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Planters performance during a very Short Rotation Coppice planting

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ABSTRACT

Very Short Rotation Coppice (vSRC) cultivation can become a good economy source for farmers, in addition to producing substantial amount of wood and benefits to society. Over the years, improved cropping and harvesting systems have been developed, which offer a good energy balance and acceptable economic results. Little research has been done in planting operations, where the mechanization is again at experimental level. The goal of the study is to evaluate the working rate and the working quality of 6 planters used for vSRC planting with different forestry species (poplar, willow and black locust). The results showed that, the working rate of the planters is low (about 0.6 ha h^{-1}) independently by the planter type used, and forestry species chosen. Furthermore, it was highlighted the necessity of setting up a specific planting machine equipped with automatic feed devices and a large surface for propagation material storages, in order to increase the working rate of vSRC planting operations.

1. Introduction

In recent years, it has been recorded increasingly a greater attention to the use of biomass as a fuel for the production of electrical and thermal energy [1]. New ambitious targets have been set for the use of biomass, increasing the demand for wood fuel [2]. Wood biomass is available in many forms and in all parts of the world, by enabling the deployment of bioenergy almost everywhere, once the main sources have been identified and evaluated [3].

Very Short Rotation Coppice (vSRC) cultivation can become a good economy source for farmers, in addition to producing substantial amount of wood and benefits to society [4,5]. Over the years, improved cropping and harvesting systems have been developed, which offer a good energy balance [6] and acceptable economic results [7]. Little has been done in planting operations, where the mechanization is again at experimental level.

Depending on by species use for SRC plantation, we can have different starting material. In poplar and willow vSRC, it is possible to use cuttings and rods, while in black locust vSRC only rooting plants. The various "forms" of the propagation material required different machines for its planting. In fact, vSRC planting can be performed with various types of machines. Most part of these machines are not specifically designed for this crop, but are "imported" from other agricultural sectors (horticultural and nursery sector) or only prototypes [8,9].

The goal of this study is to evaluate time consumption, working rate and work quality for 6 SRC planters.

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2. Materials

In this work, we have tested the main planters used in Italy for the vSRC planting. In detail, the trials were carried out with a "rod planter" (a machine that work with only rods), three "cutting planters" (machines that work only cuttings) and two "universal planters" (machines that can be working with cuttings and rooting plants) (Table 1).

All planters tested were of "mounted type" and they were different mainly by plantation device. In detail, the plantation device of Rotor planter is made up by a caterpillar on which track shoes is fixed a vertical cylinder. Into each cylinder scrolls a steel piston. When the track shoe is in upper position, the piston scroll down to gravity force and the operator can insert the cutting in the cylinder. Successively, the caterpillar rotates due to forward effect and the truck shoe is linked to the soil. At this point, the piston scroll down thanks a mechanic device inserting the cutting into the soil. The plantation device of Berto planter is composed by a steel wheel on which circumference are fixed of pliers a regular intervals. Also in this case, the wheel rotates to forward effect and plants held by pliers comes puts into the furrow previously opened by a furrower. Successively, the furrow is closed by two steel wheel of small diameter. Similar plantation device is mounted on Spapperi TTP 200 and Allasia T2 planters. Differently from Berto planter, cuttings are not positioned in a furrow, but they come inserted into the soil by a hydraulic piston (Spapperi TTP 200) or a mechanic piston (Allasia T2). Easier design is the planter Allasia R1. This planter is made up of a furrower and a photocells system. This later warn to operator by a green light, the correct position to insert plants into the furrow. After which, the furrow is closed by two steel wheel. Salix Maskiner Step planter is the only one that works with rods. Rods come put in plantation device by operator with manual method. Successively, during the forward machine, rods come into the soil using a belt transmission, and they are cut automatically by specific knifes at the desired length.

3. Methods

Trials were carried out in March 2011 considering a very Short Rotation Coppice plantation of a hybrid poplar (*Populus x canadensis*), a willow (*Salix*) and a black locust (*Robinia pseudoacacia*) because these are the main species used for the afforestation of North Italian farmland and can be considered representative of planters testing.

All planters worked on one type of alluvial soil only (sandy soil). The plots of land used for the plant had an extension of at least 3 ha and were collocated on flat country. All plots had a similar physical soil characteristic. The lands chosen had a rectangular form and a length at of least 200 m. These areas were closed in Po valley (Piedmont region) near the towns Alessandria and Cuneo in Italy, because in this geographic area there are good climate conditions for SRC cultivation. Besides the trials during three days only, all tests were carried out in same moisture soil (10–12%) and climate conditions (temperature 9–11 °C, and relative humidity 69–73%). For this reason, machines were plot allocated with random methods.

A starting density of plants of about 6700 per hectare and a 3.00 m × 0.50 m spacing were considered. Before the trials, the soil had been prepared with a plowing of 0.40 m of depth and an harrowing intervention.

All "cutting planters" have worked with poplar and willow cuttings of 9–25 mm diameter and 200–220 mm length, while the "universal planters", besides having worked with poplar and willow cuttings similar to those of "cuttings planters", have worked with black locust rooting plants of 0.60 height.

Cuttings with a diameter higher of 9 mm were used, because this is the minimum size to ensure an adequate carbohydrate reserve to sustain the cutting before establishment [10]. The max diameter used in the trials was 25 mm because it is the limit of the planting system of the Rotor machine.

For the "rod machines", poplar and willow rods of 20–40 mm diameter and about 3.00 m length, were used.

Before the planting operation, all propagation material were immersed in water for 48 h so as to hydrate it as much as possible in order to facilitate rooting and to preserve by an eventual drying for many days after the planting.

For each machine, working times and manpower requirement were recorded on the field, according to CIOSTA (Comité International d'Organisation Scientificue du Travail en Agricolture) methodology, on at least 5000 m^2 surface areas and for periods not shorter than 2 h [11]. In particular, the tests were carried out considering a period of 3 h for each planter. Forward speed has been measured with two couples of photocells (ZOOM® Z2E) positioned at the distances of 50 m. The photocells were collocated at the distance from headland boundaries of at least 50 m. All distances have been measured by a flexible ruler (LUX®) with accuracy of 2 mm. The travel time and the different working time element were recorded with a centesimal digital stopwatch (Hanhart® PROFIL 5).

Working rate has been estimated with an analytic method considering the worked surface in the unit time. In this study, this parameter has been expressed in ha h^{-1}.

The manpower requirement was determined considering the minimum number of operators necessary to the planter and the working time spent to unit surface (hectare).

Table 1 – Technical characteristics of the planters used in the trials.

	Rotor	Allasia T2	Spapp. TTP 200	Allasia R1	Berto	Salix Maskiner Step
Type	Cutting	Cutting	Cutting	Universal	Universal	Rod
Rows (no)	2	2	2	1	1	2
Plant distance (m)	variable	variable	0.5	variable	0.5	variable
Workers (no)	3	3	3	2	2	3
Mass (kg)	1400	780	1150	350	650	580
Power tractor (kW)	52	65	62	44	44	65