PHYSIOLOGICAL STUDIES ON THE EFFECT OF COLCHICINE ON RICE. II.

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Introduction.

In a previous paper of this series it has been reported by the author (Ghosh, 1948) that low concentrations of colchicine appear to act as a stimulant to rice plant producing more tillers and ears, and inducing early flowering with increased grain yield. As indicated previously the object of the author is to produce a stable polyploid rice plant by treating with colchicine since its action is known to be directly related to the doubling of chromosomes and presumably these increased numbers of chromosomes may be transmitted to succeeding generations. As a result, a stable polyploid rice plant may well be expected. Polyploid plants can be of much economic importance by increasing vegetative growth, size of spikelets, length of panicles and grain yield together with resistance to unfavourable environmental conditions. With this end in view progeny tests have been conducted from the 50 per cent. of seeds collected from the rice plants arising from colchicine treated seeds and seedlings without further treatment with colchicine in succeeding generations, while the other 50 per cent. of seeds have again been treated in succeeding generations with the same doses of colchicine as applied to parent seeds to see the cumulative effect if there be any. The descendants of the former group are called untreated progenies, and the descendants of the latter, treated progenies. The present paper deals with observations on vegetative growth, flowering and yield of these treated and untreated progenies.

Experimental Procedure.

In the present investigation the same experimental technique was adopted as described earlier (Ghosh, 1948).

In 1942 seeds of *Dhairal* were treated with 1·0% and 0·05% colchicine for 48 hours, while the sprouted seeds were soaked in 0·05%, 0·1%, 0·5% and 1·0% colchicine for 2 hours; not a single seedling survived in 0·1% and 1·0% colchicine.

In 1943 the following procedure was adopted to compare the effects of colchicine treatment in the progenies of the treated and untreated rice plants. The seeds of the selected plants of 1942 were divided in two equal portions. Half of these were sown without further treatment with colchicine solution and the other half were again treated in the same manner as their parent seeds. The same procedure was repeated in 1944. Thus in one lot was examined the cumulative effect of colchicine treatment, if any, against the other which was not treated any further. Selection was made from the early flowering and high yielding plants. After treatment the seeds were thoroughly washed with water and transferred to moist blotting paper in petri-dishes for germination along with a control set. When the seedlings were sufficiently developed nine of them were taken from each treatment and sown in earthen pots (13″×10″) on 9th April in 1942, on 12th April in 1943 and on 1st and 2nd May in 1944 with 15, 6 and 6 replicates for each treatment respectively. After a week the pots were thinned, keeping only the best three plants in each pot.

The pots were filled with an equal quantity of garden soil which was dressed with 1/8th part by volume of cowdung manure; a handful of bone-meal was also added to each pot. The pots were watered with tap water. Data on tillering, plant height, size of stomata, ear emergence and grain yield were collected. The experiment was arranged in randomized blocks. The data for ear emergence, number and length of ears and grain yield were analysed statistically.

The outline of treatments given below illustrates the procedure:—

1942

A	..	Control.
B	..	·05% of colchicine solution; 48 hours' seed treatment.
E	..	1·0% „ „ „ 48 „ „ „
J	..	·05% „ „ „ 2 „ seedling treatment.
L	..	·5% „ „ „ 2 „ „ „

1943

BP_1	..	Progeny of B; untreated.
EP_1	..	„ E; „
JP_1	..	„ J; „
LP_1	..	„ L; „
BP_1B	..	„ B; treated.
EP_1E	..	„ E; „
JP_1J	..	„ J; „
LP_1L	..	„ L; „

1944

BP_2	..	Progeny of BP_1; untreated.
BP_1BP_1	..	„ BP_1B „
EP_2	..	„ EP_1 „
EP_1EP_1	..	„ EP_1E „
JP_2	..	„ JP_1 „
JP_1JP_1	..	„ JP_1J „
LP_2	..	„ LP_1 „
BP_1BP_1B	..	„ BP_1B treated.
EP_1EP_1E	..	„ EP_1E „
JP_1JP_1J	..	„ JP_1J „

Experimental Results.

Treatment of sprouted seeds.—Sprouted seeds when treated with colchicine for 2 hours show swelling of both radicle and plumule the extent of which varies with its concentration (Fig. 1).

Tillering.—The tillers were counted weekly from 6 to 12 weeks after sowing. The figures recorded in table 1 for tiller numbers include the main shoot.

In 1942 greater tiller number is seen in all the treated plants, the largest number being under 0·05% colchicine treatment; thus confirming previous observations (Ghosh, 1948). In L only two plants and in LP_1L of 1943 only one plant survived, so no stress is attributed to their number of tillers. In 1943 the largest number of tillers was observed in BP_1 and in 1944 in LP_1L.

In 1944 an interesting feature of tillering is observed. The maximum production of tillers is reached at early stages of growth, i.e., within 7th week after sowing, thereafter the number of tillers either remains constant or a reduction is observed due to the death of some tillers. So, a definite critical period of tillering is observed in treated and untreated progenies, while in control the tiller production is progressively increasing. A cumulative effect of colchicine treatment as evidenced by a distinct critical period of tillering is suggested.

In 1943 in LP_1L the whole plant became tetraploid as suggested by its gigas characters such as darker green colour of the leaves, remarkable increase in plant height and bigger size of the spikelets of all the ears which, however, failed to set

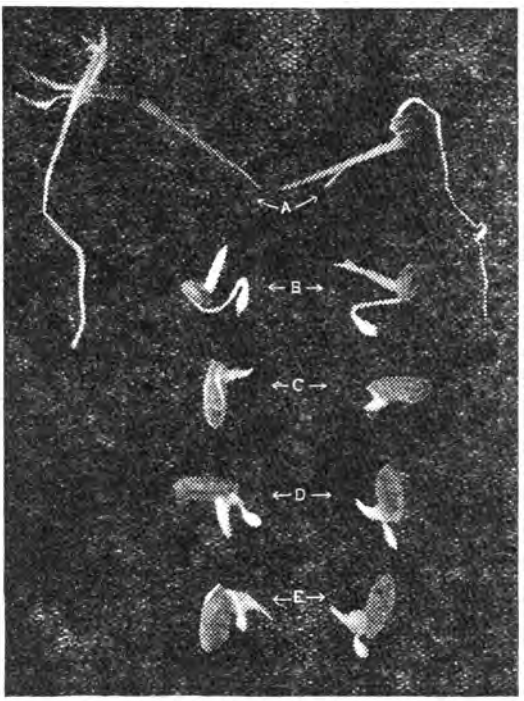

FIG. 1. Effect of varying doses of colchicine on sprouted rice seeds for 2 hours showing gradual swellings of both radicle and plumule.
A—Control; B—·05%; C—0·1%; D—0·5%; E—1·0%.

grains. The plant also tillered very profusely. In 1944, in EP_1EP_1E bigger size of the grains of some of the tillers of some plants suggested that the tillers were tetraploids, the others remaining diploid. Most of the spikelets of the tetraploid tillers failed to develop grains.

Height.—Plant height was taken from the surface of the soil up to the tip of the top leaf of the main shoot. The data are given in table 2.

Marked prolongation to reach the maximum plant height was noticed in 1942 where the growth rate was very slow. In 1943, however, the growth rate of plant height of treated and untreated progenies including control was greater than the growth rate of the plants of 1942, while in 1944 the rate was further increased. This may be shown in the order: 1944>1943>1942. The final height of the plants of the three years were more or less the same. Although the plants of 1944 took much shorter time to reach the final height, they were not weak and sickly and looked as healthy and vigorous as plants of 1942 and 1943 that had taken longer period to reach the final height.

In 1942, plants grown from colchicinet reated seeds and seedlings showed increased height over that of control; marked increase was found in B. In 1943, in all treated and untreated progenies plant height was greater than that of control; appreciable increase being noticed in EP_1E, JP_1J and LP_1. In 1944, all the plants including control showed uniform growth of plant height; in EP_1EP_1E marked increase in height was noticed.

TABLE 1.

Average number of tillers per plant.

Treatment.	VI	VII	VIII	IX	X	XI	XII
			1942				
			Weeks after sowing.				
A ..	8·1	9·5	10·4	11·8	12·1	12·5	13·0
B ..	11·8	14·5	18·0	19·5	20·4	21·2	23·1
E ..	10·8	13·0	14·0	14·1	14·5	15·1	16·1
J ..	9·1	10·8	11·8	12·9	13·7	13·8	14·1
*L ..	3·6	4·1	6·5	9·5	11·5	12·5	13·0
			1943				
A ..	10·6	13·0	13·3	13·6	14·5	14·3	15·6
BP_1 ..	11·2	14·8	14·9	15·4	16·1	16·2	16·5
BP_1B ..	11·0	13·9	13·8	14·4	14·6	14·8	15·2
EP_1 ..	10·4	12·6	12·8	13·0	13·7	13·7	14·4
EP_1E ..	9·9	13·5	13·9	14·0	14·3	14·3	15·3
JP_1 ..	10·3	12·8	13·0	12·9	13·3	13·3	14·2
JP_1J ..	9·3	12·8	13·9	14·4	15·2	15·5	15·7
LP_1 ..	10·2	12·5	12·7	13·1	13·9	13·9	15·5
**LP_1L ..	13·0	20·0	20·0	20·0	20·0	20·0	21·0
			1944				
A ..	8·6	8·6	8·5	8·6	8·8	9·2	9·3
BP_2 ..	8·6	8·7	8·7	8·7	8·7	8·7	8·7
BP_1BP_1 ..	9·2	9·2	9·2	9·1	9·2	9·1	9·1
BP_1BP_1B	9·2	9·5	9·4	9·4	9·3	9·2	9·2
EP_2 ..	9·1	9·1	9·0	9·1	9·0	9·0	8·9
EP_1EP_1 ..	9·8	9·8	9·7	9·8	9·7	9·7	9·7
EP_1EP_1E	9·0	9·6	9·6	9·7	9·5	9·4	9·6
JP_2 ..	9·2	9·2	9·2	9·2	9·2	9·1	9·1
JP_1JP_1 ..	9·9	9·9	9·9	10·0	10·0	10·0	10·0
JP_1JP_1J	7·5	7·6	7·6	7·6	7·6	7·6	7·6
LP_2 ..	8·1	8·3	8·2	8·1	8·1	7·9	7·9
LP_1L ..	10·0	10·2	10·1	11·8	11·9	12·2	12·2

* Surviving plants were only two.
** Surviving plant was only one.

Size of Stomata and of Pollen Grains.—Since polyploid individuals are characterized by increased size of stomata and pollen grains, preliminary observation for detection of the induced polyploidy in rice by colchicine treatment was made by examining the size of stomata and pollen grains.

The matured leaves of same stage of development were sampled for stomatal measurement at 8 A.M. on bright days from the control as well as from the treated and untreated progenies of 1943 and 1944. The epidermis of the leaf was stripped of with a fine scalpel and then plunged immediately into absolute alcohol for preservation in a permanent form without any change in the dimensions of the stomata. The measurements of stomata were recorded after staining them suitably with Bismarck brown. No increase in the size of stomata due to treatment was observed; they were to some extent smaller than those of control. The data are given in table 3.

The larger size of pollen grains was observed in treated progenies, while in untreated progenies the size was almost the same as the control.

TABLE 2.

Average plant height in cm.

1942

Weeks after sowing.

Treatment.	VI	VII	VIII	IX	X	XI	XII
A ..	32·0	39·4	44·9	49·5	55·2	58·7	62·0
B ..	34·6	42·1	47·3	52·0	60·5	63·6	68·3
E ..	33·8	40·9	46·8	50·6	56·7	60·8	65·4
J ..	32·4	39·8	44·3	48·4	56·2	59·7	63·2
*L ..	23·6	30·3	40·3	45·1	49·4	50·7	60·9
1943							
A ..	42·3	48·9	67·2	77·3	84·6	88·8	92·3
BP_1 ..	43·1	51·4	66·4	75·8	82·6	88·1	95·8
BP_1B ..	42·5	49·7	66·5	77·3	84·4	89·2	94·9
EP_1 ..	43·4	52·0	69·9	80·5	88·2	94·3	99·6
EP_1E ..	46·0	56·2	73·0	83·2	92·7	99·4	110·2
JP_1 ..	44·3	52·0	69·6	77·7	88·1	93·6	101·0
JP_1J ..	44·5	50·3	67·2	79·9	87·0	93·6	97·2
LP_1 ..	45·9	52·6	69·3	77·9	87·2	94·2	99·2
**LP_1L ..	55·8	61·0	78·5	96·6	101·5	106·5	113·2
1944							
A ..	50·7	59·9	66·2	72·2	80·2	88·8	92·1
BP_2 ..	52·8	63·1	68·3	72·9	80·2	87·4	91·8
BP_1BP_1 ..	50·5	59·6	64·3	68·7	74·5	83·4	88·6
BP_1BP_1B	51·9	60·3	67·7	73·8	82·1	90·2	92·9
EP_2 ..	48·2	57·5	64·8	70·5	78·3	89·3	93·2
EP_1EP_1 ..	52·9	61·9	68·0	73·4	79·9	88·2	91·7
EP_1EP_1E	56·6	63·3	70·1	76·6	82·1	92·2	100·1
JP_2 ..	48·4	56·9	63·0	68·0	72·7	81·1	85·9
JP_1JP_1 ..	54·9	63·7	70·1	76·1	86·4	94·8	96·7
JP_1JP_1J	49·4	57·5	63·8	67·7	71·3	79·0	85·6
LP_2 ..	49·6	58·8	66·3	71·1	78·3	88·3	91·9
LP_1L ..	52·7	60·8	66·4	72·4	79·2	87·1	91·9

* Surviving plants were only two.
** Surviving plant was only one.

Ear emergence.—In 1942, ear emergence occurred in both the control and plants from colchicine treated seeds and seedlings between the period middle of July to the first week of August and, in 1943, during the first half of July. While in 1944 with a late sowing by 18 days the flowering range of all plants was the same as in 1943. Thus the flowering duration (sowing to flowering) in three consecutive years varied between 96–106 days in 1942, 78–88 days in 1943 and 67–74 days in 1944. The data are given in Table 4. From statistical analysis of three years' data of ear emergence it is found that colchicine treatment induces no significant earliness in flowering, but significant retardation in flowering at 5% level from control by repeated doses of 1% and ·05% colchicine on seed and seedling progenies (EP_1EP_1E and JP_1JP_1J) respectively is noticed in 1944 (Table 5). A marked difference in earing time as noticed in three successive years appears to have been due to the use of selected seeds from early flowering plants of both control and treated and untreated progenies.

TABLE 3.

Measurement of the size of stomata (average of 75 observations).

Treatment.	Length.	Breadth.
1943		
A ..	31·399 μ	21·109 μ
BP_1 ..	27·224 ,,	18·992 ,,
EP_1E ..	26·989 ,,	20·227 ,,
LP_1L ..	28·283 ,,	20·756 ,,
1944		
A ..	31·046 ,,	19·522 ,,
BP_1BP_1 ..	25·225 ,,	16·993 ,,
BP_1BP_1B ..	26·636 ,,	17·464 ,,
EP_1EP_1 ..	26·284 ,,	17·640 ,,
EP_1EP_1E ..	28·812 ,,	18·522 ,,
JP_1JP_1 ..	26·342 ,,	17·816 ,,
JP_1JP_1J ..	27·695 ,,	17·816 ,,
LP_2 ..	27·107 ,,	17·287 ,,
LP_1L ..	29·165 ,,	17·816 ,,

Number and length of ears.—The total number of ears per plant was counted at harvest. The data are given in Table 4.

In 1942, maximum number of ears was found in B, thus confirming the previous work (Ghosh, 1948). In higher concentrations and in seedling treatment the number decreased from that of the control. This result is statistically significant at 1% level (Table 6). The differences in the number of ears per plant between the control and the treated and untreated progenies of both 1943 and 1944 do not appear statistically significant. This indicates that the ear number of the progenies of both 1943 and 1944 remains unaffected by further doses of colchicine in successive generations. As for the number of ears in the three successive years it was found that in 1943 ear number was greater than in 1942, while in 1944 the number was less than in 1943. This variation in ear number of both control and treated and untreated progenies in three successive years is possibly due to the environmental conditions which vary from year to year.

The percentage of ear-bearing tillers of both treated and untreated progenies was found to increase in successive years, except in EP_1EP_1E and EP_1EP_1 (the treated and untreated progenies of EP_1E of 1943) where percentage of ear-bearing tillers was found less than in EP_1E of 1943. In 1942, greater number of tillers were found sterile. In 1943, the number of sterile tillers decreased, while in 1944 almost all the tillers bore ear-heads, the percentage of ear-bearing tillers being greater than in the control. This indicates that in 1944, almost all the tillers of both treated and untreated progenies bore ear-heads and a large number of tillers of the control plants did not bear ears or died immature.

From statistical analysis of the data of ear length (Table 7) it appears that the repeated treatment with 1% and ·5% colchicine in 1944 on seed and seedling progenies (EP_1EP_1E and LP_1L) showed a significant increase at 1% level over the control, while in 1943, the differences between control plants and treated and untreated progenies were not statistically significant. This shows a cumulative effect of colchicine on ear length in 1944.

TABLE 4.

Showing number of days for ear emergence, number and length of ears, grain yield and ears as P.C. of maximum number of tillers.

Treatment.	Number of days from sowing to flowering.	Number of ears.	Length of ears in cm.	Grain yield per plant in grm.	Ears as P.C. of maximum number of tillers.
		1942			
A	105·9	4·2	..	2·4	30·4
B	99·7	8·2	..	5·0	33·4
E	103·5	4·0	..	2·6	23·5
J	101·2	3·6	..	2·3	24·3
*L	96·5	9·0	..	10·8	69·2
		1943			
A	85·4	8·6	20·5	7·7	57·6
BP_1	82·4	10·5	19·5	16·2	69·6
BP_1B	82·8	9·2	20·4	10·5	60·5
EP_1	82·1	10·4	20·9	12·3	72·2
EP_1E	79·1	15·0	22·6	28·6	82·3
JP_1	80·3	10·8	21·1	15·7	76·0
JP_1J	84·8	10·3	21·5	11·9	56·0
LP_1	82·3	9·6	21·5	10·5	61·9
**LP_1L	78·0	21·0	24·0	Sterile	100·0
		1944			
A	69·1	6·2	16·4	6·68	66·7
BP_2	71·5	6·7	16·8	6·04	77·0
BP_1BP_1	70·7	6·7	15·3	5·31	72·8
BP_1BP_1B ..	68·7	7·0	16·5	6·77	73·6
EP_2	69·6	6·7	16·0	5·85	73·6
EP_1EP_1	70·7	6·8	16·4	5·81	69·3
EP_1EP_1E ..	73·3	6·8	19·6	9·96	67·0
JP_2	71·6	7·1	14·5	5·76	78·2
JP_1JP_1	67·2	7·2	17·1	7·82	72·0
JP_1JP_1J	74·1	5·7	15·3	4·82	75·0
LP_2	70·2	6·4	17·0	6·11	69·8
LP_1L	72·8	9·8	18·3	10·85	69·6

*Surviving plants were only two.
** Surviving plant was only one.

TABLE 5.

Analysis of variance of the data of the ear emergence, 1944.

Source of variation.	Degrees of freedom.	Mean square.	Ratio.
Between treatments ..	11	23·7245	2·322[1]
Within treatments ..	60	10·2141	

Conclusion. $J_{P_1}J_{P_1}$, BP_1BP_1B, Cont., E_{P_2}, L_{P_2}, BP_1BP_1, EP_1EP_1, BP_2, JP_2, LP_1L, EP_1EP_1E, JP_1JP_1J.

[1] Significant at 5% level.

TABLE 6.

Analysis of variance of the data of the number of ears, 1942.

Source of variation.	Degrees of freedom.	Mean Square.	Ratio.
Between treatments ..	3	58·3766	11·565[1]
Within treatments ..	50	5·0474	

Conclusion: B > Cont., E, J.

TABLE 7.

Analysis of variance of the data of ear length, 1944.

Source of variation.	Degrees of freedom.	Mean Square.	Ratio.
Between treatments ..	11	11·2927	4·897[1]
Within treatments ..	60	2·3056	

Conclusion: EP_1EP_1E, LP_1L, JP_1JP_1, LP_2, BP_2, BP_1BP_1B, EP_1EP_1, Cont., EP_2, JP_1JP_1J, BP_1BP_1, JP_2.

[1] Significant at 1% level.

Grain Yield.—In 1942, maximum grain yield was found in B which is statistically significant at 1% level. In 1943 grain yield of all the treated and untreated progenies increased over that of the control; an improvement at 5% level of significance being in EP_1E. In 1944, treated progenies (EP_1EP_1E and LP_1L) showed significant increase at 1% level in grain yield over the control, while the other treated progenies and also the untreated progenies showed no significant difference in grain yield from that of the control (Table 8). As has been noted before that some of the tillers of EP_1EP_1E produced considerably bigger grains (Fig. 2), indicating that these tillers became tetraploids, the others remaining diploids. The individual weight of the bigger grains of the tetraploid tillers and that of the normal grains of the diploid tillers were found to be 31·00 mg. and 25·80 mg. respectively. It is interesting to note that the single grain weight of both tetraploid and diploid tillers of EP_1EP_1E was greater than that of the control plants; the single grain weight of the control plants was 24·20 mg. In all treated and untreated progenies of 1944 the number of sterile grains per plant increased over that of the control; marked increase of 145·6 and 69·8 per cent. in grain sterility over the control was found in LP_1L and EP_1EP_1E respectively, thus indicating that to some extent treatment with colchicine leads to sterility.

On the tetraploid tillers of EP_1EP_1E tiny little awn was found to develop only on two apical spikelets, all the other panicles remaining awnless. The awned spikelets were not developed into grains. In EP_1EP_1E one sheathed ear was noticed but the grains of it failed to set.

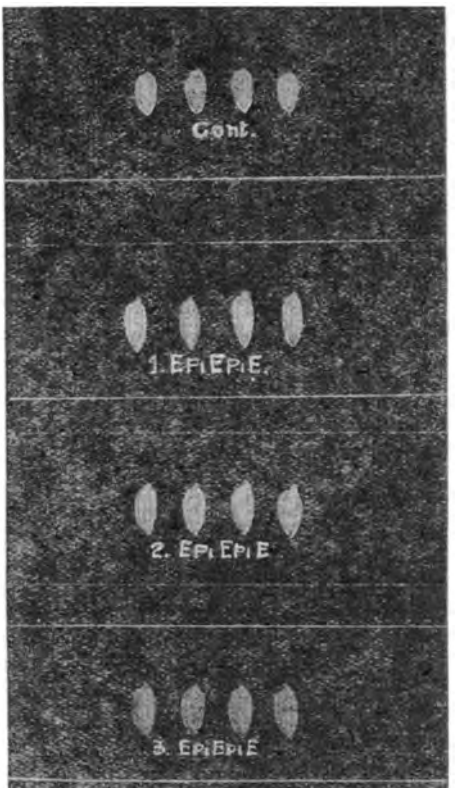

FIG. 2. Showing grains of rice from the control, and from the tetraploid chimera. Note bigger size of grains in latter.

DISCUSSION.

The tillering data presented in this paper (table 1) show clearly that in 1942 and 1943, the number of tillers increased with time in both control and treated plants. In 1944, the maximum number of tillers was produced within 7 weeks after sowing in treated and untreated progenies and thereafter the number of tillers either remained constant or decreased, whereas in control the number continued to increase up to 12 weeks. So, a cumulative effect has been obtained by colchicine treatment as evidenced by a distinct critical period of tillering in treated and untreated progenies of 1944. Engledow (1923, 1924 and 1926) in his wheat experiment stresses the importance of early tiller formation as an index of high yielding capacity in a variety. Grant and Thein Aung (1941) have observed no definite critical period of tillering in rice under lower Burma conditions, while Ramiah and Narasimhan (1936) obtained a definite critical period of tillering in rice.

A clean tetraploid plant was obtained in LP_1L in 1943 but the plant failed to set grains. In 1944, in EP_1EP_1E diploid and tetraploid chimeras having longer ears and bigger grains were obtained. It is expected that in subsequent generation a clean tetraploid might arise from these bigger grains. Blakeslee (1939) observed in *Datura stramonium* grown from a seed treated with colchicine both 2n and 4n branches, and an explanation has been given by Bergner *et al.* (1940) that when seeds

TABLE 8.

Statistical analysis of grain yield data.

1. Analysis of variance of grain yield data, 1942;

Source of variation.	Degrees of freedom.	Mean Square.	Ratio.
Between treatments ..	3	21·1626	6·4181
Within treatments ..	50	3·2972	

Conclusion: B > E, Cont., J.

2. Analysis of variance of grain yield data, 1943:

Between treatments ..	7	219·6934	2·886 2
Within treatments ..	38	76·1034	

Conclusion: $EP_1E > BP_1$, JP_1, EP_1, JP_1J, BP_1B, LP_1, Cont.

3. Analysis of variance of grain yield data, 1944 :

Between treatments ..	11	20·5033	2·712 1
Within treatments ..	60	7·5579	

Conclusion. LP_1L, EP_1EP_1E, JP_1JP_1, BP_1BP_1B, Cont., LP_2, BP_2, EP_2, EP_1EP_1, JP_2, BP_1BP_1, JP_1JP_1J.

1 Significant at 1% level.
2 Significant at 5% level.

are soaked in colchicine solutions for varying lengths of time different cells in the epicotyl may be affected differently. Consequently the plant that develops may be a chimera of one sort or another.

There was little effect of the colchicine treatment on stomatal size and if at all any it tended to reduce it. The size of the pollen grains was larger in treated progenies. Sears (1939) has also observed no changes in the size of stomata as well as in external structures of the induced polyploid material of wheat crosses. Blakeslee (1939) states that larger size of stomata is characteristic of tetraploids but this holds strictly only for comparable leaves. Stomatal size was found a reliable criterion when the stomata were taken from the floral bracts of females. The induced polyploidy can be detected more accurately by the measurement of pollen grains than of stomata (Dermen, 1940). But the surest way of detecting polyploidy is the actual counting of chromosomes.

In 1942, significant increase in grain yield over the control was noticed in B, thus confirming the previous observations of the author (Ghosh, 1948). In 1943, marked increase in yield was observed in EP_1E, and in 1944, in EP_1EP_1E and LP_1L. Colchicine appeared to retard ear emergence particularly in treatments EP_1EP_1E and JP_1JP_1J (Table 5), thus contradicting the observations reported previously (Ghosh, 1948). Awn was found to develop on two apical spikelets of the tetraploid tillers of EP_1EP_1E and one sheathed ear was also noticed in the same treatment. The occurrence of sheathed ear and awn on apical spikelets was caused by the cumulative effect of colchicine which was discussed in an earlier paper (Hedayetullah and Ghosh, 1946). Some of the tillers of EP_1EP_1E produced bigger grains suggesting that they were tetraploids and their single grain weight was found 28·1 per cent. greater than that of the control. Tetraploid plants may be expected from these bigger grains. Chen Shao-lin and Tang (1945) have reported that

colchicine-induced auto-tetraploid barley seedlings are better resistant to drying than the normal diploids. Müntzing (1936) states that polyploids are more resistant and more adaptable to adverse environmental conditions than the diploids. Whether the tetraploid plants from bigger grains of EP_1EP_1E will prove to be of economic value still remains to be seen.

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Summary.

Sprouted and unsprouted seeds of *Dhairal*, summer (*aus*) paddy, and their progenies in three generations (1942, 1943 and 1944) were treated with different concentrations of colchicine for various lengths of time.

The sprouted seeds when treated with colchicine showed swelling of both radicle and plumule, whereas in unsprouted seeds only plumule swelled. The swelling of radicle and plumule increased with increase of colchicine concentration.

A definite critical period of tillering up to 7th week of sowing was found in both the treated and untreated progenies of 1944, while in the control the tiller number continued to increase till the 12th week after sowing. In 1942 and 1943, no such critical period of tillering was observed.

In 1943, a clean tetraploid plant was obtained from sprouted seed when treated with 0·5 per cent. colchicine for two consecutive generations, but the grains of it did not set in. In 1944 tetraploid tillers with bigger grains than those of the control were noticed in some plants grown from seed treated repeatedly for three generations with 1·0 per cent. colchicine for 48 hours. The single grain weight of the bigger grains was found to be 28·1 per cent. greater than that of the control. Whether the plants grown from the bigger grains prove to be of economic importance remains yet to be seen.

There was no increase in the size of the stomata in different treatments of the treated and untreated progenies, while the pollen-grain size was found to have increased in the treated progenies only.

Colchicine seemed to have no effect on the acceleration of ear emergence; on the contrary, in 1944, significant retardation in flowering due to cumulative effect of colchicine was noticed in plants grown from seeds and seedlings treated for three successive generations with 1·0 per cent. and ·05 per cent. colchicine for 48 and 2 hours respectively.

As regards grain yield, the untreated progenies showed no significant imporvement, while treated progenies gave increased yield over the control. In 1942, yield increased in ·05 per cent. colchicine treatment. In 1943 and 1944 progenies treated successively for two and three generations with 1·0 per cent. colchicine for 48 hours showed significant increase over the control. In 1944, an increase was also noticed in plants from sprouted seeds treated for two successive generations with 0·5 per cent. colchicine for two hours.

References.

Bergner, A. D., Avery, A. G. and Blakeslee, A. F. (1940). Chromosomal deficiencies in *Datura stramonium* induced by colchicine treatment. *Amer. Jour. Bot.*, **27**, 676–683.

Blakeslee, A. F. (1939). The present and potential service of chemistry to plant breeding. *Amer. Jour. Bot.*, **26**, 163–172.

Chen, Shao-lin, and Tang, P. S. (1945). Studies on colchicine induced autotetraploid barley. III. Physiological studies. *Amer. Jour. Bot.*, **32**, 177–179.

Dermen, H. (1940). Colchicine polyploidy and Technique. *Bot. Rev.*, **6**, 599–635.

Engledow, F. L. (1923). Investigations on yield in the cereals. I. *Jour. Agri. Sci.*, Cambridge, **13**, 390.

———— and Wadham, S. M. (1924). Investigations on yield in the cereals. I. *Ibid.*, **14**, 66.

Engledow, F. L. (1926). A census of an acre of corn. *Ibid.*, **16**, 166.

Ghosh, B. N. (1948). Physiological studies on the effect of colchicine on rice (Preliminary report). *Jour. Ind. Bot. Soc.*, **27**, 119–130.

Grant, J. W. and Thein Aung, U. (1941). Growth studies in rice. *Ind. Jour. Agri. Sci.*, **11**, 580–588.

Hedayetullah, S. and Ghosh, B. N. (1946). The effect of colchicine on rice. *Curr. Sci.*, **15**, 74-75.

Müntzing, A. (1936). The evolutionary significance of autopolyploidy. *Hereditas*, **21**, 263–378.

Ramiah, K. and Narasimhan, M. (1936). Developmental studies in rice. *Mad. Agri. Jour.*, **24**, 50.

Sears, E. R. (1939). Amphidiploids in the Triticinae induced by colchicine. *Jour. Hered.*, **30**, 38–43.