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1921

Agricultural Research Institute, Pusa

Experiments with Castor Seed Conducted at Sabour

BY

C. SOMERS TAYLOR, B.A.,
Agricultural Chemist, Bihar and Orissa



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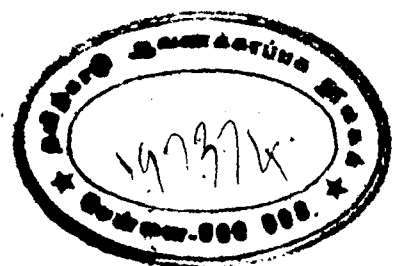
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**Experiments with Castor Seed Conducted
at Sabour.**

[Received for publication on 10th October 1920.]

THE importance of all oils has been greatly emphasized during the late war. Of all vegetable oils castor oil is perhaps the one the demand for which is most likely to increase. Originally used as an illuminant in the days before the introduction of the mineral oils, its use has now completely changed to that of one of the most valuable lubricants known. Attempts have therefore been made to determine whether by chemical selection it is possible to improve the race of castor from the point of view of its oil-yielding properties.

The main difficulty in the way of such a selection appeared to lie in the fact that the castor plant, with its separate male and female flowers, was much more likely to be subject to cross-fertilization than a plant whose flowers were hermaphrodite. In consequence the investigation, although it had appealed to the writer for many years, was left alone, as being probably of only academic value. In 1918, however, an article appeared in the *Journal of Heredity* (Vol. IX (1918), p. 198) in which it was stated that, contrary to expectation, castor plants grown in America had not been found very subject to cross-fertilization. In consequence an attempt was made to survey the different types obtained from various parts of Bihar. A number of types were sent in by different district inspectors, and were examined for oil-content in the writer's laboratory after drying. Remarkable differences in oil-content on seed were observed from these different types, of which 75 were isolated from seed characters, by courtesy of the Assistant Economic Botanist, Mr. A. C. Ghosh. This oil-content, as estimated by ether extraction, varied from as low as 21.8 per cent. to as high as 58.8 per cent. on the whole seed. Such differences appeared very striking, and selections were made and planted of seeds of very low and of very high oil-content. Of the 'low' collections, no type had an oil-content of more than 40 per cent. and the average of 14 selections was 32.9 per cent. oil on seed. Of the 'high' collections, no type contained under 50 per cent. of oil and the average oil-content of 13 selections was 52.8 per cent. These types on growing were found to be very impure. This was only to be expected as the crops have never been grown with any attempt to keep different varieties separate. It was, however, to be expected that the first generations of plants from

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seed with oil-content as widely varying as the above would also, on the average, show very large divergences which, even if they were less than those of their parents, would still be very large. Of these selections only 12 of each kind, 'high' and 'low,' actually grew, whilst actually the average oil-content of the seed of plants from 'high' seed was 49.3 per cent., and that of seed from 'low' seed was 50.6 per cent. Results such as these could not be expected to have occurred as a result of cross-fertilization, nor to have been due to mixed varieties, and it was assumed that the great differences, originally observed in oil-content in the seed of these varieties, may have been observed owing to the different conditions under which the plants were grown. At any rate it is obvious that selection of seeds at random from different localities, in which the seed may have been grown under very different conditions, is not likely to be of much use.

Fresh selections were therefore made from the highest and lowest yielders of the 1919 crop. In this crop, the plots of which were grown under uniform conditions at Sabour, the differences between high and low yielders were not so great. Fifteen parents of low oil-content were taken and twenty of high oil-content. Of the descendants of the fifteen 'low' plants only 10 plots showed good growth. It would therefore be better to consider only these ten, as it is possible that the state of growth of the plant may have an effect on the oil-content of the seed. Nine of the twenty 'high' plots should probably also be eliminated, as they were badly affected by insect attack, and, in consequence, the flowers and seed were probably abnormal. In fact, the amount of seed produced was very small, and in every case showed an oil-content below the average. The mean of the 11 good plots was 49.6 per cent. for descendants of parents whose mean was 54.2 per cent. The mean of the 10 well grown 'low' plots was 48.6 per cent. from parents whose mean was 42.5 per cent.

These results were found to differ very little from those obtained by taking the mean of all the plots, whether well or ill grown. In this case the mean of the 20 'high' parents was 54.8 per cent. and of their descendants 47.8 per cent. The mean of the 15 'low' parents was 44.1 per cent. and of their descendants 47.3 per cent. There appear, therefore, to be strong indications that in the majority of cases the plants do not transmit a high or low oil-content for even one generation, but that both 'high' and 'low' seeds give plants which, in nearly every case, give a seed near the mean oil-content, which lies somewhere close to 49 per cent. when the plants are healthy, and a little lower when the reverse is the case. It will be seen moreover that the inclusion of the unhealthy plots has in each case, as was to be expected,

lowered the mean oil-content of seed observed. Out of the whole series, however, two appear to have kept pure as regards high oil-content for more than one generation. This will be shown by the following table:—

Plot No.	Original analysis	1st generation	2nd generation	Weight of seed in ounces
26/19	51.9	52.4 green	3 distinct varieties each high in oil— Green . . . 50.0 Purple A . . 50.4 " B . . . 51.3	28 10 1
34/19	58.8	57.0 dull purple	Two distinct varieties— Purple A . . 52.8 Purple green B . . 52.8	15 22½

In addition, a plot has been observed which shows a splitting-up into different varieties which differ in oil-yielding as well as in ordinary botanical characters. This is shown by the following table:—

Plot No.	Original analysis	1st generation	2nd generation	Weight of seed in ounces
75/19	54.7	54.9 green	Four distinct varieties— Green A . . . 51.8 " B . . . 50.6 Purple A . . 46.6 " B . . . 50.4	4 12 1 1

It will be noted that in this last instance the low-yielding variety is only present in very small quantity, and may possibly be due to a first cross as the original parent was green. Observations on these three varieties will be continued.

The method used in these analyses was that of extraction of the dried seed with ether. This method, naturally, shows a higher percentage of oil than could possibly be obtained by the oil-presses used in this country. The results, however, may be taken to give a good comparison between different varieties, and give a good idea of what could be obtained commercially by the modern method of extraction by solvents such as petroleum ether or carbon tetrachloride. There were great practical difficulties in the way of extraction of more than a small quantity of seed, and in consequence it is necessary to examine how such a small sample will indicate the composition of the main

bulk. For this purpose a number of samples of seed obtained from botanically pure, or nearly pure, varieties of *bhadoi* castor were kindly placed at my disposal by Mr. A. C. Ghosh, Assistant Economic Botanist. The analysis of 15 samples from a bulk collection of one variety showed last year a standard deviation, from the mean, of ± 1.04 per cent., the mean being 49.5 per cent. (Table I.) Other analyses have been made this year, taking selections from plant to plant in each of these fairly pure varieties, and such analyses in each case show a standard deviation, from the mean of the series, of about ± 1.5 per cent., the mean varying from 47.6 per cent. in the lowest case to 50.9 per cent. in the highest (Tables II—VIII.) From these observations we may calculate that the probable error in the oil determination of a single sample of any one variety will be about ± 1.0 per cent. of the weight of the seed. This is the case when the crop is fairly evenly grown, and when the seeds appear to be properly filled out. Greater variations have been found to occur in a crop of seed which does not appear to be fully developed. As an example of the differences in magnitude of the variations which occur in a pure crop which is grown under different conditions, we may take a castor which was selected both for field characters and oil-content in 1918. This variety was isolated among others at Sabour by the Professor of Agriculture, Mr. S. N. Sil, and was finally selected as the result of analysis in the writer's laboratory. The original analysis of this variety, known as *pachka*, showed an oil-content on whole seed of 52.1 per cent. in 1918. The variety has been continued in 1919 and on to this season. A single analysis was done on this variety sown both in the *rabi* and *bhadoi* seasons. The *bhadoi* sample, which gave better developed seeds than the *rabi* grown plant, showed an oil-content of 56.2 per cent. of oil on seed, and the *rabi* sample showed 53.6 per cent. The variety therefore appeared to be keeping up its reputation for high oil yield, and in consequence ten samples were analysed of the seed grown in the *rabi* and *bhadoi* seasons, respectively. The *rabi* grown crop showed a mean of 52.3 per cent. with a standard deviation of ± 2.0 per cent., while the *bhadoi* grown crop showed an extraordinary evenness in the samples. The mean of the ten samples of this latter was 54.4 per cent. and the standard deviation only ± 0.7 per cent. (Tables IX and X.) As has been already mentioned, the *bhadoi* sown seeds gave a far better developed crop of seed than those sown in the *rabi* season, and it is probable, from the large standard deviation observed in the latter, that the effect of different conditions of growth may be strongly marked in the seed obtained from each plant. Reference has already been made above to the possibility of this phenomenon, and this result would appear

to confirm this reasonable expectation. It would, moreover, almost appear from the above results that variations in agricultural treatment may possibly have more effect on the oil-yield of the crop than actual chemical selection. As the result, therefore, of a considerable amount of work, a few varieties have been selected which appear to be richer in oil than others, and which maintain a mean oil-content greater than 49.5 per cent. which may be taken as the mean of all the types tested here. The improvement, however, is not as marked as was hoped, the greatest improvement observed above the general mean this year being just under 5 per cent. in the case of the *bhadoi pachka*, while the *rabi pachka* only showed an improvement of about 3 per cent.

TABLE I.

(Lab. No. 707.)

Percentages of oil calculated on undried material.

Serial No.	Weight of 3 seeds	Weight of 3 kernels	Percentage of oil on entire seed	Percentage of oil calculated on kernel	REMARKS
1	1.5464	1.1238	49.05	67.50	Mean 49.5 per cent. oil on seed. Standard deviation ± 1.04 per cent.
2	1.5714	1.1200	47.00	65.88	
3	1.3676	0.9526	49.13	70.54	
4	1.5734	1.1456	49.75	68.33	
5	1.5468	1.1248	49.26	67.70	
6	1.4768	1.0662	50.12	69.42	
7	1.4758	1.0548	49.09	68.67	
8	1.4760	1.0566	50.42	70.43	
9	1.4004	1.0010	48.72	68.09	
10	1.5066	1.0742	51.01	71.55	
11	1.4552	1.0434	50.63	70.61	
12	1.3438	0.9434	48.31	68.81	
13	1.4352	1.0276	49.73	69.46	
14	1.4280	1.0120	49.31	69.48	
15	1.4170	1.0162	50.93	71.02	

TABLE II.

(Lab. No. 729—738.)

Percentages of oil calculated on undried material.

Serial No.	Plant No.	Percentage of oil on entire seed	Percentage of oil on kernel	REMARKS
1	4	51.6	67.5	Mean 50.0 per cent. oil on seed. Standard deviation ± 1.2 per cent.
2	7	51.5	67.7	
3	8	51.3	66.4	
4	10	49.3	65.6	
5	11	52.8	70.3	
6	12	50.3	67.1	
7	13	52.5	70.6	
8	14	49.5	65.3	
9	15	49.6	66.7	
10	16	50.7	69.4	

TABLE III.

(Lab. No. 739—748.)

Percentages of oil calculated on undried material.

Serial No.	Plant No.	Percentage of oil on seed	Percentage of oil on kernel	REMARKS
1	1	49.1	64.2	Mean 48.1 per cent. oil on seed. Standard deviation ± 1.4 per cent.
2	2	48.4	64.1	
3	3	49.0	65.8	
4	8	45.8	62.0	
5	9	48.8	64.3	
6	13	50.2	69.3	
7	14	46.5	64.5	
8	15	47.0	66.7	
9	16	46.1	65.5	
10	17	49.2	66.4	

TABLE IV.

(Lab. No. 749—758.)

Percentages of oil calculated on undried material.

Serial No.	Plant No.	Percentage of oil on seed	Percentage of oil on kernel	REMARKS
1	1	48.8	65.3	* The kernels of No. 9 were shrunk and obviously not properly grown. This sample was therefore omitted in calculating the mean. Mean of 9 samples 49.6 per cent. oil on seed. Standard deviation ± 1.5 per cent.
2	2	49.2	65.1	
3	3	48.5	63.8	
4	5	48.3	65.0	
5	6	48.2	65.5	
6	8	51.8	68.4	
7	9	49.7	65.3	
8	13	52.7	71.4	
9	14	(43.5)	60.4)*	
10	15	49.3	65.5	

TABLE V.

(Lab. No. 759—768.)

Percentages of oil calculated on undried material.

Serial No.	Plant No.	Percentage of oil on seed	Percentage of oil on kernel	REMARKS
1	1	51.0	72.4	Mean 49.2 per cent. oil on seed. Standard deviation ± 1.4 per cent.
2	2	47.7	65.1	
3	4	48.1	65.5	
4	6	48.4	67.5	
5	7	50.5	68.0	
6	9	47.2	63.3	
7	10	51.2	69.3	
8	13	49.5	66.1	
9	14	51.1	72.1	
10	15	47.2	63.1	

TABLE VI.

(Lab. No. 773—776.)

Percentages of oil calculated on undried material.

Serial No.	Plant No.	Percentage of oil on seed	Percentage of oil on kernel	REMARKS
1	1	49.7	69.4	Mean 47.6 per cent. oil on seed. Standard deviation ± 1.3 per cent.
2	2	47.6	67.4	
3	3	46.9	62.5	
4	4	46.1	64.7	

TABLE VII.

(Lab. No. 709—728.)

Percentages of oil calculated on undried material.

Serial No.	Plant No.	Percentage of oil on entire seed	Percentage of oil on kernel	REMARKS
1	1	52.4	71.3	Average of 7 analyses from one plant.
2	2	50.9	70.0	
3	3	50.2	68.8	
4	4	52.5	70.7	
5	5	51.3	69.1	Mean of 19 varieties including Nos. 15 and 16 which seem abnormal 50.5 per cent. oil on seed. Standard deviation ± 1.7 per cent.
6	6	49.1	66.7	
7	7	50.4	71.3	
8	8	49.4	68.3	
9	9	51.4	67.8	Mean of 17 varieties (assuming 15 and 16 abnormal and to be omitted) 50.9 per cent. oil on seed. Standard deviation ± 1.2 per cent.
10	10	51.7	70.4	
11	11	52.7	72.9	
12	12	50.0	71.9	
13	13	48.5	66.9	If weight is given to mean analysis No. 1 the mean of the 25 samples is 50.9 per cent. Standard deviation ± 1.7 per cent.
14	14	51.2	70.3	
15	15	47.5	64.2	
16	16	46.9	64.0	
17	17	52.3	71.1	
18	18	50.8	68.4	
19	19	51.2	71.4	

TABLE VIII.

(Lab. No. 777—780.)

Percentages of oil calculated on undried material.

Serial No.	Plant No.	Percentage of oil on seed	Percentage of oil on kernel	REMARKS
1	1	49.4	63.5	Mean of 4 samples 49.6 per cent. oil on seed. Standard deviation ± 1.4 per cent.
2	2	47.5	62.3	
3	3	50.1	65.2	
4	4	51.5	65.6	

TABLE IX.

(Lab. No. 772.)

Percentages of oil calculated on undried material.

Serial No.	Percentage of oil on seed	Percentage of oil on kernel	REMARKS
1	51.5	70.5	<i>Pachka rabi</i> not so well developed as the <i>bhadoi</i> grown <i>Pachka</i> , some of the seeds being shrunk. Mean of 10 samples 52.3 per cent. oil on seed. Standard deviation ± 2.0 per cent., much higher than observed value in other cases.
2	50.1	70.0	
3	51.2	70.3	
4	54.8	73.6	
5	52.8	71.4	
6	54.7	72.5	
7	54.1	73.6	
8	50.4	71.1	
9	53.7	71.2	
10	49.8	68.2	

TABLE X.

(Lab. No. 771.)

Percentages of oil calculated on undried material.

Serial No.	Percentage of oil on entire seed	Percentage of oil on kernel	REMARKS
1	54.9	73.4	<i>Pachka bhadoi</i> better developed seeds than obtained from the <i>rabi</i> grown specimen of this variety. Mean of 10 samples 54.4 per cent. Standard deviation ± 0.7 per cent.
2	54.6	72.8	
3	53.0	70.4	
4	53.8	73.0	
5	55.5	73.3	
6	54.6	72.7	
7	54.4	72.8	
8	54.7	73.8	
9	54.7	72.1	
10	53.5	72.2	

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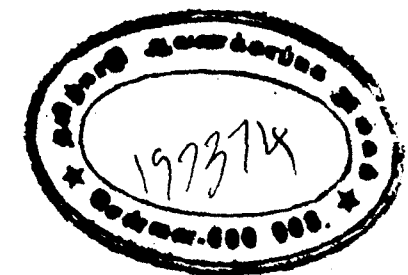
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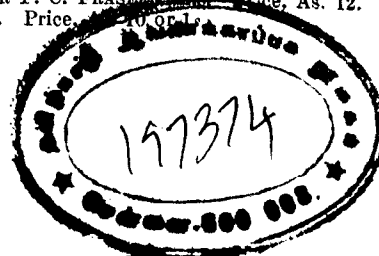
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