Mechanization of Open Ground Seedling Production

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INTRODUCTION

Appletons' Tree Nursery grows a range of 350 species of deciduous trees and conifers. Production consists of two million, one- and two-year-old seedlings grown in open-ground raised seedbeds. Climatic conditions are very favourable for seedling growth with a long growing season and defined winter dormancy period. The soil is less ideal being a silt clay loam over compacted clay which results in poor drainage during heavy periods of rain.

We practice a fixed seed bed production system. Once a seed bed is established, all subsequent operations are carried out from the tractor alleyways and after a crop is lifted the seed bed is ripped and reformed. A fixed bed production system allows for improvement of the seed bed soil structure without the soil compacted by the tractor tyres being incorporated into the seed bed. This method of seed bed management has led to an improvement in soil structure over a 15 year period. Past practice was one of complete cultivation which resulted in ground having to be rested in grass leys.

Mechanization has two major benefits. Tedious and physically strenuous tasks are made more pleasant and seedling quality is improved by, for instance, the use of reciprocating and lateral-root pruning, and accurate fertilizer and chemical application.

Increased mechanization in nurseries often means that equipment is used when the soil is moist, resulting in compaction and structural degradation. However, various facets of seedling production in which mechanization helps solve problems and improve plant quality are described.

MECHANIZATION METHODS

Agricultural Tractor. The agricultural tractor is the most common item of mechanization on an open ground nursery. It is used to carry or pull numerous implements, carrying out a range of tasks. Tractors come in various sizes, but tend to suffer from either a lack of visibility, clearance or traction, or a combination of all three. Specialized models such as the Universal high clearance, the Poppard and the Hessel high clearance bulldozer are designed for specific tasks. There is need for a tractor with one metre clearance, four wheel drive and steer, hydrostatic drive for variable speed control with a centrally positioned cab.

Land Preparation. New growing areas are first mapped and levels taken to establish directions of fall. An excavator is used to dig soak holes in low lying areas that are back-filled with drainage aggregate. This allows free drainage through the clay and stops ponding in the subsoil. To aid runoff of excess moisture soil is moved and levelled to form a constant fall in one direction. The soil is rotaryhoed deeply. Any stones brought to the top are picked up using a stone lifter and used to form all-weather access on headlands. Prior to bed forming a contractor uses a one metre vibrating ripper tine. A steel plug is drawn behind the tine, forming a 75 mm cavity in the clay substructure, aiding free water movement down the profile.

Deep Ripping. A combination alleyway and bed centre ripper is used to a depth of 40 cm. This results in aeration and drainage away from the active root growing zone after heavy rain. An arched tool frame allows ripping of compacted alleyways during the growing season. Large diameter steel discs are mounted either side of each ripper; these cut the compacted bed edge and stop large clods peeling into the seed bed. Alleyway ripping helps control weeds and greatly aids penetration by the undercutter and subsequent wrenching.

Seedbed Preparation. Raised seedbeds are used to aid drainage and allow seedbeds to warm more quickly in spring. We use a modified Howard rotaryhoe with rippers and bedformer to form raised beds. The rotaryhoe when used at high rotor speeds has the ability to break up clods and leave a fine tilth on top of the seed bed. A pan can be created by the blades smearing the subsoil, but by mounting three tines immediately behind the blades, this is fractured allowing free drainage. The bedforming attachment takes soil normally left in the tractor alleyway and forms a 150 mm high seedbed.

A power harrow with bed forming has an advantage over the rotary hoe of stirring the soil profile, not mixing wet subsoil with dryer top soil. This is particularly useful in spring when moist soil conditions often delay sowing.

Where possible seedbeds are formed in the autumn during dry conditions. As weather conditions allow during the winter and early spring a Lilliston rolling cultivator is lightly passed over the formed seedbed breaking the crust and lightly cultivating. The bed is then lightly rolled before sowing. This method results in a much improved soil structure and seedling growth when compared with spring prepared seedbeds formed during moist conditions.

Seed Sowing. Achieving the correct seeding density is critical to the quality and profitability of a crop. The physical nature of the seed dictates largely the degree and type of mechanization which can be used.

In its simplest form a ridged roller is used to form drills into which seed of species, such as, *Juglans*, *Quercus* and *Fagus* is hand planted. The Egedal Sower is specifically designed to sow in drills variable shaped seed, e.g. that of *Acer* and *Carpinus*. The SISIS Lospread is a versatile sower able to sow a wide range of seed sizes both in drills and broadcast.

The Summit vacuum drill uses an air vacuum to suck individual seeds on to a drum, from which they are dropped into drills.

Sawdust Spreader. Sawdust is used as a seedbed covering to prevent capping. The trailer has a bin capacity of two cubic metres, enough to cover a 60 m row length of *Quercus* or 240 m of *Pinus radiata*. Depth of cover is varied by opening the bin hopper and increasing tractor speed. Both wet and dry fowl litter can be spread prior to seed bed formation.

A composted mixture of *P. radiata* needle humus and litter is lightly sieved over seedlings during the growing season. This results in enhanced mycorrhizal inoculation and seedling growth.

Reciprocating Undercutter. The object of mechanical undercutting is to produce seedlings with an active compact fibrous root system. This is achieved by removing part of the tap root which forces the plant to form many new fibrous roots. The aim of undercutting is to cut the taproot cleanly at a predetermined depth without disturbing the remaining root system. A 5 mm thick blade is hardened at 25 mm intervals. The serrations self sharpen and ensure a clean cut. It is important

to have soil moisture near field capacity to reduce soil movement and plant stress. Irrigation after undercutting is advisable especially during periods of drying winds.

Lateral Root Pruner. Lateral root growth becomes especially vigorous after undercutting, as lateral roots grow into the lightly disturbed soil. A steerable linkage mounted tool frame has mounted to it nine horizontal coulters which sever lateral roots cleanly.

Wrenching. Wrenching, using either the reciprocating blade or fixed blade, is aimed at further severance of small roots and continued aeration to encourage a fibrous root system. A 125 mm wide blade is used for reciprocating wrenching and has the advantage of excellent aeration with little soil disturbance.

Fixed blade wrenchers use a thicker blade and, due to their robust construction tend to be used on deep rooting species, such as, *Juglans* and *Fraxinus*. They may also be used prior to lifting where maximum soil disturbance is required.

Seedling Lifters. Lifters allow seedlings to be easily removed from the seedbed, minimizing damage to the root system. The degree of soil agitation is normally adjustable and, depending on soil conditions and type of root structure, seedlings can be shaken to lie exposed on the soil surface. Where only part of a bed is to be lifted, trees are loosened, but left upright for harvesting at a later date.

Sprayers. The aim of any spraying operation should be to evenly apply the minimum amount of pesticide to produce the desired level of control. Applicators are divided into three main groups: Traditional pressure boom sprayers that rely on high pressure to force the mixture through nozzles in a wide range of droplet sizes; controlled droplet applicators that use a spinning disk to form evenly sized droplets (this method allows reductions in product rates, but has not been used extensively in its present format); and air-assisted sprayers that rely on a ducted air system to control the speed and direction of the droplet once it leaves the nozzle. Advantages of the latter are greater penetration of dense foliage, a large reduction in spray drift and the ability to use lower spray volume rates.

Fertilizer Application. Basal fertilizer dressing prior to bed forming is by a Vicon spreader using a 100 mm nozzle to place fertilizer only on the growing area. A Summit concentric roller spreader is used for all subsequent topdressing. This versatile spreader is able to handle powders, prills and granules. A ground wheel allows accurate calibration from 20 to 1000 kg per hectare.