ADVANCED TECHNOLOGY FOR THE FIXATION AND CULTIVATION OF THE SANDY SOILS AND OTHER UNPRODUCTIVE LANDS

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Abstract: *The paper proposes a new technology for the simultaneous fixation and cultivation of sandy, less productive or unproductive soils in dry and arid areas. The technology, especially applicable in vegetable farming, uses a hydro-agroameliorative support under the shape of a precast flexible band. Its composite material creates an optimum microclimate favorable to plant growth, thus compensating the soil deficiencies. The band, as a seed substratum, is introduced in soil in a vertical-longitudinal plane, its upper part remaining outside of the soil to play the role of a screen against wind and hydric erosion. The digging is mechanized using an especially designed equipment described in the paper. The article closes with presenting the advantages of the new technology compared to the old one. It joins together the larger part of classical agrotehnical operations.*

Keywords*: unproductive soils, hydroameliorative supports, cultivation machines.*

1. INTRODUCTION

The sandy soil fixation and cultivation are two major measures in the fight against desertification phenomenon in the arid zones (Africa, Asia, Australia and North America). These measures must also lead to the returning of sandy, less productive or unproductive soils into the agriculturally productive circuit, which has to feed a continuously growing population. Major investments might and should be done in sandy soils placed in the neighborhood of big cities.

In the South of Romania there are over than 400.000 hectares of sandy, less productive or unproductive soils, placed in areas with a high population density (on average, there are 0.5 hectares of agricultural soil per inhabitant). These soils are placed in the dry areas of Romania where the annual precipitation average is 300÷500 mm while the potential evapotranspiration goes beyond 700 mm.

Therefore, the research team has worked out a cultivation technology able to create an optimum microclimate favorable to plant growth, in order to compensate the deficiencies of such sandy less productive soils, namely:

- intensive wind and hydric erosion;
- low water retaining capacity (6-10%);
- high or very high water permeability;
- fast losing through levigation of fertilizers and nutrients needed for plant growth, a process which determine the pollution of freatic waters;
- nutrient and microelement deficiencies favored by the low content in organic material (0.2÷0.5%).

2. MATERIALS AND METHODS

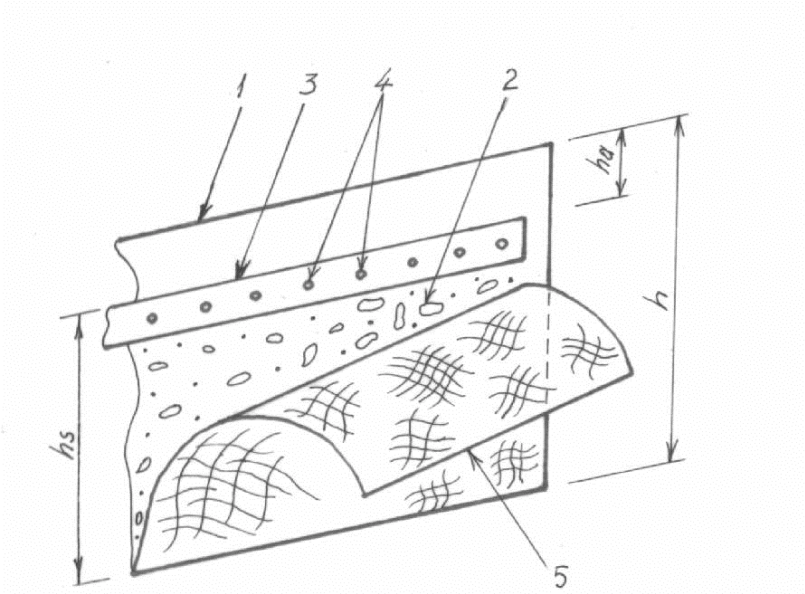
A) The hydro-ameliorative support (see Figure 1) has been manufactured under the shape of a composite band with a layered structure consisting of:

- The base layer that offers mechanical strength to the band necessary for its mechanized introduction into the soil. After many trials, it was selected a biodegradable and hydrophilic nonwoven material as the base layer having a high porosity that allows to be very easily penetrated by the plant roots;
- The superabsorbent layer of polymeric hydrogel type, which absorbs the water from irrigation or rainfalls. Hence, the water will be supplied in small amounts, only those necessary to hydrogel formation, thus reducing the water loss in depth.

Depending on the necessities, the water will be provided directly from the hydrogel to the root system. Also, the nonwoven material incorporated in the band structure can provide a reserve amount of water. A mixture that contains nitrogen, phosphorus and potassium salts as well as growth stimulating agents of mineral and organic nature were included in the hydroabsorbent of Terracottem type (Belgium made). If some hydroabsorbents without any supplements are used, the fertilizers and growth stimulents can be applied by a dry-spraying process on the surface of the base layer.

- The seed substratum of a band shape (of 10÷15 mm width) is made of porous paper having one face covered with an ecological adhesive. The installation described in Figure 2 has been used for the seed fixation on the surface of the paper band.

The feed system lets the seed to fall and then a rubber roll sticks the seeds on the adhesive surface of the band 2. The period "b" between the seed falling, depending on the agrotechnical necessities of plants, is adjusted by the position sensor 5 that commands the distributor 4. Seed band wrapped by the installation on the roll 7 is unwrapped and glued on the surface of the base layer. The position of the seed supporting paper band depends on the height of the upper support part into the air used as a screen against erosion, and on the plant-specific sowing depth (see Figure 1).



1. Base layer
2. Super-absorbing layer
3. Seed-support band
4. Seeds
5. Protection layer

Fig. 1 Hydro-ameliorative support

- The protection layer 5 covers the support and prevents band damaging while it is dug into the soil. This layer is made of a biodegradable nonwoven material, manufactured from re-usable fibers at low costs. A needle punching machine was used to interweave the protection and base layers in order to keep the optimum distribution of hydro-ameliorative support elements.

The hydro-ameliorative support [4], performed with this technology, is a precast product under the shape of rolls (see Figure 1).

The width (h) of the band support depends on:

- The necessary height (ha) of the air part used as a screen against erosion which might be maximum 50 mm thick in order to avoid bending (the screen will not be necessary for fixed sands and small slope soils);
- The height hs of radicular zone of the plant. The root system of the plant will take the growing resources directly from the support band. For the leguminous cultures, the height of the band buried in soil could be between 5÷15 cm, depending on the plants.

From the above results, it follows that the height "h" of the band must be:

- 5 cm (minimum), when the screen against erosion is not necessary and the plants have roots with superficial development;
- 20 cm (maximum), when the screen against erosion is necessary and the main part of the root system (as in the case of leguminous cultures) develop within a depth of 0÷15 cm [3].

B) Planting Machine with Band Support

This machine consist of 1 to 3 (or more) equipments assembled on a frame. Each equipment can constitute a single machine. The machine is mounted at the tractor rear. The manner in which the individual equipment is connected with the frame or with a common cross beam enables alteration of the intervals between the individual equipment and thus of the row distance, function of the vegetable planted. Considering an individual equipment, which represents a single-row machine, this machine has a structure similar to the automatic transplanting machines [2].

The single-row machine (see Figure 3) consists of the frame 1, on which are fitted the mounting system 2, adjustable ground wheels 3, press wheels 4 and the furrow opener 5. On the same frame are fitted a support 7 for the band roll 8 and a system which changes the movement of the band roll 8 in a vertical-longitudinal plane from the vertical direction to a horizontal one. This system consists of the inclined guiding roll 6 (fitted in the furrow opener) and the guiding slit 9.

The furrow opener 5 forms a furrow with a cross section approximating a rectangle, the band-support 8 enters the furrow and the two press wheels 4 pose it into the soil in the vertical-longitudinal position.

This machine is mounted at the tractor rear and has a working speed of 4÷6 km/h.

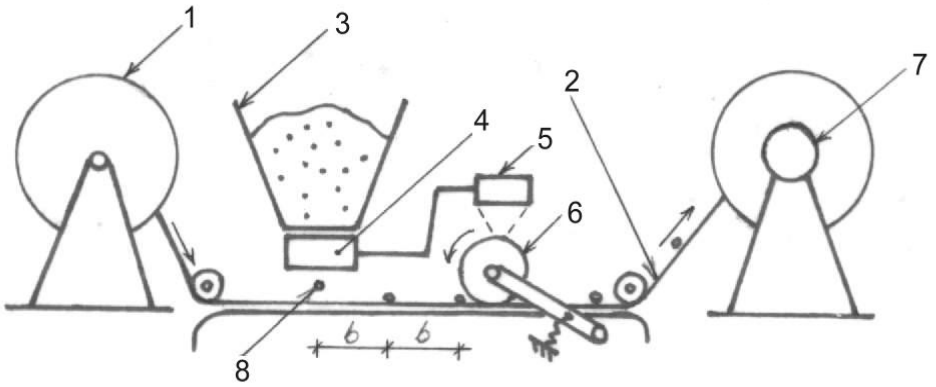
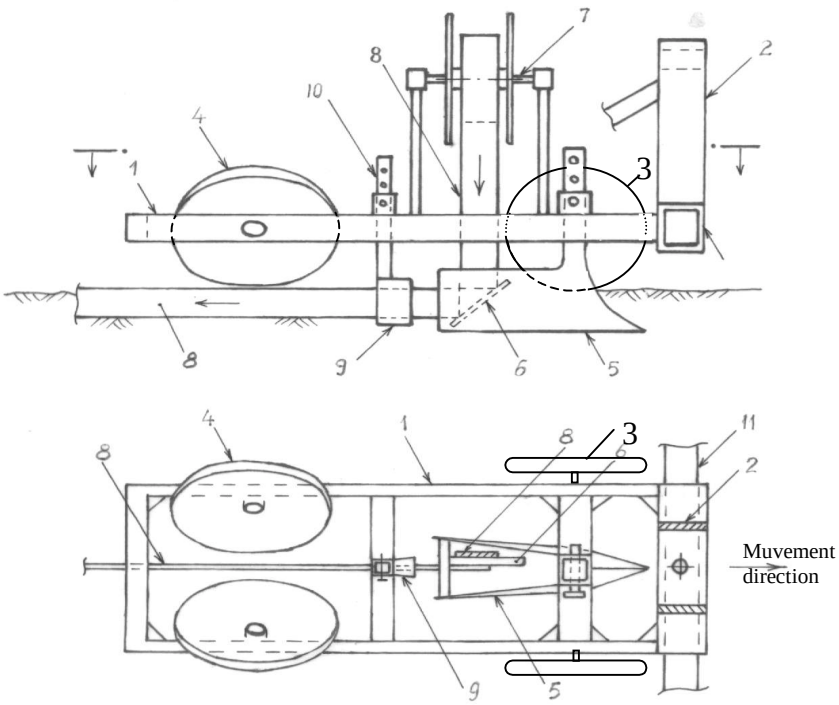


Fig. 2 Installation for seed fixing on the paper band

1. paper roll; 2. paper band; 3. seed tank; 4. electrically controlled distributor; 5. electronic control system for the row spacing of seeds; 6. seeds pressing roll; 7. Electrical engine actuating receiving roll 8. seeds



1. frame
2. mounting system
3. adjustable ground wheels
4. press wheels
5. adjustable furrow opener
6. inclined guiding roll
7. roll support
8. band support
9. guiding slit
10. adjusting device for guiding slit
11. fitting frame

Fig. 3 Planting Machine with Band Hydro-

3. PREVIOUS EXPERIMENTAL RESULTS AND DISCUSSIONS

The composite materials of the support band used for arid or unproductive land cultivation like sandy soils have been studied and tested in the Irrigation Laboratory and Nonwoven Materials unit pilot. The technology of mechanized introduction in soil and expermental model of the machine have been performed in a soil bin at the Agricultural Machinery Laboratory.

The base and protective layers are made of hydrophilic nonwoven materials manufactured from re-usable, organic and biodegradable fibers.

The band has a breaking strength on the longitudinal direction of 11.16 daN and an average elongation of 30% which allows the mechanized introduction in soil. The type of the hydro-ameliorative material of the band is Terra-Cottem a mixture of granules with the maximum diameter of 4mm which were uniformly glued with an adhesive on the support layer.

The plant seeds for cultivation are inserted in the support band structure. Grass and grain seeds fixed on a narrow paper band (of 15 mm width) were used for experiments with good results, employing the experimental model o installation presented above.

4. CONCLUSIONS

4.1 The research team proposes a new fixation and cultivation technology of unproductive lands (sandy soils).

4.2 The technology includes the manufacturing of a hydro-ameliorative support that creates optimum micro- climate favorable to plant growth. The plants germinate and grow inside of the band having, at the same time, the possibility by the radicular system to penetrate the band and grow outside. The support band is introduced in soil in a vertical-longitudinal plane, the upper part of the band remaining outside of the soil and having the role of a screen against wind and hydric erosion.

4.3 The whole technological process, starting with the manufacturing of support band and continuing with its intromission into the soil could be mechanized and

automatized, and it assures a productivity in function of the supply with the hydro-ameliorative band (theoretically, over than 0.5 ha / hour for the cultivation on the band machine).

References

[1] Balan, O. 1998. Contributions Concerning the Working Process of the Seedlings Transplanting Machines. Ph.D. Thesis. Technical University Iasi, Romania.
[2] Bernacki, H. et al. 1972. Agricultural Machines, Theory and Construction, Vol. I,, NTIS, U.S. Department of Commerce, Springfield, VA, USA.
[3] Caproiu S. et al. Soil Cultivation Machines (in Romanian). Didactic and Pedaagogic Publ. House, Bucharest 1992, 109-115.
[4] Nitescu, E. et al. Hydro-Ameliorative Support – Patent awarded with the Gold Medal at The Invention Saloon "EUREKA – 1999", Brussels – Belgium.