

A NOTE ON THE GROWTH PHASES OF RICE VARIETIES.

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'Growth' has been defined as permanent and irreversible increase in dimensions. The size of a plant, though depending in various ways on external conditions is a specific character. The rate of growth, (i. e. the enlargement of cells as well as the formation of primordia of new organs) does by no means proceed at a uniform pace even when external conditions are constant. The three phases involved in growth are (1) the formative phase, (2) the phase of enlargement, and (3) the phase of maturation. The formative phase is mainly concerned with meristematic activity. Cell-division proceeds actively and the primordia of new organs are laid down. Increase in size is the characteristic of the phase of enlargement. The cells increase in size and the primordia of new organs undergo zonal differentiation. The increase in the height of the paddy plant is really the cumulative effect of a number of cells undergoing the enlargement phase in different regions of the plant. The phase of maturation or ripening is the final phase of growth. This starts when enlargement has practically ceased.

In the Paddy Breeding Station there are nearly 400 pure lines with enormous variations in their sizes, habits, and duration. As has been recorded already in the Philippine publications there is a slight positive correlation between the days to maturity and the height, the early varieties being generally short and the late ones tall. Though the size is subject to environmental and seasonal fluctuations, it has been found to be fairly constant from year to year among the pure lines. To compare the phases of growth in types of different heights and duration about 28 specially selected types were marked out. Of these 14 were short duration types with the life periods ranging from 90-131 days, and the other 14 consisted of types with duration ranging from 150-182 days. The life period of the paddy plant consists of 3 stages, (1) the seed bed stage, (2) the stage after the transplantation and until the earheads are produced and (3) the maturing stage when the grains develop and get ready for harvest. In both the 1st and 2nd stages the plants actively grow and there is hardly any increase in the

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size of the plant in the last stage. In general the variations among varieties in the 1st and 3rd stages are very little, they are probably equal in most cases. The differences in the life periods of varieties are all apparent only in the 2nd stage. In very early varieties each of these stages is made up of $\frac{1}{3}$ of the whole life period and as the total duration of a variety increases the 2nd stage gets extended and in varieties of $4\frac{1}{2}$ months in duration these three stages are in the proportion of 1 : 2 : 1., and this becomes again 1 : 3 : 1., when the varieties are very late and over 6 months in duration.

Soaked and sprouted seeds of these were sown in well puddled seed-beds at a uniform rate and a dozen seedlings from each of the varieties were labelled carefully in the seed bed and actually measured with a c. m. scale every 5th day commencing from the 8th day after sowing. When the seedlings were ready for transplanting the labelled seedlings were carefully removed along with others and planted in the middle row of each plot which usually consists of 5 rows of plants 1' apart each way and with a spacing of 6" between plants in the row. The recording of measurements was begun after the seedlings had established themselves, and continued up to the ripe stage when growth had completely stopped. Along with the measurements, notes were taken about the number of functioning leaves present at a time, the period of tillering, the period of flowering, and the period of ripening.

Germination. The rate of germination is probably dependent on the moisture content of the seed, the ripeness of the seed and the prevailing atmospheric temperature. Under the same conditions of temperature varietal differences do exist within small limits as regards the rapidity of germination. Some varieties are slow in germinating the extreme case in this group being the wild paddies while most of the varieties sprout in 36 hours. So far as observations go in Coimbatore there does not appear to be any connection between the rate of germination and the duration of the crop. Differences are probably due to the texture of the husk and its permeability to water. Strain 24 belongs to a group where the germination is slightly delayed. Under the conditions of sowing adopted in South India, every variety should be able to germinate almost completely in the first 48 hours, and it is only then, we get a uniform stand in the seed-beds.

Seed-bed stage. The period during which the seedlings are allowed to remain in the seed beds depends on the duration of the variety; broadly speaking, the general practice is to allow 1 week in the seed bed for every month of the total life period, no variety however being transplanted earlier than 3 weeks nor later than 7 weeks. Measurements of the seedlings were begun 8 days after sowing and continued every 3rd or 4th day for about 5 weeks, each time the maximum height to the tip of the topmost leaf being recorded. The dozen plants which were measured were selected in the centre of the bed to avoid plants near the margin which may be subject to abnormal conditions. The table below gives the average heights as recorded for the different groups under study.

TABLE I.

GROUPS.	Duration in months.	Average height.	Average measurements in c. m. when the seedlings were.					days old
			9	12	18	23	28	
Very early & very short ...	3½	2'—8"	10	14	23	31	86	
Early and short ...	4	3'—2"	6	10	16	22	26	
Early but very tall ...	4	4'—6"	7	14	22	30	34	
Rather late and tall ...	5	4'—4"	8	11	17	23	37	
Very late and tall ...	6	4'—10"	7	11	17	25	31	
Very late but not so tall ...	6	3'—2"	7	10	17	25	32	

From the table it is seen that the differences in growth are not very different in the different groups. The very rapid growth in the first group is very striking. In the very early group the growth increase is more prominent than in the other groups at every period.

Leaf formation :—Almost all the varieties under study had two leaves on the 9th day after sowing when the actual measurements were commenced. The interval between the formation of two successive leaves varies from 3 to 6 days. In the beginning the interval is somewhat longer and in the later stages as growth becomes more rapid, fresh leaves come up at shorter intervals. The early varieties on the whole show a tendency for a greater

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leaf formation than the later ones, but at the same time the rate of leaf formation by which is meant the rapidity with which fresh leaves are formed and added on to those given out before is more sustained in the case of the early than in the case of the late varieties as is shown below.

TABLE II.

Days required for the reproduction of
successive leaves.

	1st.	2nd.	3rd.	4th.	5th.	6th.
Early and short	12	18	22	52
Late and tall	8	14	16	21	...

Irrespective of the duration the plants always have 4 functioning leaves at a time in the seed bed. When the 5th one emerges out and begins to function, the bottommost leaf turns yellow and dries up. The size of the leaves, though they were not actually measured were found to vary in width, stiffness etc. The area of foliage, a composite character made up of number, length, and width underlies the capacity to produce an ample crop and the quickness with which the plant develops a big area of foliage determines in a way the earliness of the crop. By the examination of the foliage of the different varieties in the seed-beds it is possible to differentiate roughly the early from the late and more precisely the coarse from the fine. During two seasons, just before the pulling out of the seedlings for transplanting, the seed beds of the various types were gone over carefully and from the look of the foliage they were classified into coarse or fine and when this classification was later compared with the actual measurements of the grains, the results were found to agree fairly.

Though there are variations in the intensity of the green colour observed in the seed-beds and which are sometimes persistent even after transplantation, one correlation of this character with that of any other has been noted so far. The colour of foliage is a varietal character though subject to environmental conditions like spacings and number of plants put in per hole.

Since the sowing is done fairly thick in the seed-beds, there is no indication of tillers being produced in the centre of the bed; but in varieties like strain 24 tillers begin to form in the plants on the borders of the bed after the third week.

Transplanting and after. When the plants are transplanted all the old roots die and new roots have to be formed. Soon after transplantation the plants show a withered appearance and the time taken to revive from the shock varies with the different varieties. All the early varieties under observation revived within 5 days whereas the later varieties took over a week. Though there is an indication of revival a few days after transplanting, yet the actual increase in size is not apparent till after 3 weeks. After the leaves with which the seedlings were transplanted dry up, fresh ones begin to form after the tenth day. The number of functioning leaves in each of the culms is 4, though in one or two of the late varieties it was occasionally five. The early group had invariably 3 leaves to each culm.

Tillering. After the shoots have begun to produce new leaves for some time, side shoots begin to develop. In both the sets of groups, the plants are found to possess 2 to 3 tillers 20 days after transplantation. When once the tillering has commenced the successive tillers appear to come faster in the later varieties than in the early ones, and the period of tillering is also extended in the former, and hence it is, that late varieties as a rule produce larger number of tillers. In the experiments under study all the varieties early and late had been given a uniform spacing of $12'' \times 6''$ which is certainly too big for the early ones. This wide spacing had unnecessarily prolonged the tillering period in the very early varieties which were observed to be producing tillers till they started flowering. The tillering period is about 3 to 4 weeks in the early varieties and about 5 weeks in the later ones i. e. the late varieties continue to produce tillers till about 8 weeks after transplantation. Of the early varieties E.B.335 was found an exception in that the tillering period got extended to 5 weeks and T.346 and E.B.371 are exceptions in the late varieties in that they finished their lateral branching in 3 weeks' time.

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Growth. The growth as measured by the height of the plant from the base to the tip of the leaf or to the tip of the panicle if that happens to be more, is progressive and continues till they enter the reproductive phase. Though the initial height may be very nearly the same both in the early and late varieties, the size increases in each successive period are very much more marked in the early than in the late varieties. The increases are at their maximum just when the plants enter their reproductive phase. This phenomenon is very striking in both the early and the late groups. If two varieties of the same duration but differing in height are compared against each other, there is practically no difference in the height increases for the first two weeks, then the taller varieties grow much more rapidly till they approach the reproductive phase when again the increases are more marked in the taller varieties. In the case of very late varieties (Example E. B. 370) whether they are tall or short, the growth increase, though progressive, is very slow in the beginning, and it practically ceases for about 2 to 3 weeks. This happens to coincide with the time when the plants finish their lateral development. There is apparently no sign of activity during this short period and then it starts again slowly first and gets accelerated until the flowering commences when the maximum increases are recorded. The successive increases in height when plotted give an unimodal curve in the case of the early varieties and a bi-modal curve in the case of late varieties. The growth phase of late and tall varieties commences ascendancy when the early and short types attained the maximum growth.

TABLE III.

Successive growth recorded in c. m. at 5 days' interval commencing
from the 21st day after transplantation.

Days after
transplanting

GROUPS.

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37 43 49 56 64 74 81 85 ...

Early and short

... 35 38 43 48 52 58 63 70 76 80 86 92 92 ...

Early but rather tall

... 33 40 45 51 58 65 72 76 79 82 86 88 93 106 114 118 ...

Late and tall

... 34 37 43 50 55 60 64 69 73 75 77 82 90 106 121 130 ...

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Flowering Phase. The period between which the flowering commences and finishes though influenced by environment one of which is too wide spacing appears to be a varietal characteristic. From an economic point of view the variety that starts and finishes flowering at a minimum period is always to be preferred. In the three very early varieties P. S. 24, P. S. 33 and T. 271, probably due to the extra spacing given, this period was as much as 3 weeks the maximum period so far observed. Generally in all varieties the duration of the period is from 5 to 10 days and it gets slightly extended in the case of varieties with a large number of tillers. In P. S. 24, the first head starts flowering and the 2nd head does not start until the first one finishes and a number of them may all start simultaneously later. This is true of several of the early varieties in general whereas in the late varieties a number of heads may start blooming all at once from the very beginning.

*Ripening and Maturation phase:—*The ripening period is the interval between the stage at which the main head is ready for harvest and the stage at which the whole plant gets ready for harvest. From the ryots' point of view the quicker the period of ripening the greater the advantage. Too much of moisture in the soil particularly in heavy and retentive soils tends to prolong the ripening and hence the local practice in the delta soils to drain the water off completely as soon as the heads are in the milk stage and thus hasten ripening. The period between the stage at which the main head is ready for harvest and the stage at which the whole plant gets ready for harvest is found to vary from 2 weeks which is the maximum noted in the case of the very early varieties, to 5 days the minimum noted in the case of the late variety E.B.371, there being no apparent connection between the duration of the crop and the length of this period. The actual period taken from the first commencement of flowering in a plant to the grain ripening appears to be distinctly a varietal characteristic. In the case of a very early variety like P.S.24, the grains are fully formed and give 100% germination 3 weeks after the flower opening and the fertilisation of the ovaries. In 5 other varieties of about 5 months in duration, there was hardly any germination even after 30 days. Satisfactory germination was obtained in one of them after 40 days and in others it took as many as 45 days. The period between the commencement of flowering and the commencement of ripening was noted in all the

Very late but not tall	35 40 43 48 53 57 60 62 63 64 68 72 80 83 86 91 100 112 113
Very late and very tall	37 41 46 50 55 59 64 67 70 71 75 83 90 98 105 111 120 134 147

varieties under study. This period is found to be 30 days in the case of most of the early varieties while in the case of the late varieties it varies from 35 to 40 days and occasionally to even 42 days. T.372 is an exception among the late varieties in that this period was only 28 days in this variety.

The branching of the culm is a common phenomenon particularly in the early varieties and these are found to remain green for a much longer period than the later ones. This is in all probably due to the fact that the early varieties ripen at a time when the environmental conditions are such to induce further growth. The late varieties generally dry up quickly except in some cases—G.E.B.24 is a typical example—where, after the harvests are over the stubbles put forth some fresh shoots and even diminutive earheads with a little grain. This phenomenon is in all probability associated with a bigger root system.

The 12 plants of each of these lots under study when ripe were harvested individually and the determinations made are recorded in the table below, the averages of two seasons.

TABLE IV.

Group.	Average number of			Average yield of individual plot in g.rs.	Average weight of 100 grains in gms.	Percentage of unsetting.
	tillers per plant.	Panicles per plant.	Grains per panicle			
Very ea-rlly & very short	8	8	44	9.65	2.44	21
Early and Short	8	7	78	12.28	2.15	12
Early and rather tall	6	5	*83	8.86	1.98	15
Late and tall	9	8	95	14.73	1.84	24
Very late but not tall	8	8	101	13.90	1.91	19
Very late and very tall	9	8	100	14.38	1.97	18

*Does not include T. 298 which has nearly double this number of grains per panicle.

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