The Efficiency of Self-and Cross-Fertility in the Onion.

By

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Ch. Darwin [2] stated that onion may be reckoned among plants possessing a high degree of self-fertility and nowadays Jones [5] supports the same opinion. Nevertheless vegetable breeders avoid pedigreed cultures of onion (cfr. Becker 1, Tschermak 9) and their hesitation arise to do not meet inbreeding phenomena. In this report an attempt is made to show the usefulness of onion isolation in breeding work and to express the influence of self-and cross-fertility on seed yield as well as on the offspring received.

The technique of the isolation process was quite simple and aliked that of Jones' [5]. There have been used parchment bags (30×15 cm) in order to enclose inflorescences in the moment when the first flower opened. In aim to have comparing data, on each specimen two flower heads were observed; one of them was bagged and the second remained open blooming. The pollination in the bags took place in making use of the small soft brush, perfectly cleaned in 95% alcohol after each pollination, for safety's sake of any cross-pollination. This behavior was applied five or six times during the encloement of the inflorescences, which extended in average 24 days (for details cfr. table I.) and met fine and hat air. I suggest, it shall be quite satisfactory to substitute in that way the activity of insects, being normally the chief agencies of pollination. The isolation has been carried out on 150 plants that grew in the garden of our Institute on sandy soil but rich in available food supply. The bags were removed when the seeds will have sufficiently developed, because it has been stated in former studies, the ripening of seed-capsules was the best while there was no enclosing material near

them. The seed was gathered September 4—12, and the appreciation of yield occurred after drying and threshing the capsules given.

The efficacy of selfing process could be determined by examination the seed productiveness of the bagged stalks expressed as percentage of the set of seeds, obtained from the same plants but concerning nonisolated stalks. The following degrees of self-compatibility were found:

% plants;	% perfect set of seeds (as weight);
7	0 (absolutely self-sterile)
22	0.5—4 (strong self-sterile)
34	5—24 (feeble self-sterile)
19	25—49 (self-fertile)
10	50—79 (strong self-fertile)
8	80—100 (perfectly self-fertile).

It is given at hand, that the variety „Zittauer“ being the subject matter of our observations, shows all kinds of self-compatibility although it ought not to be denied the presence of some self-sterile individuals too. Regarding to the seed yield, it becomes evident, that self-pollinating decreased the yield acquired, hence we have in average for bagged flower heads 1.53 *gr* and for non-bagged 2.90 *gr* (cfr. also table I.), that means the ratio: 57:100. The diminution does not affect all individuals and we can distinguish some of the selfed plants with high seed production and no lesser than that of cross-pollinated (cfr. Nr. 27, 39, 35 on table I). Contrary to the seed quantity, there was no bad influence of isolation on the seed quality, and therefore it is found the hundred seeds weights to be the same for each kind of capsules (in average 0.40 *gr*).

This behaviour of onion falls in with that of cabbage (*Brassica oleracea capitata* Metz.) reported in my previous investigation upon inbreeding (Kotowski, 6). In cabbage the isolation of flowers reduced the length of the fruit, the seed number in the fruit and the seed yield, the same being in average only 20, if the yield of non isolated fruits being 100, but also this ratio varied in broad range, dependent of the genetic constitution concerning self-sterility factors. No deleterious effect could be approved in regard to cabbage seed quality, since hundred seeds weight of isolated flowers covered 0.52 *gr* and of non isolated reached 0.58 *gr*.

Further onion investigations, accomplished Jones' [5] observations, giving some contributions, to clarify the important question

Table I.

1923					1924				
Nr. of plant and of strain	Yield of seed per head self-pollination in grams	Duration of bagging the inflorescence in days	Yield of seed per head cross-pollination in grams	Degree of self- compatibility cross pollination = 100	Selfed strains		Cross-pollinated strains		Effect of self-fertility stated as the ratio of bulb weight, cross pol- linated strains = 100
					Average weight of bulbs in grams	Coefficient of the shape diameters horizontal vertical	Average weight of bulbs in grams	Coefficient of the shape diameters horizontal vertical	
9	0.6	—	1.4	43	140	1.24	163	1.21	86
13	1.8	23	2.6	70	145	1.28	175	1.26	83
15	1.6	21	3.0	54	126	1.23	159	1.30	80
17	1.2	—	2.0	60	175	1.37	160	1.31	109
23	1.05	21	2.8	38	128	1.27	138	1.24	92
27	1.0	25	1.1	91	120	1.23	183	1.29	65
32	2.7	—	3.2	85	100	1.10	126	1.17	79
37	1.7	29	3.5	50	126	1.29	169	1.34	75
39	3.4	27	3.4	100	149	1.29	123	1.21	122
45	1.6	23	2.2	72	200	1.23	226	1.24	89
54	0.7	18	2.1	33	142	1.33	138	1.20	103
57	2.5	25	6.3	40	117	1.11	142	1.20	85
60	0.9	24	2.3	39	122	1.13	176	1.18	70
72	1.3	—	2.15	61	174	1.34	175	1.34	100
80	0.5	21	2.0	25	122	1.23	114	1.25	108
84	1.1	—	1.35	82	130	1.10	134	1.10	97
86	2.4	27	5.6	43	125	1.21	136	1.20	92
90	1.8	19	4.15	43	116	1.26	114	1.22	101
95	1.5	25	1.7	88	69	1.02	131	1.15	53
96	1.9	24	2.5	76	114	1.23	110	1.29	103
107	1.8	17	4.5	40	103	1.12	101	1.07	101
109	1.7	20	4.0	42	77	1.20	92	1.21	84
115	1.6	32	1.9	84	63	1.02	79	1.02	80
118	1.05	20	2.3	45	70	1.21	88	1.08	80
129	0.9	27	3.6	25	104	1.12	97	1.07	108
130	1.5	27	3.7	40	80	1.20	96	1.23	83
In average:	1.53	23.6	2.90	57	120	1.21	137	1.20	88

of the influence of inbreeding on the offspring. For this purpose field culture of 26 strains of onion was established. Each strain was divided in two parts: one descended from self-pollinated flowers and the second from cross-pollinated. The seeds were sown in cold frames March 12, and planted into the field on sandy, manured soil April 29. For the reliability of the final appreciation, the two sorts of seedlings developed from the same plant grew in coldframes and in the field in neighbourhood rows. The seed of 50 plants was used, however 10 strains of selfed heads possessed no viable seeds and were removed from observations owing to lack of germination. The diminution of compared strains also took place, hence some of them produced very weak seedlings, that when planted into the field died in great percentage (80—90%) during growth, though no evidence of fungous disease and of injurious insects was found on examination during summer. In the strain there were 150—200 specimens developed from each kind of seed, but at harvest time (September) any of them presented no more than 20—25% mature bulbs expressed in seedlings number, and therefore 14 strains were discarded when final conclusions were drawn. The bulbs were stored in a dry, cool airy place and in November their description (during two weeks) was performed.

The results of this treatment are reported on Table I. The size of the bulb is decreased in the most of the self-compatible offspring. That is well known, as the phenomenon of inbreeding, but so far as I believe, there are no contributions on this subject matter affecting onion (cfr. East and Jones, 4). Average weight of bulb for selfed plants was 120 grams, and that for cross-pollinated 137 grams, which determines the depression as 88:100. The effect of inbreeding is not very bad, that could be expected whilst the seed yielding problem was examined and the high self-compatibility of the onion was corroborated.

If we compared onion with cabbage, a plant species with small degree of self-compatibility, we meet inbreeding influences far clearer. The data taken from the author's not yet published work may support this opinion. There can be reported, as the average of six strains of „Warsaw“ cabbage (a Polish early local variety), that seedlings weighed after seven weeks growth 1.4 gr, if selfed seeds were sown, and they weighed 2.2 gr, if cross-pollinated seeds were used, *caeteris paribus*, especially attention was paid in sowing seed graded on screens to prevent their equal size. In the case of cabbage, the ratio indicative for inbreeding attained was: 63:100.

It may be mentioned that in nine selfed strains of onion (cfr. Nr. 17, 39, 54, 72, 80, 90, 96, 107 and 129) the weight of bulb was as great or greater as in the same but cross-pollinated. These strains have had following percentage of self-compatibility (arrangement in the alike order): 60, 100, 33, 61, 25, 43, 76, 40 and 25% ; it seems quite clear there is no relation between the biological character of the fertilization process and the vital vigor decreasing in the offspring.

The shape of the onion bulb, determined as ratio of diameters (horizontal:vertical), did not show any difference in the two kinds of the bulbs harvested. It is evident, that the shape did not depend on the factors involving weight depression, but the latter were in causal relationship with self-fertility.

Summary.

1. The onion („Zittauer“ standard commercial variety) presented a high degree of self-fertility, when an efficiency method of self-pollination was employed.

2. Large graduation in self-fertility has been stated. This fact is connected with genetic differences of the given population, which varied owing to that physiological aspect; nevertheless it was a well established strain in size and shape.

3. Self-fertility affected the yield of grain; diminished the number of seeds, but did not reduce the quality of the seed acquired.

4. Deteriorate symptoms of life vigor have not been stated on inbred onion plants, excepting a little decrease in bulb weight and probably the lower viability of seed and seedlings in some of the strains.

5. Growth and self-compatibility as well as vitality appear to be independent biological factors, hence their action can be reported in following correlation: high compatibility and low vigor and *vice versa* feeble self-fertility and normal size of the offspring

6. It ought to be emphasized that in breeding onion, the pedigreed cultures are of good value and there is no reason to avoid isolation when handling with that plant species.

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