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A METRICAL STUDY IN SETARIA ITALICA (BEAUV)—THE ITALIAN MILLET

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Varieties of Italian millet are distinguished by diverse qualities such as the colour of the grain, the pigment of the plant body or the bristle, and equally well by certain metric properties like the number of tillers, the dimension of the earhead or the size of the grain. These quantitative factors are liable to great fluctuations under the influence of the environment and do not possess the constancy of the qualitative characters. Usually the variation in one factor is governed by variations in other factors. The present study is an investigation into the relationship between some salient metrical properties both inter- and intra-varietal.

Material and Method. Forty four pure lines of this millet comprising almost all the possible variation of characters were selected and grown under rainfed condition at the Millets Breeding Station. The experimental plots consisted of about 200 plants each and of these ten plants were selected at random and the following measurements on each plant were made in the laboratory. (1) Total weight of earheads, (2) total number of primary earheads, (3) total number of secondary earheads, (4) height of plant, (5) weight of main earhead, (6) length of main earhead, (7) diameter of main earhead, (8) length of peduncle on the main tiller, (9) weight of dry straw and (10) weight of 500 grains.

The method adopted is the analysis of covariance. The between-variety critical correlation coefficient is ·30 for the level of significance P = ·05 and the within-variety coefficient is ·10.

In the actual computation, accuracy up to the sixth decimal place was maintained. However, in the presentation of the results here, two places were thought sufficient for the discussion.

The inter- and intra-varietal correlation coefficients are presented in Table I and the coefficients of variation in Table II.

Discussion. TOTAL EARHEAD YIELD AND RELATED CHARACTERS

The total number of tillers bearing earheads and the character of these earheads are the two factors determining the total yield. The varieties under discussion present a wide variation in the total yield. The coefficients of

variation are 31 per cent between varieties and 49 per cent within varieties. The total number of earheads is also a very variable character; 41 per cent is the coefficient of variation between varieties and 46 per cent within varieties.

It is seen from Table I that the correlation between the total yield and the number of earheads is ·58 between varieties and ·79 within varieties. When considering plants in a variety, the total number of earheads as a criterion for yield proves better than it does when comparing varieties as a whole.

It has already been observed (Rangaswami Ayyangar, 1935) in this breeding station that the earheads of a plant in this millet can be classified into three classes, main, primary and secondary. The main earhead is borne on the stalk arising right from the seed. The primary earheads are those borne on tillers which rise at the soil level along with the primordial tiller, and the secondary heads are those borne on tillers which shoot up from any of the primary or the main tiller. The main, primary and secondary earheads are in descending order of grain yield and they constitute three distinct classes. The coefficient of variation in the total number of primary earheads is 52 per cent between varieties and 57 per cent within varieties. The corresponding figures for secondary earheads are 66 per cent and 76 per cent. These are the most variable of all the characters considered. The inter-varietal correlation between the number of primary earheads and the total yield is ·43, whereas that between the number of secondary earheads, and the total yield is 61. (Table 1). Between varieties the number of primary earheads is correlated with the secondary earheads the correlation being ·66 (Table I).

The partial correlation between the total yield and the number of secondary earheads with the number of primary earheads eliminated is ·49 between varieties, and the partial correlation between the total yield and the number of primary earheads with the number of secondary earheads eliminated is ·01. The multiple correlation between the total yield and the number of primary and secondary earheads is ·61, an increase over the total correlation ·61 was detected only in the higher decimal places. So the linear regression of yield over these two variates is of no use.

The inter-varietal correlation between the number of primary earheads and the total yield is ·70 and that between the number of secondary earheads and the total yield is 63 (Table I). An increase in the number of primary earheads is not necessarily followed by an increase in the secondary earheads; the correlation is low being ·30 (Table I). The partial correlation between the total yield and the number of primary earheads with the number of secondary earheads eliminated is ·68, and the partial correlation between the total yield and the number of secondary earheads with the number of primary earheads eliminated is ·61. The multiple correlation between the total yield and the two factors namely, the number of primary and secondary earheads is ·82. The resolving of the number of earheads into two classes is not necessary in estimating the yield.

So far, the number of earheads and its classification was considered as one aspect of the total yield. The other factor namely, the average yield per head may be considered now. It is found that the main earhead is a very good index to the average type of earhead, especially it is so between varieties ; the correlation between the main earhead yield and the average earhead yield is ·86, and within a variety the correlation is ·55 (Table I).

The inter-varietal correlation between total yield and the main earhead yield is ·21 which is not significant, and the intra-varietal correlation is ·51 (Table I). The main earhead in itself gives no clue to the total yield in the comparison of varieties. But in conjunction with a knowledge of the total number of earheads, it becomes effective. The multiple correlation between yield and the total number of earheads and the main earhead yield is ·85 between varieties, and ·83 within varieties. Considering the product *total number of earheads* × *main earhead yield* as a single variate, the correlation between this and the total yield is ·86 between varieties, and ·85 within varieties (Table I). Though this does not improve the multiple correlation obtained by treating the two variates linearly, there is a practical significance in this deliberately introduced variate. The rule will be if required to estimate the yielding capacities of several varieties, to consider the products of the number of earheads and the main earhead yield.

The properties of this main earhead will be discussed in the sequel.

The straw weight in this study includes the leaves and the stems and is a measure of the vegetative activity. The total yield is correlated with straw. Between varieties $r = ·57$ and within varieties $r = ·82$ (Table I).

In this study the height of a plant is measured on the main tiller from the soil level to the tip of the earhead. Compared with other metrical factors, height is the least variable, the coefficient of variation being only 9 per cent between varieties and 7 per cent within a variety. The height of a plant needs no consideration in the estimation of total yield; the correlation between varieties is ·16 and within varieties ·25 (Table I).

The weight per grain is an essential factor in the determination of yield. The total number of grains for a whole plant is the resultant of the total number of earheads and the average number of grains is an earhead. In this study, 500 grains from the main earheads of a variety were picked at random and weighed. It was found that this factor varies but slightly in the varieties, the coefficient of variation being only 11 per cent. The varieties which yield high tend to have heavy grains; the correlation between these two factors is ·39 which is significant.

Main earhead and related characters. The first thing that strikes an observer in the Italian millet is the main earhead. It rises prominently above the other earheads before it droops by its own weight to be waving in the breeze. It typifies the other earheads in shape. As already pointed out, it characterises in its grain content the hypothetical average earhead (Table I). Its coefficient of vartation is 32 per cent between varieties and 23 per cent within varieties.

It is a curious fact that more the tillers a variety produces, the smaller is the yield from the main earhead. The inter-varietal correlation between the main earhead yield and the total number of earhead is −·55. (Table I). But contrary is the behaviour of a plant within a variety. The intra-varietal correlation between the number of earheads and the main earhead yield is ·33 which is significant (Table I). The causes that bring about the reciprocal adjustment in the number of tillers and the main earhead yield between different varieties seem to be different from those operating in the fluctuation of these characters within a variety.

The yield of the main earhead is to a great extent determined by its length and diameter, the dimensions which approximately decide the size. It is the maximum diameter that is considered here. Varieties of this millet vary in their earhead length and diameter, the coefficients of variation between varieties being 15 and 19 per cent respectively. Within a variety the fluctuation is restricted ; the coefficient of variation is 10 per cent for length and 11 per cent for diameter.

The inter-varietal correlation between the main earhead length and yield is ·53 and between the diameter and yield it is ·49 (Table I). The corresponding intravarietal correlations are ·64 and ·63.

The inter-varietal correlation between the number of earheads and the main earhead length and diameter are negative end significant, but the corresponding intra-varietal correlations are all positive and significant (Table I).

The main earhead length and diameter are themselves correlated, the correlation being ·45 between varieties and ·56 within varieties.

The length of the main earhead is partly determined by the height of the culm bearing it. The correlation between height and the main earhead length is ·59 between varieties and ·56 within varieties (Table I). Varieties which are short on the whole possess short earheads.

The height of the plant influences the yield of the main earhead, the inter and intra-varietal correlations being both ·43 and significant (Table I). This effect is through the length of the earhead. The partial correlation between the main earhead yield and height with the factor earhead length eliminated is ·16 between varieties and ·10 within varieties.

Peduncle is the last internode and its length is measured from the last node to the base of the earhead. The peduncle of the main tiller, like its height, varies but little. The coefficient of variation between varieties is 12 per cent and within varieties 16 per cent. Both between varieties and within varieties this length has no influence on the main earhead (Table I), and it need not be considered when looking for a good type of earhead.

The main earhead yield is determined by the total number of grains and the weight per grain. The yield is found to be closely related to the total number of grains, the correlation between the two factors being ·79.

The variation in the main earhead yield is not influenced by the variation of the weight per grain, the correlation between these two factors is ·02.

Straw and related characters. The relationship between straw yield and the total earhead yield has already been discussed. The coefficient of variation between varieties is 29 per cent and within varieties 34 per cent. Straw yield is correlated to the total number of earheads, the between varieties correlation being ·59, and the within varieties coefficient ·78. Within a variety the variation in straw is very closely related to the variation in the number of primary earheads (r= ·89); between varieties, however, the relationship is less manifest (r=·39). Here is another instance of a wide difference between inter- and intra-varietal correlations. Table I shows that the straw yield is also correlated to the number of secondary earheads. Between varieties the partial correlation between straw and number of primary tillers, with the factor secondary tillers eliminated, is ·13, and the partial correlation with the two factors interchanged is ·29. Whereas the partial correlation within varieties between straw and number of primary tillers with the factor the number of secondary tillers eliminated is ·94, and the partial correlation with the factors interchanged is ·80. In fact the total straw weight can be fairly well estimated by a double regression with the number of primary and secondary tillers as the independent variates. The multiple correlation is ·96. Within a variety these two factors suffice to determine the straw yield.

Summary. In 44 different varieties of Italian millet, inter-varietal and intra-varietal correlations and coefficients of variation have been determined. The factors considered are the total earhead yield, number of primary and secondary earheads, height of plant, main earhead yield, and its length and diameter, length of peduncle, weight of dry straw and weight of 500 grains.

The number of secondary earheads and the number of primary earheads are the most variable characters and the least variable are the weight per 500 grains, the height of the plant and the main earhead dimensions.

The product of the total number of earheads and the yield of the main earhead can be relied upon in judging the relative merits of varieties or of a plant within a variety, as the inter-and intra-varietal correlations are above ·8. The resolution of the total number of earheads into primary and secondary categories is without effect in improving the accuracy of the estimation of yield. In the determination of the total yield, straw is a factor to be reckoned with. The height of the plant need not be considered where yield is the concern, both in the comparison of varieties and within a variety. Those varieties which yield well tend to have heavy grains.

The main earhead characterises the hypothetical average earhead in grain content, especially in the comparison of different varieties. The yield and the dimensions of the main earhead are inversely related to the tillering capacity in the inter-varietal comparison. Within a variety, however, the behaviour is contrary; there is a significant positive correlation. The yield is dependent on the dimensions of the earhead which determine to a great extent the total number of grains. The height of the plant influences the main earhead through its length factor.

The production of straw is closely related to the number of tillers, particularly the primary tillers within a variety. The number of secondary and primary tillers almost completely determine the straw intra-varietally.

Literature Cited.

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TABLE I. Correlation Coefficients.

Correlates.	Correlation Coefficients.	
	Between Varieties	Within Varieties
Total earhead yield and number of earheads	·58	·79
" " " Number of primary earheads	·43	·70
" " " Number of secondary earheads	·61	·63
" " " Main earhead yield	·21	·51
" " " Main earhead yield × Number of earheads	·86	·85
" " " Straw yield	·57	·82
" " " Height of plant	·16	·25
Number of primary earheads and Number of secondary earheads	·66	·30
Main earhead yield and Average earhead yield	·86	·55
" " " Number of earheads	−·55	·33
" " " Number of primary earheads	−·61	·36
" " " Number of Secondary earheads	−·41	·25
" " " Length of main earhead	·53	·64
" " " Diameter of main earhead	·49	·63
" " " Height of plant	·59	·56
" " " Peduncle length	·08	·14
Main earhead length and Number of earheads	−·45	·35
" " " Main earhead diameter	·45	·56
" " " Height of plant	·59	·56
Main earhead diameter and Number of earheads	−·54	·23
Straw yield and Number of earhead	·59	·78
" " " Number of primary earheads	·39	·89
" " " Number of secondary earheads	·46	·62
Level of significance P=·05	·30	·10

TABLE II. Coefficients of Variation.

Factors	Coefifcients of Variation	
	Between Varieties	Within Varieties
	%	%
Total earhead yield	31	49
Number of earheads	41	46
Number of primary earheads	52	57
Number of secondary earheads	66	76
Height of plant	9	7
Main earhead yield	32	23
Length of main earhead	15	10
Diameter of main earhead	19	11
Length of peduncle	12	16
Weight of dry straw	29	34
Weight of 500 grains	11	–