THE FLOWERING HABIT AND NATURAL CROSSING IN THE EGG-PLANT

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In regard to the frequency of natural crossing in the egg-plant, *Solanum Melongena*, L., no exact experiment has ever been made so far as the author is aware. Some Japanese seedsmen are of the opinion that the natural crossing in this plant is a matter of no importance, and hence that, from the seed raising point of view, the plant can practically be treated as an autogamous one. Others, on the contrary, hold that if careful selection is not practised constantly, the variety will degenerate season after season on account of the natural crossing. Hoping to throw some light on the subject, the author made with this plant some observations on the flowering habit and also an experiment for ascertaining the percentage of the natural crossing.

THE FLOWERING HABIT AND THE MECHANISM OF FLOWERS

The egg-plant shows a peculiar habit in flower setting (Fig. 1), i.e., the flower is not set in the leaf axil as in the ordinary plants but on the stem itself, and sometimes on lower and sometimes on upper parts of the internode. The first flower appears as a rule on a definite internode of the main stem, though this first flowering internode may vary from the seventh to the thirteenth according to the difference of varieties or strains. After the appearance of the first flower, the node just below the flower shoots the first branch which exhibits almost the same vigor as the upper part of the main stem, and thus a type of pseudo-dichotomy is formed. Two flowers, then, are set almost at the same time, one on the next internode but one to the first flowering one, and the other on the third internode of the first branch; these two flowers are named in this paper "the second flowers." The fruits born from the second flowers are called by some Japanese seedsmen "*tenbin-no-mi*" or "balanced fruits," because these fruits grow almost in balance. The node just below each of the second flowers usually shoots a branch. These branches bear flowers on their third internodes, and almost at the same time the main stem and the first branch also bear flowers on the next internodes but one to those with the second flowers; the group of these flowers are named "the third flowers." In the same way,

FIG. 1. A diagram showing the flowering habit of the egg-plant; *ct*, cotyledon; *ms*, main stem; *lb*, first branch; *1st*, *2nd*, *3rd*, etc. designate the order of flower setting. The two fruits born from the flower designated by "*2nd*" are "*tembin-no-mi*" or "balanced fruits."

"the fourth flowers," "the fifth flowers," and the like are set in their turns if the condition is favorable. Meanwhile, the nodes lower than the first branching node of the main stem shoot also some branches, of which one or two upper ones display a flowering habit similar to the one seen in the case of the first branch. One peduncle bears sometimes two or three flowers, but usually only one of them is potent.

The flower is directed obliquely downwards, and remains open for two or three days without closing even at night. The number of anthers of a single flower varies, with different varieties, from six to twenty or more. It shows usually a deviation of two or three anthers with different plants in the same variety and even with different flowers of one and the same plant. The anthers of a flower converge in such a way that they form a cone which surrounds the style; the latter projects out of the cone of anthers

bending slightly downwards. The construction of the flower being such, the stigma is first touched by insect visitors. Sometimes a peculiar flower is born, in which the style is short and the stigma does not come out of the cone of anthers. The flower of such type is barren generally and does not bear fruits even when artificially pollinated. The stigma matures as soon as the flower opens, and receives pollen for a period of two or three days in general. The period for which the stigma is potent is shortened or elongated according to the rise or fall of temperature at the season, and also somewhat elongated when the stigma is not pollinated. The stigma in a fresh state is light yellow in color, while it becomes dusky on withering. The anthers dehisce at the terminal pores a short time after the flower has opened; insects, wind or anything touching or shaking them let much pollen fall. The pollen is, however, so dispersed by the agency of the wind that the stigma can not receive sufficient amount of pollen; and if the flower is wrapped with paraffined paper before blooming, the better part of pollen is preserved in anthers and remains alive until the stigma loses almost its proper function.

THE EXPERIMENT ON NATURAL CROSSING

Varieties of the egg-plant are grouped into two main types, the black and the white. The black type shows black or dark purple coloration on the skin of unripe fruits as well as on the vegetative part, the white exhibiting no such coloration at all. This difference of coloration is very distinctive in the hypocotyle of the seedling. When a cross is made between these two types, the resulting F_1 hybrid is black, and the F_2 segregates at the ratio of 3 blacks: 1 white; hence these two characters can be said to be dependent on a single factor difference, black being dominant. Accordingly, if the white is cross-fertilized accidentally by the black, the hybrid produced can be readily detected in the seedling stage by its black hypocotyle.

Fig. 2. A diagram showing the scheme of planting used for the purpose of testing the natural crossing in the egg-plant: ○, the plant of the white variety; and ●, that of the black variety.

In 1922, a white variety "Sironasu" and a black variety "Sinkuro" were mix-planted in a field in such a scheme as shown in Fig. 2, the row- and hill-distances being 3 and 2 feet respectively. In this scheme of planting, most of the crossings which occur in the plants of the white are generally of fertilization by those of the black, though only a few are by the other plants of the white.

The plants of the black variety began to bloom several days earlier than those of the white variety. This is rather convenient for the purpose of experiment, because, if adversely the white would bloom earlier than the black, early-blooming flowers of the former would as a matter of course never come in contact with those of the latter. Fruits born by the white were left without interference until they ripened, while those by the black were harvested one after another when each fruit reached the weight of about three ounces.

There were produced 63 seed-fruits by 25 plants of the white variety. The seeds obtained from each of the fruits were separately sown in a frame in the spring of the following year (1923), and the seedlings raised were examined.

TABLE I. PERCENTAGES OF NATURAL CROSSING IN SEPARATE FRUITS

Plant No.	Order of Flower Setting	Total of Seedlings Produced	Number of Hybrids	Percentage of Hybrids
7	1st	595	1	0.2
17	4th	580	6	1.0
6	1st	729	9	1.2
7	4th	819	11	1.3
21	6th	711	10	1.4
6	2nd	1,431	23	1.6
6	3rd	942	16	1.7
9	1st	652	11	1.7
13	1st	1,438	24	1.7
21	1st	389	7	1.8
1	2nd	556	12	2.1
9	3rd	1,446	30	2.1
25	5th	356	9	2.5
2	1st	3,598	98	2.7
20	3rd	645	19	2.9
21	2nd	955	29	3.0
5	1st	911	28	3.1
13	3rd	393	13	3.3
4	1st	2,702	95	3.5
8	2nd	717	29	4.0
9	1st	1,265	52	4.1
13	2nd	556	23	4.1

TABLE I. PERCENTAGES OF NATURAL CROSSING IN SEPARATE FRUITS (*continued*)

Plant No.	Order of Flower Setting	Total of Seedlings Produced	Number of Hybrids	Percentage of Hybrids
23	3rd	1,201	50	4.1
16	1st	890	37	4.2
12	5th	1,125	49	4.3
17	1st	700	30	4.3
24	2nd	937	40	4.3
11	1st	710	35	4.5
23	3rd	1,224	61	5.0
8	1st	211	11	5.2
12	5th	582	31	5.3
2	5th	402	22	5.5
10	1st	926	51	5.5
23	3rd	976	57	5.8
7	4th	17	1	5.9
12	6th	988	61	6.2
1	1st	1,814	114	6.3
23	4th	1,598	101	6.3
23	4th	867	59	6.8
24	2nd	558	39	7.0
18	3rd	735	52	7.1
4	2nd	2,215	161	7.3
10	2nd	935	70	7.5
18	2nd	1,095	83	7.5
7	3rd	988	78	7.9
5	2nd	61	5	8.2
22	1st	443	37	8.4
22	3rd	673	59	8.8
21	5th	706	63	8.9
20	4th	259	24	9.3
17	2nd	891	86	9.8
6	2nd	906	98	10.6
12	6th	918	108	11.8
12	6th	656	79	12.0
14	1st	3,792	467	12.3
15	1st	887	110	12.4
19	1st	585	80	13.7
13	3rd	323	48	14.9
24	1st	366	57	15.6
14	2nd	301	76	25.2
1	2nd	75	22	29.3
12	1st	980	315	32.1
20	1st	389	182	46.8
Total		57,291	3,762	6.57

The result obtained is shown in the table I. Among the total number of 57,291 seedlings, there were observed 3,762 black-colored ones. This shows a natural crossing of 6.57 per cent.

TABLE II. FREQUENCIES OF PERCENTAGES OF NATURAL CROSSING

Percentage of Hybrids	Number of Fruits
0.1—5.0	29
5.1—10.0	22
10.1—15.0	7
15.1—20.0	1
20.1—25.0	0
25.1—30.0	2
30.1—35.0	1
35.1—40.0	0
40.1—45.0	0
45.1—50.0	1
Total	63

The amount of natural crossing in separate flowers, as seen in the table II, range from 0.2 to 46.8 per cent, no flower having in fact performed complete self-fertilization. The crossing less than 10 per cent was quite general, and yet that of much higher percentages was not of so rare cases as we might expect.

TABLE III. PERCENTAGES OF NATURAL CROSSING GROUPED ACCORDING TO DIFFERENT ORDERS OF FLOWER SETTING.

Order of Flower Setting	Number of Fruits	Total Number of Seedlings	Number of Hybrids	Percentage of Hybrids
1st	21	23,707	1,799	7.59
2nd	16	13,454	846	6.29
3rd	11	9,546	483	5.06
4th	6	4,140	202	4.88
5th	5	3,171	174	5.49
6th	4	3,237	258	7.88
Total	63	57,291	3,762	6.57

Here we must make some consideration about the relation between the order of flower setting and the tendency of natural crossing, because some Japanese seedsmen believe that the "balanced fruits," i.e., the fruits from the second flowers, give the seed which promises the least running out. An answer to the question may be given by the table III, which shows that the

order of flower setting is of little significance in regard to the frequency of natural crossing.

FRUITFULNESS OF THE EMASCULATED FLOWERS LEFT TO NATURAL POLLINATION

The foregoing result shows that the frequency of natural crossing in the egg-plant is not so insignificant as usually believed. From this fact, one may expect the possibility of emasculated flowers producing fruits by natural cross-pollination. To ascertain this possibility, an experiment was made in 1923 on a small scale.

The white and the black varieties were planted in alternate row; the row- and hill-distances being 3 and 2 feet respectively. In the flowering season, some flowers of the white were emasculated before blooming; and some of the emasculated flowers were left to natural cross-pollination, the others being pollinated artificially when bloomed with pollen from the black. All the flowers of the white except the emasculated ones were taken off before blooming.

TABLE IV. FRUITFULNESS OF EMASCULATED FLOWERS

Treatment after Emasculation	Number of Flowers		
	Treated	Bearing Fruits	Bearing No Fruit
Pollinated artificially	14	13	1
Left to natural pollination	23	1	22

The result obtained is shown in the table iv. From 23 flowers left to natural cross-pollination only 1 fruit was obtained, while by 14 flowers pollinated artificially 13 fruits were produced. This unfruitfulness of the emasculated flowers left to natural pollination is perhaps due to insufficient amount of pollen supplied to the stigma.

It may be mentioned here that the plants which were cultivated in a net house of fine meshes so as to be protected from insects bore much less number of fruits than in case of natural pollination, unless their flowers were pollinated artificially. This is also perhaps due to the insufficiency of pollen supply, as in such a case the wind, as noted before, disperses most of pollen.

CONCLUSION

It should be affirmed, so far as the present study is concerned, that the natural crossing in the egg-plant takes place quite frequently. The fact seems to be due mainly to the following reasons: (1) the flower is so constructed that the insect visitor may touch the stigma with her body carrying

the pollen from other flowers before acting as a go-between within the flower, (2) the pollen supply to the stigma by the agency of the wind is apt to be insufficient for bearing fruit, and so the flowers often fail to give fruits without the agency of insects. Consequently, the genetical research with the egg-plant needs artificial control of pollination. In the seed-raising of the plant, too, the artificial self-pollination may deserve practical application, because the practice is not only comparatively easy, but also much seed can be obtained from a single fruit.

摘 要

茄子の開花習性と自然交配

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茄子に於ける自然交配の多少に關しては、未だ正確なる實驗を行へるものなきものゝ如く、從つて、之が採種上の應用に就きては、人に依りて意見を異にす。依つて、著者は此點に就きて明確なる事實を知らんこし、茄子の花に關する觀察並に自然交配率調査の實驗を行へり。

茄子は、一般植物の如く花を葉腋に着生するこなく、節間に着生する奇習を有す。(本文第一圖参照。ct は子葉、ms は主幹、lb は第一枝、1st, 2nd, 3rd 等は花の着次を示す)而して、第一花の着生する節間は品種に依りて略ほ一定し、第七次乃至第十三次節間とす。第一花出現後、其直下の節より第一枝を生じ、其第一枝は主幹の以上部と殆んど同程度の發育をなし、以て叉狀となり一種の Pseudo-dichotomy を出現するに至る。やがて、第一枝第三次節間、及び主幹第一花着生節間の次の次の節間に、殆んど同時に花を着生す。之等兩花を假に第二次と呼ぶべし。之等二個の第二次花より生ずる類は、殆んど均衡的に發育するが故に、俗に「天秤の類」と稱せらる。次に、第二次花直下の節より更に枝を生ずるを常とし、其枝の第三次節間、及び主幹と第一枝との第二次花着生節間の次の次の節間に、殆んど同時に花を着生す。之等の花を第三次花と呼ぶべし。斯くして、適況にある時は順次第四次花、第五次花等を形成す。此間、主幹第一枝發生節以下の數節よりも枝を生じ、内上位のもの一二枝は上述第一枝に於けるが如き着花をなす。一の花梗に二花乃至三花を着生するこもあれども、結實するものは内一花なるを常とす。

花は半ば下方に向つて二日又は三日間開き、夜間と雖も閉ぢず。一花内葯の數

は品種に依りて六個乃至二十個内外の範圍にあり、一品種内にありても株の相違、或は一株内にありても花の相違に依りて、其數に二個乃至三個の變異あり。之等葯は、抽出せる一個の柱頭を中心として周圍に圓錐狀をなして集合す。従つて、花を訪る・昆蟲は先づ柱頭に觸るゝものゝす。往々にして、柱頭が葯の外部に抽出せざる花を生ずるこゝろあれども、斯かる花は假令人爲的に授粉するも不稔に終るを常とす。柱頭は、開花直後より二三日間花粉を受くる状態にあれども、其期間は氣温の如何に依りて伸縮せられ、また授粉せられざる時は多少延長せらる。此期間を過ぐる時は、黃色なりし柱頭は漸次汚變するに至る。葯は、開花後間もなく先端に穴を生じ、昆蟲、風、其他に依りて動搖を來す時は多數の花粉を撒出せしむ。然れども、風に依る時は、大部分飛散して柱頭に充分の花粉を與へざるこゝろあり。若し、開花前パラフィン紙を以て葯を包み置く時は、柱頭が固有の作用を殆んど失ふ頃まで、花粉の大部分は葯内に生存す。

次に、自然交配率調査の實驗に於ては、大正十一年、本文第二圖に示すが如く「白茄」を「眞黒」を混植し、(第二圖の○は白茄、●は眞黒)「白茄」より生ぜる種子を翌十二年類別に播種し、之より生ぜる苗の検査を行へり。即ち、斯かる苗中、胚軸綠色なるものは自花授精種子より生ぜるものにして、其紫黑色なるものは「眞黒」の交配種子より生ぜるものなり。其結果合計 25 株 63 顆より 57.29% 本の苗を生じ内 3.76% 本は紫黑色の胚軸を有せり。即ち 6.57% の自然交配率を示せり。而して、之を類別に見る時は、完全に自家授精せるもの一花もなく、自然交配率 0.2% より 46.8% 迄の變異あり、概して 10% 以下のものを普通とせるも、遙かに高き率を示せるものも亦珍らしからざりき。尙ほ、花の着次の差異に依りて、自然交配率に特殊の差異あるを認めざりき。

更に去勢して放任せる花が、昆蟲に依り授粉せられて自然的に結實し得るや否やを知らんが爲めに、大正十二年、「白茄」を「眞黒」を交互畦に栽培し、「白茄」の花 37 花を去勢し(去勢せる外の「白茄」の花は全部摘去す)、内 14 花は「眞黒」の花粉を以て人爲的に授粉し、残り 23 花は授粉するこゝろなく自然に放置せり。其結果、前者は 13 顆を結び不結實のもの 1 花あるに過ぎざりしも、後者中 22 花は不結實に終り僅かに 1 顆を結べるのみなりき。即ち、自然的には結實に充分なる數の花粉粒を受け難きものゝ如し。

尙ほ、細かき目の網室内に栽培して昆蟲の來訪を防げる茄子は、人爲的に授粉するに非ざれば、概して結實率低し。之亦授粉の不充分なるに基くものなるが如し。

以上の觀察及び實驗の結果に據れば、茄子の自然交配は可成り多く、其原因は主として、(1) 花の構造上、昆蟲は一花内の媒介を行ふに先ち、他の花の花粉を附

着せる體を以て先づ柱頭に觸るゝこゝ、(2) 風に依る授粉は結顆するに不充分にして、昆蟲の力を籍らざれば往々にして不結顆に終るこゝの二點にあるものゝ如し。従つて、茄子の遺傳研究には授粉を人爲的に管理するを必要とし、また實用上の採種に當りても、人爲的自家授粉は比較的簡易なるのみならず、一花より多數の種子を得べきが故に之を行ふを得策す。