

актуальне, оскільки питома вага автодрезинного руху на вузькоколіїних туристичних залізницях, поряд з паровозним зростає. Зокрема економічно вмотивована потреба в таких засобах існує в таких країнах Карпатського Єврорегіону, як Польща [7], Угорщина, тощо.

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A STUDY ON SITE PREPARATION METHOD FOR MECHANIZATION

We are on the way of developing site preparation equipment in order to mechanize planting operation. As preliminary work for the development, we studied on characteristics of some different site preparation methods. We prepared the test site using vehicle based machines to make patched spots by mounding and scarification. We distinguished test plot to 4 categories, which are mound and pit from mounded spot, scarification and untreated. On each categories we measured soil density, moisture content and its change, survival rate of planted containerized seedlings and vegetation coverage 1 year after treatment. The result of soil density in order of scarified < untreated = mound < pit, that of moisture content are pit > untreated > scarified > mound, that of survival rate are pit > scarified = untreated > mound and that of vegetation coverage are scarified < pit = mound = untreated. In reference to soil density and plant coverage which is more suitable when it is smaller for seedling growth, scarification is found to be most favorable for planting. However in this test the limiting factor is found to be moisture content due to dry site environment, which lead pit plots to have shown the highest seedling survival rate.

Keywords: silvicultural machinery, site preparation, mound, scarification

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Дослідження способів механізації підготовки ґрунту для садження лісу

Мета роботи – розроблення обладнання для механізованої підготовки ґрунту до садіння лісу. Попередньо вивчалися різні методи підготовки ділянок. Машинним способом ми підготували експериментальні ділянки шляхом насипання пагорбів і розпушування ґрунту. Розрізняли 4 типи експериментальних ділянок: поверхня ґрунту з насипаними пагорбками; ямками, звідки брали ґрунт для пагорбів; розпушена земля; необроблений ґрунт. Через рік для кожної експериментальної ділянки визначали щільність ґрунту, його вологість, рівень виживання брикетованих саджанців і рослинного покриву. Результати замірів щільності ґрунту були такими: для розпушеного ґрунту < необробленого ґрунту ~ пагорбків < ямок. Вологість: ямка > необроблений ґрунт > розпушений ґрунт > пагорбок. Рослинний покрив: розпушений ґрунт < ямка ~ пагорбок ~ необроблений ґрунт. Виявилося, що розпушений ґрунт є найбільш сприятливим для садіння; чим менша щільність ґрунту і менший рослинний покрив, тим краще приймаються саджанці. Однак, у цьому експерименті був один обмежувальний фактор – низька вологість, і тому ділянка з ямками показала найбільш високий рівень виживання саджанців.

Ключові слова: садильні машини, приготування ґрунту, пагорбок, розпушений ґрунт.

1. Introduction

It is said that efficiency of planting operation is difficult to be improved through mechanization. Even manual operation realizes high efficiency by application of containerized seedlings [1, 2]. On the other hand, in scarifying operation there is a huge difference in efficiency between mechanized and manual operation. As scarification before planting delays vegetation recovery on treated area, early weeding operation may be reduced. Thus if we treat site preparation rightly, we can realize both of high efficiency and better condition of regeneration. We are developing silvicultural equipment on which the planting device and the site preparation device are combined. Prototype planting device had been manufactured already [3]. In accordance with the development, it is necessary to study on characteristics of site preparation methods to design site preparation system.

According to reports of vehicle based automatic planters [4], most of them have the scarification unit. As many of them are line scarifiers with fear of erosion on steep slope, we did not employ in this development. In this study, site preparation was done on patched area for conservation of forest floor. Mounding and scarification had been done and we measured soil density, soil moisture content, survival rate of planted containerized seedlings and vegetation recovery.

2. Study site

We set the study site in cooperative experimental forest with the forest technology center of Kanto forest administration bureau, located in Nanakai village Ibaraki pref. We set 5m by 90m rectangular section on the harvested area. The result of preliminary soil investigation by making cross cut section shows that though the soil type was determined Bc, soil moisture content was found the same as Ba according to the result of soil investigation of national forest [5] because of harvest. There was dense understory which had recovered after harvest. Thus we cleared it by the hydraulic bush cutter and grapple equipped on the articulated tracked vehicle which

was developed by us. After clearing, we do mounding and scarification by an excavator and the hydraulic earth auger equipped on the articulated tracked vehicle.

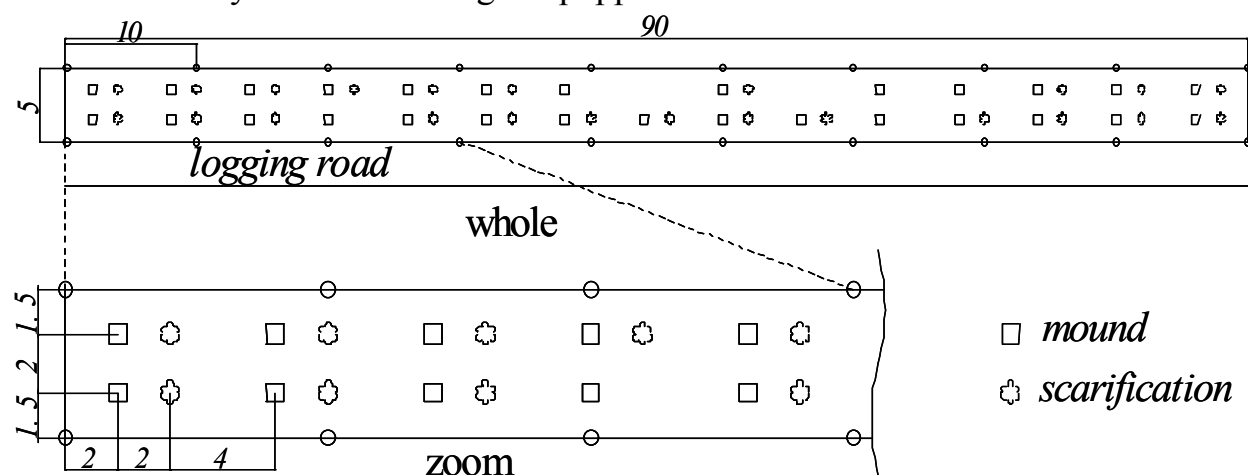


Figure 1. Distribution of treated patches

The plot distribution of each site preparation methods is shown on Figure 1. Untreated area was set also as control plot. As mounds, scarification and untreated were aligned on 2 columns by 45 rows at 2 m intervals, 30 patches of each treatment could be set, however some area could not be treated because of piles of limbs and unused stems of harvested woods. Consequently, we prepared 28 patches of mound, 23 patches of scarification and 28 patches of untreated. As there was a logging trail along the test site, operation vehicles could pass it and could work without entering into the test site using their booms which can reach more than 5m length.

3. Site preparation method

Site preparation was done in September and October 2001. At first we cleared understory by the hydraulic bush cutter and grapple as explained above. And did site preparation as described below.

3.1. Mounding

Mounding is one of the site preparation methods which are done on over-humid area. The purposes of mounding operation are improvement of soil humidity, exposure of mineral soil and increase of soil temperature. Mounding equipments are excavator, rake [6] and special other equipments [6, 7]. An excavator was used in this study. The excavator dug 600 mm by 600 mm area into 200 mm depth and reversed the dug soil on side (Figure 2a). A mound which is 200 mm higher than original floor and a pit which is 200 mm lower than original floor were made simultaneously (Figure 3). Though it is recommended to plant on mounds in humid condition [7], it is said that pit has better condition for seedling in dry condition [8]. In this test site which seems to be in dry condition, pit was supposed to be better site to plant rather than mound.

3.2. Scarification

Scarification was done by a hydraulic auger equipped on the boom of the articulated tracked vehicle into the depth of 200 mm (Figure 2b). As the diameter of the auger is 280 mm, the treated patch was made in approximately same size as mound by 7 times scarification of the honey comb shape (Figure 3).

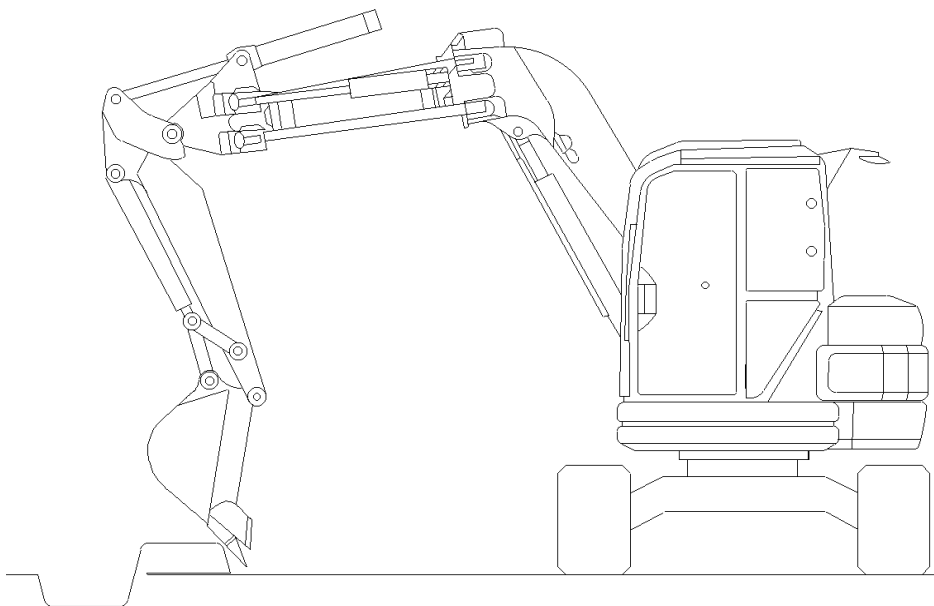


Figure 2a. Mounding

Both of site preparation methods remove or destroy existing vegetation. As the vehicles did not enter into the test site, no soil compaction had occurred.

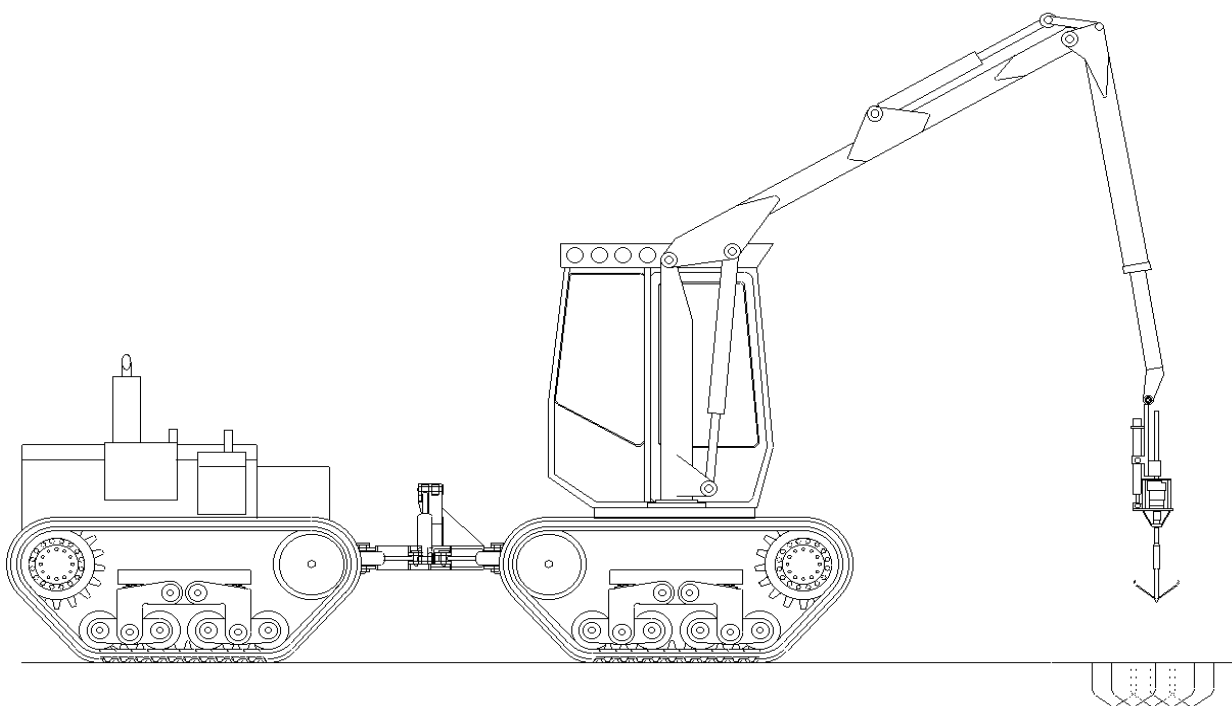


Figure 2b. Scarification

4. Study method

We had done investigations and measurements as below on each treated patch including untreated ones. Therefore we had 4 categories for investigation, which are mound, pit, scarification and untreated.

4.1. Soil density

We measured surface soil density by sampling right after the site preparation operation had finished. On untreated, samples were collected from right under the A₀ layer. 1 sample was collected out of every 3 plots in all categories. And average of 3 plots of each category was calculated.

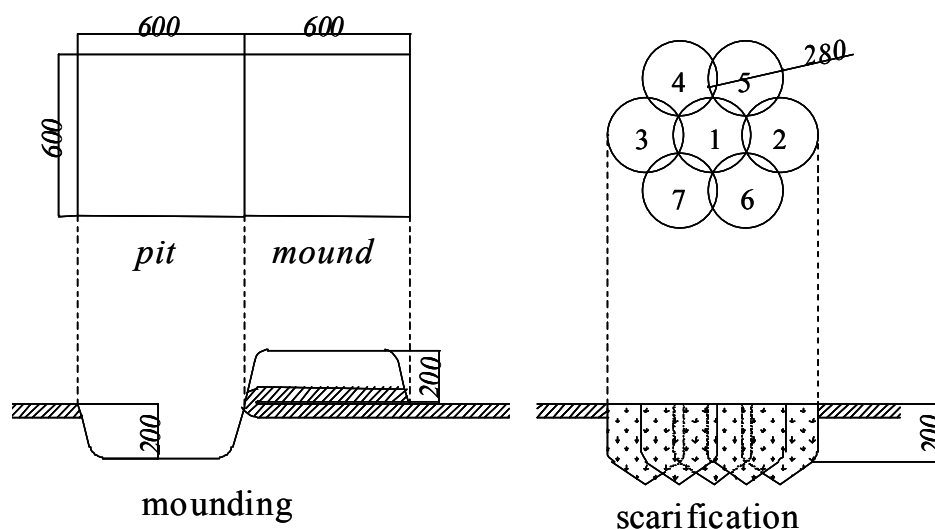


Figure 3. Method of site preparation

4.2. Soil moisture content

We buried gypsum block in the depth of 50, 150 and 250 mm on the same plot of soil sampling, and have measured soil moisture content every week in summer and every 2 weeks in the other seasons. The precipitation data for comparison was collected from weather monitoring point in Kasama the nearest point from test site. Average of 3 plots of each category was calculated.

4.3. Survival rate of planted seedlings

We planted 2 years old Hinoki (*Chamaecyparis obtusa*) containerized seedlings on the center of every treated patch in July 2004. We intended to plant them carefully to avoid influence on survival rate and growth caused by incomplete planting. Survival rate of them had been investigated every week and growth of them had been investigated every month. In survival rate investigation, we had estimated the condition of seedlings to 5 grades which are healthy, little damaged (died back less than 1/4 of whole leaf area), medium damaged (died back more than 1/4 and less than 1/2 of it) heavily damaged (died back more than 1/2 of it) and dead.

4.4. Coverage of vegetation

We investigated cover degree and height of all species of recovered vegetation on every treated patch in October in 2002. As untreated has no treated area, investigation was done in the circles of the 677 mm diameter around the planted seedlings which has the same area as mound.

Investigation of survival rate and vegetation coverage has been continued still now. As damages by wild hares on planted seedlings and moisture measuring equipments were found in winter, we analyze the data until January 2003.

5. Result

5.1. Soil density

Soil density right after site preparation is shown on Figure 4. In the order from low to high is scarification < mound = untreated < pit. The surface soil became compact because dense lower layer had been raised to the surface of mounds and exists at the pits. However soil became loose on mound by shock and vibration caused by operation and soil did not become loose on pit because no disturbance occurred on the layer. On scarified area, destruction of understory and loosening of soil had occurred at the same time.

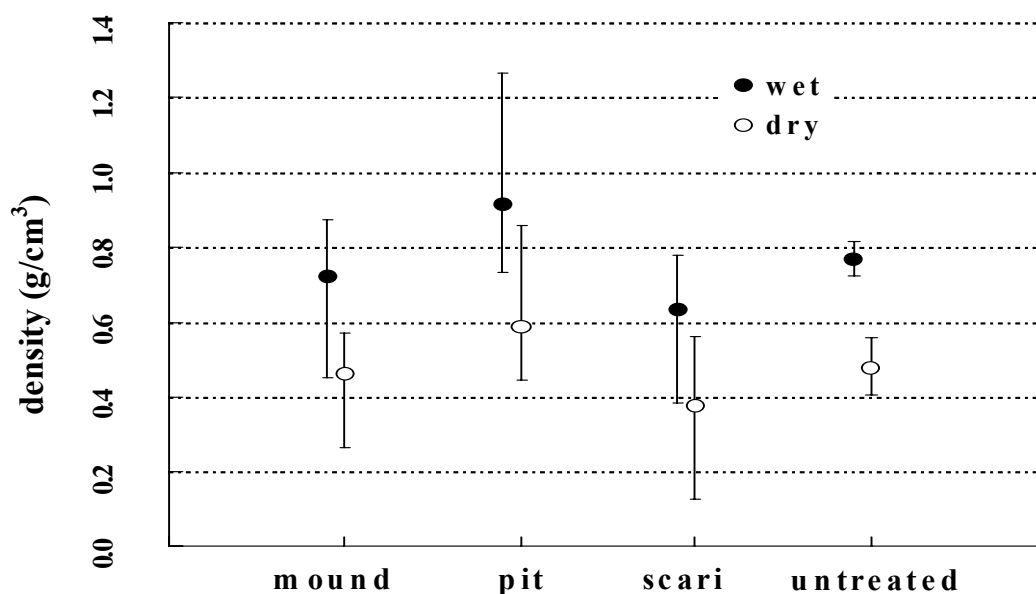


Figure 4. Soil density

5.2. Soil moisture content

Change of soil moisture content is shown on Figure 5. Average of adsorption pressure in 3 measuring plots are shown. Measurement had been done since April 2002 until January 2003. The value was high (it means the soil was dry) in summer because climate in summer in 2002 had been hot and dried (precipitation was 42 %, hours of sunlight was 143 % and average temperature was +1.8 degrees comparing with average years). It is even more promoted by that the location of test site was on ridge. Though the maximum value is not more than 1.47 MPa in Figure 5 because of the measuring range of meter, real value would reach the same as air-dry.

On mound, soil became dry to the maximum during no rain term. Soil kept moisture even during no rain term in pit. Soil becomes dry to the maximum during no rain term not soon on scarification. On untreated, though soil moisture content has changed like on scarification, final value tends to be wetter than on scarification. Mound is easy to be dry because as soil on mound is isolated from the former soil surface by folded vegetation layer, water cannot rise from below to mound through capillary. As pit is a concave, it gathers and stores rain. And moisture is easily supplied from lower layer through capillary action. Soil on scarification has much coarse pore so that moisture is difficult to be supplied from lower layer. Comparing with primary wilting point 0.62 MPa (Figure 5), all the values on mound in August were higher. Consequently it is presumed that aridity had influenced on seedlings.

5.3. Survival rate of planted seedlings

Change of damage on planted seedlings is shown on Figure 6. As explained before, summer season was very hot and dry in 2002, a lot of seedlings are damaged. Particularly 71.4 % of seedlings had died by aridity on mound until January in 2003. On the other hand, 21.4 % of seedlings had died on pit. Mortality on scarification and untreated were 47.8 % and 50.0 %. Z test of significance level of 5 % was done to examine whether there is difference in mortality between on untreated and on the other treatment or not. In most of the period since the beginning of death of seedlings, mortality had been significantly higher on mound, significantly lower on pit and no significant difference on scarification. The result is shown on Table 1.

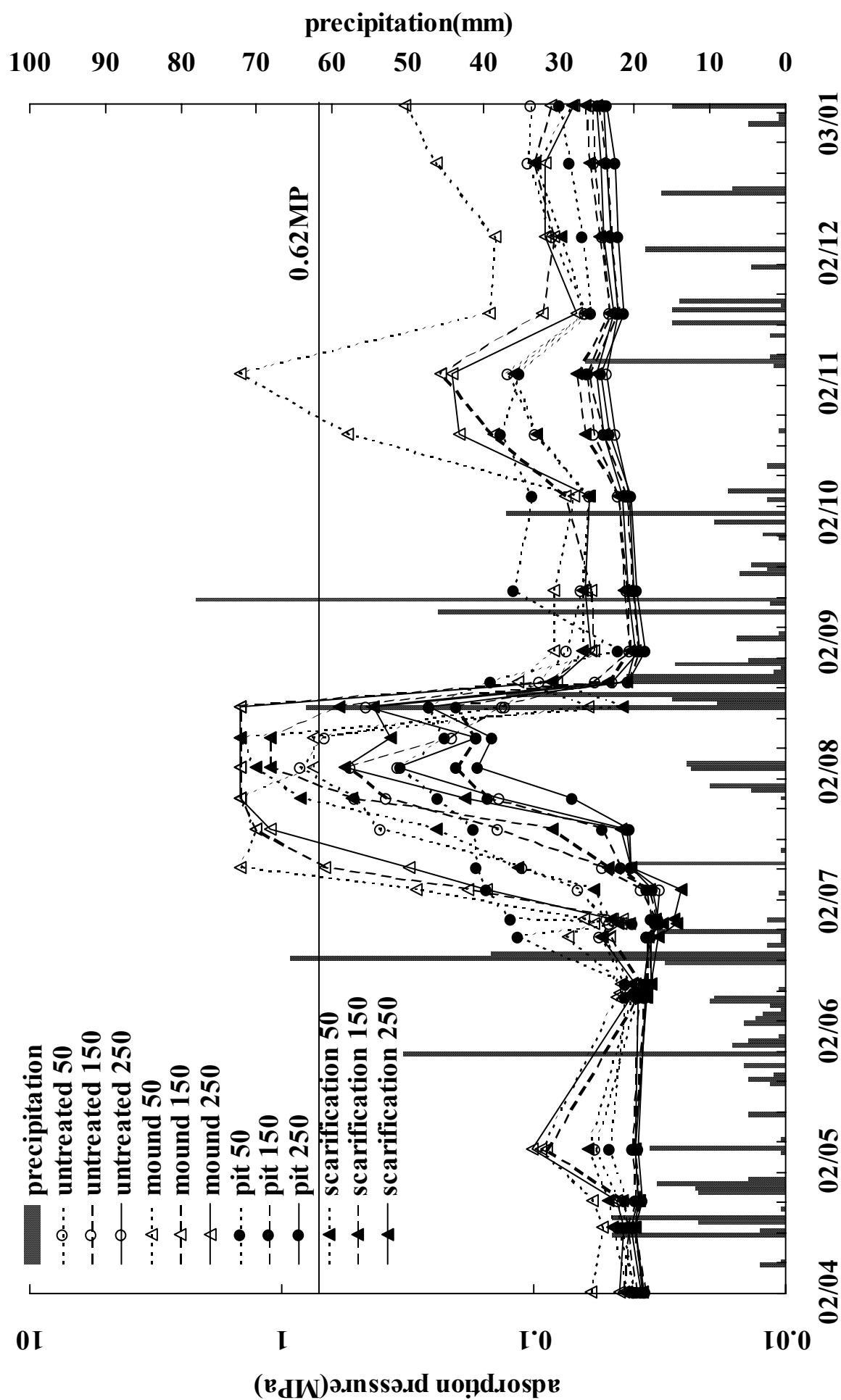


Figure 5. Precipitation and soil moisture content

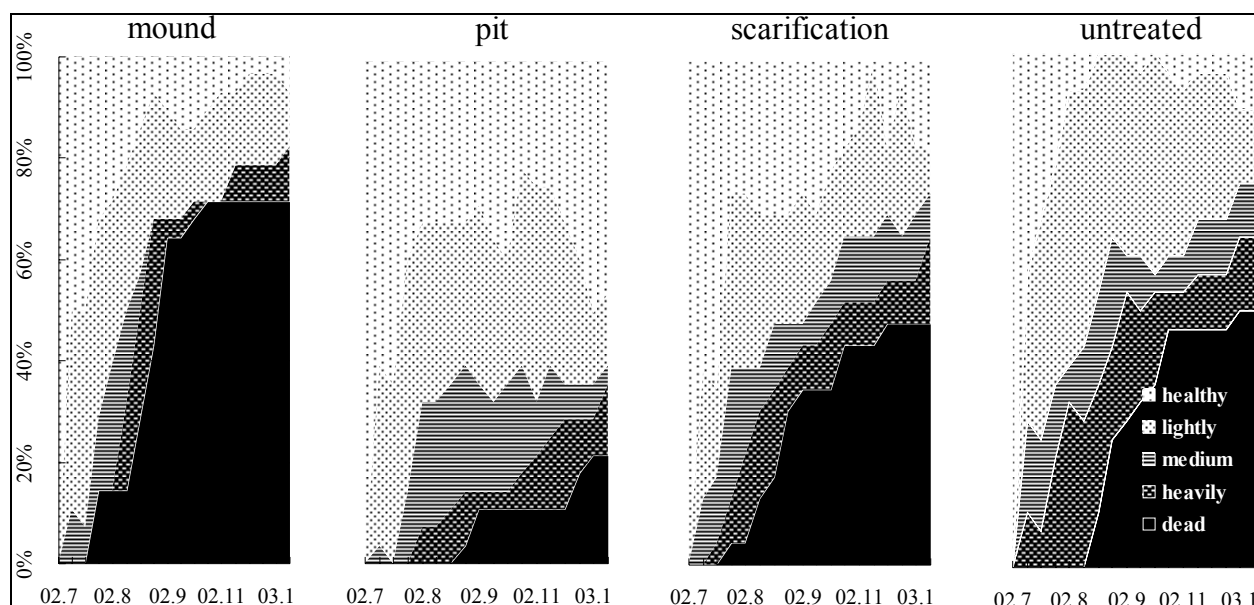


Figure 6. Survival rate of planted seedlings

5.4. Coverage of vegetation

Average and range of cover degree of each category is shown on Figure 7. Comparison of average value indicates in the order from high to low is untreated on which vegetation damage was small, mound, pit and scarification. The result of Z test of significant level of 5 % showed that only scarification is significantly lower and the other have no significant difference.

Table 1. Result of significance test at significant level 5%

	mound	pit	scari
8.30	+	0	0
9.6	+	—	0
9.12	+	—	0
9.19	+	—	0
10.3	+	—	0
10.25	+	—	0
11.8	+	—	0
11.22	+	—	0
12.6	+	—	0
12.24	+	—	0
1.10	+	—	0
1.23	+	—	0
+ : significantly higher			
— : significantly lower			
0 : no significant difference comparing with untreated			

5.5. Discussion

Mortality of seedlings has the same tendency as soil moisture content. Consequently, it is decided that the limiting factor of survival was soil moisture. In dry condition like this test site, the principal factor in survival of seedlings is soil moisture content and the other factors are subsidiary. Therefore pit as wet micro site is appropriate for regeneration. However the suppressive effect on vegetation recovery was found on scarification. Scarification can be expected to prevent suppression on seedlings for long term.

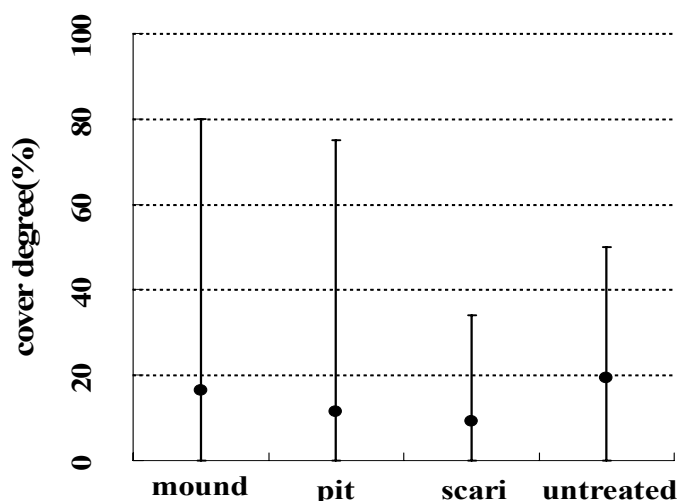


Figure 7. Cover degree of vegetation

6. Conclusion

In this study, the result shows the order of survival rate among planted seedlings from high to low was pit > scarification = untreated > mound. This result would be caused by soil moisture content because of quite dry condition on this test site. Though this result can be referred to silviculture in dry condition, it is expected that different result will be found in humid or mesic condition. Thus it is necessary to do similar study on the hillside or the bottom of slope, or using different species.

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THE INFLUENCE OF FOREST STAND SIZE AND LOCALITY ON THE OPERATIONAL EFFICIENCY OF MECHANISED FOREST OPERATIONS

The sizes of stands on which forest operations are carried out upon, and the distances between pairs of stands, were analysed for four regions comprising all Danish state forests.