https://doi.org/10.29321/MAJ.10.A04828

# THE RESPONSE OF RAGI—*ELEUSINE CORACANA* (GAERTN)—THE FINGER MILLET—TO SOWINGS IN THE DIFFERENT SEASONS OF THE YEAR

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**Introduction.** The Coimbatore farmer sows his main *ragi* crop under irrigation in May or June and the summer crop at the end of December. The main crop needs to be harvested before the last week of September or October if tobacco or wheat as the case may be, follows it. The prudent farmer has therefore to time the sowing so as to secure a maximum yield without at the same time protracting into the proper sowing time for the following crop. The scope for the summer crop is wider ; anytime from December to March, the crop may be sown, there being no time limitations except the availability of water. For these reasons, it was undertaken to investigate the reactions of different seasonal sowings on the crop.

Besides this consideration, there was another problem to be studied. *Ragi* is a crop reputed to grow fairly well, flower and set seed at practically all times of the year. The differential response of the plant to the vicissitudes of weather was a problem awaiting scrutiny. An experiment was accordingly designed to ascertain (1) tha most suitable time for sowing for the main and summer crops, (2) the plant characters which respond to climatic factors in the same manner as grain yield, and (3) the duration of a crop in relation to the time of sowing.

**Material and Method.** E. C. 1000, a strain usually $3\frac{1}{2}$ months in duration and E. C. 24 later by about a month in duration, both un-purple-pigmented, of the same grain colour and panicle shape, were chosen for the study. On the first of every month, the two strains were sown in nurseries and on the 25th day after sowing, they were transplanted in plots 110 × 7 square links in a field, the most standardised at the Millets Breeding Station. Planting was done in 5 lines, 110 links long and one link apart with a space of 1 link between plants in a line. This experiment was carried on for 28 months commencing from June 1930. When the main earhead completely emerged and flowered, a fixed number of plants, 50 at first and then increased to 200 was labelled at random in the three central lines of the plot excluding a region of 5 links at either ends. The following measurements were recorded for each plant :—

1. Number of nodes on the main axis.
2. Number of leaves on the main axis.
3. Length of flag on the main axis.
4. Width of flag on the main axis.
5. Height of the main axis.
6. Length of peduncle on the main axis.
7. Number of thumbs on the main earhead.
8. Number of fingers on the main earhead.
9. Length of fingers on the main earhead.
10. Number of earheads.
11. Weight of first harvest grain.
12. Weight of second harvest grain.
13. Weight of dry straw.
14. Weight of roots.

Unlike other millets, in *ragi*, the earheads ripen unevenly. There is a first flush of ripening of most of the primary earheads, and then follows the ripening of the other earheads. To secure the maximum yield of a crop, it is necessary to harvest all the ears. After a first harvest the general practice is to allow about ten days to elapse for the second harvest which is also the final. As much as 30 per cent of the total yield is sometimes contributed by the second harvest. In the present study, the plants marked were harvested individually when the first flush of earheads ripened and a second harvest was made 10 days later. The plants were then uprooted carefully and the roots washed and dried. The weight of the dry straw and the weight of roots were obtained separately. In Tables I and II are presented the grain yields and the duration of the crop. Table III presents the coefficients of variation. Tables IV and V present the analysis of variance of grain. Table VI gives the correlation coefficients.

**Discussion**. Though there are some definitely good seasons for raising a *ragi* crop, in no season does it completely fail. For the main crop, E. C. 1000, an early strain sown in the first week of June and July ripens about the second week of September and October respectively ; the May and July sowings yield less than the June sowing (Table I), the differences being statistically significant. E. C. 24 when sown in the first week of June and July ripens about the first week of October - and November respectively. There is nothing to be gained by delaying the sowing in June, the yield of July sowings equalling that of June (Table II). The May sown crop not only yields less, but takes about a week longer to mature than the June sown crop. In the June crop 1 to 30 per cent of the total yield in the case of E. C. 1000 and 5 to 10 per cent in the case of E. C. 24 are contributed by the second harvest. With a variety like E. C. 24, no great loss will be incurred if only one harvest is made when circumstances press, whereas with a variety like E. C. 1000, the second harvest cannot be ignored and the duration of the crop must be allowed 10 days more than that mentioned above.

The summer crop can be raised successfully from December onwards. The grain yield during those months is very variable (Tables I and II) and no one period can be taken as better than another. However, December and January sowings are to be preferred for the reason that the duration tends to lengthen in the later sown crops (Tables I and II). The growth of a crop is determined not by the calendar but by the weather conditions. The practice of fixing definite times for sowing depends on the general association between a particular weather complex and a calendar month, and this is by no means rigid. For instance, E. C. 24 gave about the lowest yield in the March sowing of one year (Table II) and in the next March sown crop, the yield was the highest for that year. The chief merit of the main season crop, the one sown in June, is that it comes under the generally reliable weather complex of the South-West monsoon and therefore the yield is steady. It is also evident from Tables I and II, that the November sown crop which comes under the winter spell is about the poorest in growth and yields the least.

The next enquiry was directed to the variations in the other plant characters. On the whole, the differential response, of each character as measured by the co-efficient of variation corresponds in the two varieties studied. Climatic factors have the most pronounced effect on straw, root and grain yield (Table III). The coefficient of correlation between the corresponding coefficient of variation in the two varieties is 0·87. There is noticeable in the case of E. C. 1000, a significant excess of variability in the earhead characters (Table III), namely, the number of fingers and the number of thumbs.

Since grain yield is the primary concern, an analysis was made to see whether the variation between months within years was of the same order as the variation within months with due regard to the respective degrees of freedom. The period of two years from June 1930 to May 1932, was considered to examine also the effect of the two cycles of 12 months. It is seen from Tables IV and V that the variation between months is more than can be accounted for by the variation within months ($P < \cdot 01$), and signifies the reality of the effect of season. The year June 1930 to May 1931 was on the whole more favourable to *ragi* than the following year.

The next step was to determine what plant characters had the variation induced by weather factors corresponding to those of the grain yield. This was done by the method of correlations. The number of leaves on the main axis, the number of nodes on the main axis, the length and breadth of the flag, the height of the plant, the length of peduncle, the weight of root, are all associated with vegetative activity. It is seen in Table VI that all these characters are positively correlated with grain yield through the changing seasons. And straw which is the sum of all vegetative activity is highly correlated with grain yield.

For both the early and late varieties, the grain yield is absolutely independent of the variations in tillering produced by season (Table VI).

In the *ragi* panicle, below the normal whorl, there are usually one or more fingers appearing like the vestiges of a second whorl. These fingers are called thumbs consistent with the nomenclature fingers for the spikes of the first whorl. The manifestation of thumbs varies from season to season; for E. C. 24 the C. of V. is 12·2 and for E. C. 1000, 31·8. It is found that in times of affluence, the early variety puts forth more thumbs (r = ·7) these becoming the marks of prosperity. With E. C. 24, the expression of thumbs is erratic (Table VI) (r = ·08).

In seasons favourable to high yield, the fingers are long and many in the panicle; the corresponding correlations are above the level of significance (Table VI). These factors secure an extension of the effective region of grain production.

The duration of a crop measured from the sowing date to ripening is the least variable of the factors considered. The C. of V. is 5·7 for E. C· 1000 and 5·6 for E. C. 24. The crop sown in April which comes under the full blaze of the summer sun is the most prolonged; the exception is the behaviour of E. C. 1000 in April 1932. External conditions may retard or hasten ripening, but the performance of a crop is not dependent on the changes in the duration, the corresponding correlations being ·21 and −·05 (Table VI).

**Summary.** The optimum sowing time for the main *ragi* crop is June for E. C. 1000, an early strain. E. C. 24, a long duration strain can be sown in June or July. For the summer crop, December and January sowings are to be preferred to a late sowing for the reason that the duration tends to lengthen in the later sown crops. The plant characters which respond to climatic factors in the same manner as the grain yield are the number of leaves, the number of nodes, height of plant, length of peduncle, length and width of the flag, weight of straw, weight of root, number and length of fingers in the main earhead. The variation in the number of earheads due to season is not reflected in the total grain production.

The alterations in the duration of a crop caused by the seasonal changes in no way affects the final yield.

**TABLE I. E. C. 1000. Duration and Average Yield per plant.**

| Month of Sowing. | | Weight of grain First harvest | Second harvest | Duration Days. |
|---|---|---|---|---|
| | | gm. | gm. | |
| June | 1930 | 13·0 | 5·5 | 108 |
| July | ,, | 10·7 | 1·6 | 110 |
| August | ,, | 9·8 | 0·4 | 104 |
| September | ,, | 8·6 | 1·3 | 103 |
| October | ,, | 16·0 | 2·1 | 99 |
| November | ,, | 6·0 | 0·7 | 95 |
| December | ,, | 11·0 | 2·5 | 101 |
| January | 1931 | 13·2 | 1·7 | 99 |
| February | ,, | 9·8 | 1·4 | 109 |
| March | ,, | 12·8 | 1·6 | 114 |
| April | ,, | 12·1 | 1·2 | 116 |
| May | ,, | 11·4 | 1·3 | 116 |
| June | ,, | 11·8 | 2·3 | 108 |
| July | ,, | 10·7 | 0·8 | 108 |
| August | ,, | 10·3 | 2·9 | 108 |
| September | ,, | 5·6 | 1·1 | 96 |
| October | ,, | 5·5 | 1·3 | 104 |
| November | ,, | 4·1 | 1·4 | 116 |
| December | ,, | 5·2 | 0·4 | 102 |
| January | 1932 | 8·1 | 1·1 | 103 |
| February | ,, | 11·4 | 0·0 | 105 |
| March | ,, | 14·6 | 0·1 | 103 |
| April | ,, | 11·2 | 0·3 | 96 |
| May | ,, | 8·2 | 0·5 | 102 |
| June | ,, | 15·5 | 0·2 | 110 |
| July | ,, | 11·9 | 2·1 | 103 |
| August | ,, | 8·8 | 1·3 | 99 |
| September | ,, | 7·3 | 1·2 | 94 |

**TABLE II. E. C. 24. Duration and Average Yield per plant.**

| Month of Sowing. | | Weight of Grain First harvest | Second harvest | Duration Days. |
|---|---|---|---|---|
| | | gm. | gm. | |
| June | 1930 | 20·0 | 2·0 | 140 |
| July | ,, | 21·8 | 1·1 | 134 |
| August | ,, | 20·0 | 0·2 | 133 |
| September | ,, | 18·1 | 3·8 | 120 |
| October | ,, | 17·4 | 3·6 | 116 |
| November | ,, | 13·8 | 4·1 | 120 |
| December | ,, | 16·6 | 3·0 | 120 |
| January | 1931 | 21·8 | 1·7 | 128 |
| February | ,, | 11·8 | 0·4 | 132 |
| March | ,, | 13·6 | 0·7 | 143 |
| April | ,, | 17·9 | 1·3 | 150 |
| May | ,, | 18·2 | 0·9 | 144 |
| June | ,, | 18·9 | 1·0 | 134 |
| July | ,, | 17·9 | 1·3 | 128 |
| August | ,, | 11·7 | 2·7 | 124 |
| September | ,, | 12·7 | 4·4 | 127 |
| October | ,, | 10·8 | 1·8 | 125 |
| November | ,, | 9·1 | 2·9 | 130 |
| December | ,, | 11·7 | 3·2 | 123 |
| January | 1932 | 12·3 | 1·2 | 127 |
| February | ,, | 18·0 | 0·7 | 125 |
| March | ,, | 25·6 | 0·3 | 126 |
| April | ,, | 14·3 | 0·7 | 142 |
| May | ,, | 16·4 | 0·2 | 134 |
| June | ,, | 22·8 | 2·2 | 127 |
| July | ,, | 20·7 | 4·3 | 123 |
| August | ,, | 14·5 | 1·4 | 117 |
| September | ,, | 11·2 | 1·0 | 128 |

**TABLE III. Co-efficients of Variation.**

| Factor. | Coefficient of Variation. | |
|---|---|---|
| | E. C. 1000. | E. C. 24. |
| Grain yield | 32·1 | 26·1 |
| Number of leaves on the main axis | 27·3 | 21·2 |
| Number of nodes on the main axis | 16·0 | 22·0 |
| Height of the main axis | 21·4 | 22·3 |
| Length of flag on the main axis | 10·6 | 12·2 |
| Width of flag on the main axis | 8·7 | 10·2 |
| Length of peduncle on the main axis | 9·7 | 10·5 |
| Weight of straw | 47·5 | 55·4 |
| Weight of root | 45·6 | 51·9 |
| Number of earheads | 27·4 | 30·2 |
| Number of fingers in the main earhead | 19·0 | 6·2 |
| Length of fingers in the main earhead | 9·0 | 10·7 |
| Number of thumbs in the main earhead | 31·8 | 12·2 |
| Duration | 5·7 | 5·6 |

**TABLE. IV. E. C. 1000. Analysis of Variance of Grain Yield.**

| Variation. | Degrees of Freedom. | Sum of squares. | Mean square. | ½ Log e (Mean square) |
|---|---|---|---|---|
| Between years | 1 | 4461 | 4461 | 4·20 |
| Between months within years | 22 | 9384 | 427 | 3·03 |
| Within months | 2416 | 92312 | 38 | 1·82 |
| Total | 2439 | 106157 | ... | ... |

**TABLE V. E. C. 24. Analysis of Variance of Grain Yield.**

| Variation. | Degrees of Freedom. | Sum of squares. | Mean square. | ½ Log e (Mean square). |
|---|---|---|---|---|
| Between years | 1 | 3365 | 3365 | 4·06 |
| Between months within years | 22 | 58831 | 2674 | 3·95 |
| Within months | 2386 | 214586 | 90 | 2·25 |
| Total | 2409 | 276782 | ... | ... |

**TABLE VI Correlations.**

| Correlates. | Coefficient of Correlation. | |
|---|---|---|
| | E. C. 1000. | E. C. 24. |
| Grain yield and number of leaves on the main axis * | ·55 | ·44 |
| ,, number of nodes on the main axis * | ·68 | ·66 |
| ,, height of the main axis * * | ·77 | ·58 |
| ,, length of flag on the main axis * | ·71 | ·58 |
| ,, width of flag on the main axis * | ·71 | ·60 |
| ,, length of peduncle on the main axis * | ·73 | ·50 |
| ,, weight of straw * * | ·85 | ·86 |
| ,, weight of root * | ·74 | ·76 |
| ,, number of earheads | ·05 | ·06 |
| ,, number of fingers in the main earhead * | ·68 | ·63 |
| ,, length of fingers in the main earhead * | ·70 | ·37 |
| ,, number of thumbs in the main earhead * | ·70 | ·08 |
| ,, duration * * | ·21 | −·05 |
| ,, proportion of first harvest to total grain | ·28 | ·29 |
| * * *Level of significance* P=·05 | *·37* | *·37* |
| | *·38* | *·38* |