Arundo Donax Planting Prototype

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ABSTRACT

The common cane cultivation is one of the most promising biomass crop due to its high biomass yielding. One of the main problems that do not permit its cultivations in large scale, is the planting procedures. CRA-ING, with the aims to find the best system to permit the planting of common cane taking in account the operation cost and the obtained results in term of plant surviving, stated the evaluation of 4 different planting systems: 1. Micro propagate plants; 2. Stem cut radicated; 3. Rhyzome cut; 4. Stem part planted along the row. Each system is under evaluation, in order to find the best one, with the aim of foster the possibility of start the plantation in large scale, a prototype to permit the last system (stem part planted along the row) was developed. Tests were carried out in a 5 ha plantations. The prototype is attached at the 3 points of the tractor, and need one operator. The last is sits on the seat (A) and manually introduces the stem pieces, which are allocated in the two lateral boxes (B), inside the rows. The rows, 200 – 250 mm deep, are open by two ploughs V shaped (C) positioned close to the operator. Two metal parties avoid the soil entering into the row during the operation the position of the stem (D). The row are then filled by ground by two discs (F), after that a compacting roll (G) permit to obtain a compacted flat ground. 5 ha were planted in 2008 using the new prototype, in different thesis. The thesis are related to the soil characteristics, and irrigation. Prototype technical evaluation and planting cost calculation are reported. After 6 months the evaluation of the new plants growth were evaluated in the different thesis, data collected are reported. The new prototype is able to plant common cane with good results and having a planting cost acceptable.

Keywords: Common cane, stem, operating cost, Italy.

1. INTRODUCTION

The common cultivated cane is one of the most promising crops to use in systems of high biomass production for energy uses (Ceotto, 2006). This crop demands little regard to soil type and is able to give satisfactory crop yields even under non-optimal conditions. Maximum yields

Luigi Pari, Francesco Gallucci, Alessandro Suardi, Angelo Del Giudice. "Arundo Donax Planting Prototype". International Commission of Agricultural and Biological Engineers, Section V. Conference "Technology and Management to Increase the Efficiency in Sustainable Agricultural Systems", Rosario, Argentina, 1-4 September 2009.

are obtained from fresh, deep and well-drained soils, with average yields reaching 35 t/dm/ha/year (Di Candilo, 2005). The main weakness of this crop is definitely related to its reproduction/propagation. The reproductive systems used for its cultivation are: small micro-propagated plants; rooted cuttings; rhizome cuttings; and stem parts planted along the row. Based on national and international studies, more focus on the roots of the rhizomes/rootstocks rather than cane culms was highlighted. However, the cost is still too high for micro-propagated plants or cuttings to rhizome due to the high density of the planting (8,000-10,000 p/ha). To date, the best solution for a reproductive system that guarantees the success of planting at a sustainable cost is not yet clear. The cane culms can be a good alternative, as they are easily available at a reduced cost. It is important to understand the validity of such a reproduction technique; this requires further experimentation.

In order to make it easier, as well as to develop big dimensions planting with reduced costs, both agronomic researchers and the partners of the SUSCACE Project (whom these experimental tests are referred to), CRA-ING designed and charged the construction of a prototype for cane culm transplantation to the Spapperi S.r.l. Company. This work is also aimed at evaluating, in a experimental way, the mechanical choices necessary to develop the machine, and to see if this reproductive system could be the best one. According to this system, cane parts measuring 1.1 – 1.2 m in length, were laid on two rows, 0.70 m spaced, into a furrow 200 – 250 m deep. Transplanting trials were conducted in various sites in Sardinia, Umbria, Emilia Romagna and Tuscany.

2. PROTOTYPE DESCRIPTION

The prototype (Fig. 1), a towed machine, was attached to a tractor at the 3 rear points. The operators sat on two seats (a), one opposite of the other. They were provided with a footboard. They manually introduced the stem pieces, which were allocated in the two lateral boxes (in shaped sheet) (b) that were positioned at a particular length and distance from the operators, enough so that effort was reduced during material sampling. The furrows were opened up to 200 – 250 mm depth by two ploughs, V shaped (c), which were positioned close to the operators. Two metal structures avoided the soil entering into the furrow during the operation of the position of the stem (d). To keep the cane at the bottom of the furrow, two idle wheels (e), which were particularly useful in a non-linear cane condition, were installed.

The furrows were closed by a couple of dual ridging discs that served to cover furrow (f). Finally, the prototype was equipped with a compaction roller (g), which had the same width of the machine lateral side play, and whose performance was adjusted to improve the contact between the soil and the planted stems. In order to avoid soil from excessively adhering to the roller, a scratch-roller was mounted behind the roller itself (h). The position and working height of member-machine was adjusted to guarantee its maximum adaptability to different features of the fields. The working height was directly adjusted from the tractors hydraulic lift as well as from the two idle wheels (adjustable in height) (i).

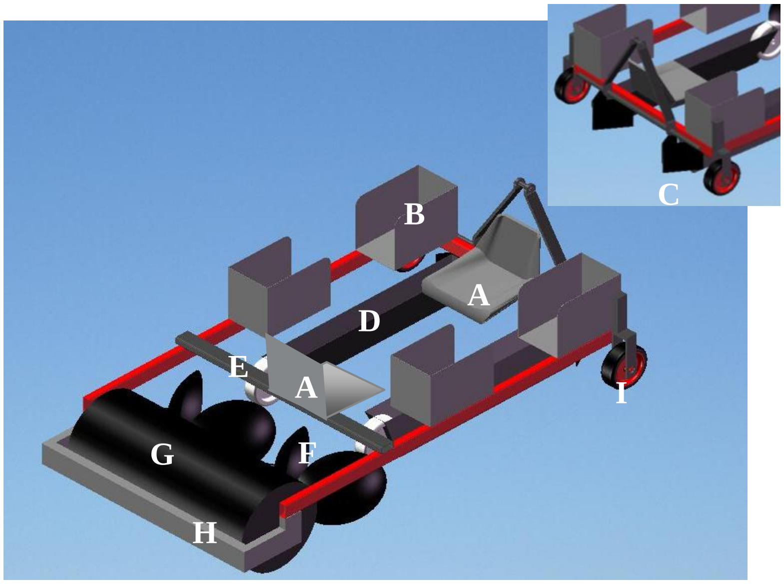

Figure 1. The prototype consists of: a) seat; b) lateral boxes for culms containing; c) "V" shake ploughs; d) metal structures avoid soil entering into the furrow; e) idle wheels hold culms back in the furrow; f) a couple of dual ridging discs serving to cover furrow; g) compaction roller; h) sratch-roller; i) idle wheels.

3. EXPERIENTAL PROOF ON TRANSPLANTING

Power Crop Company used the prototype for cane planting on large areas in different regions of Italy, and had contributed to its development. The results reported in this study are based on tests carried out by the collaboration of CRA-ING and Arsia in order to verify the emergence of buds in relation to the number of buds per meter. These tests were conducted in May 2009, which was in proximity to the Testing and innovation transfer Centre of Cesa (Arsia) in Marciano della Chiana (Ar) on a 600 m^2 plot. Planting cane culms from local landraces, a few days before being surveyed from an adjoining plant, were divided into three parts, which were 1.1 m in length. The basal and intermediate stem parts were characterized by an average diameter of 17.50 mm, and had 4.6 buds per meter. The apical portions, however, resulted in having twice the number of buds, more or less, (8.4 buds per meter), while the average diameter of the culm was slightly more than 10 mm.

According to the experimental protocol, four different methods for burying 1.10 m culms were considered: 1 culm/m density, where we took the material from the basal or intermediate stem part and then put in sprouting 65,780 buds/ ha; 1.5 culms/m density, where we took the material from the basal or intermediate stem part and then put in sprouting 98,670 buds/ ha; 2 culms/m density, where we took the material from the basal or intermediate stem part and then put in sprouting 131,560 buds/ha; and finally, 2 culms/m density, where we took the material from the apical stem part and then put in sprouting 240,240 buds/ha.

4. RESULTS

The work in the field (Fig. 1) has highlighted the validity of the project proposed by CRA-ING.

Figure 1. Prototype at work: sampling and culms placement on a single row by each operator

The member-machine involved in the following: opening and closing the furrows, burying the propagation material, and soil compacting, resulted to be well designed and efficient (Figure 2 and 3).

Figure 2. Culms planting at a depth between 200 and 250 mm

Figure 3. Operations of planting and furrows closing

Height adjustments of the member-machine (as described above) resulted in having a good performance adapting to soils of different characteristics. The side boxes that contained the culms, however, did not contain the right quantity of material. In order to reduce the accessory time, necessary to their supply, it was thought to extend the size of the boxes for extracting the culms from below, which was unlike those that are currently provided; it was also thought to equip the prototype with an additional third container, which would have been mounted on the compaction roller topside.
These tests also permitted the evaluation of the performance of the prototype (Table 1). The accessory times resulted in 9.54% by times for turns and supply times 14.13%. However, rest times and downtime inevitable times were not recorded. The machine reached an operating working capacity of 0.10 ha/h at an advancing speed of 0.37 m/s. Advancing speeds higher than those mentioned above showed an incorrect execution of the surveys and laying of culms in the furrows, as well as excessive effort by the operators.

Table 1. Standard times and performance of the prototype

Standard times		
Effective time	%	76,33
Accessory time	%	23,67
- Times for turning	%	9,54
- Unloading and supplying time	%	14,13
- Maintenance time	%	0
Rest time	%	0
Downtime inevitable times	%	0
Standard times	%	100
Machine performance		
Operative yielding	%	76,33
Effective speed	m/s	0,37
Operative speed	m/s	0,28
Effective working capacity	ha/h	0,12
Operative working capacity	ha/h	0,10

We want to emphasize that the function of the prototype was to facilitate the establishment of experimental plots in order to evaluate the efficiency of the proposed planting and not to plant large areas. In order to improve productivity of the prototype, the working width has to be significantly increased and the automated survey as well the burial have to be modified.

5. CONCLUSIONS

These experiments have shown that both the design is valid and the performance of the machine is excellent. However, the validity of such a propagation technique in relation to the experimental methods and to the climatic conditions at the test station, still need to be evaluated. If testing shows good results, a new transplanter prototype, on the basis of the methodology tested, could be developed. The new prototype should be able to work on no less than 6 rows (working width 3.75 m) and will be equipped with adequately well-sized containers for material as well as an automated sampling and burial system for cane parts. In addition, another machine for harvesting and dissection of standing canes has to be utilized, in order to produce the propagating material necessary for the planting; currently, this operation is performed manually with considerable use of manpower and time.

6. REFERENCES

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