HANDLING PLANTING STOCK

RISKS FOR PLANTING STOCK DURING HANDLING AND STORAGE

- A loss of water
- Food reserve loss
- Mycorrhiza damage
- Scalding/steaming
- Fungi infection
- Mechanical damage – avoid throwing the planting stock, do not tip down from trucks

Weight loss (of water) of spruce 3+0 after 30 to 180 minutes of exposure by planting stock drying in an open area

Weight loss (%)				
	Exposure to drying (min)			
	30	**60**	**120**	**180**
The above-ground part	7	15	23	25
The root system	21	43	49	53
The entire plant	11	20	27	33
Mortality (%)	52	92	100	100

VIABILITY OF FINE ROOTS OF SPRUCE 2+2 AND OAK 1-1 AFTER EXPOSURE IN OPEN AREA (air temperature 15°C, RH 55%, no wind, no sunlight)

Planting stock	Exposure duration (min)	Viability of fine roots (%)
Picea abies	10	91
	30	53
	60	21
Quercus petraea	10	84
	30	35
	60	0

Spruce 3+0 mortality 1 year after planting when the planting stock was treated with an antidessicant (Agricol) or antitranspirant (Folicot) product and stressed before planting for 60 and 120 minutes by exposure to drying out in the open (normal weather after planting)

Protection method	Mortality after planting (%)	
	Exposure 60 min	Exposure 120 min
Agricol	12	66
Folicot	75	99
Agricol + Folicot	10	44
No treatment	84	100
Control variant (no exposure)	7	7

Spruce 2+2 mortality 1 year after planting if the planting stock was stressed by a 0 to 120 minute exposure to drying in an open area prior to planting and by a 3-week drying after planting

Drying exposure duration before planting (min)	Mortality after planting (%)	
	Normal weather after planting	3-week drying after planting
0	4	3
15	13	21
30	48	87
60	84	100
120	100	100

Spruce 2+2 mortality 1 year after planting depending on the drying rate – drying out to a loss of 20% of the weight of the root system (root growth restored at the time of stress, normal weather after planting)

Drying rate	Mortality after planting (%)
40 minutes	42
220 minutes	30
12 days	18

Losses of weight (water) of the entire plant (after the same drying stress) and losses 1 year after planting of spruce 2+2 depending on the plant phenophase during stress; the same plants evaluated

Measurement month	Phenophase and plant placement	Water losses (%)	Mortality after planting (%)	
			Normal weather after planting	3-week drying after planting
March	Dormant - from the bed	12	5	6
April	Not sprouted - 3 weeks in a snow pit	18	12	31
	Sprouted - from the bed	25	42	100

DRYING OF PLANTING STOCK

- The root system dries 3 times faster than the above-ground part
- *Quercus* – the most sensitive (do not heel in)
- *Pinus sylvestris, Larix decidua, Picea abies* – very sensitive
- *Abies alba, Pseudotsuga menziesii, Fagus sylvatica, Pinus nigra* – "relatively resistant"

ALL SPECIES DRY OUT, IT DEPENDS ONLY ON THE INTENSITY OF THE CONDITIONS AND THE LENGTH OF THEIR DURATION!

FOOD RESERVE LOSS IN SPRUCE 2+2, BEECH 1-1 AT DIFFERENT STORAGE TEMPERATURES, PLANTS IN THE STORAGE AREA FOR 20 DAYS (100% content of food reserves before storage, plants not sprouted, spring storage)

Tree species	**Food reserve content (%)**	
	Storage temperature **0-4 °C**	Storage temperature **6-10 °C**
Picea abies	98	64
Fagus sylvatica	100	81

Loss of food reserves and mortality 1 year after the planting of spruce 2+2 depending on the handling method, phenophase of the planting stock and weather after planting (prior to planting, the planting stock was not subjected to drying, the same plants were evaluated)

Month	Phenophase and plant placement	Food reserve content (%)	Mortality after planting (%)	
			Normal weather after planting	3-week drying after planting
October	Dormant - from the patch	100	-	-
March	Dormant - from the patch	100	4	3
	After winter heeling in under a stand	64	39	74
April	Not sprouted - 3 weeks in a snow pit	86	18	39
	Not sprouted - 3 weeks under a stand	52	62	100

Mortality 1 year after the planting of spruce 2+2 depending on the temperature of the steamy planting stock (normal weather after planting)

Planting stock temperature	Mortality after planting (%)
to 30 °C	21
to 40 °C	46
to 50 °C	87

The influence of low temperatures on short-term heeling in on losses after planting

Heeling in temperature	Mortality (%)	
	Pinus sylvestris	*Picea abies*
+5 °C	6	4
0 °C	6	6
-9 °C	64	53

IN CASE OF DANGER FROM A LATE FROST, DO NOT SHORT-TERM HEEL IN!!!

CONDITIONS OF HARMLESS HANDLING AND TRANSPORT

- Dormant plants
- Plants in the dark
- Air temperature -1.5 to +8°C (optimum 0 to +2°C)
- Air humidity above 90%
- Heat removal from plants (ventilation)

Nursery workers provide better transportation of planting stock!

PLANTING STOCK TRANSPORT

- Without any root system protection
- With root system protection
  - Antidesiccants
  - Crates + pouring soil through the root system
  - Root system packed with a shrinkwrap
- Entire plant protection
  - Bags
    - Plastic (black – silver, white)
    - Paper (several layers)
  - Cardboard boxes
- Antitranspirants are also suitable for root system protection

Transport without any root system protection

Transport without any root system protection

Transport without any root system protection

Transport with root system protection – planting stock in crates

Transport with root system protection – containerized planting stock packed with a shrinkwrap

Transport with root system protection – containerized planting stock packed with a shrinkwrap

Transport with root system protection – containerized planting stock in plastic bags

Transport with root system protection – containerized planting stock in gunny-sacks

Transport with root system protection – containerized planting stock in containers on cultivation frames

Transport with root system protection – containerized planting stock in containers

Transport with root system protection (paper bags)

Transport with root system protection – plants in open plastic bags

Transport with entire plant protection – planting stock enclosed in polyethylene bags

Transport with entire plant protection – planting stock enclosed in bags

Transport with entire plant protection – heeling in a planting stock enclosed in bags

Transport with entire plant protection – planting stock enclosed in paper bags

Transport with entire plant protection – planting stock enclosed in cardboard boxes (advantage – can be stacked)

Transport of planting stock in pallets

Planting stock transport
- storage with possible ventilation

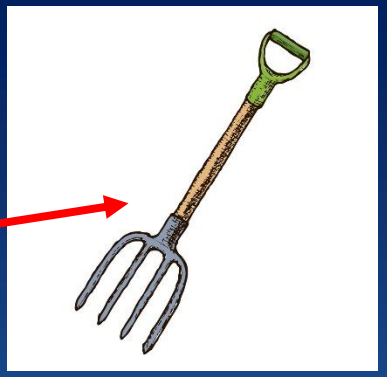
The safest transport of planting stock

- plants in containers (fewer plants can be transported), storage with possible ventilation

Lifting planting stock

- in autumn
  - sale
  - long-term winter storage
  - planting
- in spring
  - sale
  - planting
  - short-term storage and planting, possible heeling in (max. 3 days)
- in summer
  - seedlings for summer transplanting (only short-term storage)
  - conifer planting “from ground to ground” (without any storage)

Lifting methods



- manually (spading pitchfork)
- mechanized in a single row (also bundling)
- mechanized in the entire bad
  - . machine only undercuts, then manually
  - . machine lifts, then manually
  - . machine lifts, plants travel on a plane to a counter, then manually

- lifting is followed by packaging into transport wrappers and transport (but also sorting, bundling, protection of the root system against drying, possibly protection against *Hylobius abietis*)
- heeling in at a bed for a maximum of 6 hours or until the next morning
- transport – see above
- no lifter can sort
- lifting up – the biggest technical problem faced by nurseries

Plant lifter

Bed lifter


ZETOR
ZETOR 8340
Egedal

Lifting planting stock

Bed lifter


Egedal


SMZ
SMZ
PL ECO 3


Egedi

Lifting seedlings

Lifting seedlings

Lifting planting stock, sorting and bundling

Soaking plants in antidesiccant

Heeling in planting stock

Heeling in planting stock “into hedgehogs”

Planting stock sorting

After being lifted, the planting stock must not dry out!

Sorting at beds

- overcast, no wind, low temperatures
- planting stock is homogenous
- bundling
- root system protection, heeling in or packaging
- transport

Sorting in the handling hall

- temperature up to +13 °C (heating, ventilation)
- handling tables with irrigation
- wooden (heated) floor
- the following is sorted
  - non-homogenous planting stock
  - inappropriate weather for beds
  - sorting can also be done in winter when using air-conditioned warehouses
- bundling, root system protection, transport (sale)
- hall disinfection

Sorting methods

- sorting according to the valid standard
- sorting also according to the customer's requirements
- experienced workers – tools (meter, root collar diameter template)
- there are machines that do automatic sorting
- during sorting, it is possible to mechanically modify the above-ground part and the root system (smooth, perpendicular and not frayed cuts)

Bundling

- 5 to 50 plants in a bundle (according to size)
- smaller plants are bundled at the root collar
- larger plants – above the root collar
- use only material that won't damage the plants (string, no wire)
- root protection and plant marking immediately after bundling

Mobile shelter for plant sorting

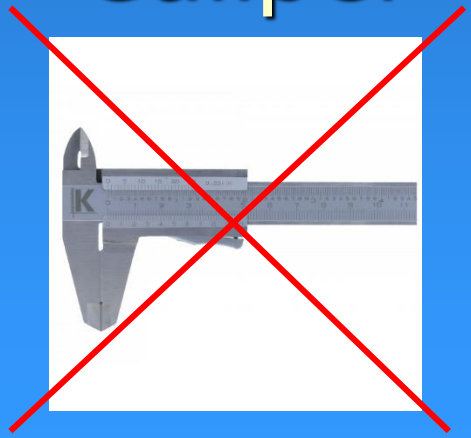
Plant sorting

Handling for plant sorting

Planting stock sorting in the handling hall

A template to determine the root collar diameter

Caliper



Handling table with a template to determine the root collar diameter

Plant bundling machine

Plant bundling

Application of antitranspirants

The pine weevil *Hylobius abietis* (L.)

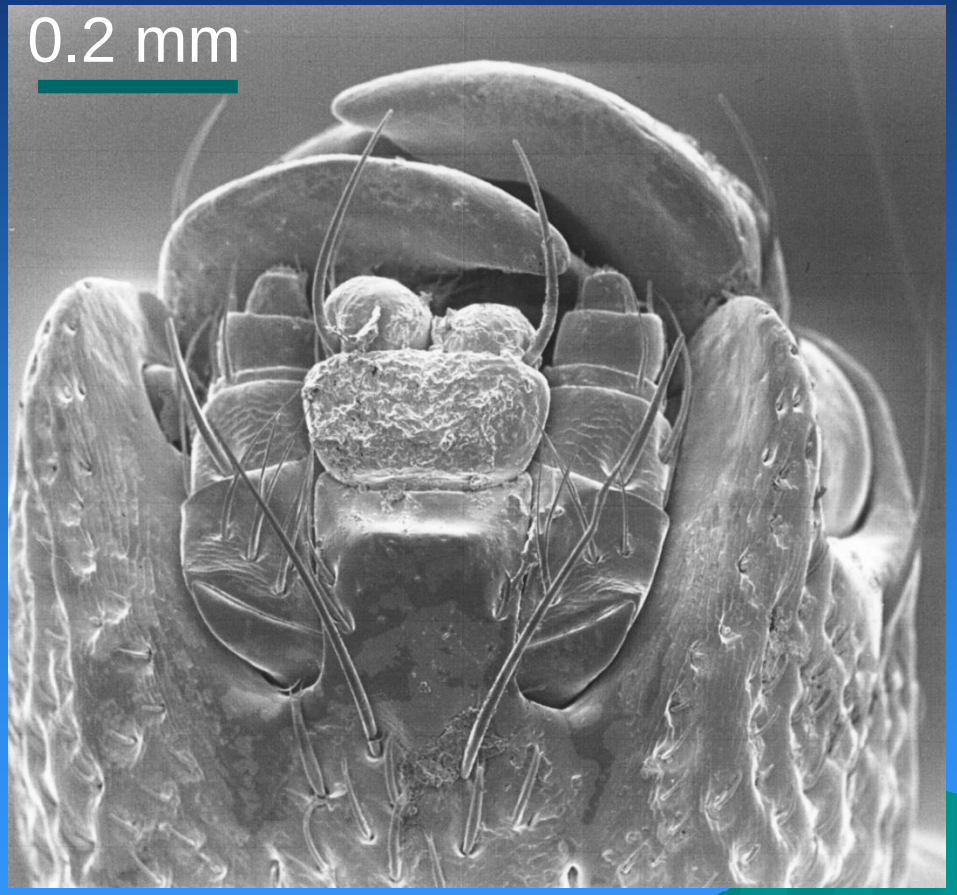
- Eats bark on freshly planted seedlings
- Without counter measures, up to 80% of the seedlings are killed
- The most economic important forest insect

Protection against the pine weevil

- ~~Chemical protection~~
- Non-chemical protection
  - Conniflex®
  - Woodcoat
  - Hylonox
  - Cambiguard
  - Wax
  - Etc.

How Conniflex® works

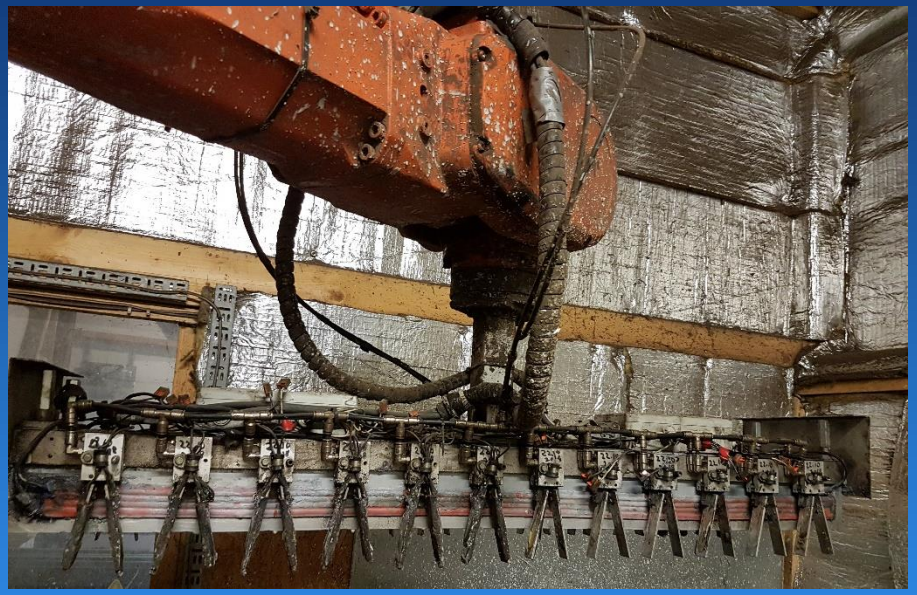
- Small grains of sand (0.2 mm) are lodged between the pine weevils' jaws
- Thus, the weevil doesn't gnaw on the seedling
- Flexibel coating with sand on the stem



Conniflex® - protective coating with sand

Conniflex
(protection against *Hylobius abietis*)

Wax
(protection against *Hylobius abietis*)



Mechanized plant sorting

Mechanized plant sorting

Manual plant packaging

Lifting-up homogenous plants from containers and packing them into cardboard boxes

Fully mechanized lifting-up of homogenous plants from containers and packing them into cardboard boxes

PLANTING STOCK TRANSPORT

- Gentle handling (no tossing, no treading, no folding)
- Transport must be done at night when:
  - The air temperature is above 16 °C
  - Transport time is longer than 2 hours (including loading and heeling in)
  - Plants are sprouted
- Transport during the day is possible only when:
  - The weather is cold with high relative air humidity
  - Transport is not longer than 2 hours (including loading and heeling in)

- Transport only plants with protected root systems
  - Enclosed wrappers are best
  - Root system packed with a shrinkwrap
  - Root system covered with a wet substrate
  - + antidesiccant
  - no dipping in clay mixture

- Transport is possible with unprotected root systems only when:
  - The temperature does not exceed 16 °C
  - The transport time is no longer than 1 hour
  - Plants do not sprout and few plants are transported
  - Antidesiccant was applied + covering the whole plants with wet material (a tarp, straw, etc.)

- Do not transport plants in heated wagons
- The transport space is covered with a well-sealed tarp
- In case of several hours long transports, the transport space should be ventilated (after 2hours), pour water on cloth tarps
- The layer height of the transported plants must not exceed 60 cm

  => stackable containers or multi-storey spaces

Stackable containers

Stackable containers

Stackable containers

Stackable containers in the transport space

A multi-storey transport space

- Transportation ends with good heeling in (storage) – not folding of the plants into a pile
- Sprouted plants cannot be transported in enclosed wrappers and cannot be stored
- For oaks and large-sized plants, it is necessary to agree to go "from ground to ground" (the best way)
- In case of long transport distances for deciduous species, transport and planting is best done in autumn

HEELING IN OF PLANTING STOCK (open air)

- SOIL
- SAND (SAWDUST)

STORAGE OF PLANTING STOCK (special equipment)

- SNOW PITS
- BASEMENTS, CAVES
- UNDER THE SNOW
- AIR-COND. WAREHOUSES

HEELING IN OF BARE-ROOTED PLANTING STOCK

- The heeling in site needs to prepared – ploughed!
  - Lighter and wetter soils, no large particles
  - A sheltered, protected and shaded area (sun, wind, frost, animals)
  - Build shelters (mobile)
  - A water source at long-term heeling in sites (or transport of water)

HEELING IN OF BARE-ROOTED PLANTING STOCK

- Piles of sand and sawdust are not the most suitable
  - Drying up to 15 cm
  - No fresh sawdust!!!
- Protect the above-ground part against the sun when heeling in

- **Short-term heeling in (max. 3 days)**
  - Plants may stay in a bundle, place the root system into the slot/furrow
  - Cover the root system with soil and seal/fasten it
  - Soil at least 2 cm above the root collar
  - Provide shade
    - with brushwood (but don't cover entirely to prevent scalding)
    - with a shelter
    - cover with cloth
  - At temperatures above 15 °C and for sprouted plants, bundles need to be untied
  - In nurseries, plants can be planted into beds for a max. of 6 hours (in water for max. 3 days, only flowing)
    - Place roots in soil, do not cover with soil on the surface

- **Long-term heeling in (over winter)**

– Plants must be dormant

– Bundles must be untied, plants must be placed "individually" into the slot/furrow

– Cover roots with soil, seal/fasten; each root must be in contact with soil

– Soil at least 10 cm above the root collar

– Provide shade
  - With brushwood (but do not cover)
  - With a shelter
  - With cloth

– Fencing – protection against animals

– Fencing at the bottom – protection against rodents

– Irrigation necessary, but only for the root system (scalding)

- Recommended – soak plants for several hours with the root system into water prior to and after heeling in
- No long-term heeling in
  - Sprouted plants (more than 3 days)
  - *Quercus, Pseudotsuga menziesii, Betula, Robinia pseudoacacia* (over winter)
  - Conifers except *Larix decidua* (over winter)
- **Rather do not heel in anything during winter!!!**
  - Not in peat (slow defrosting)

RECOMMENDED – A CENTRAL HEELING IN SITE

Heeled in planting stock

Heeled in planting stock

Heeled in planting stock covered with brushwood

Heeled in planting stock covered with cloth

Heeled in planting stock under a shelter

Heeled in planting stock

Heeled in planting stock – piles with the root system covered by cloth (Austria)

Planting stock heeled in in a nursery (Austria)

Planting stock heeled in in a nursery for the long term (Austria)

Planting stock heeled in in a nursery for the long term (Austria)

STORING PLANTING STOCK IN SNOW PITS

- 2 types of snow pits (bottom and lateral cooling)
- Plants stored in a dormant state
- Max. biologically acceptable storage is 3 weeks
- The snow pit must provide
  - Insulation (temperatures up to 10 °C, RH above 80%)
    - approx. 60 cm of soil at the walls/ceiling
  - Dark
  - Minimal air flow (ventilation ducts)

- The root system of the stored plant must be covered!
  - Plants in enclosed wrappers
  - Storage for longer than 3 days – need to unbundle
    - Place the root system into a wet substrate
    - Seal, substrate at least 5 cm above the root collar
    - The root system must not be placed into snow
- Before planting, acclimatize the plants for at least 10 hours (by taking them out of the pit)
- Buffer-room (for acclimatizing) in large snow pits
- No long-term heeling in after transport
- When the plants start to sprout, it is better to remove them up and let them develop roots


Snow pit


Snow pit


Snow pit


Snow pit


Snow pit

“Snow pit”

STORAGE OF PLANTING STOCK IN BASEMENTS, CAVES ...

- Storage conditions
  - Temperature (-2 to +8 °C)
  - Relative humidity above 80%
  - Dark
  - Minimal air flow

- Spring (shot-term) storage – same as for snow pits

- Long-term storage (over winter)
  (also applies to air-conditioned warehouses)
  - Plant in a dormant stage (lift up in October, November)
  - Plants prepared
    - Do not fertilize with nitrogen, use phosphorus and potassium
    - Treated with fungicide
    - Broadleaves without any leaves
    - Healthy
    - With a high water content (profuse irrigation prior to lifting up)

The root system

- into a substrate (monitor its wetness)
- or in enclosed wrappers

Plants in polyethylene (PE) bags

- Plants dry, without any leaves
- Root system without soil
- Better unbundled
- Push the air out and bind the bags after inserting the plants
- Place the bags on a wooden surface
- Max. 1 layer of bags

- Continuously monitor health
- At least 24 hours of acclimatization before planting

(the same applies to cardboard boxes)

Long-term storage of planting stock in a cave

Long-term storage of planting stock in mobile storage

Long-term storage of planting stock in mobile storage

Long-term storage of planting stock in mobile storage

Long-term storage of planting stock in mobile storage

AIR-CONDITIONED STORAGE

- 2 types – with direct cooling
  – with indirect cooling (better)
- Conditions regulated and controlled via sensors
- Use of the entire storage area – forklift trucks
- Acclimatization of planting stock before transport
- Disinfection of the warehouse and containers
- Store up until June

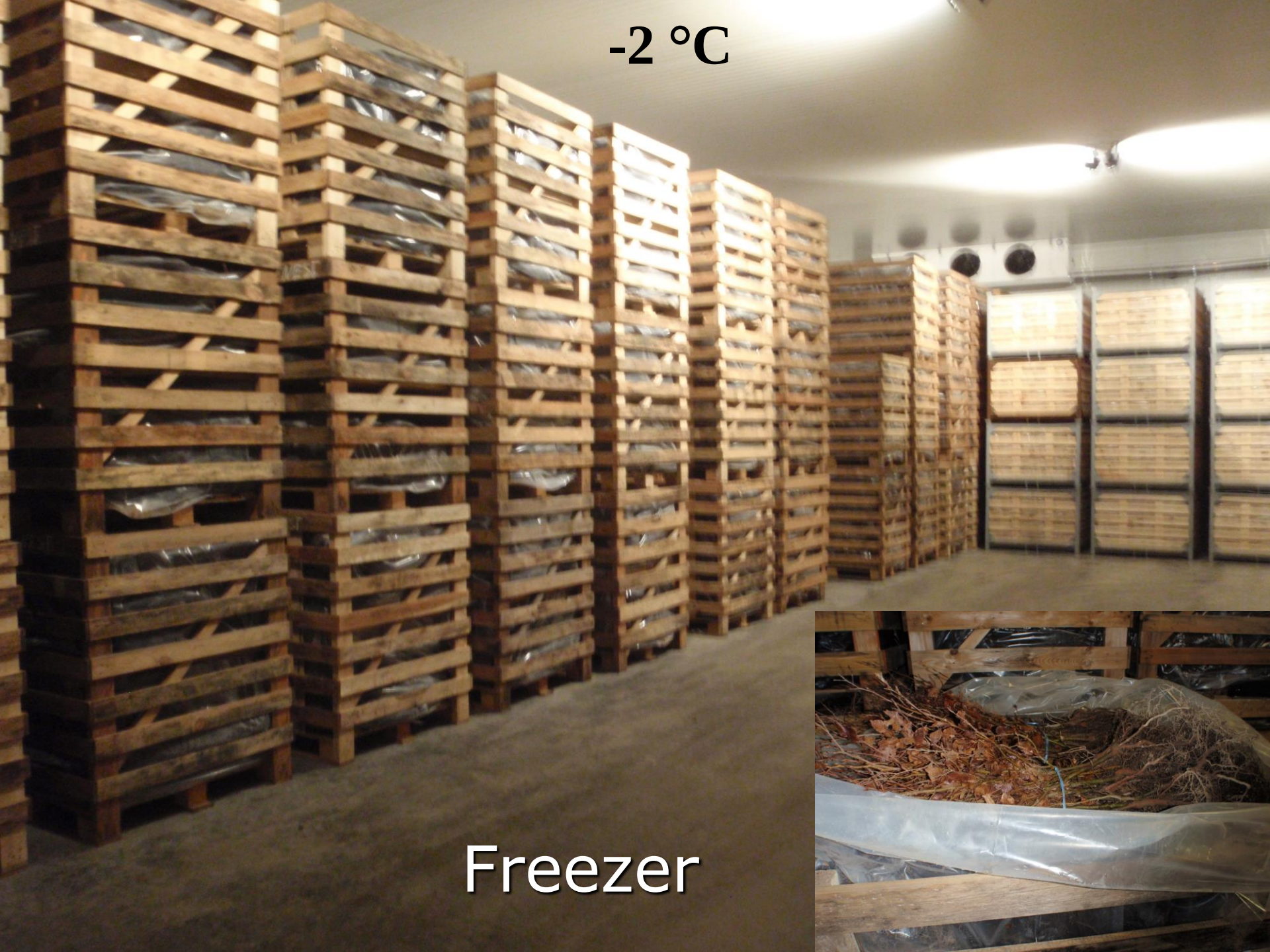

Air-conditioned
warehouse with
direct cooling


Air-conditioned
wharehouse


-1.5 to 2 °C, 98% RH

Air-conditioned warehouse


Air-conditioned
warehouse
ALSAKER
H-111
www.alsaker.no


-2 °C
Freezer

Storage in a freezer - planting stock enclosed in PE bags

Storage in a freezer - planting stock enclosed in PE bags

Storage in a freezer - planting stock enclosed in cardboard boxes

STORAGE OF BARE-ROOTED PLANTING STOCK UNDER THE SNOW

- Replaces an air-conditioned warehouse

1. Plants are lifted during dormancy (late autumn, winter, early spring)
2. Placed into plastic bags (enclosed wrappers)
3. Preferably transport immediately to the place of storage, but can also be placed in an air-conditioned warehouse, cave, etc.
   - Transport to the storage site in winter, early spring
   - At temperatures of -2 °C to + 5 °C

Place of storage:

- At higher elevations
- In road ditches
- Covered with a stand

4. Storage

- Compress snow (create a layer of about 20 to 50 cm)
- Place wooden pads on snow
- Place the bags on the pads
  - Max. 2 side by side, 1 m gap between the rows
  - Cannot be layered
- Cover everything with a thin plastic foil and with snow
  - Min. layer of 50 cm
- Snow must not mechanically damage the plants
  - Lightweight construction above the stored bags
- If necessary, import the snow

- At least 24 hours of acclimatization before planting
- Application
  - Afforestation at higher altitudes
  - Storage only at higher altitudes

HEELING IN OF BARE-ROOTED PLANTING STOCK IN ENCLOSED WRAPPERS

- Laid loosely on the soil surface
- Only in covered and shaded areas – or under shelter, brushwood (do not cover)
- If the plants are dormant and the temperature does not exceed 18 °C – heeling in possible for 3 weeks
  - At temperatures above 18 °C – one week
- Monitor the condition at least once every 2 days
- In case of sprouting – plant immediately, fungi infection – open container

HANDLING CONTAINERIZED PLANTING STOCK

- Do not plant
  - During the period of intense spring increments, before late frosts, during the period of drying, into frozen soil
  - Wet habitats (rain) – planting into holes only
- The root ball must not dry out
  - Heel in at covered areas (sun, wind)
  - Irrigate – dried peat does not accept water!
- The root ball must not be disturbed
- Plant
  - With a wet root ball
  - Cover the ball's surface with soil (turf) after planting

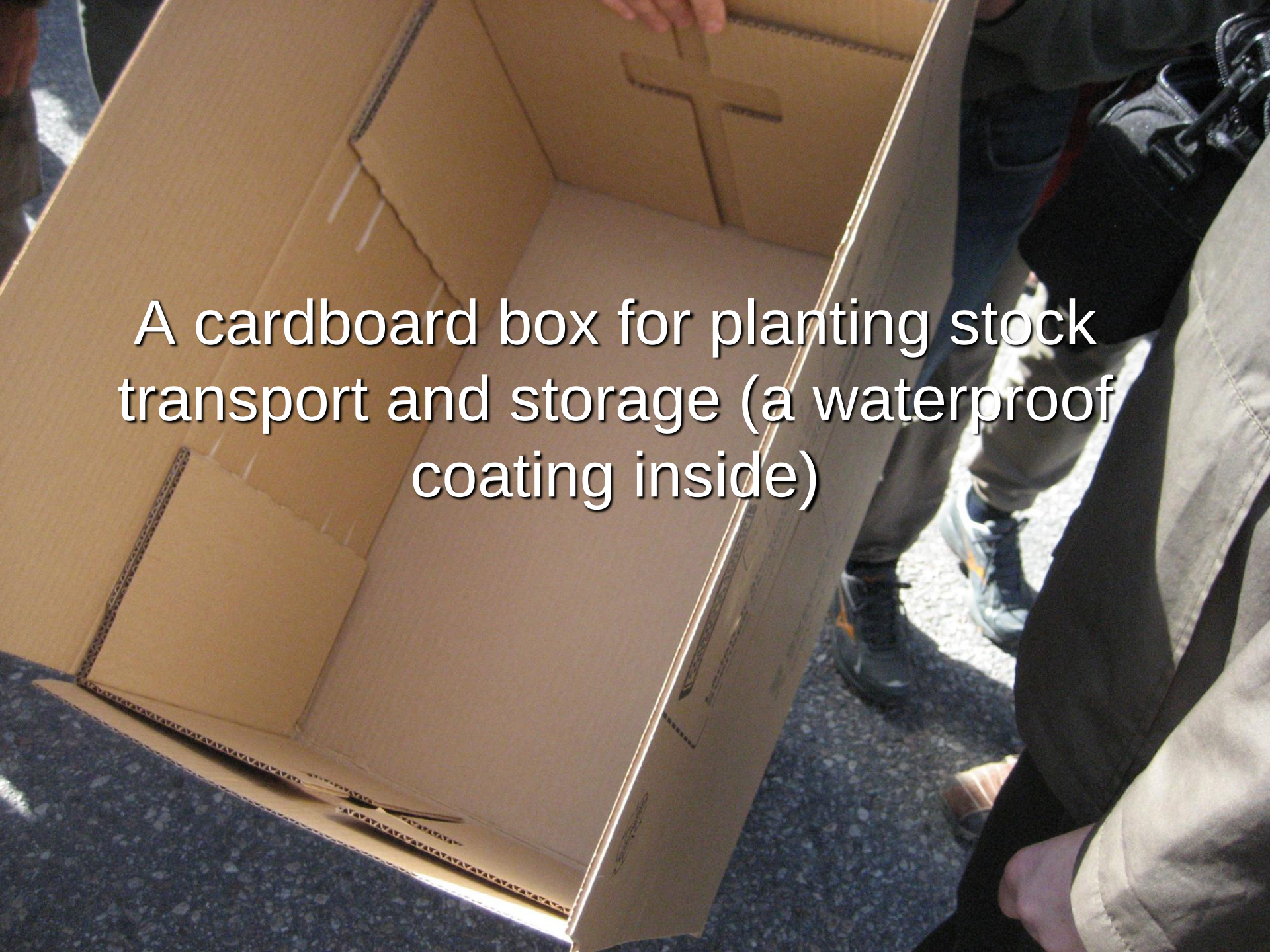
- Before transport from a nursery
  - Fertilization
  - Check whether the substrate is not dry (check continuously during cultivation)
- Transport
  - In containers (containers need to be returned to the nursery)
  - On pallettes
  - In cardboard boxes
  - Packed with shrinkwrap (overwrap)
  - Plastic bags

Plants removed from the containers (phlug)

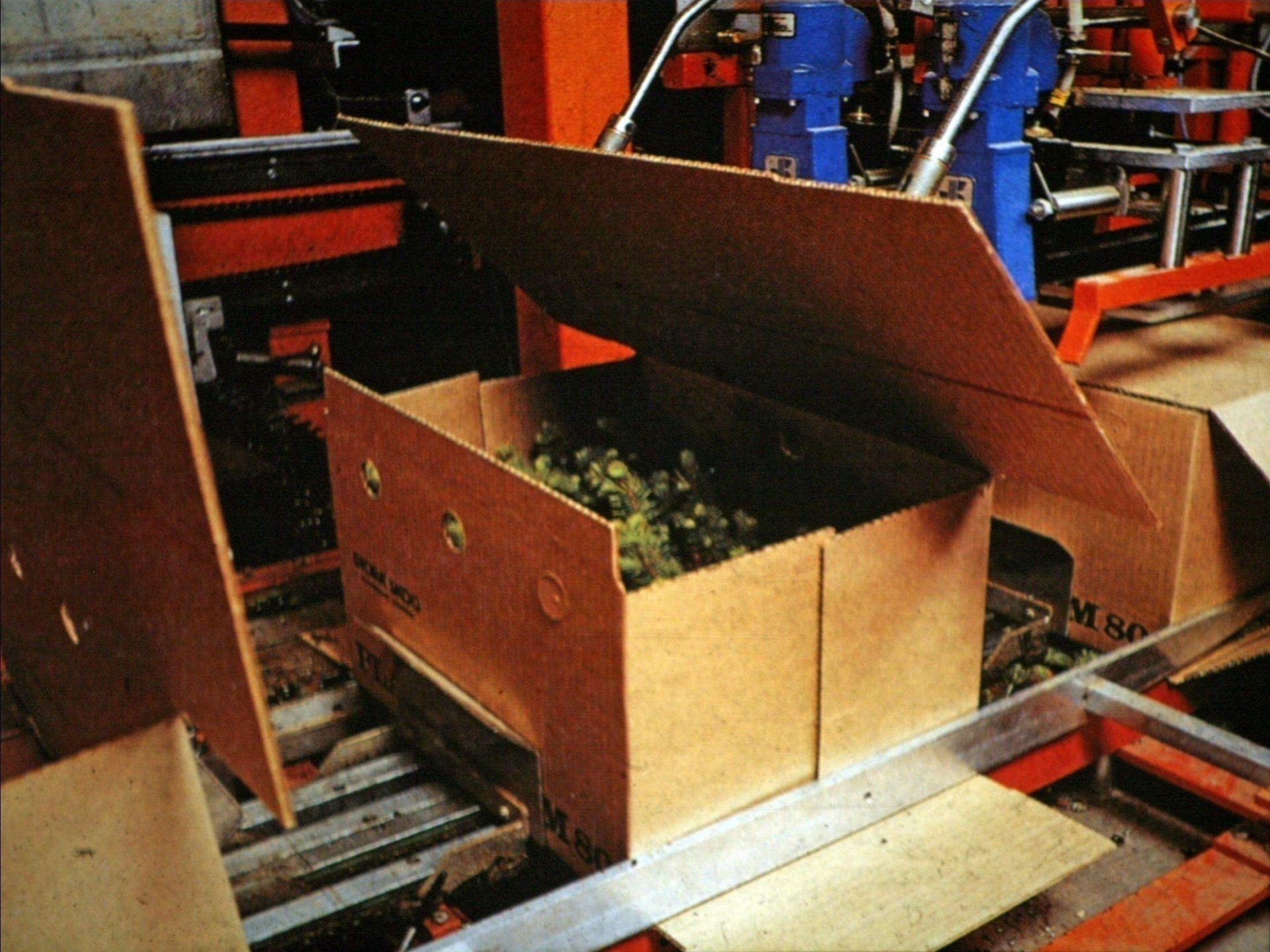
  - Other non-returnable packaging (wooden pallets, etc.) can be used


Handling hall

Lifting-up of containerized planting stock in the holding area


A cardboard box for planting stock transport and storage (a waterproof coating inside)


SVENSKA
SKOGSPLANTOR
www.skogsplantor.se
NFP-TAIMI
NORDIC FOREST PLANTS OY
www.nordicforestplants.fi
JÄMSÄ / JUVA




TAIMIEN PAKKASVARASTOINTI PÄÄTTYI /
PLANTANS FRYSLAGRING AVSLUTADES
KK / MÅNAD
PÄIVÄ / DATUM
HUHTI APRIL
TOUKO MAJ
KESÄ JUNI
TAIMIEN PAKKASVARASTOINTI PÄÄTTYI /
PLANTANS FRYSLAGRING AVSLUTADES
KK / MÅNAD
PÄIVÄ / DATUM
HUHTI APRIL
TOUKO MAJ
KESÄ JUNI

Transport of planting stock to the planting site

Planting of containerized planting stock – a hollow rod (Pottiputki)

Containerized planting stock in crates

Wooden crate

Cardboard crate

Cardboard crate laid out with a foil

Plastic crate


Plastic crate


Plastic crates instead of cultivation frames


A multi-storey transport space, plants packed with a shrinkwrap
CZ 5U0 0211

Planting stock packed with a shrinkwrap

Planting stock packed with a shrinkwrap in cardboard box

Transport of planting stock packed with a shrinkwrap

Pallets for storage and transport of planting stock

Planting stock packed with a shrinkwrap in a plastic bag

Planting stock packed with a shrinkwrap in a palette

Planting stock in containers in palettes

Transport of planting stock in palette

Transport of planting stock plastic bags


Transport of planting stock plastic bags
(from inside black, from ouside white)

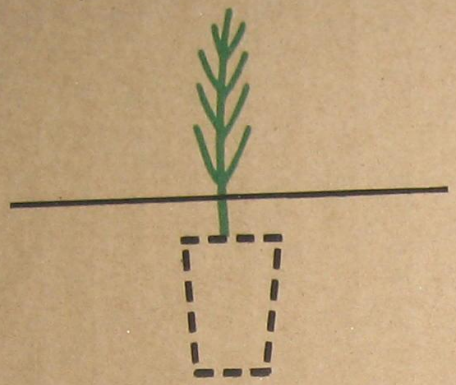
Transport of planting stock in containers in multi-storey palettes

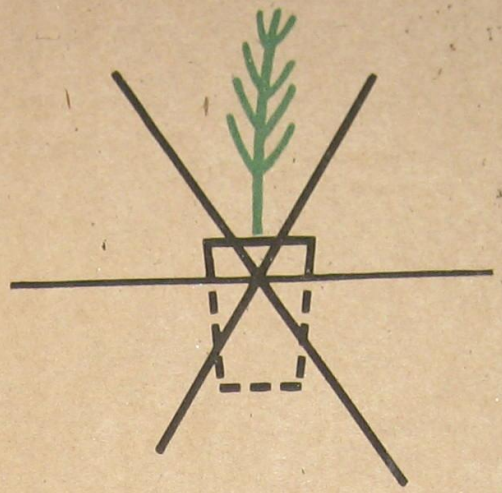
Planting stock in containers in multi-storey palettes

Transport of containerized planting stock in crates

Storage of planting stock in containers in superimposed cultivation frames

Planting stock in containers in a plastic bag (from inside black, from ouside white)





OBS!

1. "Färskvara"! Plantera snarast!
2. Torvklumpen måste vara helt upptinad före plantering!
3. Ställ kartongen skuggigt och svalt. Tryck ut kartongbitarna vid handtagshålen.
4. Blir planteringen försenad, öppna kartongen, vattna vid behov.
5. Lådan är återvinningsbar. Svenska Skogsplantor AB är anslutna till REPA.