THE PROPAGATION OF PICEA BY SEED

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INTRODUCTION

The germination of a seed and a seedlings subsequent growth are two of natures most fascinating and complex phenomena In the propagation of *Picea* by seed, as is true with other plants, this process of germination is of utmost importance Over a long period of time plant propagators have developed many cultural practices designed to regulate the germination of a seed and its subsequent development. The cultural practices described in this paper may not agree with all the very latest scientific findings on the subject, since the practices discussed are based upon ones actually used at the Evergreen Nursery in Northwestern Wisconsin They have been developed over the past 92 years by continual study of scientific and commercial findings along with our own experience. Further, the discussion which follows is limited to those *Picea* species and varieties commonly grown from seed by our nursery. *Picea abies, Picea pungens glauca, Picea glauca* and *Picea glauca densata.* The propagation of *Picea* by seed is limited to those species and varieties which do not require asexual reproduction Propagation by seed is almost always used whenever it is possible since it is considerably cheaper than other methods.

SEED

In almost every discussion of propagation by seed, the importance of good seed selection is emphasized. Stressing the fact that it is important to secure high quality seed is an excellent idea, although the actual problem of securing this type of seed is often difficult and exasperating. We find it necessary to have seed sources in Japan and Europe as well as the United States. Since the source of seed has become increasingly important in this phase of propagation, the field of genetics also has become more important in helping to solve some of the problems in seed source and selection. Good seed dealers take a great deal of care to select the type of seed which is desired by the customer. Once the cones have been collected it is necessary to have a very strict labeling procedure, since this will be the only sure means of identification between strains of the same varieties and species. Very often it is necessary to buy seed for two or three or more years in advance when there is a good crop, since the next year (s) the crop may be rather poor. The *Picea* which we are discussing may all be stored in sealed containers at 40 degrees Fahrenheit for a maximum of five years without a great deal of loss in germination percentage White spruce, Black Hills spruce and Colorado Blue spruce can often be kept even longer than this. Generally we do not store our seeds for periods longer than three years.

It is an excellent idea to run a germination test or a cutting test on the seed you plan to sow. We usually run a cutting test, and where we obtain seed from sources that we are not too familiar with, we will also have a germination test made for us. A cutting test is by no means a sure indication of whether or not the seed will germinate, since it is hard

to pick out weak embryos and rancid seed. Generally the actual germination will be between 10 to 20% lower than the cutting test indicates. The advantage of this test is that it is very fast and can be performed in a rather short time. We all realize that in order for seed to germinate there are several factors which must be favorable. These can be broken down into two general classes. The first is that of environmental conditions that are necessary for good germination. When these external factors will not permit germination, the phase is often referred to as quiescence. Moisture is one of these influencing factors, the lack of it, or an over-abundance of moisture will prevent germination. This is why we must have ample drainage for seed bed areas. Oxygen is another factor which must be present in order to have germination. If seeds are covered too deeply or water stands in certain areas, oxygen will not be sufficient. Although light is usually not necessary in the very early stages of germination of *Picea*, it certainly is necessary as soon as the germinating seedling pushes its way to the surface. There is a rather critical time when the straw or mulch must be removed from the germinating beds in order to insure the subsequent development of a good seedling. Temperature is another factor which is very important to germination. Spruce seeds will germinate rather slowly and poorly during warm weather. That is one of the reasons we plant our seeds in the fall so that they germinate during the cool spring months and have all of the following summer to develop into a strong seedling There are many other environmental factors which affect germination, but they are rather minor, in most cases. The second general classification of factors affecting germination is that of rest or internal dormancy. This will be discussed later under the heading of "PreTreatment of Seed." It is necessary for us to control these factors to the best of our ability through various cultural practices in order that we might insure a good germination and quality seedling. It is well to remember before a seed can germinate, usually a complex series of chemical changes take place within the seed which makes germination possible. The tiny seed is not static but rather a living and dynamic object.

PREPARATION OF SEED BED AREAS

The selection of a proper soil type is extremely important First, we feel it should be a very well drained area with a pH of 6.0 or slightly lower if possible We prefer a sandy loam type of soil with a slight slope for good air drainage We have selected certain areas throughout our nursery which we feel will make good seed bed areas and set them aside for this purpose only. We have also set up a crop rotation program for these areas. Usually the old seed beds are cleaned up at the end of spring and then these areas are treated with 10 pounds of Dalapon plus 2½ pounds of Amino Triazole per acre to eradicate quack grass. After ten days the field is plowed and an application of approximately 50 pounds per acre of a 5-20-20 fertilizer is made. The type and amount of fertilizer applied is based on soil test results. The land is then worked until late June when a combination of oats and alfalfa are sown. This may seem rather late to be sowing oats, but it works out very well for us since we do not cut the oats but allow it

to stand as a winter protection for the alfalfa. Because our soils are very low in potassium and boron, we top dress the alfalfa with 0-10-30-B at the rate of 200 pounds per acre in late fall. The alfalfa is grown only until the first crop is ready for harvesting, which is about July 10 of the following year. If quack grass is not under control at this point, we will again apply the quack grass herbicide treatment, wait ten days and plow under the alfalfa crop. We do not remove the oats or any alfalfa from the land. Before plowing the alfalfa down we apply nitrogen in the form of nitro pills to insure quick decomposition of the alfalfa plants. After plowing we apply the necessary commercial fertilizer determined by soil tests to bring phosphorous and potassium up to a high level. Approximately 20 tons per acre of manure is also applied at this time. The soil is then treated for grubs with an application of Dieldrin applied as a liquid which is immediately disked in. We have been experimenting wth Vapam for control of weeds and damping off. If we find it becomes feasible to use this material, we probably would apply it in August when the environmental conditions are right for its usage. Our crop rotation then consists of one year of oats, one year of alfalfa and three years of seed beds, thus forming a six year rotation program. We have adapted this rotation to suit our own needs and it no doubt would not agree with what other seedling growers are using.

PREPARATION OF ACTUAL SEED BEDS

We start our actual preparation of the seed bed during the first week of November. We feel that fall sowing of *Picea* has proved more satisfactory than spring sowing, since nature will stratify the seed very well over the winter, which results in very even germination early in the spring. Also, we believe a larger 1-0 seedling will be obtained by fall sowing. The reason for not starting sowing before the first week in November is to insure that germination will not begin that fall. After a final dragging of the seed bed areas by a meeker which levels the soil, we mark out the beds and prepare them for seedling. The beds always run in an east and west direction, since this gives the proper distribution of light under the shade through the course of the day. We have attempted to mechanize as many of the operations as possible. The beds are marked out with a device attached to one of our tractors which accurately marks out 4 foot wide beds with 30 inch aisles. This size bed and aisle enables us to drive all of our mechanized units over the beds which certainly speeds up many of the operations. After the beds are marked, some of the soil from the aisles is thrown into the bed area with the result that the beds are raised to insure good drainage The beds are then raked by hand with regular garden rakes. Next is a heavy application of Milorganite applied with a 4 foot spreader. We feel that the organic nitrogen will release itself at a rate slow enough so the tiny seedlings will not be injured and yet have a sufficient nitrogen supply for their first year development The Milorganite is raked in lightly and the area rolled. Beds are now ready for seeding.

PRE-TREATMENT OF SEED

Even though the seed is given all of the necessary environmental factors for germination, we still must consider whether or not the seed itself is ready for germination. It has been our experience over the past years that if Norway, White, Black Hills or Colorado Blue spruce is sown in the fall, the possible resting conditions which might exist within the seed and prevented its germination will be overcome by nature during the winter. In the past, most literature suggests that Norway spruce and Black Hills spruce generally do not have any of these resting conditions, while Colorado Blue spruce and White spruce sometimes do. They recommended stratifying these seeds in moist sand at 40 degrees Fahrenheit for approximately 30 to 60 days We feel that it is much cheaper and easier to plant in the fall. If it is necessary to plant in the spring, due to late arrival of seed or inclement fall weather, the storage of the seed in a bag at cold, moist temperatures seems to overcome the resting condition satisfactorily. We pellet our seed with Arasan as a protection against damping off organisms and bird damage. Norway spruce, White spruce and Black Hills spruce are pelleted, but we have not found it necessary to do so on the Colorado Blue spruce.

SOWING OPERATIONS

After the bed has been rolled, the seed is spread by means of a Scott's Spreader, thick enough so that we obtain approximately 40-60 healthy seedlings per square foot, depending on type of seedling desired. It is rather difficult to calculate the exact amount of seed that should be sown since the purity, soundness, germination percentage and other factors all vary with different years and can easily change the number of seedlings that finally develop. In the case of White spruce, the seed is so fine that it is often necessary to slightly roughen the bed area with a broom rake before seeding. After seeding the beds are rolled and labeled as to kind of seed, source of seed and other pertinent data. The seed is then covered with Lake Michigan beach sand to a depth of approximately twice the thickness of the seed. Although there has been a lot of discussion and some scientific data on the depth to cover seed, we have found that it is not as critical as we used to believe. The machine that is used for applying the sand is able to apply this layer of sand to whatever depth is desired Beds are then rolled again and a mulch of combined rye straw is applied to a depth of approximately 2 to 3 inches. We use a converted manure spreader for this purpose. The final step is to place shades over the straw to prevent it from blowing off.

CULTURAL PRACTICES DURING SEED GERMINATION AND THE FIRST YEAR

The following spring the *Picea* seeds will commence germinating between May 15th and 20th The Colorado Blue spruce and Norway spruce generally germinate sooner than the White and Black Hills spruce. It is extremely important during the time germination is expected, to check the beds each day for the progress of the germination process. We uncover the germinating *Picea* seed just before it pushes

through the surface of the sand. The shadings are then set to one side and the straw is removed by means of forks and broom rakes. Stakes are driven in along the edge of the beds, wire stretched on these stakes and the shadings are replaced on the wire Now starts a critical period of time during which the moisture level of the soil must be kept at optimum conditions for the development of the very young and tender seedling. This is accomplished by setting up a semi-permanent overhead sprinkling system which will stay in operation during the first and second growing season The water is supplied by means of a 6 inch main through which we are able to pump water from a swamp lake or from a deep well. We prefer to use the rather warm water from a swamp lake in preference to the cold well water During the first season the seedlings are watered every other day for 1 to 1½ hours during the middle of the day. Since the roots are so small and located rather shallow, it is necessary to water often but not too much at a time. As the seedlings develop they are watered less often but with a heavier application. At the present time we still hand weed all of our seed beds since we have not found a satisfactory weed control chemical. However, we do use extensive chemical weed control on transplants. It is difficult to apply the chemical over a thick seed bed so that sufficient chemical reaches the ground at the base of the seedling. Possibly this is one reason for our failures Hand weeding is a rather costly process but unless it is done regularly it will mushroom into a situation in which the weeds are so large that many trees are destroyed during the weeding operation. All of our weeding on seed beds is done by women. We do not fertilize during the first growing season, since the organic nitrogen that we added when the seeds were sown usually supplies sufficient nitrogen for the small seedling. Also, the crop rotation usually gives us sufficient potassium and phosphorous for healthy development of the seedling At the present time we have not found it necessary to spray any of the *Picea* seedlings for insects or diseases as has been necessary with pines It is necessary to give these small seedlings some winter protection which we accomplish by first removing the shadings and then applying a 3 to 4 inch layer of combined rye straw with the same machine that was previously described The straw is tucked under the edge of wire which was used to support the shadings. This prevents the straw from blowing away. The mulch is left until early spring when it is removed by hand.

CULTURAL PRACTICES THE SECOND AND THIRD YEARS

During the second and third year there are no shades over the beds, since we find that with the overhead irrigation we can develop better plants under full sun. At this point we do fertilize with a liquid fertilizer which generally is a nitrogenous type. We prefer ammonium sulphate for this job, since we get a combination of nitrate as well as ammonia types of nitrogen The application of the high nitrogenous fertilizer usually gives a very good growth response because the other nutrients necessary for plant growth are in good supply, due to crop rotation Again all the weeding is done by hand We begin removing the seedlings for commercial distribution and transplanting as 2-0

seedlings. However, some of the spruce are grown on into 3-0 plants The beds that remain after digging operations in the spring are root pruned with a large blade that undercuts the bed. We dig our seedlings by a blade attached to a tractor that digs and lifts the entire seed bed in one operation. The seedlings are then removed to a building where they are run over a conveyor belt for grading purposes. The plants that are designated for shipping are then carefully packed by experts who have had many years experience. We have always felt that packing must be done by people that are skilled in this job and realize that even the best quality seedling is of little value to the customer if it arrives in poor condition In conclusion, we would again like to emphasize the fact that these practices which we follow certainly may not necessarily be the best or fit your particular situation. These practices are ever changing as we put into use new and better ideas in an attempt to most economically produce the type of quality seedlings our customers desire. (Applause)

MODERATOR MEAHL: Thank you very much, Mr. Pinney. We will proceed right along with our next subject, the propagation of spruce by grafting Our speaker is Mr. John Ravestein, Mentor, Ohio.

Mr Ravestein presented his paper, "Our Method of Grafting Blue Spruce." (Applause)

OUR METHOD OF GRAFTING BLUE SPRUCE

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The understock used for the grafting of spruce is not grown at our nursery Norway spruce is purchased from a reliable source as 2 to 3 year old seedlings, preferably once transplanted. You should be certain that the understock is healthy with a fibrous root system These seedlings can vary in size from 6″ to 12″. We always plan to have our understock arrive in the spring in plenty of time to allow us to inspect the plants and to trim the roots in order to establish a fibrous root system. We then heel in the plants for a short time in order to induce some new root growth. They are then planted out

We plan to have the understock grow in our nursery for two years. However, there are exceptions to this, which I will point out later.

We prefer to plant on a sandy soil which is not too rich in nutrients. The ground should be prepared as early as possible in the spring by spreading ¾″ to 1″ peat over the bed and Rototilling to a depth of approximately 8″. We use the peat to get a more fibrous root system, which in our estimation is necessary to make a go of it. At the time of grafting a fibrous root system is absolutely necessary to insure the survival of the understock during the process of establishing a growing graft.

We plant in rows 12 inches apart, spacing our understock 2½ to 3″ apart in the row. This spacing may sound very close to you but we