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Antti Laine

Synthesis report on the available and affordable propagation methods for novel bioenergy crops

Sustainable Bioenergy
Solutions for Tomorrow

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Preface

This report is a part of the Sustainable Bioenergy Solutions for Tomorrow (BEST) research program, which is joint research program by FIBIC Ltd, and CLEEN Ltd. BEST program is funded by the Finnish Funding Agency for Technology and Innovation, Tekes.

The report belongs to BEST research program's Working Package 2 (WP2) "Radical improvement of bioenergy supply chains", and it's Task 2.1 "Raw materials". This report describes propagation methods of the high-yielding bioenergy crops Igniscum and Virginia Mallow.

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Name of the report: Synthesis report on the available and affordable propagation methods for novel bioenergy crops

Key words: bioenergy, biomass, Igniscum, Sida hermaphrodita

Contents

1 Igniscum cultivation

Igniscum ® is a fast-growing perennial plant hybrid which is generated from Japanese knotweed and Fallopia sachalinensis through mutation. The plant has two forms; in the spring dry-harvested Igniscum Basic and as a biogas raw material Igniscum Candy, which is different from the previous, as a result of the higher sugar content. The features of Igniscum are that it is not produce seeds, sprouts do not spread outside of the cultivation area and it is a sustainable and is high yielding. It increase in the cultivation happens buds, stems, or from cuttings, and tissue or meristem cultivated seedlings.

1.1 The establishment of the crop

1.1.1 Micropropagation

The biggest problem of establishment of the Igniscum crop is high cost. The cost of micropropaginated seedlings was 1,5 € per pieces in 2011. The high price is largely based on the charges, as Igniscum plant has a patent and trademark. The production cost of micropropaginated plant has been in the same period 0,39 € per pieces (Fehner). Micropropaginated plant, which is ready for planting is 5 to 15 cm high. It has been planted to the growth plates, in which the seedling growth space is 4 x 4 cm. Seedling rearing and culture to this size will increase the cost of the plants. The acquisition of micropropaginated plants in smaller micro cuttings and growing them in farm to bigger seedlings in the plastic greenhouses would degrease price of planting material. Corresponding practice is currently in Finland, among others, in the production of elite plants in Laukaa Natural Resources Institute Finland, which has sought methods to lower the production costs of seedling plants.

1.1.2 Cuttings propagation

Igniscumin cutting propagation from scion is also possible like currants. Igniscum scion, which contains leaf buds, are taken early in the spring. Cuttings will be transferred to the growth medium in moisture place, where cuttings rooting is done. Moisture room can be a plastic tunnel or plastic lightweight season greenhouse. Room humidity is kept to be close to 100 %, so that the cuttings don't dry, because roots have not yet developed by means they could take water from the growing medium to compensate water evaporation through the leaves. In Natural Resources Institute Finland has been studied the impact of the growing medium in cuttings nursery. Composted growing medium has contributed to the growth of cuttings compared to peat. Top cuttings rooting has take place without rooting hormone, while the use of the rooting hormone in lignified cuttings is recommended.

1.1.3 Root-cutting

Propagation of Igniscumin can also do just piece of root shoots. In the autumn 2013 in Piikkiö Natural Resources Institute Finland were raised root seedlings of Igniscum with nursery lifting machine, which lifts the root up and at the same time shakes loose soil off. The lifting machine works best on light sand or sandy soils, which allows lifting machine to detach soil off roots. Now the lifting took place a little more clayey soil and roots still remained clay touched.

Igniscumin rhizome is mainly in the surface layer to a depth of 40 cm. The Igniscum roots have mainly three different types of roots, diameter of 20-30 mm thick and long roots helps the plant spreads to a wider, 5-10 mm thick roots have stem buds and just a 1 mm diameter thin roots, which take the water and nutrients from soil to the plant. Roots diameter 8 to 10 mm thick with root stem buds were chosen and put to cool (+ 1 ° C) warehouse. The storage boxes of roots wrapped to plastic film to wait for use. Plastic film prevents roots from drying out during storage. The roots will persist to next spring, until the roots can be put horizontal in the growth medium to a depth of about 10 cm. After become rooted and produced stem the seedlings cuts off and separated from each others. Roots can also chop up about 10 cm long pieces, which contain at least one root buds and put them straight to field under cover. Covering material could be biodegradable material so it decomposes after use by itself. Under covering cuttings rooting takes place without irrigation if the soil is still fresh when planting, and the capillary flow of water takes place in the soil. Natural Resources Institute Finland was examined in the Department of Horticulture the planting time of root cuttings. The alternative times were in late autumn at the end of the growing season and early spring, before the beginning of the growing season. In both cases, the ridge was covered with a biodegradable plastic film before planting. Planting takes place trough plastic membrane to a depth of approximately 5 cm. Plantings made in autumn, rooted 52.5 % in the spring, while plantings made in the spring rooted 78.5 %. A contributing factor to the poor propagation in the fall could be a shallow planting depth, combined with a hard frost equated to snow free earth. The lowest temperature over snow free time were - 22 °C and minus degrees continues for nearly two weeks more than - 15 °C. This could cause damage to root buds, particularly left close to the soil surface. The best growth is in roots, which were protected against evaporation with plastic film and kept in storage building to the spring.

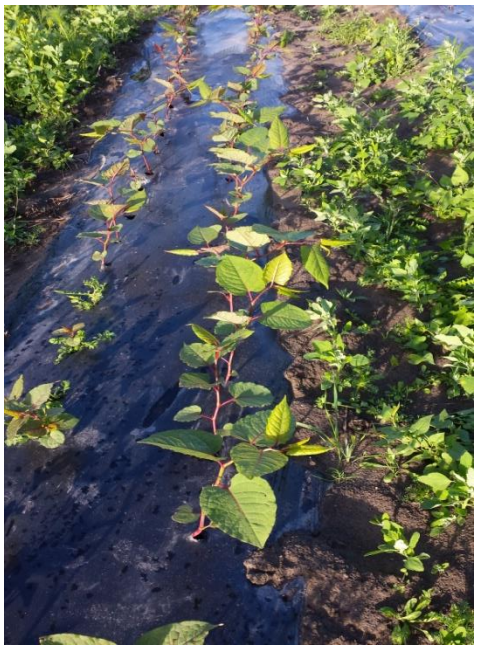
The roots kept in stock will be prepared in the spring about 10 cm long cuttings, which can be planted for example with the cabbage-planting machine. Planter drags to the ground about 8-10 cm depth and 5 cm wide furrow, where scions are placed in every row. The planter's discs spades covers rows both sides and compress furrows. Planters can have more than one furrow, depending on its working width. Soil could be compressed by roller thoroughly after planting, in order to promote the capillary rise of moisture. In this case plastic film is not used over the bedding and this allows mulching slurry or rejects waters after planting too. In planting may also be used a planter which plant trough plastic film (e.g. Hortec). Machine makes at first wide low ridge and local fertilizer, after this stage the machine spread plastic membrane over the ridge. The planting is done by placing the cuttings or seedlings by hand or automatically to planting unit, which penetrate membrane and locate seedlings to soil.

Seedlings lifting machine that shakes the soil off the roots

The machine has been brought up Igniscum rhizomes which contain lots of buds.

Root buds of the roots after lifting in the autumn

The buds are very vigorous in the spring after stored in cool (+ 1 ° C) just before planting.



In the 6 May 2014 through plastic film planted root –cuttings are in good growth in the 17 June 2014. Herbicide treatment is carried out between the lines with glyphosate, rows must sheltered when spraying.

The crop of Igniscum two months after planting in August 2010.

2 Virginia Mallow (Sida hermaphrodita) cultivation

Virginia Mallow is a perennial plant belonging to the Mallow family. It is studied as a bioenergy plant particularly in Poland. The plant features have been studied as a soil stabilizer, fodder, nectar plant, fiber plant in pulp and paper industry (Spooner et al. 1985). The plant is originally from the Appalachian Mountains, where it thrives in sunny or half-shadow sandy and cobble river banks or wetlands, which are waterlogged year-round.

In addition to the use of bioenergy, plant is suitable for the animal feed as a result of high protein content (almost 30%) (Styk B. 1984, Borkowska H., Styk B. 1997,2006). The green growth can be used in medicine, feed, honey and biogas production. In the spring harvested dry material can be used as insulation and cellulose like pine fiber. As a short rotation bio-energy plant, it is used as pellets, briquette, methanol, cellulose based ethanol, biogas power and heating plants.

2.1.1 The establishment of the crop

The establishment of the Virginia mallow crop will be made in the spring to well prepared soil. Root-propagated weeds are good to get off from fields in the previous autumn with glyphosate treatment. If the soil needs liming, it is a good thing to do, before the autumn ploughing, because liming material mulching will no longer be possible to carry out. Ploughed area is worth to leveling in autumn if the stand will be set up to direct sowing. Soil fertility especially good phosphorus, potassium and magnesium values are for the benefit, as well as neutral or a little sour pH-value.

2.1.2 Sowing

Virginia mallow is possible to sown early in the spring. Seeding is most successful in the mineral lands of good capillary rise of water, because the tiny seeds will be sown about 1-2 cm deep. As a result, it is important that the ground has no large bumps in the autumn after ploughing, so it is recommended to made flat and even germinating surface already in autumn. A small sowing depth requires low tilling, which may not be deeper than the seeding depth. If a soil top to sowing depth has already dry at tilling time, seed does not get in contact with damp soil, tilling depth can be increased when using precision seeding-machine. Dumpling plows in front of drill boots can move dry topsoil off so that the seeding depth does not become too deep and drill boots reaches to untreated surface of the soil, where seeds should settled. Sowing is carried out on the rows with precision drill machine. Row spacing can vary from 0,5 to 0,75 m. The establishment of the crop needed seeds 1-2 kg per hectare, depending on seed germination. The thousand-seed weight is only 4 - 4.5 g, so the seeds will be 22 - 45 pieces/m2. The ideal value would be about 100 000 seedlings per hectare to make fast shady growth. There are major differences between the seed germination activity between different years and production lots. Because of hard-seed, germination can be only 5-10 %. Seed treatment by scrubbing the seed surface before sowing has been improved seed germination, as well as hot water seed treatment, which has improved germination capacity to 50 %. By filtering the floating deeds off after hot water treatment germination capacity is raised up to 80 %. Half-an-hour immersion in 95 % sulphuric acid has improved best germination of Virginia Mallow (Packa, D. et al., 2014).

2.1.3 Bedding

As a result of poor seed germination, growth of Virginian mallow could established by planting seedlings or root cuttings, when growth will be even and without openings. The seeds are grown to plants in growth medium in the seasonal greenhouses. Before planting seedlings must harden in the open air protected from direct sunlight. Planting can be made for example with the cabbage-planting machine to well prepared field. The weed control is made by weed hoe when it is necessary in planting year and early next season. Later weed control is not necessary because shade of crop.

Seed-grown transplants of Virginia Mallow

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