag.) Thesis submitted to Acharya N.G Ranga Agricultural University, Hyderabad. pp : 107

Lush J L 1949. Heritability of quantitative characters in farm animals. Proceedings of 8th Congress of Genetic Hereditas: 35 : 356-387

Meade G P and Chen J C P 1977. Cane sugar hand book. 10th Edition. John wiley Inter Science. John wiley and Sons. New York.

Milligan S B, Gravois K A and Martin F A 1996. Inheritance of sugarcane ratooning ability of the relationship of younger crop traits and older crop traits. Crop Science 36 : 45-50

Nair N V and Srinivasan T V 1989. Analysis of stalk yield components in *Saccharum officinarum L.* Ph.D Thesis submitted to Sugarcane Breeding Institute, Coimbatore

Nair N V, Somarajan K G and Balasundaram B 1980. Genetic variability and genetic advance in *Saccharum officinarum L*. International Sugarcane 82 : 275-286

Panse V G and Sukhatme P V 1978. Statistical methods for agricultural workers. ICAR Publications pp : 361

Rajabapa Rao V 2002. Studies on stability and genetic parameters in selected genotypes of sugarcane (*Saccharum spp.*). Ph.D thesis submitted to Acharya N G Ranga Agricultural University, Hyderabad pp: 296

Rao K P 1999. Studies on family performance, selection efficiency and repeatability at seedling and clonal stages of open pollinated progenies of sugarcane (*Saccharum spp.*). Ph.D. Thesis submitted to Acharya N.G Ranga Agricultural University, Hyderabad (A.P) pp : 207

Singh H N, Singh S B, Verma, P S and Singh R V 1981. Correlation and path analysis in Sugarcane. Indian Journal of Agricultural Research 15 : 126-130

Singh R and Sangwan R S 1983. Genetic evaluation of "Co" canes for commercial characters under North Indian Conditions. Co-operative Sugar 14 (10) : 521-524

Singh Sarvajeet and Khan A Q 1995. Studies on the variability, heritability and genetic advance of some quality attributes in sugarcane. Indian Sugar. 31 : 911-914

Sivasubramanian S and Madhava Menon P 1973. Genotypic and phenotypic variability in rice. Madras Agricultural Journal 60 : 1093-1096

Srivastava S C, Johari D P and Gill P S 1988. Manual of sugarcane production in India Indian Council of Agricultural Research New Delhi pp 194

Stansfield, W D 1969. Theory and problems of genetics M C Grow hill New York pp 392

Tyagi S D and Singh D N 1998. Studies on genetic variability for stalk characters in sugarcane. Indian Sugar 48 : 259-262

Tyagi S D and Singh D N 2000. Correlation and heritability studies in sugarcane. Indian Sugar 50 (5) : 303 – 308

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