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Early Growth in Rice varieties in relation to their Duration and response to growth-substances

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A good deal of attention has been devoted in recent years to the inter-relations that exist in a number of crop plants between differences in the early growth and the subsequent growth behaviour of these plants. (Thimann and Lone, 1938; Sinnott, 1939; Van Overbeek, 1935; Kaiser and Albaum 1938). The last two workers were able to find a close relation in the case of oats, between the early growth and the subsequent flowering behaviour. An early-flowering variety (*Fulghum*) was found to have in the early stages of growth a slower rate of root growth than a late-flowering type *Black Norway*. The two varieties differed also in their response to different concentrations of the growth-promoting substance *B*-indole acetic acid. The late-flowering type *Black Norway* showed a more rapid shoot growth when treated with concentrations of ·002 mg./litre to 2·0 mg./litre, while the early-flowering type *Fulghum* remained unaffected. A similar relation was observed in two other varieties of oats as well and the authors concluded that if such a relation was found to be general, it could be made to serve as a valuable index of flowering time.

In the course of certain studies on vernalisation that were taken up at Coimbatore on rice the need was felt for a method of predicting the probable duration of pretreated seed as compared to the controls. With this aim, an investigation was started on three rice varieties in each of three duration groups short, (100 days); medium (150 days) and long duration (200 days and over) to see how far they differed in the growth-rates of root and shoots in the early seedling stages, under the action of different concentrationd of the auxin, B-indole acetic acid.

Material and Methods: The method adopted for carrying out growth measurements on rice seedlings over a period of five or six days was as follows:— About 10 gms. of disinfected seed of nine varieties viz., Adt 3, Co. 21 and PTB 10 in the short duration group, SLO 16, Adt. 10 and GEB 24 in the medium group and AKP 5, SLO 18 and MTU 7 in the long-duration group were taken in petri dishes, soaked in distilled water and germinated for 24 hours in an incubator at 30° C. Fifteen germinated seeds from each variety were then picked and carefully mounted on filter paper sheets using a suitable mixture of melted paraffin wax and vaseline to keep them in place. The paper with the mounted seeds was then rolled and inserted into tall cylindrical jars (500 cc. measuring

cylinders were convenient for this purpose) containing 100 cc. of different concentrations namely, 0, 0·05, 0·5, 5; 10, 20 and 50 parts per million of B-indole acetic acid in distilled water. Care was taken to see that the mounted seeds were all in a line at the same height from the liquid level; and also to see that the seeds were so oriented as to ensure the roots growing vertically downwards and the shoots upwards, so as to avoid errors due to measuring across the curved surface of the cylindrical jars. The jars were then covered to prevent loss by evaporation and kept in a light-proof chamber. Under such conditions the seedlings continued their growth and repeated measurements could be made through the glass without difficulty and without disturbing the seedlings. The length of the longest root was taken as a measure of root growth (*Lane 1936*). Shoot measurements were taken from the point of emergence from the grain to the coleoptile tip. All figures are averages of ten plants. Final measurements on the length of shoot and number of roots were made at the end of seven days after removing the plants from the cylinders.

The stock auxin solution was prepared by dissolving *B*-indole acetic acid in distilled water with slight heating. The concenerations employed ranged from 0·05 p.p.m. upto 50 parts per million and were obtained by diluting the stock solution.

Results: *Root growth*: The normal growth of roots in the three duration groups under the conditions of the experiments is represented in the control column in Table I. It will be observed that short duration types have on the average a more rapid rate of growth than the medium and long-duration types.

The average rate of growth (final length of the longest root divided by the growth period) is 0·677 mm./hr. for the short duration varieties while it is 0·629 mm./hr. and 0·662 mm./hr. in the medium and long duration varieties.

Shoot: The normal growth measurement on the length of young shoot (mesocotyl plus coleoptile) in the three groups is shown in Table II, control column. Here too, the average rate of growth in 120 hours is seen to be higher in short duration varieties (0·388 mm./hr.) than in the medium and long duration groups where it is 0·257 mm./hr. and 0·347 mm./hr. respectively.

Effect of auxin treatment: *Root length*: The data are presented in full in table I and in fig. 1 for typical concentrations of ·05 p.p.m. control, 10 p.p.m. and 50 p.p.m. of auxin, for the sake of clarity. It will be noted that in all the three groups the lower concentrations of auxin especially ·05 and ·5 p.p.m., stimulate root growth while higher concentrations of 10, 20 and 50 parts per million depress growth. This point is brought out more clearly when the values are expressed as percentages of the control against time, as in Table I (a).

Fig.1. Effect of Indole-acetic acid on Root-growth in Rice Varieties

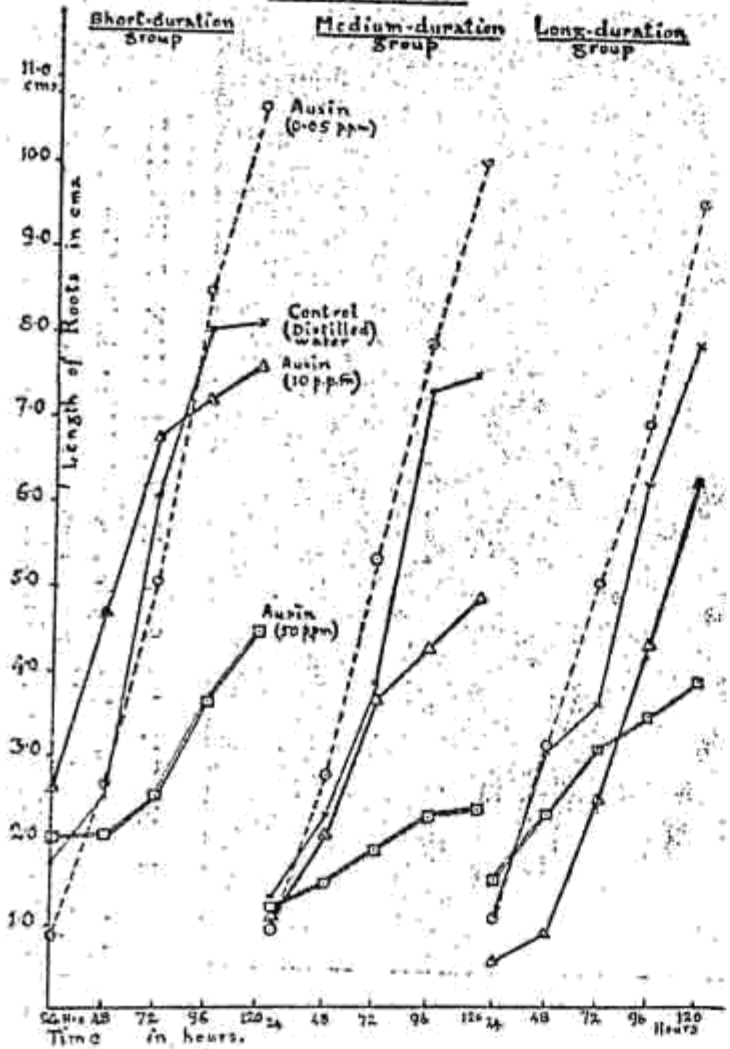
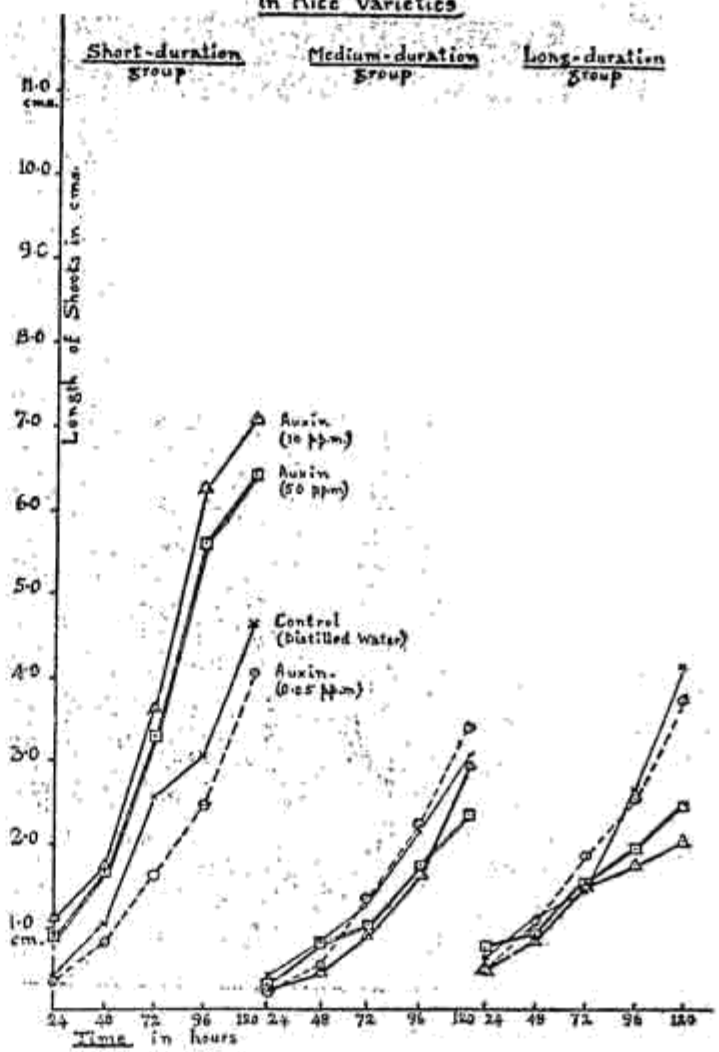


Fig.2. Effect of Indole-acetic acid on Shoot-growth in Rice Varieties



LONDON RECEPTION TO INDIAN SCIENTIST

A largely attended reception was held at India House, London, to meet the Indian Scientist Sir C. V. Raman who is now on a short visit to the United Kingdom. Sir C. V. Raman at India House.

This effect on Rice is in line with that observed in oats (Kaiser and Albaum) that exceedingly low concentrations of auxins were stimulating while higher concentrations inhibited root growth. When expressed as percentages, it would be clear that root growth in the short duration group, is less than in control up to 72 hours, at a concentration of 0·05 p.p.m., of auxin, but later on, i. e. after 96 hours. it exceeds the control by nearly 32% at the end of 120 hours. A similar effect is noticeable with the next higher concentrations also, but the increase over control at the end of 120 hours, is only 26% with 0·5 p.p.m. and 16% with 5 p.p.m. of auxin.

With still higher concentrations of 10, 20 and 50 parts per million the effect in the short duration group is to have an initial stimulation of root growth up to 24 hours, after which it is progressively depressed, the growth at the end of 120 hours relative to the controls, being only 95%, 51% and 55% respectively.

A closely similar trend, is noticeable in the medium and long duration groups also.

(b) *Root Number*: The number of roots possessed by the three groups at the end of 168 hours after germination when growing in distilled water and in different concentrations of indole acetic acid is shown in Table III. It will be noted that under normal conditions, the long duration types put forth a larger number of roots than short and medium types. With added auxins the root number is increased in short duration types, by 10 parts per million of indole acetic acid and reduced by higher concentrations of 20 and 50 p.p.m. In the medium duration group, the number of roots is less than in control, with low concentrations of auxin, viz., 0·05 and 0.5 parts per million and is more or less the same as in control with higher concentrations. In the long duration group, the root number is unaffected by 0·05 p.p.m. but thereafter seems to get depressed by higher concentrations, 10 parts of auxin per million in particular showing the greatest reduction in the average number of roots.

Shoot Length: Table II gives the results of applying B-indole acetic acid in solution through the roots on the shoot length in the three duration groups and the same is shown graphically in figure 2. Under normal conditions the average rate of shoot growth appears to be higher in short duration types than in medium and long duration types. With the addition of indole-acetic acid, the shoot-growth is stimulated, to a very marked extent in the short group by 10, 20 and 50 p.p.m. whereas the same concentrations show no such increase in the case of the other two groups. Lower concentrations of 0·05, 0·5 and 5 p.p.m. appear to have if at all, only a slight depressant effect in the short group and an ill-defined fluctuating effect in the medium and long duration groups.

Discussion: The results obtained with rice are similar in certain respects to those observed in oats by Kaiser and Albaum (1939) and in oats and wheat by Thimann and Lane (1938) but are markedly different in some others. Thus Kaiser and Albaum found that low concentrations of auxin from ·002 mg./litre to 2·0 mg./litre, stimulated root length and higher concentrations inhibited it in the late flowering oat variety *Black Norway*, whereas no such effect was shown in the early variety *Fulghum*. In rice however all the three duration groups early, medium and late showed stimulations of root length by low concentrations of auxin, from ·05 to 5 mg./litre. The relative degree of stimulation also was more or less the same in all the three groups being 31·8% in short. 32·3% in medium and 40·9% in the long-duration group, with a concentration of ·05 mg./litre of indole acetic acid. The response in rice to higher concentrations of 10, 20 and 50 mg./litre was however the same as in oats being progressively inhibited with both time and concentration of auxin.

In respect to Root number, Kaiser and Albaum observed a larger of roots under normal conditions in the early variety Fulghum that in the late variety Black Norway, but in rice it is the late varieties that are found to have a larger number of roots normally than the early and medium varieties. Under the effect of 10 p.p.m. of auxin, the early group in rice produced a larger number of roots than the control, the medium group had the same number both in auxin and in distilled water, while seedlings of the long-duration group had a much smaller number of roots in 10 p.p.m. auxin solution than in distilled water. At higher concentrations of 20 and 50 p.p.m. the average root number was depressed in the short group, remained unchanged in medium and was increased in the long-duration group. A somewhat similar effect has been reported by Thimann and Lane (1938) in oats and wheat, that high concentrations up to 100 mg./litre of auxin, increased the root number but as they studied only a single variety in each crop it is not possible to say whether the response would have been the same with other varieties of different durations. The effect noted on root number in rice would seem to indicate that the longer duration varieties have a lower rate of intrinsic auxin production than short-duration varieties, as in the case of the two oat varieties tested by Kaiser and Albaum, but the effects observed on root length and shoot growth do not bear out such an assumption.

In the case shoot-growth in particular, the effects on rice are the opposite of those reported for oats. In rice the shoot-growth is very markedly stimulated in short-duration varieties by 10 p.p.m. of indole-acetic acid and also by higher concentrations of 20 and 50 p.p.m. In medium and long duration groups, the shoot-growth is depressed by the same concentrations. With oats on the other hand, the late variety showed a more rapid growth when treated with auxin concentrations from ·002 to 2·0 mg./litre, while the early variety remained unaffected.

Further study on these as well as other varieties of rice is obviously needed before the differences in response could be explained on a rational basis. For the present it is sufficient to note that the method appears to offer a possible way of judging the duration of a particular variety by testing its response in root and shoot growth to different strengths of growth-promoting chemicals. A more detailed study is being undertaken to verify and collate the observations noted above.

Summary.

A simple method is described for carrying out growth-measurements on rice seedlings over a period of five or six days, based upon a similar study on oats by Kaiser and Albaum (1939). The differences in response of rice varieties of short, medium and long durations, when grown in water and in various concentrations of *B*-indole acetic acid, are presented and discussed.

Root growth under normal conditions is more rapid in the short duration varieties than in the medium or long duration varieties. With the addition of indole-acetic acid, the root-growth is depressed by low concentrations upto 72 hours and stimulated thereafter. The lowest concentration of auxin, used namely 0·05 mgms./litre showed the highest percentage of increase. Higher concentrations of 10, 25 and 50 mgms./litre stimulate root-growth only upto 24 hours, after that they show a progressive depression with time. This response is common to all the three duration grougs so far tested in paddy.

In *root number* the short and medium duration groups are similar and show a smaller number of roots than long duration varieties. Under the action of indole-acetic acid, the root number is increased in short duration varieties by 10 p.p.m. but depressed by 50 p.p.m. Medium varieties show a decrease in root number by low concentrations of 0·05 and 0·5 p.p.m. while in the long duration varieties, the root number is depressed by all concentrations higher than 0·05 ppm. of indole acetic acid.

Shoot growth: Short duration varieties when grown in distilled water have a higher rate of growth than medium and long duration varieties. With indole-acetic acid the short group shows a marked stimulation of growth at 10, 20 and 50 p.p.m. while the response in the other two groups is not very regular or well-defined.

The method would seem to offer a possibility of judging the duration of varieties by testing their early root and shoot growth in different concentrations of growth-promoting substances.

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TABLE No. I.

Effect of Indole-acetic acid on Rice roots

Hours	Adt 3, PTB 10, Co, 21. Short Duration							SLO 16, Adt 10, GEB 24. Medium Duration							AKP 5, SLO 18, MTU 7, Long Duration.						
	D. W. Control.	·05 ppp.	·5 ppm.	5 ppm.	10 ppm.	20 ppm.	50 ppm.	D. W. Control.	·05 ppm.	·5 ppm.	5·0 ppm.	10 ppm.	20 ppm.	50 ppm.	D.W. Control.	·05 ppm.	.5 ppm.	5 ppm.	10 ppm.	20 ppm.	50 ppm.
								(a) Average lengths (cms.) :—													
24	1·77	0·91	0·93	1·09	2·60	0·99	2·01	1·37	0·96	1·05	1·13	1·11	1·17	1·15	1·19	1·11	1·09	0·96	0·57	2·08	1·53
48	2·52	2·64	2·91	2·99	4·69	2·56	2·02	2·31	2·78	2·50	2·98	2·07	1·30	1·50	3·03	3·13	3·09	2·29	0·90	2·85	2·30
72	6·09	5·08	5·50	3·85	6·78	3·03	2·54	3·84	5·35	4·64	3·52	3·68	2·64	1·89	3·62	5·06	4·83	3·85	2·47	3·61	3·08
96	8·03	8·53	8·09	8·22	7·20	3·58	3·65	7·39	7·92	6·79	7·52	4·28	3·39	2·26	6·23	6·98	6·57	5·41	4·38	3·71	3·48
120	8·12	10·70	10·22	9·44	7·60	4·14	4·49	7·55	10·09	8·57	8·49	4·89	3·48	2·37	7·94	9·60	8·89	6·31	6·29	3·81	3·88
								(b) As percentage on control :—													
24	...	51·4	52·5	61·6	146·9	55·9	113·5	...	70·0	76·6	82·5	80·9	85·4	83·9	...	93·3	91·6	80·7	47·9	174·9	128·3
48	...	77·2	82·7	83·4	133·2	72·7	57·4	...	120·3	108·2	129·0	89·6	56·3	64·9	...	103·3	100·9	75·6	29·7	94·0	75·9
72	...	83·4	90·3	63·2	111·3	49·7	46·6	...	139·3	120·8	91·6	95·8	68·7	49·2	...	139·8	133·4	106·3	68·2	99·8	85·1
96	...	106·2	100·7	102·3	87·1	44·5	45·4	...	107·1	91·9	101·7	59·2	45·8	30·6	...	112·0	105·4	86·8	70·2	59·5	55·8
120	...	131·8	125·7	116·2	93·6	50·9	55·3	...	132·3	113·5	112·4	67·2	46·1	31·3	...	140·9	114·9	79·5	79·2	47·9	48·8

TABLE No. II.

Effect of Indole-acetic acid on Rice shoots

Hours	Adt 3, PTB 10, Co, 21. Short Duration							SLO 16. Adt 10, GEB 24 Medium Duration							AKP 5, SLO 18. MTU 7 Long Duration.						
	D. W. Con- trol.	·05 ppm.	5·0 ppm.	0·5 ppm	10·0 pom.	20·0 ppm.	50·0 ppm.	D. W. Con- trol.	·05 ppm.	·5 ppm.	5·0 ppm.	10 ppm.	20 ppm	50 ppm.	D. W. Con- trol.	·05 ppm.	·5 ppm.	5 ppm.	10 ppm.	20 ppm.	50 ppm.
								(a) Average lengths (cms.) :—													
24	0·41	0·38	0·18	0·36	1·12	0·32	0·93	0·40	0·20	0·33	0·33	0·23	0·43	0·27	0·62	0·49	0·45	0·55	0·50	0·74	0·76
48	1·08	0·81	0·62	0·81	1·76	1·80	1·69	0·82	0·55	0·56	0·93	0·48	0·86	0·80	1·16	1·12	0·91	1·08	0·84	0·95	0·91
72	2·55	1·62	1·43	1·64	3·61	2·84	3·30	1·28	1·38	1·12	1·44	0·92	1·16	1·01	1·41	1·85	1·57	1·38	1·48	1·54	1·49
96	3·09	2·46	2·25	2·59	6·29	3·85	5·62	2·18	2·21	1·68	1·85	1·62	1·86	1·74	2·65	2·57	2·23	2·09	1·77	2·44	1·97
120	4·65	4·08	3·72	4·13	7·11	5·43	6·42	3·08	3·42	2·56	2·89	2·95	2·69	2·32	4·16	3·74	3·41	3·19	2·02	2.63	2.44
								(b) As percentage on control :—													
24	...	92·6	43·9	87·8	273·1	78·0	226·8	...	50·0	82·5	82·5	57·5	107·5	67·5	...	79·0	72·5	88·7	80·6	119·3	122·6
28	...	75·0	57·4	75·0	162·9	166·7	156·5	...	67·1	68·3	113·4	58·5	104·9	97·5	...	96·6	78·8	93·1	72·2	81·9	78·8
72	...	63·5	56·0	64·3	145·5	111·3	129·4	...	107·8	87·5	112·5	71·9	90·6	78·9	...	131·2	111·3	97·9	104·9	109·2	105·6
96	...	79·6	72·8	83·8	203·5	124·6	181·9	...	101·4	77·1	84·8	74·3	85·3	79·8	...	96·9	84·2	78·8	66·8	92·1	74·3
120	...	87·7	80·0	88·8	152·9	116·9	135·9	...	111·0	83·1	93·8	95·8	87·3	75·3	...	89·9	81·9	76·7	48·5	63·2	38.6

TABLE III.

Effect of Auxin Concentrations on Root-Number in Rice.

(Counted at the end of 168 hours after germination and expressed as mean of 10 plants).

	Short.	Medium.	Long.
Distilled water (Control) ...	44	41	64
Auxin :			
0·05 mgms. per litre ...	39	29	63
0·50 mgms. per litre ...	40	20	49
5·00 mgms. per litre ...	46	38	50
10·00 mgms. per litre ...	62	42	35
20·00 mgms. per litre ...	48	49	38
50·00 mgms. per litre ...	36	41	42

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Note:— *B* represents Beta.