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Choice of Position of Leaf on Main Shoot to Represent Total Leaf Area and Prediction of Grain Yield from Plant Characters in Ragi (*Eleusine coracana* Gaertn.)

by

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Introduction: The leaves are indispensable for plants for synthesis of plant food and number of leaves and leaf area have been found to have a bearing on yield. As the measurement of the total leaf area is practically impossible, it has been the custom particularly in millets to record the area of the leaf at a given position on the main shoot to represent the total leaf area of the plant. For example in *Sorghum* and *Ragi* the measurement of area of the fourth leaf from top has been in vogue. There are no previous results available on which this practice is based. The present investigation has, therefore, been aimed at determining the position of the single leaf which is most representative of the total leaf area of the plant in ragi. In addition, the relationship between the grain yield and various yield components was also studied to evaluate the relative contribution of the various characters to the grain yield.

Review of Literature: Divakaran (1959) reported that in ragi efficiency is achieved by the telescoping of internodes which enable the packing of a large number of leaves in a limited space. It was also observed that with increasing duration and height, there is a progressive increase in number and length of internodes. The small size of the plant is well compensated by the tillering habit and increase in number of leaves. Samathuvam (1962) reported that the maximum yield contribution is by the main stem. The data also reveal that varietal differences exist in the relative yielding capacity of the main stem and successive tillers. Mahalanobis (1934) studying various characters of rice varieties found that mean yield is moderately correlated with the number of tillers per plant and length of leaf.

Patel and Patel (1928) found positive relationship between leaf area, plant height, thickness of stem, length of rachis, density of panicle branches and grain yield in Jowar. Swarup and Chavgale (1962) reported that the plant height was positively correlated with grain yield and while fodder yields were positively correlated with number of days for panicle emergence, plant height, stalk diameter and leaf number.

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Mohankumaran *et al.* (1964) have made use of regression analysis to estimate the leaf area in grapes with the length of the leaf. A quadratic regression equation using the leaf length has given very precise estimates of the leaf area.

Materials and Methods: Within the cultivated ragi varieties there are two shades of grain colour—brown and white and to represent both, five varieties from brown group and six varieties from white group were chosen, The brown grain colour types AKP. 1, AKP. 2, E.C. 4840, Co. 7 and Co. 8 and the white grain types were E.C.W. 840, 847. 887, 895, 1261 and 1262.

In general outline, the ragi leaf is long, narrow, tapering to a point at the tip. The leaf blades have prominent midrib and inspite of this, many of the well-grown leaves show a tendency to snap and hang down about their upper middle. The length and breadth of each leaf at a point one-quarter of the distance from base was measured to the nearest mm for calculation of leaf area. The measurements made '*in situ*' after fertilization were not only rapid but also left the plant in tact. The number of leaves from top to bottom on the main tiller was counted and measurements were recorded. The individual leaf area from top to bottom showed that there is an increase upto sixth leaf or so and later a gradual decrease. Therefore, the individual leaf area of the first six leaves from top was compared with the respective total leaf area to find out the relationship between the earhead weight of the main tiller to that of the total earhead weight of the plant. The data were subjected to statistical analysis and correlation and regression co-efficients were determined.

In addition, studies on total number of tillers, number of productive tillers, total number of leaves on main tiller, number of fingers, length of fingers and thousand grain weight were also studied. Each character was correlated with the total earhead yield of the plant and between themselves to find out their association.

Results: The ragi varieties utilised in this study were divided into three broad types namely (1) Brown varieties with an average duration of 85 to 100 days (2) white varieties with a duration of 90 to 95 days and (3) white varieties with a duration of 100 to 120 days. In each group, simple correlations were worked out between the total leaf area on the one hand and the area of individual leaves commencing from the boot leaf and ending with the sixth leaf on the other. Linear regression equations were also fitted to predict the total leaf area of the central shoot from the leaf area of individual leaves. The simple correlation co-efficient, the linear regression co-efficient and the percentage reliability of the predicted leaf area in each case are furnished in Table 1.

TABLE 1. *Correlation of total leaf area of central shoot with area of individual leaves from boot leaf to the sixth leaf.*

Type	Particulars	First boot leaf	Second leaf	Third leaf	Fourth leaf	Fifth leaf	Sixth leaf
Brown (85–90 days)	Correlation coefficient	0.780**	0.861**	0.935**	0.869**	0.894**	0.897**
	Linear regression coefficient	14.57**	16.74**	12.22**	13.22**	11 62**	10.66**
	Predictability coefficient	61.00	74.16	87.43	75·63	80.00	80.43
White (90–95 days)	–do–	0.545*	0.597**	0.688**	0.829**	0 633**	0.315
		10.67*	11.76**	13.81**	15.61**	11.02**	4 67
		29.70	35 62	47.33	68.72	40.09	N.S.
White (100–120 days)	–do–	0.328	0.174	0.413	0.449	0 476*	0.539
		6.72	2.74	7.42	8.01	9.78	9.48
		N.S.	N.S.	N.S.	20 17	22.66	29.05

* Significant at 5% level. ** Significant at 1% level.

An examination of the correlation coefficient revealed that in the brown type while all the correlation coefficient were highly significant, the one between the third leaf area and the total leaf area recorded the highest value of 0.935. This indicated that there is an exact correspondence between the two leaf areas which would justify by itself the inference that the third leaf represents the total leaf area best. The total leaf area predicted from the linear prediction equation relating to the third leaf has also the highest predictability value of 87.43%.

In the white varieties with duration of 90 to 95 days the correlation co-efficient of individual leaf area from the second to fifth with the total leaf area are all highly significant, the highest value of being that between the fourth leaf and total leaf area namely 0.83. The predictability is also the highest namely 68.7% in the linear prediction equation involving the fourth leaf. Thus the fourth leaf area can be assumed as being the closest representative of the total leaf area.

In the white varieties with 100 to 120 days duration the correlation co-efficients between the fifth and sixth leaf from the top on one hand and the total leaf area on the other are above significant. The linear regression co-efficient are also significant but the highest predictability of 29% is recorded by the linear prediction equation involving the sixth leaf area. The predictability co-efficient is obviously very low indicating a relatively large margin of error in the predicted leaf area. It is possible that leaves at still lower positions might represent the total leaf area better but this requires further investigation.

The three regression equations are given below. *Brown varieties* (85 to 100 days) $Y = 14\ 22\ x_3 - 88.66$; *White varieties* (90—95 days) $Y = 15.61\ x_4 - 93.73$; *White varieties* (100 to 120 days) $Y = 86.79 + 9.48\ x_6$.

Note: x_3, x_4 and x_6 refer to the area of the third, fourth and sixth leaf from the top respectively and Y is the predicted total leaf area.

The above study was extended to the determination of the degree of association between the yield and the yield components. These correlation co-efficients and the level of significance for each group is given in Table 2.

TABLE 2. *Correlation coefficients and regression of characters with yield as well as between themselves.*

	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7	Coefficient $b_y x$	Prediction equation y
Brown (85–100 days)										
X_1	0.505**	—	-0.890**	-0.194	-0 048	-0.189	-0.120	-0.110	1.74**	7.90+1.74x
X_2	0.461*		—	0.155	0.012	-0.166	-0.029	-0.041	2.25**	6.93+2.25x
X_3	0.204			—	0.528**	0.793	0.523**	0.105	1.19	
X_4	0.417				—	0.596	0.489**	0.506**	0 55*	0.55x - 5.43
X_5	0.209					—	0.542**	0.140	0.73	
X_6	0.601**						—	0.498**	2.98**	5.01+2.98x
X_7	0.460*								15.35*	15.35x - 15.74
White (90–95 days)										
X_1	0.704**	—	0 832**	0.206	0 574*	0.359	0 777**	-0 670	5.36**	5.26x - 11.62
X_2	0.510*		—	0.466	0.461*	0 454*	0.507*	0 028	3.94*	1.45+3.94x
X_3	0.115			—	0.129	0.332	0.084	-0.160	1.29	
X_4	0.574*				—	0.588*	0.668**	-0.140	1.03	1.03x - 40.78
X_5	0.348					—	0.396	-0.500	1.74	
X_6	0.892**						—	-0.046	3.83**	3.93x - 5.30
X_7	0.067								3.32	
White (100 to 120 days)										
X_1	0.497*	—	0.494*	0.314	-0.075	-0.240	0.487*	0.244	3.93*	3.93 - 4.22
X_2	0.677**		—	0.012	-0.072	-0.380	0.502*	0.509*	6.39**	6.39 - 11.88
X_3	0.090			—	0.458	0.381	0.423	-0.270	2.36	
X_4	0.374				—	0.437	0.424	-0.180	0.52	
X_5	-0.002					—	0 118	-0.360	0.11	
X_6	0.892**						—	0.226	3.26	
X_7	0.543								41.69	1.69x - 87.47

* Significant at 5% level
** Significant at 1% level
Y = Yield of plant
X_1 = Total number of tillers
X_2 = Number of productive tillers
X_3 = Number of fingers
X_4 = Length of fingers
X_5 = Number of leaves
X_6 = Yield of main tiller
X_7 = Thousand grain weight

The correlation matrices in Table 2 would show that in brown varieties the value between Y on the one hand and X_3 and X_5 on the other (yield with number of fingers and with number of leaves on the main tiller) are almost negligible and were therefore omitted from further consideration. Similarly, in the white type with 90 to 96 days duration X_3 and X_7 were omitted and in the white varieties with 100 to 120 days duration, the characters X_3 and X_5 as in the brown varieties were deleted. The remaining correlation co-efficients were formed into a matrix for each type and was used for solving the five normal equations generated from each type using the abbreviated Doolittle solution. The co-efficients of partial regression of grain yield on each of the five other characters were thus computed. These were fitted together into multiple regression equations for estimating the grain yield for given values of the five characters. The equations are given below:

Brown (85 to 100 days)

$$Y = 9.79 + 0.96\ X_1^{**} - 0.40\ x_2 + 0.06\ X_4 + 0.59\ X_6^{**} + 0.23\ X_7$$

White (90 to 95 days)

$$Y = 18.88 - 0.21\ x_1 + 0.22\ X_2 + 0.04\ X_4 - 0.045\ X_5 + 0.99\ X_6^{*}$$

White (100 to 120 days)

$$Y = 3.20 + 0.03\ X_1 + 0.19\ X_2 + 0.18\ X_4 + 0.63\ X_5^{**} + 0.33\ X_7^{*}$$

The main tiller yield (X_6) as should be expected exerts the maximum influence on the plant yield in all the three types. In the brown type the total number of tillers is also seen to exert some tangible influence on the plant yield, while in the white type of 100 to 120 days duration the thousand grain weight also makes tangible contribution to the plant yield. None of the other characters seems to have any real value in the estimation of plant yield.

The coefficients of predictability as well as the multiple correlation coefficients were worked out for the three types and are given below:-

	Coefficient prediction %	Multiple correlation coefficient
Brown (85 to 100)	78	0.88
White (90 to 95)	81	0.91
White (100 to 120)	95	0.98

The prediction value of all the three equations is high but it is the highest in the case of white varieties with long duration, while it is about equal in the brown and white types with 90 to 95 days duration. The coefficients of linear regression of yield with each of the other seven characters were also worked out and linear prediction equations were fitted where appropriate (Vide Table 2).

The linear regression coefficients are more or less corroborative of the relationship between grain yield and the plant characters. For example the

number of ear bearing tillers is throughout important as well as total number of tillers. Yield of the main tiller exerts tangible influence on the yield in the brown and short duration white types while it is non-significant in the white grain long duration types.

Discussion: The results of the study of the individual leaf area on the central shoot in ragi as represented the total leaf area of the central shoot has shown that the third leaf in the brown type and the fourth leaf in the white with short duration are the most representative. In the long duration white type the sixth leaf represents the total leaf area best among the leaf positions studied. Possibly a better relationship might be found with some leaf lower than the sixth. Thus the brown and the white types of short duration are approximately alike with regard to the position of the leaf to be chosen to represent the total leaf area. The long duration white type is distinctly different in this respect. Probably because there are in general, larger number of leaves on the main shoot in long duration varieties than in short duration ones. It is also a safe inference that the representative nature of the leaf position is subject to marked influence by the duration than by the colour of the seed. The problem referred to in the paper by Mohankumaran *et al.* (1964) involves the estimation of actual leaf area from the length of the lamina by a quadratic regression equation. It is, therefore, different from and not comparable to the present study.

In the multiple regression of grain yield on the yield components and other plant characters, it was seen that the yield of the central shoot uniformly influenced the plant yield in all the three types. This finding agrees with that reported by Samathuvam (1962) and with Mahadevappa and Ponnaiya (1965). It is only in the short duration brown type that the total number of tillers tangibly influences the grain yield while in the other two white types no such relationship is discernible. In regard to thousand grain weight it is seen that this character partly determines the grain yield in the long duration white types only.

Summary: The results of a study to find the individual leaf which represents the total leaf area best of the ragi plant have been presented in this paper. It was found that the third and fourth leaf from the top of the central shoot represented the total leaf area best in the short duration brown and white types respectively, while in the long duration white types the lowest position namely the sixth from the top was found to be the best in this respect. In the three multiple regression equations fitted for estimating the grain yield from related plant characters it was found that the yield of the main ear was uniformly important in all types with the tillering capacity of the plants coming next in importance. Linear regression equations of yield on each plant character also generally confirm these findings.

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OBITUARY

We record with deep regret the passing away of Mr. G. V. Ramana, Deputy Director of Agriculture and later Agronomist and Associate Professor of Agronomy, Agricultural College, Madurai, as a victim of bladder cancer on 28-6-'68 at an untimely age of 54. A Cloughston medalist, he was and he graduated in 1937 with a creditable record. He distinguished himself both on the extension side and teaching. An active worker and a keen sportsman he continued till almost the very end. His life had been warm and vibrant and remarkable for the indefatigable energy and inspiring ambition. Condolences to the bereaved family.