Influence of Agronomic Factors on the Time of Flowering of Rice

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Introduction: *Flowering duration* of rice as defined in terms of the number of days that elapses from the date of sowing to the d... of flowering, is an important varietal character though with wi... variations; some of the cultivated rices mature within 50 days while the longest of them takes well over 150 days from sowing to flowering. It is observed that earliness and lateness constitute a pair of contrasting heritable characters, their behaviour in inheritance being simple or complex according to the genetic make-up of the parents involved. While this is true of the varieties native to a tract, instances are commonly found of varieties changing their duration when introduced into another tract with differing climatic conditions. Ramiah (1927) has recorded some outstanding examples of such changes in duration in the Province of Madras as also cases of constancy wherein the duration remains unaltered despite changes in climatic environment.

Within the same tract again, varieties fall under two imp... groups; the time-limited varieties which come to flower with... definite period irrespective of the season of sowing and season-limited varieties which flower only in a particular season of the year, their duration getting extended or reduced according as they are sown early or late. Even in a particular season in which a variety, whether season-limited or time-limited, is grown, changes in the time of flowering as well as in the period of flowering are noticed as a result of agronomic factors like time of sowing, age in the nursery, spacing given in the field, application of manures etc. This paper embodies some typical examples of such changes in the time and period of flowering recorded in the course of various field experiments (randomized replicated trials) conducted for over a decade at the Agricultural Research Station, Pattambi on the west-coast district of Malabar. *Time of flowering* herein refers to the date on which more than 75% of the plants in a population comes to flower and the *period of flowering* to the number of days that elapses between the commencement and completion of flowering in a given strip or clump of plants.

Varieties and Seasons: In the typical swamp soils of Malabar rice is cultivated in three seasons:— 1. First crop or the autumn rices grown from April — May to September — October. 2. Second crop or winter rices from September — October to December — January, and 3. Third crop or spring rices that are raised in limited areas with facilities for lift irrigation from February to May. The autumn rices are either broadcast or transplanted (major area being broadcast) while the winter and spring rices are as a rule transplanted. Monthly sowing trials with ten of the most popular varieties have indicated that the second-crop varieties and the long-duration first-crop varieties are season-limited while the short-duration first-crop varieties like PTB. 7, 8 and 9, tend to be time-limited along with the well-known cosmopolitan strain PTB. 10., which is pre-eminently time-limited and is generally raised in all the three seasons.

Experimental: *Broadcasting versus transplanting*: As indicated above, the autumn rices are sown broadcast with the early rains or sown with the early rains in a nursery and transplanted. Dates of flowering were observed in two series of experiments in one of which strain PTB. 1 with season-limited flowering was broadcast at three intervals and planted in one batch, the date of broadcast sowing being determined by the fall of adequate showers from April onwards. The second experiment comprised of one batch of sowing and one of transplanting with nursery sown on the same day of broadcasting, with strain PTB. 9. The experiments were conducted for three seasons. The results given in tables I and II indicate that even with a difference of 1 to 1½ months in the time of broadcast sowings, the flowering dates fall within a period of three weeks, the duration decreasing from an average of 140 days to 110 days. For the same dates of sowing the transplant crop flowered later than broadcast crop except in one season. This is confirmed in all the seasons in the second experiment where the transplant crop flowered 7 days, 6 days and 4 days later than the corresponding broadcast crop.

TABLE I

PTB. I. —Broadcast at intervals and transplanted

	Date of sowing		Time of flowering	Duration in days
1936—'37				
1. Broadcast	6—4—36		29—8—36	145
2. do.	15—5—36		4—9—36	112
3. do.	21—5—36		7—9—36	109
4. Transplant	15—5—36	(planted 17—6—36)	4—9—36	112

	Date of sowing		Time of flowering	Duartion in day
1937—'38				
1. Broadcast	27—4—37		30—8—37	126
2. do.	20—5—37		7—9—37	110
3. do.	28—5—37		14—9—37	109
4. Transplant	20—5—37	(planted 28—6—37)	11—9—37	114
1938—'39				
1. Broadcast	17—4—38		27—8—38	132
2. do.	26—4—38		29—8—38	125
3. do.	14—5—38		8—9—38	117
4. Transplant	26—4—38	(planted 9—6—38)	7—9—38	134

TABLE II

PTB. 9. —Broadcast and transplanted

	Date of sowing	Date of planting	Time of flowering	Duration in da
1942—'43				
1. Broadcast	27—4—42		11—8—42	106
2. Transplant	do.	17—6—42	18—8—42	113
1943—'44				
1. Broadcast	23—4—43		8—8—43	107
2. Transplant	do.	30—5—43	14—8—43	113
1944—'45				
1. Broadcast	7—5—44		17—8—44	102
2. Transplant	do.	14—6—44	21—8—44	106

(b) Age of seedling: Observations on flowering were continued in the experiments with different ages of seedlings for an ordinary transplant crop during first, second and third crop seasons.

In the first series of experiments three varieties were sown in three batches of sowings and all planted on the same day in the normal season. In the second series different ages of seedlings from 65 to 25 days were combined with different batches of plantings at intervals of 10 days. In the second crop season, the experiment was conducted for three seasons in two series, the first series was sown at intervals of 10 days and the seedlings planted on the same day and the second series sown on the same day was planted at intervals of 10 days. In the first, the age of seedlings gets reduced from 60 to 30 days by virtue of the difference in time of sowings while in the second series the age gets extended from 30 to 60 days as a result of delayed plantings. In the third crop season the time-limited variety PTB. 10 was sown on the same day and planted at intervals of 5 days, thus increasing the age in nursery from 15 to 55 days. As the flowering was found to be protracted in certain strips the period of flowering was also noted in this case. Experimental details and results are given in tables III to VI below.

TABLE III

Strains PTB. 1, 2 and 5 sown at different times and planted on the same day

	Date of sowing	Date of planting	Age in nursery in days	Time of flowering.	Duration in days
1945—'46					
PTB. 1.	4—4—45	15—6—45	72	3—9—45	152
	19—4—45	do.	57	6—9—45	140
	25—5—45	do.	21	9—9—45	107
PTB. 2.	4—4—45	do.	72	28—8—45	146
	19—4—45	do.	57	29—8—45	132
	25—5—45	do.	21	4—9—45	102
PTB. 5.	4—4—45	do.	72	31—8—45	149
	19—4—45	do.	57	2—9—45	136
	25—5—45	do.	21	7—9—45	105
1947—'48					
PTB. 1.	24—4—47	10—6—47	47	6—9—47	135
	8—5—47	do.	33	do.	121
	24—5—47	do.	17	10—9—47	109
PTB. 2.	24—4—47	do.	47	27—8—47	125
	8—5—47	do.	33	29—8—47	113
	24—5—47	do.	17	4—9—47	103
PTB. 5.	24—4—47	do.	47	1—9—47	130
	8—5—47	do.	33	5—9—47	120
	24—5—47	do.	17	8—9—47	107

Results are similar to those obtained in the case of broadcast sowings; irrespective of a long interval in the times of sowing the flowering dates fall close together.

TABLE IV

PTB. 2. —Different ages in 4 batches of plantings

Date of sowing	Time of flowering	Age in days	Duration in days	Time of sowing	Time of flowering	Age in days	Duration in days
	I. planting 10—6—'47				**II. planting 20—6—'47**		
25—4—47	25—8—47	45	122	25—4—47	30—8—47	55	127
5—5—47	do.	35	112	5—5—47	1—9—47	45	119
15—5—47	30—8—47	25	107	15—5—47	2—9—47	35	110
25—5—47	*	*	*	25—5—47	8—9—47	25	106
	III. planting 30—6—'47				**IV. planting 10—7—'47**		
25—4—47	30—8—47	65	127	*	*	*	*
5—5—47	do.	55	117	5—5—47	6—9—47	65	124
15—5—47	1—9—47	45	109	15—5—47	8—9—47	55	116
25—5—47	9—9—47	35	107	25—5—47	9—9—47	45	107

* Seedlings over 65 days and under 25 days were not planted.

For the same date of planting the duration gets reduced with decreasing age in the nursery and for the same age it gets reduced with delayed plantings. In the second batch of planting for instance, the flowering duration gets reduced from 127 days to 106 days; for an age of 45 days, the duration of 122 days in the first planting falls to 107 days in the fourth batch of planting.

As regards time of flowering, it is delayed for the same date of planting as the age in nursery gets reduced and is also delayed with advancing season with a difference of 15 days in flowering for a delay of 30 days in the time of planting.

TABLE V.

Second crop PTB. 3 sown and planted at 10 days intervals

	Date of sowing	Date of planting	Age in days	Time of flowering	Duration in days
1935—36	10—8—35	9—10—35	60	24—12—35	136
	20—8—35	do.	50	do.	126
	30—8—35	do.	40	do.	116
	9—9—35	do.	30	do.	106
	do.	19—10—35	40	20—12—35	102
	do.	29—10—35	50	24—12—35	106
	do.	8—11—35	60	26—12—35	108
1936—37	12—8—36	12—10—36	60	8—12—36	118
	22—8—36	do.	50	do.	108
	1—9—36	do.	40	13—12—36	103
	11—9—36	do.	30	14—12—36	94
	do.	22—10—36	40	21—12—36	101
	do.	1—11—36	50	24—12—36	104
1937—38	11—8—37	10—10—37	60	10—12—37	121
	21—8—37	do.	50	9—12—37	110
	31—8—37	do.	40	10—12—37	101
	10—9—37	do.	30	do.	91
	do.	20—10—37	40	17—12—37	98
	do.	30—10—37	50	23—12—37	104
	do.	9—11—37	60	27—12—37	108

The results show that, provided the planting is done in the season, for the same date of planting, even a difference of 30 days in the age of the seedling does not materially affect the time of flowering, all the lots coming to flower on the same date, while delayed plantings delay the time of flowering. Here, in the second-crop season, the age in nursery has far less effect on the time of flowering than in the first-crop season.

TABLE VI

Third crop—PTB. 10. sown on the same day and planted at intervals.

Date of sowing	Date of planting	Age in days	Time of flowering	Duration in days	Period of flowering
29—1—40	13—2—40	15	10—4—40	72	5
do.	18—2—40	20	10—4—40	72	7
do.	23—2—40	25	12—4—40	74	9
do.	28—2—40	30	19—4—40	81	9
do.	4—3—40	35	20—4—40	82	15
do.	9—3—40	40	20—4—40	82	15
do.	14—3—40	45	20—4—40	82	16
do.	19—3—40	50	22—4—40	84	17
do.	24—3—40	55	22—4—40	84	17

For this variety in the third-crop season, an age of 20 to 25 days in the nursery is the optimum. Beyond that the flowering gets shifted by about a week and remains more or less steady within the age group 30 to 55 days. Here however, the flowering is observed to be protracted, the period of flowering extending to 17 days in the case of seedlings aged 50 to 55 days.

(c) Spacing: A number of experiments were conducted at the Agricultural Research Station, Pattambi, as elsewhere in the Province of Madras, giving different spacings to rice seedlings at planting and the data published hitherto refer exclusively to the influence of spacing on the yield. In the course of a series of such experiments it was noticed every year and in every season that the time of flowering was also changed as a result of spacing. Close-spaced plots were inclined to be early and uniform, whereas as spacing was increased the trend was towards delay in the time of flowering. Typical examples of such changes in time of flowering are given below for first and second-crop seasons. In one experiment different spacings from 3″ x 3″ to 12″ x 15″ were adopted, keeping the number of seedlings per hole constant. In the second series the spacings were increased from 3″ x 3″ to 12″ x 12″ and the number of seedlings in each hole is also increased from 1 to 4.

In these experiments it was also noted that the most vigorous seedling in a bunch of seedlings flowered first while others took more time and the tillers they produced subsequently still more time to flower, the tillering and consequent protraction in flowering being induced by wide spacings between the clumps. In order to study in detail the sequence of flowering, six clumps were marked out at random

in the experimental sub-plots in one of the experiments during first and second crop seasons and the average interval between the time of flowering of the first and the last tiller in the clump (period of flowering) noted. Results are given in the tables below :

TABLE VII

Different spacing with number of seedlings per hole constant

Spacing	Number of Seedlings	First Crop—PTB. 9 Time of flowering	Duration in days	Period of flowering	Second Crop—PTB. 3 Time of flowering	Duration in days	Period of flowering
3 x 3 inches	2	26—8—39	111	3	14—12—39	97	2
3 x 6 ,,	2	27—8—39	112	8	15—12—39	98	8
6 x 6 ,,	2	29—8—39	114	8	16—12—39	99	10
6 x 9 ,,	2	30—8—39	115	10	17—12—39	100	17
6 x 12 ,,	2	29—8—39	114	11	...	100	18
12 x 9 ,,	2	1—9—39	117	12	19—12—39	102	21
12 x 12 ,,	2	2—9—39	118	13	22—12—39	105	26
12 x 15 ,,	2	3—9—39	119	14	24—12—39	107	28

TABLE VIII

Different spacing with varying number of seedlings

Spacing	Number of seedlings	First crop—PTB. 5. Time of flowerings	Duration in days	Second crop—PTB. 4. Time of flowering	Duration in days
3 x 3 inches	1	10—9—43	130	27—12—42	111
...	2	...	130	25—12—42	109
...	3	...	130	...	109
...	4	9—9—43	129	24—12—42	108
4 x 4 ,,	1	12—9—43	132	28—12—42	112
...	2	...	132	27—12—42	111
...	3	9—9—43	129	25—12—42	109
...	4	8—9—43	128	26—12—42	110
6 x 6 ,,	1	12—9—43	132	1— 1—43	116
...	2	...	132	28—12—42	112
...	3	11—9—43	131	27—12—42	111
...	4	10—9—43	130	...	111
8 x 8 ,,	1	13—9—40	133	3—1—43	118
...	2	13—9—43	133	1— 1—43	116
...	3	12—9—43	132	29—12—42	113
...	4	10—9—43	130	...	113
12 x 12 ,,	1	14—9—43	134	7—1—43	122
...	2	14—9—43	134	4—1—43	119
...	3	12—9—43	132	2—1—43	117
...	4	12—9—43	132	...	117

The foregoing results would show that the flowering time tends to get delayed as the spacing is increased and that the delay is less when the number of seedlings per hole is increased. The period also gets lengthened as the spacing is increased and the differences in both time and period of flowering between different spacings are more distinct in the second-crop season than in the first-crop season. It must be mentioned here that the date of flowering in bunch planting denotes the date on which the more vigorous seedling in more than 75% of bunches in the sub-plot came to flower and not the date of flowering of all the seedlings in the individual bunches.

(d) Manures: It is common observation that heavy dressing of manures delay the time of flowering in most of the varieties but ordinarily the shift in time is not more than two or three days at the most. Marked deviation however, in the time of flowering was noticed in the manurial experiments with wood ash when it was applied to transplant fields at the fairly high rate of 4,000 lb. per acre either alone or in combination with other manures like green leaf, groundnut cake etc. Experimental details and results are given below:

TABLE IX

Treatments:

1. No manure (Control)
2. Wood ash at 4000 lb. per acre.
3. Wood ash at 4000 lb. plus leaf at 4000 lb. per acre.
4. Leaf at 4000 lb. per acre.
5. Wood ash at 4000 lb. plus groundnut cake at 4000 lb. per acre.
6. Groundnut cake 400 lb per acre.

		First crop—PTB. 14.		Second crop—PTB. 4.	
Year	Treatments	Time of flowering	Duration in days	Time of flowering	Duration in days
1943—44	1	25—8—43	116	2—1—44	127
	2	20—8—43	111	31—12—43	125
	3	21—8—43	112	1—1—44	126
	4	24—8—43	115	1—1—44	126
	5	20—8—43	111	31—12—43	125
	6	25—8—43	116	...	125
1944—45	1	25—8—44	99	19—12—44	111
	2	21—8—44	95	19—12—44	111
	3	21—8—44	95	19—12—44	111
	4	23—8—44	97	19—12—44	111
	5	21—8—44	95	20—12—44	112
	6	24—8—44	98	20—12—44	112

The time of flowering in the first-crop season is advanced by about a week by the application of wood ash at 4,000 lb. per acre alone or in combination with leaf or cake, while it has very little effect during the second-crop season.

4. **Discussion:** From the periodical broadcasting experiments it is seen that the flowering is delayed as sowing is delayed but the shift in time of flowering is not in direct proportion to the length of sowing intervals. For a difference of 30 days in the dates of sowing, for instance, the corresponding difference in flowering is 15 days or less. This would show that up to a particular period within the season, weather favours vegetative growth while in the later stages it is predominantly conducive to flowering. For the same date of sowing for the broadcast and transplant series, flowering is found to be delayed in transplant crop (vide Table I and II). Only in one out of six seasons of trial have the transplant and the broadcast crops flowered on the same date. These results are at variance with those obtained in Coimbatore where, the flowering of the transplant crop was found to be sharp and uniform while in the broadcast crop it was uneven and delayed (Ramiah and Hanumantha Rao, 1936.)

It is also found that the flowering was not affected if planting was done on the same date in the season whatever the age in the nursery, but in delayed plantings the earlier the planting the earlier was the flowering. These results are more or less similar to those obtained in the experiments conducted at Coimbatore (Ramiah, K. 1936). In the first-crop season, however the flowering is also found to be delayed with decreasing age in the nursery i. e., the older the seedlings the earlier was the flowering. It may be mentioned that both in the first and second-crop seasons, the crop yield suffers if planting is delayed irrespective of the growth of seedlings, the time of planting having a greater influence in maintaining yields than age in nursery. In the light of the above findings, the *duration* generally specified for a variety should be considered as the *minimum period of time* required for it to give its natural yield within a particular season.

Of all the agronomic factors spacing is found to have the maximum effect on the time of flowering. It is delayed as the spacing is increased and in wider spacing it is possible to check the delay if the number of seedlings per hole is also correspondingly increased. Ramiah has observed that when extra spacing between plants was given the *period* between which the flowerings commenced and finished as much as three weeks. This *period* which in the

above experiments had gone up to four weeks, could be reduced only to a limited extent by increasing the number of seedlings per hole. It is found that the age of seedlings also affects the period of flowering (vide Tables VI and VII). There are rices which have an inherently protracted period of flowering (long period) and from the agronomic point of view the variety that starts and finishes flowering in a minimum period (short period) is always to be preferred. (Ramiah 1927). Pattambi strains PTB. 15 and 16 are typical examples of the former while all the rest of the strains belong to the short period group. Protracted flowering is found to be characteristic of some varieties and is probably a heritable feature. While it is possible to induce this long-period nature in otherwise short-period varieties by nature in this case by wide spacing of plants, close planting in bunches is ineffective in bringing about sharp flowering in 'long period' varieties. A study therefore, of the 'short period' flowering in 'long period' varieties would prove very useful as also varietal studies with special reference to the inheritance of this character.

While heavy dressing of most of the manures tend, if at all, to shift the flowering towards lateness, wood ash at 4000 lb. per acre (100 lb. K_2O) was found to hasten it by four to five days in the first-crop season. No such effect was noticed in the second-crop season. In previous experiments also, wood ash at 1000, 2000 and 3000 lb. per acre did not show any marked difference in flowering nor did potassium sulphate to supply 60 lb. K_2O per acre. Whether the effect on flowering is due to potash and if so its ceiling dose beyond which flowering gets shifted can be assessed only after further trials with wood ash and potassium sulphate at high incremental doses.

5. Summary

1. The effect of different agronomic influences on flowering in rice was studied for a number of seasons.

2. In broadcast sowing at different intervals, flowering is delayed with delayed sowing; the dates of flowering fall at shorter intervals than the dates of sowing. These narrow shifts in time of flowering are attributed to the later weather conditions which are more favourable to flowering.

3. For the same dates of sowing, for broadcast and transplant crop flowering in transplant plots tends to be delayed, unlike the results obtained at Coimbatore.

4. In delayed plantings, with different ages of seedlings the earlier the planting the earlier was the flowering; in the first-crop season it was earlier with older seedlings as well.
5. Spacing is found to have the maximum effect in changing the time of flowering as also the period, the time approaching that of close planting to a limited extent with increase in the number of seedlings.
6. Wood ash at the fairly high rate of 4,000 lb. per acre is found to hasten flowering by about a week in the first-crop season while it has no effect in the second-crop season.
7. The need for further experiments is pointed out and future line of work suggested as regards inheritance studies with reference to flowering habit as also regarding the influence of potash on the time of flowering of rice.

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