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STABILISATION OF WIND ERODIBLE LAND BY AN INTERMEDIATE CROP

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ABSTRACT

Stabilisation of wind erodible soils can be achieved in several ways. Methods and means can be divided in two main groups, namely :

- *those which can decrease the wind velocity at the soil surface, and*
- *those which can reduce the erodibility of the soil itself.*

Besides the technical suitability of the method, the economic applicability is very important, very often decisive !

The artificial crust-forming agents to be sprayed upon - or to be mixed through - the erodible soils, are too expensive for use on the relative large agricultural fields.

A cheap method, which agriculture can afford, is to grow an early crop. At a suitable time this crop is spray-killed with a weed killer. In the mulch of this intermediate crop -which may be still green, dying, or dead- the summer crop, for instance sugar beets, is sown. In this way the soil surface is continuously covered, first by the green intermediate crop, later by the dead mulch and finally by the growing summer crop. The method can also be applied when potatoes or corn have grown up far enough to take over the protection.

Essentially any crop can be used for this purpose. This paper deals only with the effect of winter rye as intermediate crop. A study was conducted in the windtunnel of the institute using artificial rye plants, and in which plant spacing and height could be varied.

It will be described which plant height and spacing met the desired criterion and how windvelocities up to a few decimeters above plant level are influenced by the crop.

INTRODUCTION

In agriculture and horticulture wind erosion can cause great damage on soils which are susceptible to blowing. This damage consists not only in loss of valuable topsoil and sometimes of seeds and fertilizers, but also in injury to a young crop caused by the scouring effect of jumping sand grains; furthermore the displaced sand may settle in ditches and other places where it is objectionable. Often -after a severe storm- the land has to be reseeded.

Areas in which civil engineering projects are in progress, also incur damage and trouble from blowing sand, especially large sites raised or filled with sand, sand dikes for road bodies, and dug-off areas where sand, susceptible to wind erosion, has come to the surface. Replacement of sand where it has been blown away, and damage to implements and buildings constitute still other important losses.

It is not the purpose of this paper to mention all methods and materials which can be used to fight wind erosion. Summarizing, one can divide these methods and materials in two main groups, viz. those which can decrease the wind velocity at the surface and those which can reduce the erodibility of the soil itself. Generally speaking, the choice of a method or an agent is determined by regional or local circumstances, by climate -possibility the weather- and the costs. Besides the technical suitability of the product, the economic applicability is also very important, could even be decisive.

This can be illustrated by the story of Krilium, a copolymer of vinylacetate and maleic acid, one of the products to improve the structure of soils containing some clay (< 2 μm), introduced in December 1951. The technical results were found to be very successful. In spite of this the production of Krilium was stopped after a few years. It was too expensive for practical application in agriculture with its large acreages.

The same is true for the crust-forming anti-erosion products which are at present available for sale or being tested. Many of the products give good results and have good handling properties.

However, it is too expensive to use the materials on large agricultural areas. Sometimes practical application is economically possible for high-prices cash crops, but usually the only consumer of these manufactured products is civil engineering. In contrast with the need for annual application in agriculture, in engineering projects they are used once; relative to the costs of the whole project, the expenses of soil stabilizer application are rather low.

The Institute for Soil Fertility has done much research on these products. Noteworthy is that in The Netherlands the use of these products is governed by the Fertilizers Regulations. Sale is permitted only when it is sure that the effect is positive -with regard to the purpose- and no harmful complications can occur in crop, soil and environment.

INTERMEDIATE CROPS TO FIGHT WIND EROSION

A method to fight soil blowing that agriculture and horticulture can afford, is to grow an intermediate crop on the spot. The crop will cover the soil surface during the time that the main crop has not yet been sown or planted, or is still insufficiently developed to protect the soil surface. This intermediate crop is killed by spraying a weed killer at a suitable time. The main crop is sown or planted before or after spraying, depending on the kind of crop. Essentially every intermediate crop can be used for this purpose.

The technique of using intermediate crops on a practical scale is still under development. The cultivation system is investigated by the Research Station for Arable Farming (Lelystad, The Netherlands). The protection of the soil surface against blowing makes demands on the compactness and the height of the intermediate crop. These factors are studied by our institute. This paper is restricted to the use of winter rye as intermediate crop.

Until now this method appears to be the only one which is economically acceptable to fight blowing in agriculture sufficiently. The last few years the method has been gaining ground in the cultivation of sugar beets, potatoes and maize.

In practice it has been found already that it is now possible to obtain good yields on soils susceptible to wind erosion, where the growing of sugar beets, potatoes and maize has been quite risky.

The culture of winter rye for this purpose differs strongly in some respects from the ordinary culture. In the normal culture of winter rye harvest is the final point and therefore one can sow the seed very late, for instance up to December. This is in contrast with the culture for the special purpose here : harvest is not important but it is necessary to realize a sufficient cover on the soil surface before winter begins. Rye hardly grows during winter, and in February or March weather and soil conditions may already favour blowing. These conditions are : a dry surface which is bare, or almost so, and a strong wind of low humidity. So it is necessary to sow at an early date.

The culture of the intermediate crop of winter rye should be done as follows. At the end of September or at the beginning of October winter rye is broadcast. Under average weather conditions a sufficiently protective cover can grow before winter comes. Winter rye can tolerate severe frosts. The crop is spray-killed at a suitable time after winter with an agent containing paraquat, for example Gramoxone, at the rate of 4-5 litres per ha in 600-800 litres of water. The time of application depends on various factors, among others on the main crop (sugar beets, potatoes or maize) and its planting date, the condition of the rye crop and on the weather conditions.

WINTER RYE BEFORE SUGAR BEETS

Before sugar beets, winter rye is sown at the rate of 120-130 kg/ha[(1)] preferably in the second half of September. For later sowing dates more seed should be used; for instance in the second half of October up to 200 kg/ha or more. It is clear that by sowing late one will be strongly dependent on the weather conditions for the realisation of a sufficient crop cover before winter begins. The rye is spray-killed before sowing the beets. The beet seed is sown in the mulch with a special sowing machine. A sufficiently robust crop will cover the soil surface when the dead rye mulch has almost or completely decayed. So the soil remains protected from erosive influences of the wind during a long time : first by the young, growing winter rye, then by the dead mulch of this crop together with the developing beet crop and finally by the beet crop itself.

WINTER RYE BEFORE POTATOES

Before the culture of potatoes, about 100 kg rye per ha[(1)] is sown, preferably in the second half of September. If the seed is sown later than the middle of September, more seed should be used : up to 160 kg/ha or more when the sowing date is near the end of October or the beginning of November. Again, by sowing later than the preferred time one is more and more dependent on the weather conditions to obtain the desired cover before winter starts. At a suitable time before planting the potatoes the green rye cover and surface soil are lightly treated with a cultivator. The intention is to loosen the soil surface a bit, so that the tubers can be covered better during planting; at the same time a rye crop that is too dense is thinned out and evaporation of moisture from the soil may decrease. The rye is spray-killed by the time the potato crop emerges.

(1) Handboek voor de Akkerbouw, Deel I. Algemeen en gewassen. Proefstn. Akkerbouw, Lelystad-Wageningen, Publ. 9 (1973).

WINTER RYE BEFORE MAIZE

In the culture of maize[(1)] the same procedure as for potatoes is followed. Here the sowing time of the winter rye begins after 10 October. The maize seed is sown in the green rye crop. The rye is spray-killed at least 4 days before the maize plants emerge.

WIND TUNNEL RESEARCH

As criterion for a sufficient protection the demand was made that no blowing will occur with wind speeds up to 21 m/s[(2)] (Beaufort scale : up to 9). The research was made with the help of the wind tunnel of the Institute. For technical reasons the research could not be done with a living crop; it was carried out with artificial rye plants, made of plastic raffia. The treatments were : a dry, loose sandy soil left bare and the same soil covered with various patterns of artificial plants, mutually spaced 12, 10 and 6 cm apart. The average heights of the plants were 8 - 8½ cm ("standing" crop) and 5 - 5½ cm ("lodged" crop) (see figure 1).

The height of 5 - 5½ cm was realized by squeezing down the standing plants. In this way not only the height of the plants was varied, but also the percentage of the soil surface covered by the plants, viewed from above (see figure 2).

It would seem that, for the same pattern, the lower crop affords a better cover, but measurements in the wind tunnel have shown the opposite.

This was done as follows. By gradually increasing the wind velocity, it could be checked at what wind speed the soil started to blow (the critical wind velocity). The amount of soil carried off by the wind was determined by weighing (see figure 3). If the sand surface was unprotected, there was a sudden change from a "not blowing" to a "blowing" surface; this happened at a wind velocity of about 6 m/s (the critical wind velocity for the bare soil). The crop-covered treatments showed a critical velocity which was only a few meters per second higher than that of loose sand. But there was a limited loss of sand, even at higher wind velocities. These losses were found to depend on the density and the height of the crop. At still higher wind velocities the loss of soil increased rather suddenly.

From figures 2 and 3 it is apparent that within certain limits the height of the crop is a more important factor than the percentage of the soil surface covered by the plants.

Visual observation (figure 2) indicates that, with a spacing of 10 cm the treatment with a plant height of 5 - 5½ cm gives a better cover than the treatment with a plant height of 8 - 8½ cm. However, figure 3 shows clearly that actually a better protection against the force of the wind is given by the plants with a height of 8 - 8½. The same is true in the case of the 6 cm spacing.

According to our criterion a cover must be able to protect the soil surface at wind velocities of up to 21 m/s. Figure 3 shows that only the treatment with 6 cm spacing and an average crop height of 8 - 8½ cm, meets this criterion.

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(2) Wind speeds given in this paper are all calculated for a standard height of 10 m.

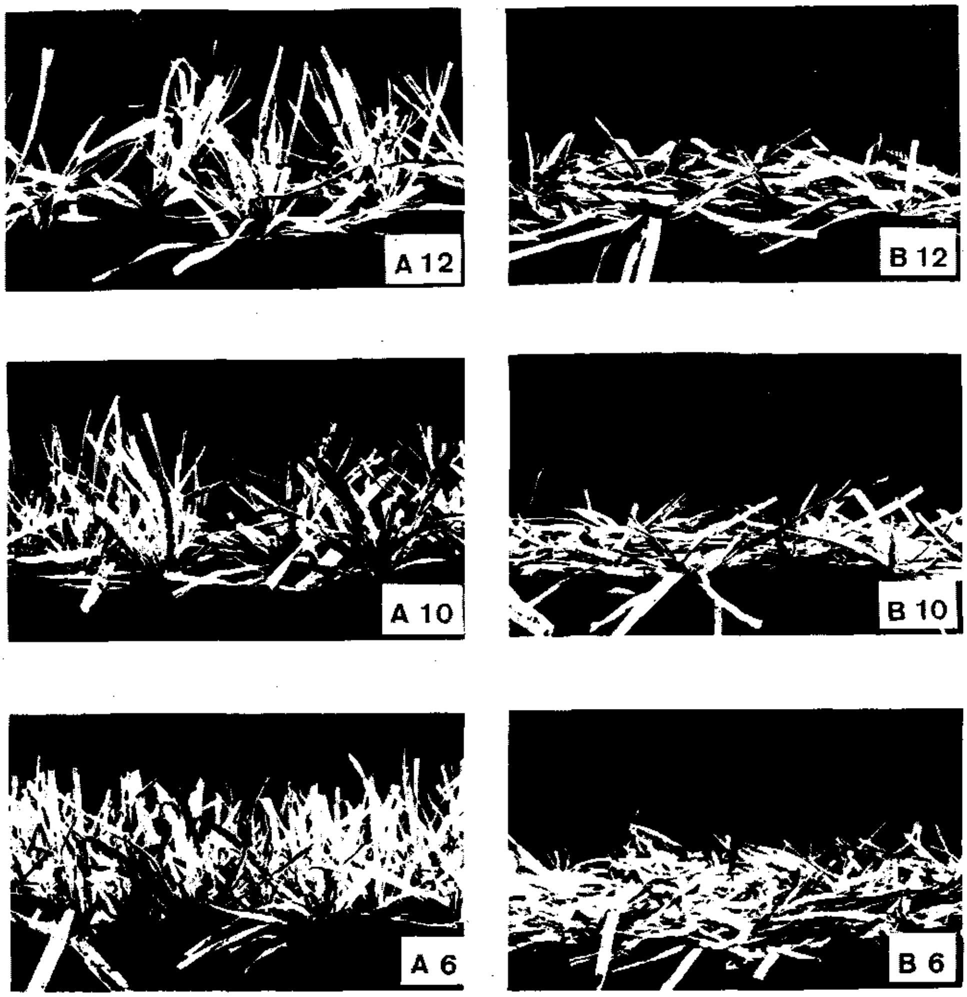
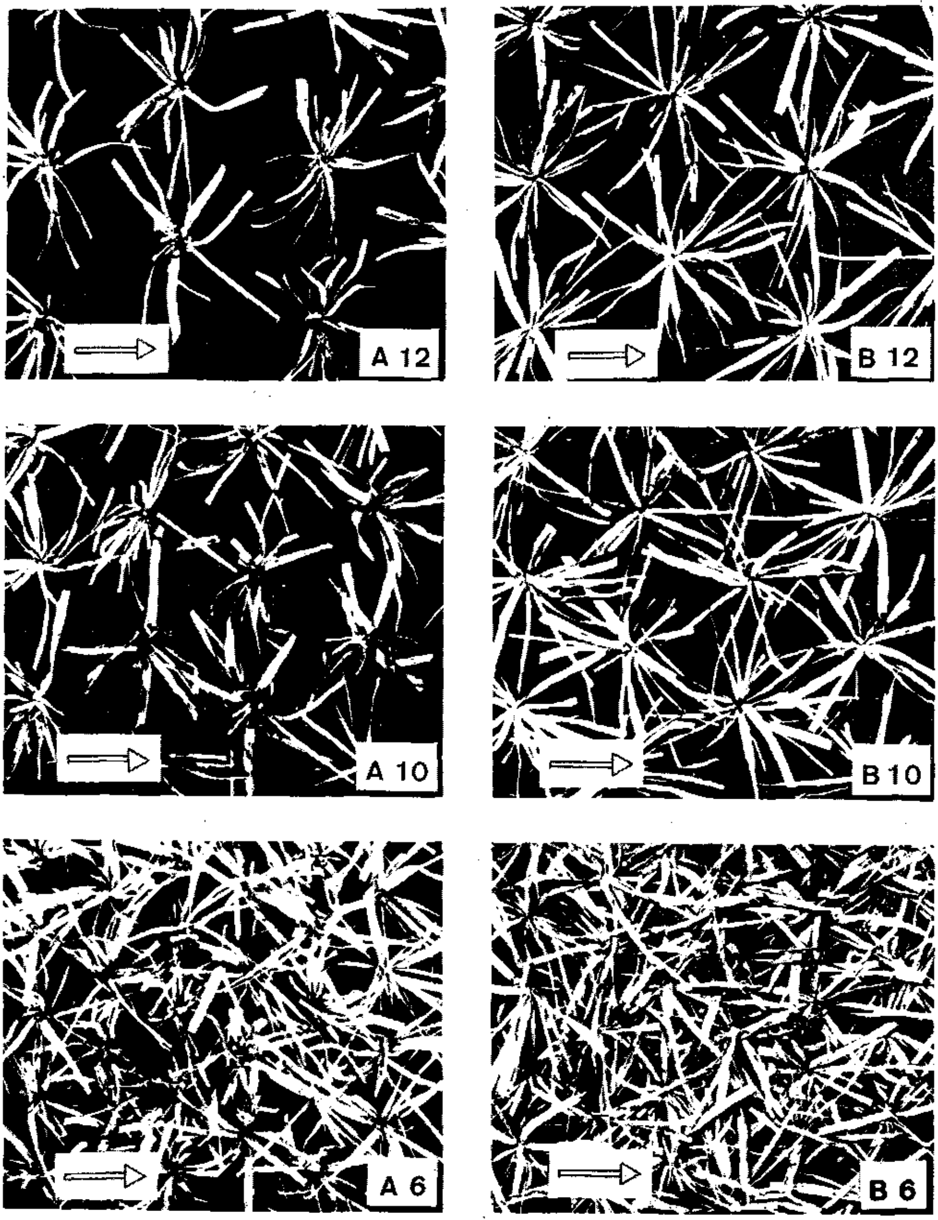


Fig. 1 : Heights of the model crop (side view).
Series A : "standing" crop, height 8 - 8½ cm,
Series B : "lodged" crop, height 5 - 5½ cm,
(A and B) 12, 10, 6 : plant spacing in cm.



<u>Fig. 2</u> : The model crop viewed from above; degree of soil cover.
Series A : "standing" crop, height 8 - 8½ cm,
Series B : "lodged" crop, height 5 - 5½ cm,
(A and B) 12, 10, 6 : plant spacing in cm,
Arrow : direction of wind during the experiments.

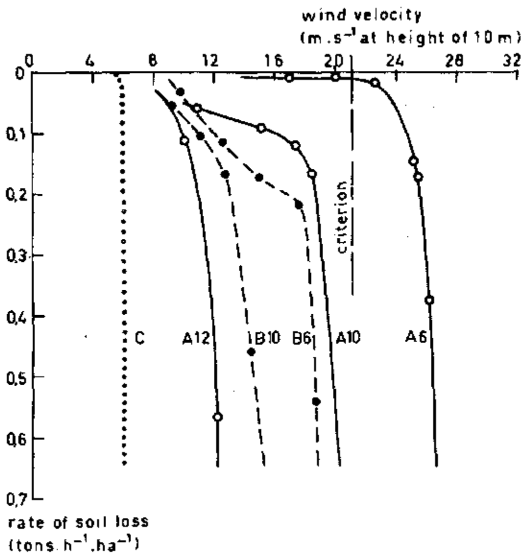


Fig. 3 : Relation between wind velocity and rate of soil loss for different heights and different densities of a plastic model crop.

——— A : "standing" crop (height 8 - 8½ cm),

------- B : "lodged" crop (height 5 - 5½ cm),

...... C : dry, loose sand surface.

12, 10 or 6 : plant spacing in cm.

It is important to the farmer that these results, obtained in an artificial situation, can be related to natural situations. It has been shown that the artificial "crop" of these experiments with a plant spacing of 6 cm and a height of 8 - 8½ cm is comparable to a natural crop cover, grown under average normal weather conditions before winter sets in by broadcasting 120 - 130 kg rye per ha about the second week of October. As this experiment gives a "minimum" situation -that means average weather conditions, a relatively late time of sowing and a relatively low plant height- it may be better to sow earlier or to use more seed.

In addition to the economic applicability in agriculture, the method described here gives an important profit compared with crust-forming agents.

Blowing sand can damage a protective crust and cut off young emerging plants by the scouring effect of blowing (jumping) sand. In the green rye crop as well as in the dead mulch the blowing sand can be fixed quickly. In this way no or less damage is caused by jumping sand grains.