THE CROPPING OF FRUIT TREES IN RELATION TO WINDBREAK PROTECTION [1]

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SUMMARY

In the fruit-growing districts of Zeeland, where wind damage occurs quite frequently, observations were made during the past five years in order to determine the effect of wind protection by means of living windbreaks. It was found that the yields were influenced by shelter to a high, positive degree. A provisional calculation is made of the most profitable distance between windbreak rows and the net profits obtained with apples and pears in 1956. The causes of the positive effect of shelter are discussed.

INTRODUCTION

In the Dutch coastal province of Zeeland, where strong winds are of quite frequent occurrence, the damage done by wind to fruit cultivation becomes an important matter. The most common feature of wind damage is the drop of fruit, but trees may often also lose a part of their leaves and blossom by the direct effect of the wind. The strong prevailing westerly winds, blowing in from the sea, are regarded as being very destructive, especially in the coastal areas. It is found that when fruit trees as well as other woody species in this area are exposed to these winds they develop most on the downwind side.

The trees also suffer severely from the harmful atmospheric conditions caused by wind-borne sea-salt. During gales in particular, sea-salt may blacken plants and tree foliage over wide areas so that the trees become stunted in growth. Under such conditions there is no doubt that damage may assume alarming proportions, especially in years of high winds in areas where wind protection is scarce. For this reason attention has been given for many years to the problem of protecting orchards from damage by establishing living windbreaks. It should not, however, be forgotten that there may be favourable aspects of wind protection under less extreme or even normal weather conditions.

Although it has long been recognised that orchards require protection in the form of windbreaks, there are still many growers who do not properly understand the problem of wind protection. The disadvantages of root competition and shading, as well as the decrease in yield caused by devoting a part of the orchard area to windbreaks are factors which have brought intensification of wind protection into disfavour. In addition difficulties presented by mechanization have also led to some opposition to the planting of more windbreaks.

It was therefore nececssary to undertake research into the effect of wind protection in order to determine its advantage and disadvantages. During the past five years the Institute for Biological Field Research has been engaged on this study which was introduced by VAN DER LINDE (1) in 1952 and continued by the writer during the last two years in co-operation with the Horti-

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cultural Advisory Service in Zeeland. This paper is a preliminary report on the results [2]).

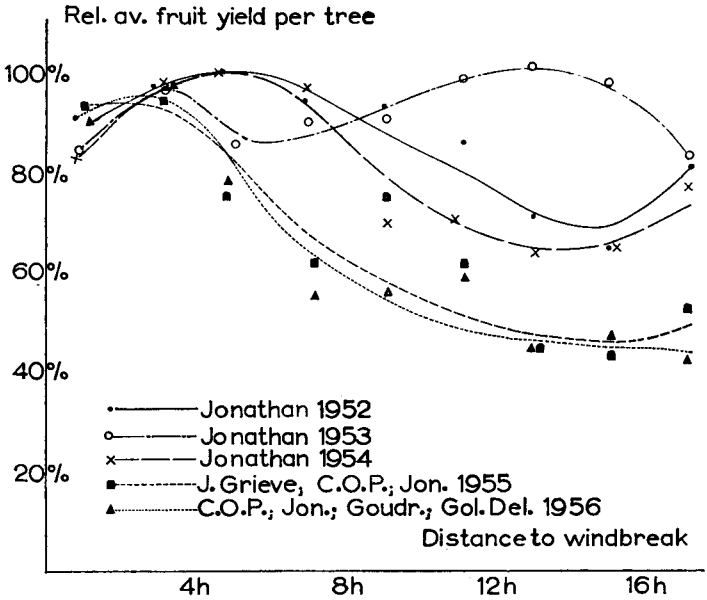

FIG. 1 APPLE VARIETIES ON VIGOROUS ROOTSTOCKS (BUSH).

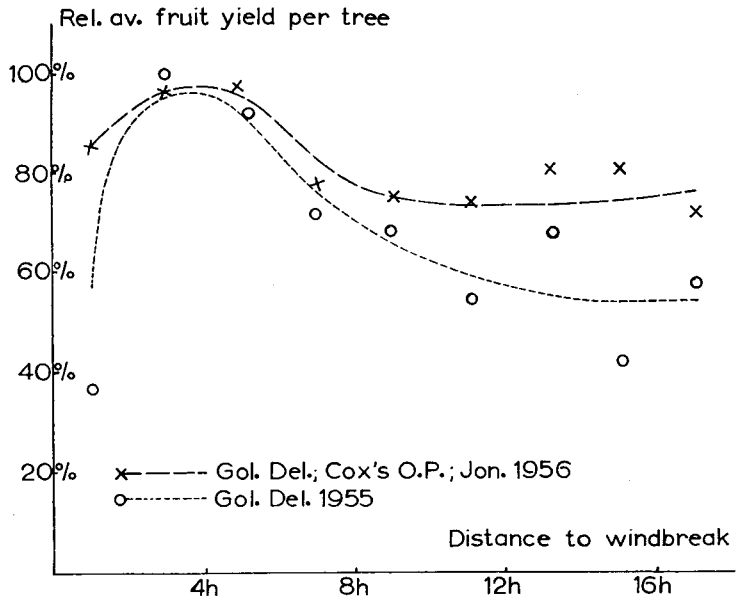

FIG. 2 APPLE VARIETIES ON DWARFING TREES ("SPILLEN" ON E.M. IX).

[2]) The results of these investigations were also published in the annual reports of the Institute for Biological Field Research and the "Mededelingen van de Directeur van de Tuinbouw" (Bulletins of the Ministery of Agriculture, Fisheries and Food, The Hague). No. 20, 1957.

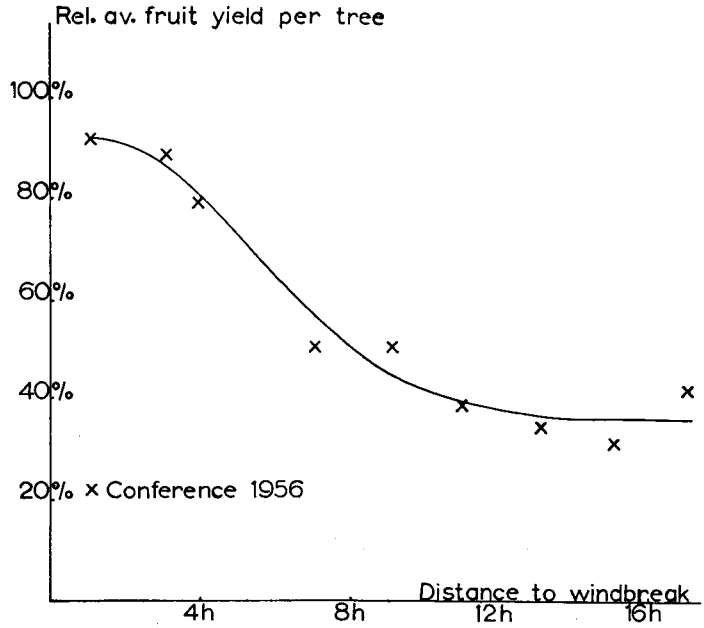

FIG. 3 PEARS (CONFERENCE).

THE EFFECT OF WIND PROTECTION ON THE CROPPING OF FRUIT TREES

This investigation calls for close observation of the fruit yield of trees in orchards protected from the prevailing westerly winds. The effect of wind protection should be determined by a comparison of the returns at different distances from the windbreak. Measurements of the yield per tree were made of the dominant apple varieties on both vigorous and dwarfing rootstocks, and during the last year (1956) of Conference pears as well. The results are summarised in figures 1, 2 and 3. These figures show the relation ship of the average yield per tree, expressed in relative terms, to the degree of shelter, expressed in distance from the windbreak.

It is obvious that the average fruit yield of trees of all apple varieties and pears in the zone of effective protection (the area from the screen up to 6—10 times the height) is in striking contrast to the yield of trees outside it. The yield trend of the trees in these zones was the same for all varieties; in any year, except 1953 when no effect was reported, every variety yielded more in the protected area than in the unprotected one.

Apple varieties on vigorous rootstocks and pears are found to benefit more greatly from shelter than dwarfing apple trees (on E.M. IX). It is evident, moreover, that the proper relationship between production and the degree of shelter is probably influenced by local conditions and varies with the annual changes in the weather conditions as well as with the different varieties.

The fact that the points lie close to a curve with the maximum in a territory of about 6 times h (the height of the windbreak) behind the screen, suggests an obvious correspondence to the reduction of the wind velocity to the leeward of the windbreak. This agrees with the results of wind measurements taken, for instance, by NÄGELI (2), who concluded that in this restricted

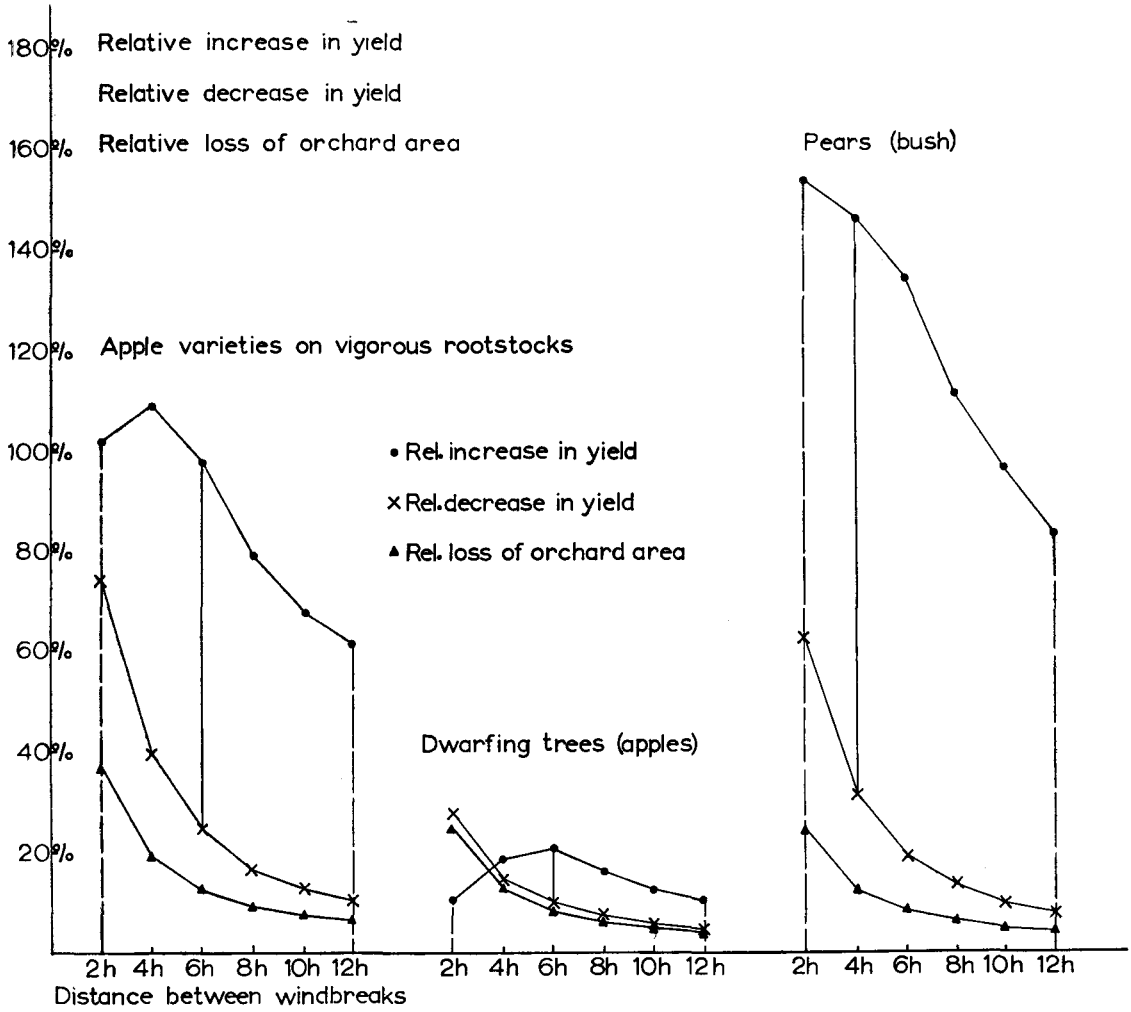

FIG. 4 THE EFFECT OF WIND PROTECTION IN RELATION TO THE SPACING OF WINDBREAK ROWS IN 1956.

Above the increases in yield by wind protection and the decreases in yield by loss of orchard area are shown in relation to different distances between windbreak rows. The increases in yield have been determined by calculating the differences between the average returns of sheltered and unprotected trees. These values are expressed as percentage of the mean returns of unprotected trees. For calculating the losses of orchard area with different planting systems, it is supposed that trees on vigorous rootstocks have been planted in ros at distances of 6 meter; dwarfing trees (on EM IX) and pears both at distances of 4 meter. The height of the windbreak is assumed to be 8 meter. Further it is estimated that by planting windbreak trees only one row of fruit trees is devoted to one windbreak row. For further explanation see the text.

area windbreaks reduce wind velocity more than 50 per cent, whereas outside this area the wind reduction is less.

It is also clear that the zone of effective protention is about 10 h wide, although the reduction in wind velocity may be traced much farther away. This is not, however, a real advantage, at any rate not as far as fruit production is concerned.

A PROVISIONAL CALCULATION OF THE MOST PROFITABLE DISTANCE BETWEEN WINDBREAK ROWS

The 1956 observations were used to make a provisional calculation of the effect of wind protection. Fig. 4 shows the average increase in yield in the lee and the decrease in yield by loss of orchard area, both in relation to the different distances between windbreak rows. Assuming the cost of establishing and maintaining one windbreak row to be equal to the cost of and attention required by one row of fruit trees, it is only necessary to deduct the decreases in yield by loss of orchard area from the increases in yield by wind protection in order to arrive at the net profit.

Fig. 4 shows that the decreases in yield caused by the losses of orchard area rise as the distance between the windbreak planting is reduced, but they do not rise as rapidly as the increases in yield resulting from intensification of wind protection. Distances of about 6 h with apples and 4 h with pears appear to be the most profitable. Net profits of about 73 % and 11 % with apples and 120 % on pears were calculated for 1956. It is clear that the disadvantage of root competition and shading are accounted for net in the advantage. A lowered production of the row windward of the adjacent windbreak might be expected from it, but this is offset by the beneficial windbreak influences to windward.

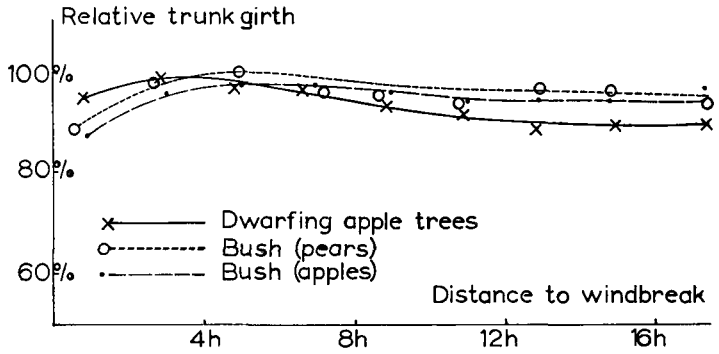

FIG. 5 RELATIVE TRUNK GIRTH IN RELATION TO THE DEGREE OF SHELTER.

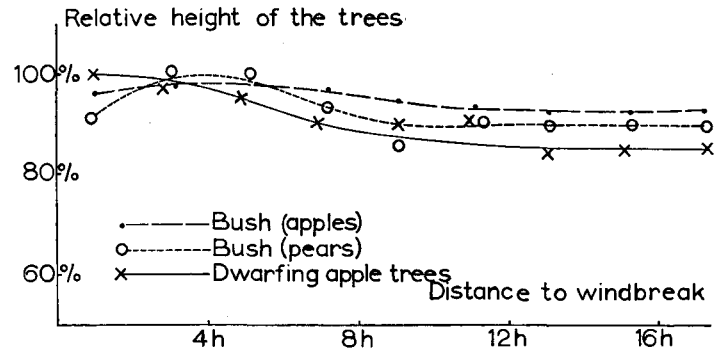

FIG. 6 RELATIVE HEIGHT OF TREES IN RELATION TO THE DEGREE OF SHELTER.

The causes of the positive effect of shelter

It is important to consider the causes of different cropping as they also determine what steps are required to make wind protection more profitable.

Measurements were made of trunk girth and mean height. Figs. 5 and 6 show that the sheltered trees were actually about 10 % larger than the unprotected ones. The results also show that the influence of the wind on the growth was greater in the case of apples on dwarfing rootstocks and pears than in the case of apples on vigorous rootstocks. This might be due to the drought susceptibility of these crops. However, the differences in tree size could not possibly explain the great differences in yield, though it might be expected that the vigorous growth of protected trees would somehow ensure better returns.

It will be noticed from table 1 that no correlation was found between the average fruit weight and the degree of shelter. Records of the windfall obtained from one orchard show that the drop of fruit, which occurs in late summer and autumn, actually only differs slightly at different distances from the windbreak (table 2).

Table 1 Average fruit weights of wind protected and unprotected trees in kg (the number of fruits on which the average value is based is shown in parentheses).

	James Grieve	Cox's O.P.	G. Delicious	Jonathan
Wind-protected	0.15 (450)	0.12 (493)	0.17 (270)	0.14 (350)
Unprotected	0.15 (450)	0.11 (465)	0.17 (140)	0.14 (350)

Table 2 Percentage of windfalls in relation to wind protection after a storm.

	1 h	3 h	5 h	7 h	9 h	11 h	13 h
Percentage of windfalls	2.1	7.0	6.3	8.5	9.6	8.0	9.9

As these results indicate that neither the differences in tree growth, the growth of the individual fruit, nor the windfalls, account for the substantial losses by wind during the period 1952–1955, some observations regarding the fertility of the trees were made in 1956. These results show that the wind should be recognized as a major factor in fruit cropping, firstly because it affects the setting of the blossoms and secondly because it influences the formation of flower buds in the case of pears.

Discussion

The causes of different cropping are undoubtedly very complex. There is, however, strong evidence to suggest that the wind may affect fructification, as well as growth firstly by considerably damaging the flowers of unprotected trees, presumably only in the case of high winds, and secondly by affecting the setting of the blossoms and the retention of the young fruit. It seems very likely that very high losses of blossoms were occasioned by the severe

storms of May 1955. On the other hand it is possible that in other years with normal winds, microclimatic differences in the sheltered area having high and low temperatures are sufficient to influence the fruit setting and drop of fruit. Another hypothesis is that heavy winds increase the laceration of the foliage; it may be owing to this laceration that unprotected trees bear fewer flower buds in the following spring than those in sheltered sites. Finally the wind effect might be caused by insects working more among sheltered trees and thus increasing the chances of cross-pollination.

More research should be undertaken in this direction, for there can be no reasonable doubt of the beneficial effect of a windbreak, this being clearly evident as early as May and June, if the suggested hypothesis proves to be right. In this period there is presumably less risk of the flowers and young fruit being damaged if the orchards are also protected against occasional northerly winds.

Conclusions

The results of this study show that in Zeeland:

1 The dominant apple and pear varieties are subject to severe wind damage; apple varieties on vigorous rootstocks and Conference pears are more susceptible than apples on dwarfing trees (EM IX).

2 A considerable improvement of the growing conditions and productivity in orchards could be obtained by planting windbreak trees.

3 The zone of favourable shelter is about 10 times the height of the windbreak trees (h); but had the windscreens been planted 6 times h apart in the case of apples and 4 h in the case of pears, maximum returns would have been obtained in 1956. In that year the net benefit would have been 73 % in the case of apples on vigorous rootstocks and 120 % in the case of pears. The increase in the yield of apples on dwarfing trees was calculated to be 11 %. But observations should be made over a long period of years in order to estimate the average effect of wind protection.

4 Measurements of the mean height and the trunk girth of the trees, and observations of the fruit falls and fruit weights, showed little relation to the degree of shelter. The wind-protected trees were slightly larger than the unprotected ones, but these differences could not possibly explain for the larger increase in yield in the sheltered zone.

5 The cause of different cropping by wind protection is undoubtedly complex. A working hypothesis is suggested to account for it. There are indications that the wind may affect the setting of the blossoms and influence the formation and development of the flower buds as a result of laceration of the foliage. It might be expected that the trees stunted in growth by wind would also render lower returns. A proper understanding of these problems will contribute to a final conclusion as to how the wind can be more succesfully controlled.

References

1 Linde, R. J. van der: Windschermen in de Zeeuwse fruitteelt. *De Fruitteelt*, Christmas number 1956.

2 Nägeli, W.: Untersuchungen über die Windverhältnisse im Bereich von Windschutzstreifen. *Mitt. der Schweiz Anst. für das Forstliche Versuchswesen* 24, 1946, 2.