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Increased Scion Vigour Induced by Certain Foreign Root-stocks.

BY

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With Plate XXXVIII and one Figure in the Text.

IN the course of grafting experiments made by the author at the Rothamsted Experimental Station, and designed to throw light on the causes of the limitation of certain parasites and symbiotic bacteria (2, 3) to definite host plants, combinations were observed in which the scion made better growth on a foreign root-stock than on its own. These observations seem sufficiently interesting to be collected together in spite of the fact that they were made incidentally to other work, and so are not as complete as could be desired for the present purpose.

I. WOODY NIGHTSHADE ON POTATO.

In the summer of 1922 a number of equal-sized cuttings taken from a single plant of woody nightshade (*Solanum Dulcamara*) were rooted in moist soil in 10-in. pots; of these rooted cuttings five were selected as being as uniform in size, vigour, &c., as possible. Two of these were set aside as controls; the other three were cut off just above soil-level and grafted on single-stem potato (*S. tuberosum*) plants which had been obtained by tearing from the parent tuber a single rooted shoot as soon as leaves appeared above soil, and planting it in a 10-in. pot.

The grafts took readily and, in spite of starting off shorter because of the bits of stem removed in the operation of grafting, they soon outgrew the two controls. In Pl. XXXVIII, Fig. 5, are shown the two control plants and one grafted one. The leaves of the grafted plants were three or four times the area of the control ones and of a much more luxuriant appearance. The axillary bud of almost every leaf on the grafted plants developed into a strong shoot, whereas the ungrafted plants were hardly branched at all. The girth of the grafted plants soon exceeded that of the control ones.

No marked differences in date of flowering or fruiting was noticed. The condition of the mature plants is shown at the top of Plate XXXVIII;

[*Annals of Botany*, Vol. XLIV. No. CLXXVI. October, 1930.]

Fig. 1 is of two control plants, and Figs. 2, 3, 4 each show a single grafted plant. The two control plants were taken together. The marked increase in size of top due to grafting on potato is well seen in the illustrations.

The grafted plants were cut off just above the graft, and the controls at a corresponding height above soil-level. The weights of tops were:

Grafted plants	11 grm.	19 grm.	12 grm.	Average = 14 grm.
Control plants	5 "	7 "		" = 6 "

Hence the tops of the grafted plants were on the average more than twice the weight of the ungrafted ones. The grafted plants also produced potato tubers below ground, making the increased vigour of the top the more remarkable.

Potato on woody nightshade. At least a dozen grafts were made of potato on woody nightshade, in which apparently satisfactory organic union took place. Even when dry sand was held round the stem to allow of natural tuber formation the potato scion remained very stunted.

II. *VICIA FABAE* (BROAD BEAN) ON *V. NARBONENSIS* GRAFTS.

In an attempt made with Dr. J. Davidson to study the nature of the resistance of *Vicia narbonensis* and the extreme susceptibility of *V. faba* to aphid attack, a number of grafts between these two plants were made in order to ascertain the effect on the aphides of grafting a foreign root-stock to their host plant. The main results of this work have not yet been published. The following observations were made incidentally during the course of the experiments.

1924 Experiment.

Seeds were sown in soil in 10-in. pots, three seeds to a pot. At the time of grafting the seedlings were thinned to one per pot, the thinning being done so as to give as uniform a set of seedlings as possible. The *V. narbonensis* seed was sown two or three days before the *V. faba* seed to counteract somewhat the difference in circumference of the stems. Cleft grafts were made as described elsewhere (2, 3) when the first foliage leaf was opening.

The heights of the plants are shown in the text-fig. The grafts were made on 23/5/24. By 3/6/24 the plants grafted on *V. faba* had outstripped the ones grafted on *V. narbonensis* root-stock, the average height of the one (12.6 cm.) being 1.4 times that of the other (8.8). On 14/6/24 the average heights were 18.8 cm. and 13 cm. respectively, the plants on *V. faba* again being 1.4 times as high as those on their own roots.

Unfortunately, before the next records were taken, on 25/3/24, four plants had died, leaving only two *V. narbonensis* on *V. faba* grafts alive

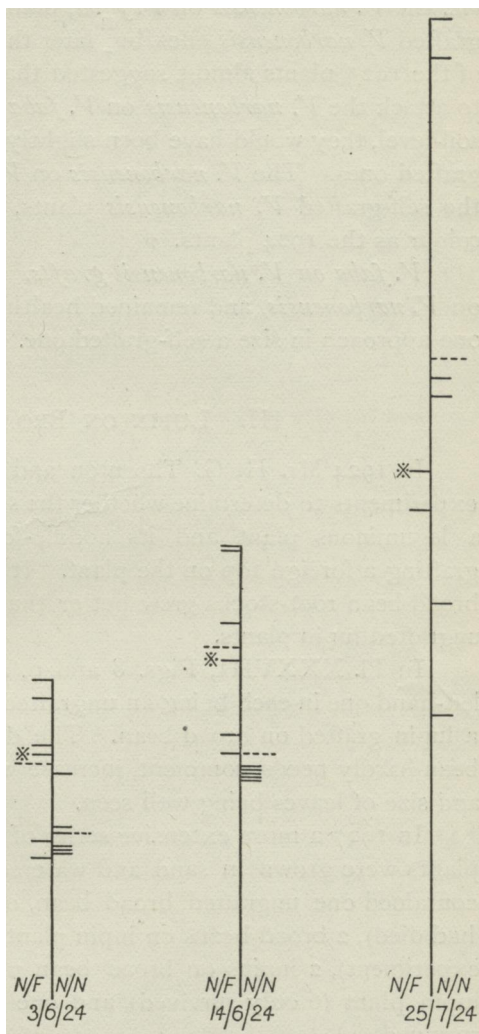
and healthy, but all six self-grafted *V. narbonensis* plants were healthy. Their average height of 34 cms. was well above that of the one marked *, i. e. 28 cm., which on the two previous occasions was almost exactly an average specimen of the *V. narbonensis* or broad bean grafts. This supports the visual impression that a week or so previous to the day when the final record was taken, before any of the *V. narbonensis* on *V. faba* plants had died, they had been overtaken by the self-grafted *V. narbonensis* plants.

Flowering. On 16/6/24 only one self-grafted *V. narbonensis* plant showed any signs of flowering; in it only the purple tips of flowers were showing. Of the *V. narbonensis* on *V. faba* plants, however, two had one flower each nearly open, two others had one each fully open, and the other two had two flowers each fully open.

Foliage. The foliage of the *V. narbonensis* on *V. faba* plants was of a distinctly yellowish colour and of a 'softer' appearance than the self-grafted *V. narbonensis* plants. This yellowing in the bottom leaves gave place to actual browning and final withering, even in plants which were less than half-grown, whereas the self-grafted *V. narbonensis* ones never showed the yellowing, and their bottom leaves only became brown and dry some weeks after the plants had reached their full height.

1925 Experiment.

When a similar experiment was carried out in 1925 no plant measurements were taken until the end of the experiments because of the risk of



TEXT-FIG. Heights of *Vicia narbonensis* on *V. faba* (N/F) and self-grafted *V. narbonensis* (N/N). The grafts were made on 23/5/24. Averages represented by dotted lines.

damaging or disturbing the aphides; inspection of the plants, however, was sufficient to confirm the deductions drawn from the 1924 experiment—viz. the *V. narbonensis* on *V. faba*, plants at first grew faster than the self-grafted *V. narbonensis* ones, but later they lost their lead. The appearance of the 1925 plants almost suggested that, apart from disease which tended to attack the *V. narbonensis* on *V. faba* plants at the graft unions and at soil-level, they would have been slightly shorter when mature than the self-grafted ones. The *V. narbonensis* on *V. faba* plants flowered earlier than the self-grafted *V. narbonensis* plants, and again were the same curious colour as the 1924 plants.

V. faba on *V. narbonensis* grafts. *V. faba* took readily when grafted on *V. narbonensis*, and remained healthy-looking, but in no single graft did one approach in size a self-grafted one.

III. LUPIN ON BROAD BEAN GRAFTS.

In 1924 Mr. H. G. Thornton and the writer commenced a series of experiments to determine whether the specific relationship existing between a leguminous plant and its nodule-forming organism is influenced by grafting a foreign top on the plant. It was noticed that lupins grafted on broad bean root-stocks grew better than when self-grafted, and even than ungrafted lupin plants.

In Pl. XXXVIII, Figs. 8 and 9, are shown two pairs of plants, the left-hand one in each being an ungrafted lupin plant, and the right-hand one a lupin grafted on broad bean. The difference due to grafting on broad bean hardly needs comment, increase in stem girth, amount of branching, and size of leaves being well seen.

In 1927 a more extensive series of experiments was carried out. The plants were grown in sand and watered with culture solution. Each pot contained one ungrafted broad bean, one self-grafted broad bean (1 only had died), 2 broad beans on lupin plants (only 7 survived to the end of the experiment), 2 lupins on broad bean plants (15 survived), one self-grafted lupin plant (6 only survived), and one ungrafted lupin plant (all of these survived).

The following notes were taken when the plants were washed out to search for nodules on the roots (see Pl. XXXVIII, Figs. 6 and 7, in each of which from left to right are two lupins grafted on broad bean plants, one self-grafted lupin, one ungrafted lupin). As none of the lupin roots had nodules on them, for fairness in comparison and simplicity of presentation only those broad bean roots which remained uninfected are considered, although the inclusion of the infected plants would make little, if any, difference to the general conclusions.

Every self-grafted lupin was smaller than its ungrafted fellow. Twelve

lupins on broad bean plants (including one with slightly-diseased roots) were each larger than the corresponding ungrafted lupins; one more was larger than the corresponding self-grafted lupin, but smaller than the ungrafted one. Two, including one with slightly diseased roots, were smaller than the corresponding ungrafted lupin, but larger than all the self-grafted lupins. (The self-grafted lupins actually corresponding to them had died.)

Broad Bean on Lupin Grafts. Broad beans, when grafted on lupins, remained stunted, although, as far as could be judged from a naked-eye examination, satisfactory organic union had taken place.

DISCUSSION.

Darwin, in 'Animals and Plants under Domestication' (vol. i, p. 147), states: 'According to Mrs. Abbey, grafts or buds generally take on a distinct variety or even species . . . with greater facility than on stocks raised from seeds of the variety which is grafted; and he believes this cannot be altogether explained by the stocks in question being better adapted to the soil and climate of the place. It should, however, be added that varieties grafted or budded on very distinct kinds, though they may take more readily and grow at first more vigorously than when grafted on closely-allied stocks, afterwards often become unhealthy.' Darwin was referring to woody grafts, but it is interesting to note how closely the results of grafting *V. narbonensis* on *V. faba* are in agreement. There was little, if any, evidence in the lupin on broad bean grafts to suggest a loss of health in the mature plant. Certainly the woody-nightshade scions grafted on potato retained their enhanced vigour to the end of the season. Any more detailed comparisons of the foregoing results with those of woody grafts, as summarized by Hatton (3), though tempting, would hardly serve a useful purpose at this stage.

SUMMARY.

Three examples are described of a scion being more vigorous when grafted on a foreign root-stock than on its own.

Woody nightshade (*Solanum Dulcamara*) attained more than twice its normal weight when grafted on potato (*S. tuberosum*), and assumed a more branching habit. *Vicia narbonensis* at first grew abnormally tall when grafted on *V. faba*, and then was overtaken by the self-grafted plants, becoming unhealthy before reaching maturity; flowering was earlier.

Lupin when grafted on broad bean was of greater girth and height than when on its own roots.

In the three reciprocal grafts the root-stock had a dwarfing effect.

EXPLANATION OF PLATE XXXVIII.

Illustrating Dr. W. A. Roach's paper on Increased Scion Vigour Induced by Certain Foreign Root-stocks.

- Fig. 1. Two ungrafted woody nightshade (*Solanum Dulcamara*) plants.
 Figs. 2, 3, 4. Single woody nightshade grafted on potato plants.
 Fig. 5. Early stage of the above plants. Left to right: two ungrafted woody nightshade plants, one woody nightshade grafted on potato plant.
 Figs. 6 and 7. Left to right: two lupins grafted on broad beans, one self-grafted lupin, one ungrafted lupin.
 Figs. 8 and 9. Left: Ungrafted lupin. Right: Lupin grafted on broad bean.

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ROACH — SCION VIGOUR

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