Mn-DEFICIENCY AS THE CAUSE OF MARSH SPOT OF PEA SEEDS [1])

INTRODUCTION

Recent researches have strongly suggested that Marsh Spot of peas is caused by Mn-deficiency. Löhnis (8) stated by chemical analysis that healthy peas had a higher manganese content than diseased ones, and Pethybridge (14), Ovinge (11, 12) and Koopman (6) reduced the percentage of Marsh Spot in field crops by the application of $MnSO_4$ to them. In pot-cultures Heintze (4) obtained a similar result. Symptoms of Mn-deficiency in the leaves and stems of peas have already been described by McHargue (9) and by Samuel and Piper (15), but its effect on the seed has not previously been investigated.

METHODS

The experiments were made with solutions differing in composition, without and with increasing quantities of $MnSO_4$. Only Schering-Kahlbaum pure analytical chemicals and distilled water were used for the water and glass-sand-cultures set up. For the first, paraffined glass jam jars with a volume of about 650 cc were employed. For the sand-cultures glazed pots holding about 8 kg of glass-sand were used. The sand used in some of the pots was purified by treatment with HCl, in others it was not thus treated.

The variety Jumboka, being very sensitive to the disease, was used in the experiments. The seeds were disinfected with corrosive sublimate and germinated in pure glass-sand. A single seedling was placed in each jam jar, whereas 3 were put into each sand-culture pot. In each of these pots 3 oat-plants were also grown at the same time; the symptoms of Mn-deficiency in oats being very characteristic these plants served as controls. They always showed these symptoms earlier than the peas, and were thus useful as ,,indicators'' to show whether, in certain cases, a still larger amount of $MnSO_4$ was wanted.

The plants were grown out of doors, but could be sheltered from rain. They were grown at the normal time for growing peas in the field, all the seeds being placed to germinate out of doors before March 31st. As a result, the stems and leaves were vigorous and quite normal. In 1937 a very large number of the pea seeds were lost owing to attack by *Grapholitha*. In 1938 this loss was less.

Two types of solutions were used, one slightly acid (*a*) the other slightly basic (*b*). Their composition (without manganese) is given in the table on page 110.

1937 Results.

The results for 1937 are tabulated on page 111. From those of the water cultures it is seen that to obtain healthy peas more $MnSO_4$ is required for the basic than for the acid solutions. Untreated glass-sand was used in this year for the majority of the sand-cultures; but it was found that this still contained too large a quantity of Mn to obtain satisfactory

[1]) Thanks are due to Dr G. H. Pethybridge for kindly correcting the English.

results. The large differences between individual plants were very striking; probably the Mn-content of the individual mother-seeds themselves varied considerably, and was on the whole rather high.

1938 Results.

In this year only glass-sand treated with HCl was used. To obtain mother-seeds with as low an Mn-content as possible, from which to raise the experimental seedlings, they were taken from a lot known to contain 34,5% of affected seeds. Furthermore, the greater part of the cotyledons was removed before the seedlings were placed in the pots. This method gave very distinct and uniform results, as will be seen in the tables on page 113.

The percentage of peas affected with Marsh Spot in the series containing no Mn, or with small quantities of it, was 100, or nearly so, as compared with the series containing the highest Mn-dose in which the seed was mostly healthy. In addition, the severity of the symptoms was very different, a point which is not evident from the table. Fig. 1 shows severely diseased peas from a sandculture (*a*), without Mn; healthy seeds from a plant that had the highest Mn-dose are seen in fig. 3. When Marsh Spot occurred at all in this series, the seeds had only a few, very small necrotic lesions.

More Mn was necessary for the basic (*b*) solutions than for the acid (*a*) solutions to obtain healthy peas. Many plants in the former series either died as a result of Mn-deficiency or formed no seeds. The plants in the sand-cultures showed particularly clear symptoms in the leaves, tendrils and growing points.

In the (*a*) solution water-cultures, without Mn, no ripe pods developed; but in corresponding sand-cultures, without any addition of Mn, even a large number of seeds were formed. In general, the plants developed better in the acid than in the basic solutions.

The pH of the sand *a* was 5,9 at the start; when the experiment was over it was 6,3. Sand *b* started at pH 8,4; this changed in the 3 lowest series to pH = 8,15, in that of the highest dose to pH = 7,7. Only the pure solutions in the watercultures were tested for pH; the values were 4,55 and 9,1 at the start, they were not determined at the finish.

CONCLUSIONS

The occurrence of Marsh Spot in the absence of Mn or in the presence of only small quantities of it prove that Mn-deficiency is the cause of the disease, especially since the results were obtained in solutions of different pH values.

The Mn in the more acid solutions is more readily available to the plant than that in the more basic ones; but if $MnSO_4$ is totally absent or present only in very small quantities, the pea seeds still become affected. The Mn-content is of primary importance, pH is secondary.

The seeds in the later developed pods of an individual plant showed more severe symptoms than those in the first formed pods (fig. 2). Probably more Mn is available for the first developed seeds. This corresponds with the increase in percentage of diseased peas found in the field during the last period of ripening (DE BRUYN, 1; LACEY, 7).

In the field, the greatest number of seeds affected with Marsh Spot is found among the heaviest peas (DE BRUYN (1), OVINGE (10), FURNEAUX and GLASSCOCK (2), LÖHNIS (8), KOOPMAN (6). LÖHNIS (8) explains this by saying „that, as a result of the building up of a large amount of organic matter, some element might be present in the plant in only minimum amount, and thus deficiency-symptoms might appear". The correlation between weight of seed and occurrence of disease in the cultures is, however, different. The minimum amount of Mn used in these experiments was such as almost to prohibit growth. It is evident, therefore, that under these circumstances the plants must suffer to a certain extent; and this was proved by the smaller weight of the affected peas (p. 116).

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VERKLARING DER FIGUREN
(EXPLANATION OF FIGURES)

Fig. 1. Eén erwt uit iedere peul in volgorde van groei van een plant uit zandcultuur, zure oplossing (*a*), 1938, zonder mangaan. Onderste erwt links gezien van buiten oppervlak.

One pea from each pod in succession of growth of a plant from acid (*a*) sand-culture 1938 without manganese. Left pea last row seen from the outerside.

Fig. 2. Eén erwt uit iedere peul in volgorde van groei van een plant uit zandcultuur, zure oplossing (*a*) 1938 met 0,1 mg $MnSO_4$ per pot. Sterker symptomen bij later gevormde erwten.

One pea from each pod in succession of growth of a plant from acid (*a*) sand-culture 1938 with 0,1 mg $MnSO_4$ per pot. More severe symptoms on later formed peas.

Fig. 3. Eén erwt uit iedere peul in volgorde van groei van een plant uit zandcultuur, zure oplossing (*a*) 1938 met 2 mg $MnSO_4$ per pot. Alle erwten gezond.

One pea from each pod in succession of growth of a plant from acid (*a*) sand-culture 1938, with 2 mg $MnSO_4$ per pot. All peas healthy.

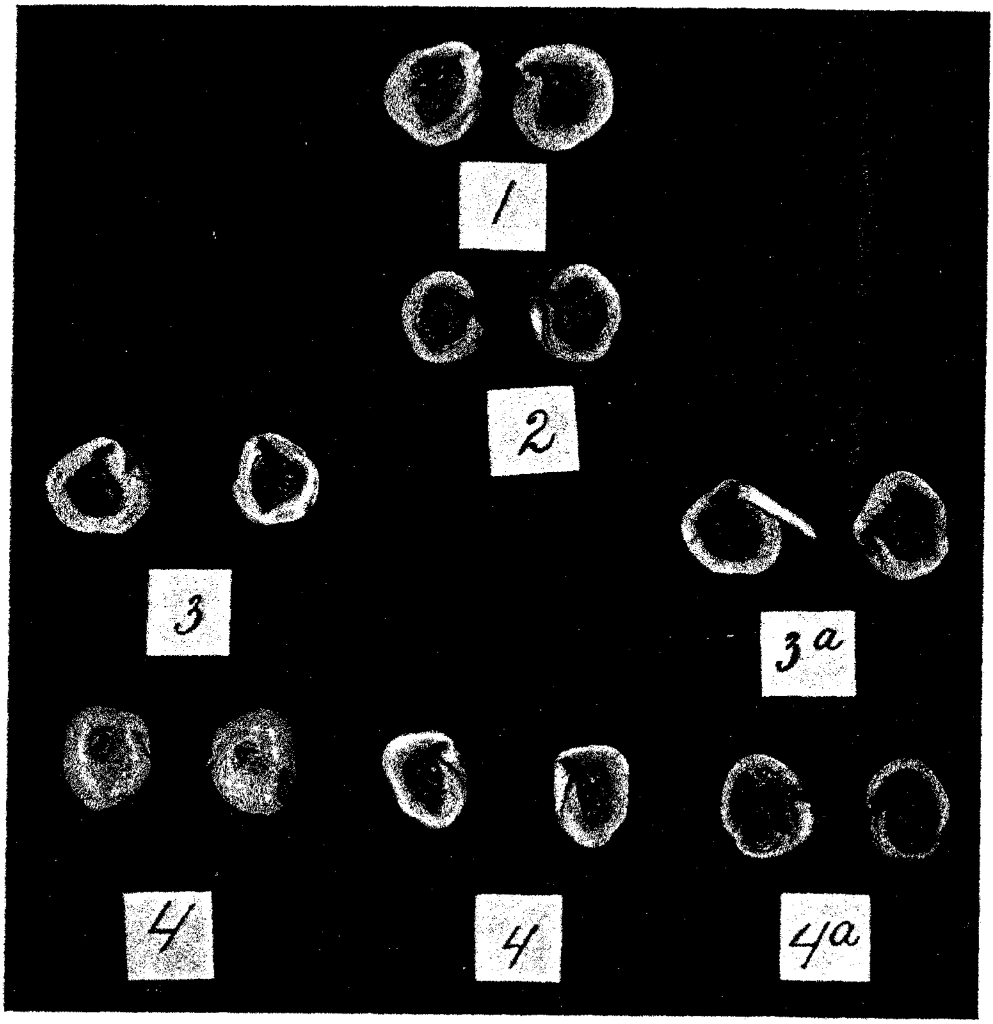

Fig. 1

Phot. Jb. v. d. Peppel

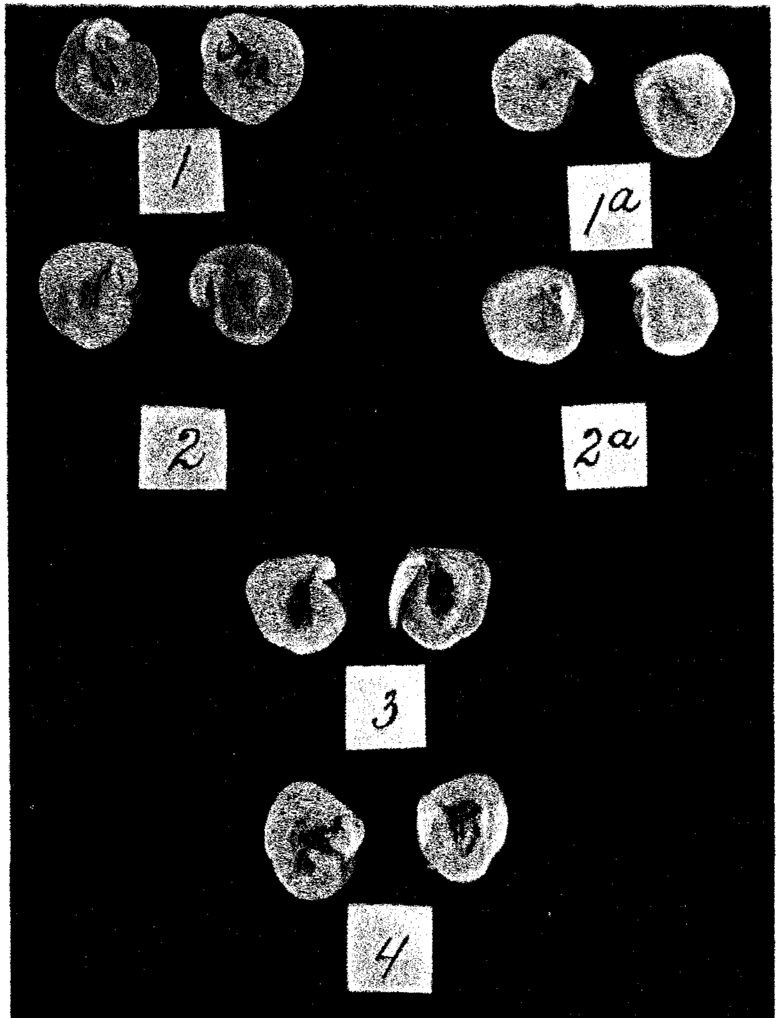

Fig. 2

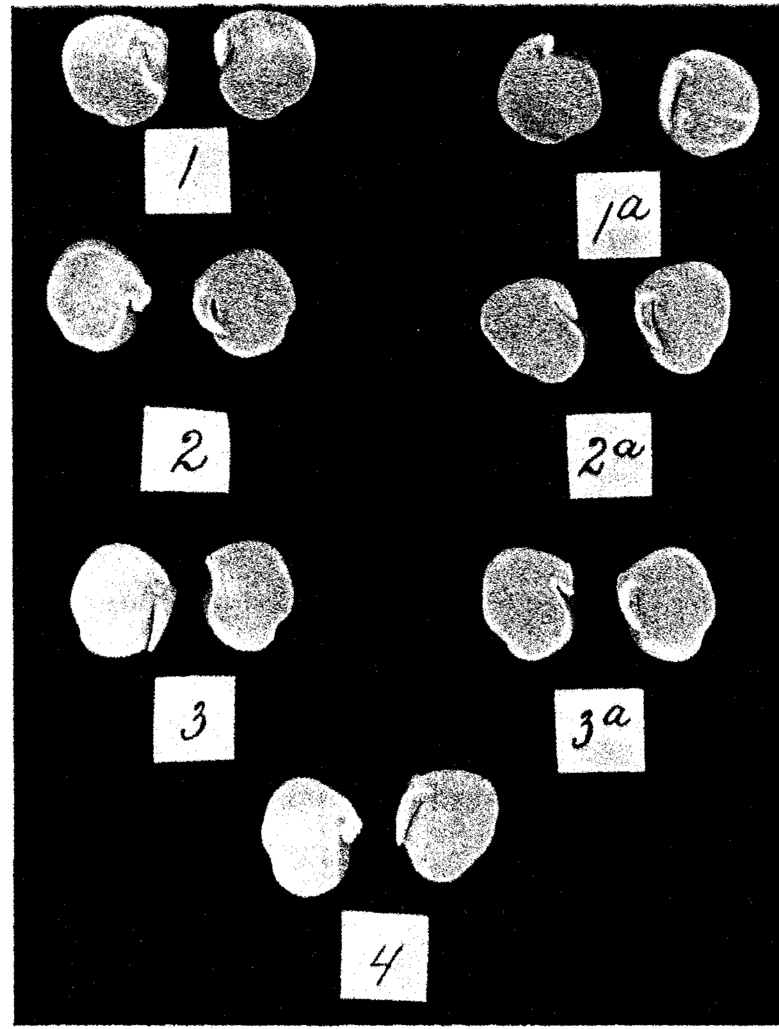

Fig. 3

Phot. Jb. v. d. Peppel