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Forestry

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Dakota Agricultural College

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Bulletin No. 15.

NOVEMBER 1889.

DEPARTMENT OF FORESTRY, HORTICULTURE AND BOTANY.

FORESTRY.

SENTINEL STEAM PRINT, BROOKINGS, SOUTH DAKOTA.

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Any resident of Dakota can have the bulletins of the Station mailed to him free by addressing a request to the Director at Brookings, South Dakota.

Correspondence is invited upon any question relating to farm interests. Questions relating to farm crops or stock should be addressed to Professor Foster; questions relating to tree culture or to gardening should be addressed to Professor Keffer; questions relating to insects should be addressed to Professor Orcutt; questions concerning the chemical composition of soils or waters should be addressed to Professor Shepard, and questions about the diseases of animals and their treatment should be addressed to Dr. Cary, all at Brookings, South Dakota.

• LEWIS McLOUTH, Director.

Department of Forestry, Horticulture and Botany.

CHAS. A. KEFFER, Superintendent.

FORESTRY.

The work of experimentation in forestry has been pursued during the past season under the same unfavorable conditions that have troubled the farmers over the greater portion of the state. Insects have attacked our trees, and the fall was dry, and the spring was dry and cold. In order to give the most accurate basis possible from which to judge the results of the work, a few items from the meteorological record are inserted.

Beginning with September, 1888, the weather, as observed at the Station was as follows:

MONTH.	RAINFALL.			TEMPERATURE.			WIND.	
	1888.	No. Days.	Greatest in 1 Day.	Total.	Highest.	Lowest.	Mean.	Northerly
September.....	5	.387 inch.	.56 inch.	93.2 °	28 °	57.3 °		
October.....	5	.44 "	.62 "	82 °	21 °	42.9 °		
November.....	0			67 °	2 °	31.49 °		
December.....	4			58 °	5 °	25.96 °	16	13
January, 1889.....			.3 inch.	41	24 °	15 °		
February, ".....			.5 "	43 °	30 °	19.6 °	11	
March, ".....			.16 "	55	4 °	32 °	17	6
April, ".....	11	.27 "	1.025 "	83 °	12 °	51.2 °	10	15
May, ".....	9	.62 "	1.93 "	91 °	20 °	56.7 °	15	8
June, ".....	11	.54 "	1.485 "	93.6 °	36.1 °	64.2 °	15	14
July, ".....	9	.89 "	2.918 "	98 °	40 °	68.8 °	11	16
August, ".....	3	.53 "	.72 "	97 °	41.8 °	69.5 °	6	15
September ".....	4	2.22 "	2.70 "	89	30 °	55.1 °	9	10

It will be noted that only 1.18 inches of rain fell during the autumn months, and of this amount .872 fell in two days, Sept. 20, and Oct. 11. Many farmers in this vicinity plowed as late as December 20, showing that no severe freezing had occurred up to that date. As is well known, evaporation is greater before the ground freezes than afterward; hence, it is safe to conclude that there was comparatively little moisture in the soil when cold weather came. During the month of February, the coldest month of the season, the thermometer fell below zero on 14 days; the lowest point reached being -30° Fahrenheit.

Compared with the preceding winter, the weather was warmer, but there was much less snow, thus affording less protection to plants. In March the precipitation was very slight (not quite one-sixth of an inch.)

During April a very little more than one inch of rain fell on 11 days, the greatest amount in one day being only about one-fourth of an inch. In May there was almost two inches of rain, but the weather was not at all favorable for growth; after vegetation had started nicely and gardeners' early crops were well above ground, a night with the thermometer 12 degrees below the freezing point entirely checked growth, killing the early vegetables.

The subjoined tables of growth for the several months of the season, in addition to what has been said of the weather of the preceding fall and winter, will aid the reader in getting a fair idea of the atmospheric and soil conditions during the year. In considering the action of any variety of tree on our grounds, the above facts should be kept in mind. Our weather is not more severe than is met with in all the northern half, possibly the northern two-thirds of the State. If then, knowing the conditions of growth, a variety is found to succeed with us, it is fair to suppose it worthy of trial over the greater part of the state. Results in all experiments in forestry and horticulture, require time for their full determination, and thus far we can announce but few things proven. Our experiments are rich in suggestions and indications, and all things considered, they point to ultimate success in forestry, and give great promise of successful fruit-growing.

THE FORESTRY PLANTATION.

The seedling trees that were planted in nursery in the spring of '88, and a record of whose growth will be found in Bulletin No. 12, were planted in permanent forest plats in April, 1889. The location chosen is almost level ground at the bottom of a long, gentle slope, with a very slight slant to the north. It is an open prairie with no trees or other protection. The ground had been cropped the four years previous in

small grain, save a small portion, on which corn was grown last year. It was plowed twelve inches deep, with narrow furrows, in April, and was repeatedly harrowed and planked until the soil was fine and free from clods. The plats were made 8x10 rods, with a road $16\frac{1}{2}$ feet wide on each side, and with a path eight feet wide between the plats.

Following is a diagram of the plantation, with the varieties of the trees used:

NORTH.

ROAD.

PLAT 1.	PLAT 3.	PLAT 5.	PLAT 7.	PLAT 9.
Black Hills Spruce. Box Elder. Cottonwood. Populus Certinensis. Scotch Pine.	European Larch. Box Elder.	* White Elm. Box Elder. White Oak. Black Walnut.	Box Elder. White Ash. Black Walnut. Blk Wild Cherry. White Elm. Populus, 2 var.	Black Walnut. Cherry. Box Elder. White Walnut. P. Certinensis. White Elm. Salix Fragilis. White Birch. White Ash. White Pine.

ROAD.

1 rod.

PLAT 2.	PLAT 4.	PLAT 6.	PLAT 8.	PLAT 10.
Populus, (4 var.) Black Walnut. White Walnut. " Birch. " Elm. " Ash. Box Elder.	Box Elder. Yellow Birch. White Pine.	Pop. Certinensis. White Elm. White Ash.	Soft Maple. Cottonwood. Scotch Pine. White Ash. * White Birch.	Black Cherry. Yellow Birch. White Birch. White Ash. White Elm.

ROAD.

SOUTH.

The trees were dug as soon as the frost was out of the ground, and were carefully heeled in. When planting begun, the roots of all the trees were "puddled" in a mixture of fresh cow-dung, clay and water. In planting, the trees were carried in buckets, with earth thrown over the roots. All were planted with a spade, four feet apart both ways. In setting the small trees, the spade was thrust into the ground the full length of the blade, the earth was pressed back, the tree inserted, and the hole filled and tramped firmly with the feet. For all trees having fibrous roots a hole was dug. All were made firm by tramping close to the crown. The plats are so arranged that the soft wooded varieties will serve as nurses to slower growing hard wooded sorts, compelling them to grow tall and straight. The hard wooded sorts are arranged so that all trees of the same variety in one plat are equally distant; by this means if any one kind be removed, the relative position of the remainder will not be changed.

An effort was made to give the permanent trees as much space as possible. The culture has been thorough. At no time during the season has a crust been permitted to remain on the plats, and no weeds or grasses have been allowed to grow. Almost the entire work of cultivation has been done with harrow-tooth cultivators, implements of the highest value where only surface-stirring of the soil, and weed killing, are desired. It is necessary in their use, however, to keep them going. It is impossible to use them to advantage after the ground has become weedy, but for killing small weeds I know nothing better.

Twice during the season the plantation was carefully examined for couch grass or quack grass (*Triticum repens*), and the few plants found were carefully dug out with a spade. This weed is the greatest enemy to tree-claims in Dakota. It spreads very rapidly by means of slender underground stems, every joint of which strikes root and sends up leaves. If the plant be pulled up, these underground stems, which are very delicate, break off and remain in the soil to continue the growth of the pest. It is almost impossible to kill the couch grass after it is once established. The only safe plan is to keep the tree plantation entirely free from the first.

Freedom from weeds is the least of the benefits derived from thorough culture. By far the greatest good is seen in the condition of the soil. At any time during the dry month of June, when the adjacent prairie grass seemed almost dead for want of water, moist soil could be found anywhere in the tree-plantation by brushing a little of the surface soil away with the foot. Places that were not well cultivated were baked and hard, while moist soil could always be found just below the

"dust blanket" of the tree-plantations, and the orchards. If there is a remedy short of irrigation for long seasons of drouth, it will be found in deep plowing and thorough shallow cultivation.

The plantation was cultivated on the following dates: May 4, June 10, June 22, July 6, July 22. Each time the cultivator was followed by the hoe, so that no weeds were allowed to stand near the trees. The harrow-tooth cultivator leaves the surface soil very fine, and almost without furrows. It stirs the soil to a depth of two to four inches.

The only serious enemy experienced during the year was the cutworm. Probably on account of the extremely dry autumn and open winter, this worm appeared in large numbers. The months of May and June were unfavorable for tree growth, so that in June, when the cutworms were most numerous, the trees in the forestry plat had but just begun to grow. The worms ascended the small trees in the night, and in many cases completely denuded them of leaves. The elm and black wild cherry suffered most: in many of these trees not only the leaves, but the young buds also, were eaten off, destroying quite a number of trees. All the varieties, including the pines and spruce, were more or less damaged. A few trees of box elder were barked by jack rabbits, but only small loss resulted.

In the following table, all the figures given are averages. A number of the trees that made the greatest growth during the month were measured, and the average of these measurements is recorded as the maximum growth; the other columns were determined in the same way. It will be seen but little growth was made in May. This month was quite cold, and for the time of year, dry. Cutworms, also, seriously retarded growth during the latter part of the month.

NAME OF VARIETY	MAY.			JUNE.			JULY.			AUGUST.			SEPT.			TOTAL.		
	Growth in inches.			Growth in inches.			Growth in inches.			Growth in inches.			Growth in inches.			Growth in inches.		
	Max.	Min.	Av'g.	Max.	Min.	Av'g.	Max.	Min.	Av'g.	Max.	Min.	Av'g.	Max.	Min.	Av'g.	Max.	Min.	Av'g.
Populus Pyramidalis.....	3	2	2 $\frac{1}{2}$	6	1	2 $\frac{1}{2}$	10	5	8	3	2	2 $\frac{1}{2}$	1		1 $\frac{1}{2}$	23	10	16
Populus Nolester.....	2 $\frac{1}{2}$	$\frac{1}{4}$	1 $\frac{3}{8}$	9 $\frac{1}{2}$	1 $\frac{3}{4}$	6	17	2 $\frac{1}{2}$	9 $\frac{1}{2}$	1	$\frac{1}{2}$	1 $\frac{1}{4}$			1 $\frac{1}{4}$	30	5	18 $\frac{1}{2}$
Black Walnut.....	1		1 $\frac{1}{2}$	4	2	2	2	1	1 $\frac{1}{2}$	$\frac{1}{2}$		1 $\frac{1}{4}$			1 $\frac{1}{4}$	7 $\frac{1}{2}$	1 $\frac{1}{2}$	4 $\frac{1}{4}$
White Walnut.....		$\frac{3}{4}$	1 $\frac{1}{4}$	4 $\frac{1}{4}$	3 $\frac{1}{2}$	2 $\frac{1}{4}$	2 $\frac{1}{4}$	1	1 $\frac{3}{4}$	2		1 $\frac{1}{4}$			1 $\frac{1}{4}$	9 $\frac{1}{4}$	1 $\frac{1}{4}$	6 $\frac{1}{4}$
Yellow Birch.....	2		1 $\frac{1}{2}$	3	1 $\frac{1}{4}$	2 $\frac{1}{4}$	3	1 $\frac{1}{4}$	2 $\frac{3}{4}$	2	$\frac{1}{4}$	1 $\frac{1}{4}$			1 $\frac{1}{4}$	10	3	6
White Birch.....	1 $\frac{1}{2}$		1	1 $\frac{1}{2}$	1	1 $\frac{1}{4}$	2 $\frac{1}{2}$	1 $\frac{1}{2}$	2	1 $\frac{1}{4}$		1 $\frac{1}{4}$		1	$\frac{1}{4}$	7 $\frac{3}{4}$	2 $\frac{1}{2}$	5 $\frac{1}{2}$
White Oak.....	1		1 $\frac{1}{4}$	4 $\frac{1}{2}$	1	1 $\frac{1}{4}$	8	1 $\frac{1}{2}$	4 $\frac{1}{4}$	6	$\frac{1}{4}$	1 $\frac{1}{2}$			1	5	1	1 $\frac{3}{8}$
White Elm.....	2 $\frac{1}{2}$		1 $\frac{1}{4}$	4 $\frac{1}{2}$	1	1 $\frac{3}{4}$	8	2	4 $\frac{1}{2}$	2	$\frac{1}{2}$	2	3	1	1	24	3	9 $\frac{1}{2}$
Black Wild Cherry.....	1 $\frac{1}{2}$		1	3 $\frac{1}{2}$	2	2 $\frac{3}{4}$	3 $\frac{1}{2}$	2	2 $\frac{3}{4}$	2		1 $\frac{1}{4}$		1	$\frac{1}{4}$	12	4	8
Soft Maple.....	2		1 $\frac{1}{2}$	2	2	2	4	1 $\frac{1}{2}$	3 $\frac{3}{4}$	3 $\frac{3}{4}$	$\frac{1}{2}$	2			1 $\frac{1}{4}$	12 $\frac{1}{4}$	4	8 $\frac{5}{8}$
Salix Fragilis.....	2	$\frac{1}{2}$	1 $\frac{1}{4}$	2 $\frac{1}{2}$	1 $\frac{1}{2}$	1 $\frac{1}{2}$	10	4	8	5	3	4 $\frac{1}{2}$		1	1	21 $\frac{1}{2}$	8	15 $\frac{1}{4}$
Scotch Pine.....	1 $\frac{1}{2}$	1 $\frac{1}{4}$	1 $\frac{1}{2}$	1 $\frac{1}{2}$	1 $\frac{1}{2}$	1 $\frac{1}{2}$	2 $\frac{1}{2}$	$\frac{1}{2}$	2	2		1 $\frac{1}{4}$				7 $\frac{3}{4}$	2 $\frac{1}{4}$	4 $\frac{3}{4}$
Larch.....		1 $\frac{1}{4}$	1 $\frac{1}{4}$	2 $\frac{1}{4}$	1 $\frac{1}{4}$	1 $\frac{1}{4}$	2 $\frac{1}{4}$	1	1	1 $\frac{3}{4}$	1	1 $\frac{1}{4}$		1		7 $\frac{1}{2}$	2 $\frac{1}{2}$	5 $\frac{1}{2}$
Black Hills Spruce.....	1		1 $\frac{1}{2}$	2 $\frac{1}{2}$	2	2	2	2	1 $\frac{1}{2}$	1		1 $\frac{1}{4}$				5 $\frac{1}{2}$	1	2 $\frac{3}{4}$
White Pine.....		$\frac{1}{2}$	1 $\frac{1}{2}$	4	2	2	2	2	1 $\frac{1}{2}$	1		1 $\frac{1}{2}$				7 $\frac{1}{2}$	$\frac{1}{2}$	4 $\frac{3}{8}$
Populus Certinensis.....	2		1 $\frac{1}{2}$	6	2	5	11	3	8 $\frac{1}{4}$	16	4	10		4	1 $\frac{1}{4}$	39	9	25 $\frac{1}{8}$
Box Elder, 1 year old.....	2 $\frac{1}{2}$		1	4 $\frac{1}{2}$	1 $\frac{1}{2}$	2 $\frac{1}{4}$	15	$\frac{1}{2}$	5	8	1	2		2	$\frac{1}{4}$	32	3 $\frac{1}{4}$	10 $\frac{3}{4}$
Box Elder, 2 years old.....	4		2 $\frac{1}{2}$	12	1 $\frac{3}{4}$	5 $\frac{1}{2}$	12	2 $\frac{3}{4}$	6 $\frac{1}{4}$	4	1	2 $\frac{1}{2}$		2	1 $\frac{1}{2}$	34	5 $\frac{1}{2}$	18
Cottonwood, 1 year old.....		$\frac{1}{2}$	1 $\frac{1}{4}$	7 $\frac{1}{2}$	1 $\frac{1}{2}$	2	9	1 $\frac{1}{2}$	4 $\frac{1}{4}$	5	2	4		3	$\frac{1}{2}$	25	4 $\frac{1}{2}$	15 $\frac{1}{2}$

The month of July brought with it many seasonable showers, and these, with the warmer weather, enabled the trees to make a good start. The last cultivation was given during the week ending July 27th; after that date the barn grass and tall growing weeds were kept down with hoes.

THE SEEDLING FOREST PLAT.

This plantation, covering two acres 49 rods, was planted with tree seeds in the fall of 1887. The method of planting, and growth during 1888, has been described in Bulletin No. 12. In April all the vacant places were set with one and two year old trees of the following varieties: Box elder, cottonwood, Norway poplar, laurel leaved willow, white birch, yellow birch, Scotch pine, white pine, white ash, white elm. On June 14th all the tips of the lateral branches of the trees which had come from the seed planting were pinched back, leaving only one leader; the effect was to increase the growth of the leading branch.

In the following table the letter T after the name of a variety indicates that it has been set in the plantation the present year. All other varieties are of the original planting of seed in the fall of '87, and hence the measurement of the two years' growth is given. It has been interesting to observe the growth of the transplanted trees compared with those grown from the seed where they stand. Without exception, the seedlings are far in advance of the transplanted sorts. It is equally apparent that the trees in the forestry plats, for which the ground was deeply plowed before planting, have grown better, as a rule, than those set among the seedlings where plowing was impossible, though as thorough culture was given in one case as in the other.

NAME OF VARIETY.	May.			June.			July.			August.			Sept.			TOTAL.			Total growth in 1888.
	Gr'h in in.			Gro'th in in.			Gro'th in in.			Gr'h in in.			Gr'h in in.			Gro'th in inches.			
	Max	Mn	Av.	Max	Mn	Av.	Max	Mn	Av.	Max	Mn	Av.	Max	Mn	Av.	Max	Min.	Av'g.	
Box elder.....	8	2	4	22	1	14	21	5	14	2		1							24 in.
Box elder T.....	2		$\frac{1}{2}$	5 $\frac{1}{2}$	1	3	7 $\frac{1}{2}$	1	2 $\frac{1}{2}$	5 $\frac{1}{2}$	5	4	4 $\frac{1}{2}$						
White ash.....	3		2	9	1	3	8 $\frac{1}{2}$	2 $\frac{1}{2}$	8 $\frac{1}{4}$	1 $\frac{1}{2}$	1	1							11 in.
Black wild cherry.....	3	1	$\frac{1}{4}$	2	$\frac{1}{2}$	1 $\frac{1}{4}$	7	1 $\frac{1}{2}$	2 $\frac{3}{4}$	1 $\frac{1}{2}$	1	$\frac{1}{2}$	1						13 in.
Honey locust.....	2	1	$\frac{1}{2}$	4	1 $\frac{1}{2}$	2 $\frac{3}{4}$	8	1 $\frac{1}{2}$	2 $\frac{1}{2}$	6	1	2 $\frac{1}{2}$							11 in.
Oak.....	2		$\frac{1}{2}$	11 $\frac{1}{4}$	1 $\frac{1}{4}$	3 $\frac{3}{4}$	11 $\frac{1}{4}$	1 $\frac{1}{2}$	1	1 $\frac{1}{2}$	1 $\frac{1}{4}$	1 $\frac{1}{4}$	1 $\frac{1}{4}$						5 in.
Walnut.....	2		$\frac{1}{2}$	3 $\frac{1}{2}$	2 $\frac{1}{2}$	3	3	2	2 $\frac{1}{4}$	1 $\frac{1}{2}$	1 $\frac{1}{2}$	1 $\frac{1}{4}$	1 $\frac{1}{4}$						8 in.
Butternut.....	2		$\frac{1}{2}$	3	1 $\frac{1}{2}$	2 $\frac{1}{4}$	11	1	1 $\frac{1}{4}$	1 $\frac{1}{2}$	1 $\frac{1}{2}$	1 $\frac{1}{4}$	1 $\frac{1}{4}$						7 $\frac{1}{2}$ in.
Hard maple.....	2		$\frac{1}{2}$	11 $\frac{1}{2}$	1 $\frac{1}{2}$	3 $\frac{3}{4}$	11 $\frac{1}{4}$	1 $\frac{1}{4}$	1	1 $\frac{1}{2}$	1 $\frac{1}{2}$	1 $\frac{1}{2}$	1 $\frac{1}{4}$						7 $\frac{1}{4}$ in.
Norway poplar T.....	2		$\frac{1}{2}$	7 $\frac{1}{2}$	1	3 $\frac{3}{4}$	3	2	2 $\frac{3}{4}$	2 $\frac{1}{2}$	1	1							
White birch T.....			$\frac{1}{4}$	4 $\frac{1}{2}$	1 $\frac{1}{2}$	2 $\frac{3}{4}$	3 $\frac{1}{2}$	3	3 $\frac{1}{4}$	1	1	1 $\frac{1}{2}$	1 $\frac{1}{2}$						
White elm T.....			$\frac{1}{2}$	2	1	1 $\frac{1}{2}$	3	2	2 $\frac{1}{2}$	2	1	1 $\frac{1}{2}$	1 $\frac{1}{2}$						
Populus certinensis T.....			$\frac{1}{2}$	9 $\frac{1}{2}$	6 $\frac{1}{2}$	7 $\frac{3}{4}$	4 $\frac{1}{2}$	1 $\frac{1}{2}$	2 $\frac{1}{2}$	4 $\frac{1}{2}$	1	2 $\frac{1}{2}$	1						
Salix laurifolia T.....			$\frac{1}{2}$	12	3	6 $\frac{1}{2}$	6 $\frac{1}{2}$	5	6	2	1	1 $\frac{1}{4}$	1 $\frac{1}{2}$						
Populus nolester T.....			$\frac{1}{2}$	11	3	6	7	2 $\frac{1}{2}$	5 $\frac{3}{4}$	5	1	1 $\frac{1}{2}$	1						
White pine T.....			$\frac{1}{2}$	3 $\frac{1}{2}$	1	2	1	1	1	1	1	1	1						
Scotch pine T.....			$\frac{1}{2}$	2 $\frac{1}{2}$	1	2	1	1	1	1	1	1	1						

The culture for the year consisted of the frequent use of the harrow tooth cultivator. The last cultivation was given July 31st. The trees were hoed three times during the season.

GROWTH OF ROOT.

In the latter part of September, trees of each of the varieties of seedlings above noted, were carefully taken up.

In digging the green ash it was found that the root descended almost in a vertical line. It was traced down three feet and two inches, where it was still the thickness of knitting cotton. In its descent it passed through the black loam, into which the strongest lateral roots grew, thence through a six inch stratum, poorly defined, of gravelly loam, thence through a foot of yellow clay of somewhat loamy texture, finally penetrating into the stiff clay which contains white chalky deposits, wrongly called by many people, "hard pan." The tree in question is two years old, the seed having been planted in October, '87.

Box elder trees of the same age showed an equal tendency of the roots to penetrate the lower soil, though in box elder the tap root was not so well developed, one of the trees dug having four deep-growing lateral roots.

Black walnut and honey locust of the same age had also grown deep into the ground. The root of a hard maple tree which had a top only eight inches high, was followed almost straight down for three feet, where it was broken off; but it had become very thin at that point. Another hard maple and a black wild cherry had long roots which only went about a foot deep, and then grew laterally.

These facts are noted as refuting a statement very commonly heard in Dakota: "Trees will not grow here because their roots do not grow deep." In the case of box elder, white ash, black walnut and honey locust, it is seen that two year old trees penetrate the ground as deep in Dakota prairie as in any other soil.

At the time of digging these seedlings, trees of the same sorts that had been set in the plantation in April, were taken up. A fine growth of fibrous roots was found, the box elder having made the greatest root growth, closely followed by white ash. The ash trees had not developed a tap root, but the growth of fibrous roots was excellent, surpassing the lateral root-growth of the two year old trees from seed. So also the black walnut and honey locust, trees that develop a strong tap root when grown from the seed, when transplanted made a fine growth of fibrous roots, none of which seemed to follow the habit of tap roots. In digging trees that have stood a few years after transplanting, deep-growing roots are always found. This growth of fibrous roots the first

year after transplanting becomes, then, a matter of prime importance. Careful preparation of the ground by deep plowing and thorough harrowing, and high cultivation after planting, are aids to growth that the planter should never lose sight of. Root growth is of far greater importance, during the first years of a tree's life, than top growth, though luxuriant foliage always indicates good healthy root action.

THE FOREST-TREE NURSERY.

During the first week in March the following forest-tree seeds were received from Douglas & Sons, of Waukegan, Ill: Norway maple (*Acer platinoides*). Scotch alder (*Alnus incana*), white birch (*Betula alba*), European larch (*Larix Europæa*), red elm (*Ulmus fulva*), cockspur thorn (*Crataegus crus-galli*), white willow (*Salix alba*), red oak (*Quercus rubra*), scarlet oak (*Quercus coccinea*), pin oak (*Q. palustris*), hawthorn (*Crataegus oxycantha*), white walnut or butternut (*Juglans cinerea*), black walnut (*Juglans nigra*) bitter hickory (*Carya amara*), shellbark hickory (*Carya alba*), pig nut (*Carya porcena*), Ohio buckeye (*Æsculus glabra*), yellow birch (*Betula lutea*), honey locust (*Gleditschia tricanthos*), ironwood (*Ostrya Virginica*), Kentucky coffee tree (*Gymnocladus Canadensis*), hackberry (*Celtis occidentalis*), sugar maple (*Acer saccharinum*), canoe birch (*Betula papyracea*), black locust (*Robinia pseudacacia*), basswood (*Tilia Americana*), black wild cherry (*Prunus serotina*), white ash (*Fraxinus Americana*) from Michigan and from Kansas; box elder (*Negundo aceroides*) from Michigan and from Kansas.

As a rule there is enough cold weather in March to freeze any variety of seed sufficient for its germination.

The following varieties were mixed with moist sand and placed in a shaded situation, where they were frozen until near the time of planting: The maples, ash, box elder, oaks, thorns, hackberry, basswood, wild cherry and buckeye. The walnuts, butternuts and hickories were spread on the ground in layers three inches deep in a shaded place, and covered lightly with straw. Here they were kept until ten days before planting, when they were placed in a barrel of water and soaked until planted. The remaining seeds were kept dry until four days before planting, when they were put to soak. The seeds of black locust, honey locust and Kentucky coffee tree were covered with boiling water 24 hours before planting. All the varieties were planted April 10th. The vessels containing the soaking seeds were carried to the field and the seeds were sown direct from them. The frozen seeds were sown with the sand in which they were kept.

The ground for the deciduous trees had been plowed very deep in the fall, and was in the finest condition at planting time. It sloped to the east, with a slight southern trend. The plat was laid off in rows 165 feet long, four feet apart. The seeds were sown quite thick in narrow drills, and covered from one to three inches deep—the latter covering only for the nuts, acorns and buckeyes.

The subjoined tabulated statement will give in brief the record of the year.

The white ash was almost an entire failure, but few seeds germinating. There was but little severe weather after the seeds were put out to freeze, and this may account for the failure to germinate. We have had the best results with ash with fall-planted seed, having tried fall-planting, soaking in water 10 days, and the plan above mentioned. If the seeds could be placed to freeze in the fall, it would be better than March 1st.

It is customary to plant the seeds of birch and alder under shade. In this experiment all the seeds were given the same treatment. Not a single seed of birch or alder germinated. The ground was very dry for a while after the seeds were put in, and this may account for it. Seeds of birch from the Turtle Mountain region, N. D., were soaked in water a week and then planted under a well-built shade, in moist soil. These also failed to germinate.

A heavy loss was caused by cutworms; entire rows of box elders were cut off when the trees were in the fourth leaf, and maple, black wild cherry, apple and black locust, were badly cut. During the time that the cutworms were at work the weather was dry and cold, making altogether a most unfavorable season up to the month of July. During this month frequent showers and warm growing weather started an excellent growth. As will be seen by the table, the hickory nuts and several other sorts did not germinate until the warm weather and rains of July came. The black locust, honey locust, hickories, hackberry, walnuts and Kentucky coffee tree were very irregular in sprouting, some new plants appearing from time to time until frost came in October. Following is a tabulated record of the sprouting and growth of the different varieties:

NAME OF VARIETY.	FIRST UP.	WELL UP.	MAY.			JUNE.			JULY.			AUGUST.			SEPT.			TOTAL.		
			Gr'h in in.			Gr'h in in.			Gr'h in in.			Gr'h in in.			Gr'h in in.			Growth in in.		
			Mx	Mn	Av	Mx	Mn	Av	Mx	Mn	Av	Mx	Mn	Av	Mx	Mn	Av	Max	Min	Av.
White ash, Mich.*	May 15.		1 1/2		1															
White ash, Kan.	May 8.		1 1/2		1		3 4/4	2	1	1 1/2	1 1/2	1 1/2	1 1/2			6	1 1/2	4		
Box elder, Mich.	April 26.		2		1 1/2	3	1 1/4	7	1 1/2	2 3/4	3	2	2 1/4			15	3 1/2	7 3/4		
Box elder, Kan.	April 26.	May 10.	2		1 1/2	4	2	9	1	6	5	3	3 1/2			21 1/2	4 1/2	13 3/4		
Sugar maple	April 25.	May 8.	2		1 1/2	1 1/2	1	1	1 1/2	3 4	1	1 1/2	3 4	1 1/2	3 4	5 1/2	1	4		
Norway maple*	April 26.		2		1															
Black wild cherry	April 26.	May 5.	1 3/4		1 1/2	1 1/2	1	6 3/4	2	2 3/4	5	1	2 1/2			15	3	8 1/2		
Apple	April 26.	May 1.	1 3/2		1 1/4	4 1/2	1 1/4	7	2	4	4	1	3	3 1/2	2	21	5	12		
Pin oak	May 2.	May 12.	2		1	2	1 3/4	2	1 1/2	1 3/4	1 1/2	1 1/4	3 3/8			6 1/2	1 3/4	4 3/8		
Scarlet oak	May 1.	May 12.	2 1/2		2 1/4	1	2	2	1 1/2	1 1/4	1 1/2	1 1/4	3 3/8			6	1 1/4	5 3/8		
Red oak†																				
Hackberry	May 20.	June 12.	1		3 4	1	3 4	2	1 1/2	1 3/4	1	1 1/2	3 4			5	2	4		
American linden*	May 7.		1 1/2		1															
English hawthorn†																				
Cockspur thorn†																				
Ohio buckeye*	May 13.		3		2															
Am. hop hornbeam†																				
Shellbark hickory†	July 1.							2 1/2	1	1 1/4	1	1 1/2	3 4			3 1/2	1 1/2	2 1/4		
Canoe birch†																				
Hoary alder†																				
Kentucky coffee tree†	May 31.		3		1 1/2	1	1 1/2	3 4	1	1 1/2	3 4	1 1/2	1 4	3 8		5 1/2	1 4	2 7/8		
Yellow birch†																				
White birch†																				
Black locust†	May 20.	May 28.	1		1 3/4	3 4	1 1/2	2	1	1 1/4	3 1/2	2	1 1/2			7 1/4	1	4 1/4		
Honey locust†	May 16.	June 10.	2		1 3/4	2	1	2	1	1 1/4	2	1 1/2	1 1/2	1		9	1 1/2	5 1/2		
Native box elder†	May 29.	June 12.	1		1 3/4	1	3 4	2	1 1/2	1 3/4	2	2	1 1/2	1		7	2	5 3/4		
Native ash	May 23.	May 25.	1		1 1/2	1	1 1/2	3	1	2 1/4	2	2	1 1/4			7	2	5		
Bitter hickory†	May 25.	June 5.	1		1 1/2	1 1/2	1 1/4	2 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2			5	1 1/2	4		
Pig-nut†	June 12.				2 1/2	1	2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2			4 1/2	1 4	3 1/8		
Black walnut	June 12.	June 20.			6	2	4 1/2	2 1/2	1 1/2	2	1 1/2	1 1/2	1 1/4			10	4 1/2	7 3/4		
White walnut	June 13.				2 1/2	1	1 1/4	2 1/4	1 1/2	1 1/4	1 1/2	1 1/2	1 1/2			6 1/2	2 1/2	4 1/2		

*Killed by cut-worms. †Did not come up. ‡These were germinating until frost came.

CUTTINGS.

In addition to the above named tree seeds, cuttings of the following trees and ornamental shrubs were planted: *Populus alba argentia*, *Populus nolester*, *P. pyramidalis*, *P. pyramidalis suaveolens*, *P. certineusis*, *Salix laurifolia*, *S. fragalis*, *S. lanceolata*, *Salix* (Russian yellow) *Lonicera gracilis*, *L. rubra grandiflora*, *L. speciosa*, *L. elegans*, *L. vicolor*, *L. splendidus*, *L. lutea*, *L. nana*, *Tamerix Amurensis*, *Philadelphus Gordoniana* and *P. speciosa*.

The cuttings were received during the winter and were packed in damp sand in a cold cellar. As soon as the frost was out of the ground sufficiently in March, a shallow pit was dug, and the cuttings placed perpendicularly in it, butts up. They were then covered with three inches of fine soil and two feet of coarse stable litter. As soon as the days became warm in April, the litter was removed during the day, permitting the warm sunshine to fall on the cutting bed. Toward night the litter was replaced. The cuttings were kept moist by occasional waterings. By May 1st the poplars and willows showed a good callous formation, planting was begun May 4th and was continued till May 9th. The cuttings were carried to the field in water, and the callous and young roots (which were striking before the planting was finished), were thus protected. They were planted in rows that had been subsoiled to a depth of 14 inches. Like the forest tree seedlings, the cuttings suffered great injury from cutworms during May and June. Almost every cutting of poplar and willow (together aggregating over 100,000), started growth. But they were kept completely denuded of foliage, save in a very few cases. As will be seen by the accompanying table of growth, but little more than an inch is recorded for *P. certineusis*—an exceptionally rapid grower up to July 1st.

The above method of treating cuttings before planting seems to save much time and puts them in a far better condition for growth as soon as set. The cuttings may be placed in pit in the fall, which is much the best time for making them. It is important that the cuttings remain in the pit until calloused, and I have had the best success when the cuttings have been left until the roots begin to appear. Some varieties require much more time than others, so that each variety should be kept to itself.

POPLAR GRAFTS.

During the winter of 1888 a number of cions of *Populus bolleana*, *Populus alba* and *Populus alba argentia*, all Silver-leaved poplars from Russia, were grafted on roots of the cottonwood (*Populus monilifera*). Of about 100 whip grafts (the method used in root grafting the apple)

only two grew, and neither of these made good growth. Of 400 wedge grafts (the method practiced with the cherry, plum and pear) about 40 per cent. grew and nearly all made fine growth. An examination shows a perfect union between cion and stock.

The silver poplars are difficult to grow from cuttings, so that any method of propagation that will increase the number of these trees, especially the beautiful Russian forms, is worthy of notice. The growth of cuttings and poplar grafts during the season is shown in the following table:

NAME OF VARIETY	MAY.			JUNE.			JULY.			AUGUST.			SEPT.			TOTAL.			
	Growth in inches.			Growth in inches.			Growth in inches.			Growth in inches.			Growth in inches.			Growth in inches.			
	Max.	Min.	Av'g.	Max.	Min.	Av'g.	Max.	Min.	Av'g.	Max.	Min.	Av'g.	Max.	Min.	Av'g.	Max.	Min.	Av'g.	
Populus baliannat	2 $\frac{1}{2}$	11	1	5	1	2 $\frac{1}{2}$	13 $\frac{1}{2}$	7	9	18	8	14	8 $\frac{1}{2}$	4	5	50	20	31 $\frac{1}{2}$	
P.bolianna (small root)†	2 $\frac{1}{2}$		1 $\frac{1}{2}$	10	3	6 $\frac{3}{4}$	12	8	10 $\frac{1}{2}$	10	5	8 $\frac{1}{2}$	2	1	1 $\frac{1}{2}$	36 $\frac{1}{2}$	18	28 $\frac{3}{4}$	
Populus albat	2		1 $\frac{1}{2}$	10	2	4 $\frac{1}{2}$	11	3	9 $\frac{1}{2}$	9	3 $\frac{1}{2}$	8	4	2 $\frac{1}{2}$	3 $\frac{1}{2}$	36	11	27	
Populus nolester	$\frac{1}{2}$		$\frac{1}{4}$	7 $\frac{1}{2}$	2	3 $\frac{1}{4}$	12	3	6 $\frac{1}{2}$	4	1	3 $\frac{1}{4}$	2		$\frac{3}{4}$	26	6	14	
Populus pyramidalis*																			
P. pyramidalis suaveolens*																			
Populus certinensis	1		$\frac{1}{4}$	6	1	3	9	2 $\frac{1}{2}$	4 $\frac{3}{4}$	8	1 $\frac{1}{2}$	6	2 $\frac{1}{2}$	2	2 $\frac{1}{4}$	26 $\frac{1}{2}$	7	16 $\frac{1}{4}$	
Populus alba argentia	$\frac{1}{2}$		$\frac{1}{4}$	3 $\frac{1}{4}$	1	2 $\frac{1}{4}$	2 $\frac{1}{2}$	2	2 $\frac{1}{4}$	2	1 $\frac{1}{2}$	1 $\frac{1}{2}$	1 $\frac{1}{2}$		1 $\frac{1}{4}$	9 $\frac{3}{4}$	3 $\frac{1}{2}$	7 $\frac{1}{2}$	
Salix laurifolia	$\frac{1}{2}$		$\frac{1}{4}$	4 $\frac{1}{2}$	1 $\frac{1}{2}$	2	5	2	4 $\frac{1}{4}$	3	1	2 $\frac{1}{2}$	1		1 $\frac{1}{2}$	14	4 $\frac{1}{2}$	9 $\frac{1}{2}$	
Salix fragilis	$\frac{1}{2}$		$\frac{1}{4}$	6 $\frac{1}{2}$	1	2 $\frac{1}{4}$	9	5	6	3	1	1 $\frac{3}{4}$	1		$\frac{1}{4}$	20	7	10 $\frac{1}{2}$	
Salix lanceolata	1		$\frac{1}{4}$	3	1	2 $\frac{1}{4}$	4	3	2 $\frac{1}{2}$	3	1	1 $\frac{1}{2}$			$\frac{1}{4}$	11	5	6 $\frac{1}{2}$	
Lonicera fragilis			$\frac{1}{2}$	5	1 $\frac{1}{2}$	3 $\frac{1}{4}$	5 $\frac{1}{2}$	2	2 $\frac{1}{2}$	1 $\frac{1}{2}$	1	1 $\frac{1}{2}$	1		$\frac{1}{4}$	13	4 $\frac{1}{2}$	7 $\frac{1}{4}$	
“ rubra grandiflora	$\frac{3}{4}$		$\frac{1}{4}$	4	1	2 $\frac{3}{4}$	2	1	1 $\frac{1}{4}$	2	1	1	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{4}$	9 $\frac{3}{4}$	3	6 $\frac{1}{4}$	
Lonicera speciosa	1 $\frac{3}{4}$		$\frac{1}{2}$	3 $\frac{3}{4}$	1 $\frac{3}{4}$	2 $\frac{1}{2}$	3	2	2 $\frac{1}{4}$	2	$\frac{1}{2}$	1		$\frac{1}{2}$	$\frac{1}{4}$	11	4 $\frac{1}{4}$	6 $\frac{3}{4}$	
Lonicera elegans	$\frac{1}{2}$		$\frac{1}{4}$	3 $\frac{1}{2}$	1	2	5 $\frac{1}{2}$	3	3 $\frac{1}{2}$	1 $\frac{1}{2}$	$\frac{1}{2}$	1		$\frac{1}{2}$	$\frac{1}{4}$	11 $\frac{1}{2}$	4 $\frac{1}{2}$	7	
Lonicera bicolor	2		1	6	1 $\frac{1}{2}$	2 $\frac{1}{4}$	7	2	3 $\frac{1}{2}$	3	1	1 $\frac{1}{2}$			$\frac{1}{4}$	18	4 $\frac{3}{4}$	8 $\frac{1}{4}$	
Lonicera splendens	$\frac{3}{4}$		$\frac{1}{4}$	5	1 $\frac{1}{2}$	1 $\frac{1}{4}$	2	1	1 $\frac{1}{2}$	1 $\frac{1}{2}$	$\frac{1}{2}$	3 $\frac{3}{4}$			$\frac{1}{4}$	9 $\frac{1}{4}$	2	4 $\frac{1}{2}$	
Lonicera lutea	1 $\frac{1}{4}$		$\frac{1}{2}$	4	1	2	3 $\frac{1}{2}$	2	2 $\frac{1}{4}$	1 $\frac{1}{2}$	$\frac{1}{2}$	1 $\frac{1}{4}$	$\frac{1}{2}$		$\frac{1}{4}$	10 $\frac{3}{4}$	3 $\frac{1}{2}$	6 $\frac{3}{4}$	
Lonicera nana†	$\frac{1}{2}$		$\frac{1}{4}$	2 $\frac{1}{2}$	1	2	1	$\frac{1}{2}$	1										
Tamerix amurensis				4	1	3	8	2	5	5	2	4	2 $\frac{3}{4}$			19 $\frac{3}{4}$	5	14	
Black currant	$\frac{1}{2}$		$\frac{1}{8}$																
Philadelp's grandiflora				1		$\frac{1}{2}$	3	1 $\frac{1}{2}$	2 $\frac{3}{4}$	4	1 $\frac{1}{2}$	2	2		$\frac{1}{2}$	10	3	5 $\frac{3}{4}$	

*These did not grow.

†Killed by cut-worms.

‡Grafts.

TREES IN THE COLLEGE LAWN.

In May the mulch was removed from the trees planted in the lawn, and the ground about each tree was turned with a digging fork, and made fine, for a distance of five feet from the trunk. A heavy mulch was then spread over the forked ground. This was the only culture the tree received. The record of growth, with that of 1887 and 1888, is as follows:

NAME OF VARIETY.	1887.		1888.		1889.	
	Ft.	In.	Ft.	In.	Ft.	In.
Box elder.....	2	2	2	6	2	8
Cut leaved birch.....		9	1	1		9
White birch.....	3	1	2	8	3	0
White ash.....	1	1		1		7
White elm.....	1	1		10	2	9
Lombard, poplar.....	4	6	1	3	1	4
Oak leaved mountain ash.....		9	1	4	1	1
Wier's cut leaved maple.....		5	1	6	1	5
Silver maple.....	2	3	2	2		10
Basswood or lynn.....		9	1	3	1	4
Mountain ash.....	1	6	1	10	1	9
Black spruce.....				7		8
Norway spruce.....		6		6		9
Balsam fir.....		4		5		6
Red cedar.....		8		10		5
Scotch pine.....		1		1		2
European larch.....	1	1		10		8
Wisconsin Weeping willow.....	5	4		3		
Arbor vitæ.....	1	1				10
Alder.....	1	3	2	2	2	6

THE EVERGREENS.

None of the conifers have been transplanted from the nursery, except as referred to in the plantation. Five thousand small trees, from four to eight inches high, were set under a well built shade last spring; these have made very little growth, and the stand is not enough better than that secured last year in open planting (see our Bulletin No. 12) to warrant the expense of a shade.

The Douglass fir and arbor vitæ suffered in nursery from sun-burned foliage; Colorado blue spruce (*Picea pungens*) has grown fairly well and has had fine foliage throughout the season. The Scotch pine has made a fine growth and thus far leads all varieties. The trees have stood in nursery rows and the ground is heavily mulched. During the growing season they were kept free from weeds. Following is a table of the growth of the different varieties for the year:

NAME OF VARIETY.	May.			June.			July.			August.			Sept.			TOTAL.		
	Growth in In.			Growth in In.			Growth in In.			Growth in In.			Growth in In			Growth in Inches.		
	Mx.	Min.	Av.	Mx.	Min	Av.	Mx.	Min	Av.	Mx.	Min	Av.	Mx.	Min.	Av.	Max.	Min.	Average.
Scotch pine.....	6	1	4	5 $\frac{1}{2}$	2	3 $\frac{3}{4}$	3	2	2 $\frac{3}{4}$	1 $\frac{1}{2}$		1 $\frac{1}{4}$			15	5	9 $\frac{3}{4}$	
White pine.....	3	$\frac{1}{2}$	1 $\frac{1}{2}$	2	$\frac{1}{4}$	1 $\frac{1}{4}$	1	$\frac{1}{2}$	1 $\frac{1}{2}$	$\frac{1}{2}$		1 $\frac{1}{4}$			6 $\frac{1}{2}$	1 $\frac{1}{4}$	3 $\frac{3}{4}$	
White spruce.....	2	$\frac{1}{2}$	1 $\frac{1}{2}$	2 $\frac{1}{2}$	$\frac{1}{2}$	1 $\frac{1}{2}$	1 $\frac{1}{2}$		1	$\frac{1}{2}$		1 $\frac{1}{4}$			6 $\frac{1}{2}$	2	4 $\frac{3}{8}$	
Norway spruce.....	2 $\frac{1}{2}$	$\frac{1}{2}$	2	2	$\frac{1}{2}$	1 $\frac{1}{2}$	2	1	1 $\frac{1}{2}$	1 $\frac{1}{2}$	$\frac{1}{2}$	1 $\frac{1}{4}$	1		9	3	6 $\frac{3}{8}$	
Balsam fir.....	2	$\frac{1}{2}$	1 $\frac{1}{2}$	2	$\frac{1}{2}$	1 $\frac{1}{2}$	2	$\frac{1}{2}$	1	1	$\frac{1}{2}$	1 $\frac{1}{4}$		$\frac{3}{4}$	6	1 $\frac{1}{4}$	4 $\frac{1}{8}$	
Colorado blue spruce.....	2 $\frac{1}{2}$	$\frac{1}{2}$	2	2	$\frac{1}{2}$	1 $\frac{1}{2}$	1		1	$\frac{1}{2}$		1 $\frac{1}{4}$		$\frac{1}{2}$	6 $\frac{1}{2}$	1 $\frac{1}{4}$	4 $\frac{1}{4}$	
Douglass spruce.....	1 $\frac{1}{2}$		1	1		1	$\frac{1}{2}$	$\frac{1}{2}$	1 $\frac{1}{4}$	$\frac{1}{2}$		1 $\frac{1}{4}$		1	3 $\frac{3}{4}$	3 $\frac{3}{4}$	3	
Gray pine.....	2		1	1 $\frac{1}{2}$		1	$\frac{1}{2}$	$\frac{1}{2}$	1 $\frac{1}{4}$	$\frac{1}{2}$		1 $\frac{1}{4}$		1	4 $\frac{1}{4}$	4 $\frac{1}{4}$	2 $\frac{1}{2}$	
Black Hills pine.....	1 $\frac{1}{2}$		1	1		1	$\frac{1}{2}$	$\frac{1}{2}$	1 $\frac{1}{4}$	$\frac{1}{2}$		1 $\frac{1}{4}$		1	4	1	3 $\frac{3}{8}$	
Red cedar.....	1		1	1		1	$\frac{1}{2}$	$\frac{1}{2}$	1 $\frac{1}{4}$	$\frac{1}{2}$		1 $\frac{1}{4}$		1	4	1	2 $\frac{3}{8}$	
Arbor vitæ.....	1		1	2	1	2 $\frac{1}{4}$	2	1	2 $\frac{1}{4}$	1		1 $\frac{1}{2}$		1	7	2 $\frac{1}{2}$	5 $\frac{1}{2}$	

EVERGREENS FROM SEED.

From one-fourth to one pound of seeds of the following varieties were received in March: White pine, Scotch pine, Balsam fir, White spruce, Colorado blue spruce, Austrian pine. The seeds were kept dry until April 30th when they were put to soak in water and allowed to stand ten days. They were planted in close drills, under a well built shade, and the soil was kept moist by mulching. The only variety that sprouted well was white pine, and of this nearly all grew. Only a few seeds of the other sorts germinated. The White pine seedlings suffered very little from "damping off" (rotting at the ground) and are now, at the end of the season, a little more than one inch high and in good condition.

TIMBER CLAIMS.

By far the greater part of the trees planted in Dakota are set on timber claims, with a view to securing title to the land from the national government. Comparatively few of the plantations thus made have proven as successful as is desirable. Without commenting on other, and possibly more important causes of failure, a few suggestions on the care and management of timber claims may be pertinent.

First of all, the man who thinks a timber claim title can be secured with little labor is greatly mistaken. Successful growers have found that tree culture is as laborious as the care of the most exacting crop the farm can produce. From a large correspondence extending to nearly every county east of the Missouri river, and confined largely to questions of tree growing, and from my own observations and the testimony of successful cultivators, I am led to believe that the principal causes of failure in the management of timber claims are two: lack of preparation of the soil, and too little cultivation. I believe that the time during which the claimant may cultivate the land before planting any trees should be extended two years, so that the soil could be more thoroughly subdued and the prairie grasses and other plants killed, thus removing a prolific cause of failure. But under the present law the settler should adopt a method of culture that will be most effectual in rotting the roots of the native plants and permit deep plowing for his trees. The following plan has been followed with success: The ground for trees was broken early in June and millet was sown on the breaking. This crop was removed early in September and the land was immediately back-set, cutting but an inch deeper than the breaking. Late in the fall the piece was again plowed, somewhat deeper than before. The millet, being a rank grower, choked down the native grasses during the summer, and the shallow plowing in September turned the

ground up, and the remaining grass and weed roots were thus mostly killed. The fall plowing left the land in the best condition for absorbing and holding moisture. In the spring the land was well harrowed and was planted with oats. This crop is a far better one for preventing weed growth than wheat. As soon as the oats could be harvested the ground was plowed about eight inches deep, and was again left until late in the fall, when the final plowing for the trees was done.

Deep plowing is necessary for successful tree growing. The land should be plowed eleven or twelve inches deep at the east. I am aware that there is a prevalent idea that new land in Dakota cannot be plowed so deep, but if the plan above outlined, or one similar to it, is followed, the field can be plowed twelve inches deep the second autumn. The work requires three horses, and I have always used a fourteen-inch walking plow. The furrows should be narrow and straight; the plow should go as deep as three horses can pull it, and the work should be done in the fall of the year. The frosts of winter will aid very materially in pulverizing the plowed land. During the early spring the melting snow will be retained in the field, instead of running off, as it would if the ground were unplowed and hard. The tree-grower should lose no opportunity, however slight, to save to his soil the water that falls on it as rain or snow. As early in the spring as the land can be worked it should be thoroughly harrowed and pulverized. I have found the Acme pulverizer a most useful implement in fining the soil for trees. A final harrowing, going diagonally across the plat, will better prepare it for the marker.

In planting, the points to be observed are: see that the roots are kept moist and are well placed and not turned up at the ends; plant a little deeper than the tree stood before, and press the earth firm about the roots. The first and last points are of especial importance.

The only cultivation that can be called good is that which keeps the soil in the best possible condition. It is possible for land to be free from weeds and yet not to be well cultivated. A harrow-tooth cultivator is best for use among young trees, because it does not go deep enough to strike the fibrous roots, and leaves the soil very fine; but excellent work can be done with a common corn cultivator, so set that it will not go deeper than four inches. The kind of implement is of far less importance than that it be kept going. During the entire season, from the time the trees are planted until August, the ground in the tree-claim should be a dust blanket—so fine that the foot sinks into it. This will require quite as much work as any crop that can be put in. And herein is the great mistake of many settlers. They imagine, because trees

grow with comparatively little care in states east and south, that their tree claims can be neglected. I am convinced that no crop demands more care and attention.

It is usually true that the settler is more or less dependent on his year's crop, and hence turns all his energies to the care of the fields that will bring him a harvest; but there is always an interval between seed time and harvest—just at the season when trees should be receiving the highest culture. The importance of thorough culture cannot be too greatly emphasized.

Among the worst enemies to trees in Dakota is the couch grass (*Triticum repens* L.) mentioned in this bulletin. It is almost impossible to rid a tree-claim of this pest after it is well established. The only way is to dig out the plants with a spade, being careful to secure all the delicate underground stems, for every bud that is left will grow, and the plant spreads rapidly.

Culture should cease early in August. Thereafter it is only necessary to watch carefully for couch grass, removing every plant of it. If seeds are used instead of trees, they may be planted either in the fall or spring. All things considered, I think it will be found safest to save seed in the fall, (unless, like white elm and cottonwood, they ripen very early in summer) mix them with damp sand, and bury them slightly in a shady place, so that they will remain frozen until they can be planted in the spring. The results of experiments with seeds are given in this bulletin.

As to varieties, green ash and box elder are favorably mentioned in every part of the state. White elm has been generally successful throughout the state. Cotton wood and willow are more preyed upon by insects than box elder, but both are hardy and cheap, and will doubtless continue to form a large part of our tree-claims.

NOTES ON VARIETIES.

WHITE ELM.—To the many planters who are seeking for a better timber tree than box elder for use in tree-claims and shelter-belts, the white elm is worthy a trial. In the plantation set last spring, two year old trees of this species made excellent growth. In the table of measurements only one branch of a tree is measured, but the white elm is a branching tree, and hence has many leaves, indicating also a good growth of root. The wood is tough and far more durable than box-elder. Save the item of rapid growth, the elm is in every way superior to the soft wooded trees. Elm seed should be planted as soon as ripe, in May or June. The seed soon loses its vitality and will seldom germinate if kept till the following spring. It is a slender grower the first

few years, and is apt to form forked branches; usually one of the branches will take the lead, in which case pruning is unnecessary; but if two branches of equal strength grow up, one should be cut off. The white elm is universally recognized as one of the very best lawn and street trees in America.

BOX ELDER.—I have been often asked to recommend a variety that will take the place of box elder. The objections to this species are its small size when mature, low trunk and poor quality of timber. It is harder to prepare for the stove than cottonwood and makes no better fuel. Its merits are ease of propagation, rapid growth while young, suitability for nearly all locations and soils, general good health and comparative freedom from insect pests. For the present I am inclined to think the box elder is fairly entitled to rank as a leading variety for Dakota planting. It is one of the few trees that nature has distributed throughout the west, and we are as yet not sufficiently out of the pioneer stage to warrant discarding any tree that will grow as well as this species. As the country becomes more thickly settled the box elder will probably give place to a variety having more economic value.

ASH.—A number of correspondents have asked what is the species of the native ash—*Fraxinus viridis* (green ash) or *Fraxinus Americana* (white ash). My first thought was that ours is the white ash, but in looking up the authorities, I find the weight of testimony favors naming it the green ash. Dr. Sargeant places us beyond the range of the *F. Americana*, which all botanists agree is the larger and better tree. It is quite impossible to give characteristics that will enable the amateur to distinguish between young trees of the two species; the only strong point of difference is in the size of the mature trees; *F. Americana* attains a height of 90 to 125 feet and a diameter of 3 to 5 feet. *F. viridis* reaches a height of 45 to 54 feet and diameter of $1\frac{1}{2}$ to 2 feet. Other points of difference noted by botanists are: In the white ash the leaflets are slightly downy beneath, 7 to 9 in number, ovate pointed, but little toothed. In the green ash the leaflets are smooth beneath, 5 to 9 in number, narrower than last, sharp toothed margins. But in either variety may be found specimens that approach so near to the description of the other that it is often very difficult to determine the species. In the fruit of green ash the body is more than half the entire length; often the wing is but little longer than the body; in white ash the body of the fruit is only from one-third to one-half the length of the wing. These points are given to aid the reader in determining between the two most valuable species of the genus.

Robert Douglass, one of the leading practical foresters of the United States, strongly advises the planting of green ash in the west, rather than white, because the former species ranges farther west naturally and is therefore presumed to be better adapted to the climate. While smaller than white ash, the green ash is yet a timber of the highest value for almost all farm uses. No species has given a better stand on our grounds, and none have shown better foliage or stood transplanting better. The seed does not germinate as readily when sown in spring as box elder (see experiments in germination of forest tree seeds), but with fall planted seed we have had quite as good success with the ash as with the box elder.

The ash is not as good a lawn or street tree as elm. It grows slower in grass and does not make as fine a top.

WHITE AND YELLOW BIRCH.—These species seem to do about equally well in the Station grounds, so they are considered together, though the yellow birch (*Betula lutea*) is by far the more desirable timber tree, on account of its greater size.

The dry weather of last fall and winter showed the weak point of the birches. Nearly all the trees winter-killed very badly, both in the lawn and in nursery rows. A few specimens in the lawn were uninjured and these made a fine growth during the summer. The trees that killed back (from $\frac{1}{2}$ to $\frac{3}{4}$ of each tree was killed) have put out strong new branches, and the new growth is perfectly healthy. The birch trees are found native far north into Manitoba, so it could not have been the cold that killed our trees. Both species are beautiful lawn trees, and doubtless they are safe to plant in the lawn; but the experience of the past year is not favorable to their general planting in timber belts. However, they should receive a further test before being discarded.

EUROPEAN LARCH.—This species also shows the effect of a dry fall and winter. The lawn trees have made very little growth this season. The trees set in the plantation last spring made a fine start and all seemed to be growing; they were set earlier than the other sorts and before they had begun to grow. But a few weeks of bad weather in May killed quite a number of them, and the remainder have made only a moderate growth. Further trial is necessary before any estimate can be formed.

COTTONWOOD.—Our young trees of this species, one year old when transplanted last spring, have made a growth that fully explains the popularity of the tree for timber-claim planting. It is being found by experience however, that the cottonwood does not succeed in so

great a variety of soils and locations as the box elder. It is native along streams, in low, rich land, and when transplanted to ridges it often fails. Of late too, the cottonwood beetle has become a very serious pest, not infrequently killing whole plantations. I am not aware of any effectual way of killing this beetle. The principal value of the cottonwood is in its rapid growth. The timber is about equal to box elder, neither being good for much save for burning, and they are of only moderate value as fuel.

THE RUSSIAN POPLARS.—A number of poplars—trees closely resembling the cottonwood—have been disseminated over the northwest by the Department of Agriculture and the Iowa Agricultural College. Most of these varieties are known by the common name Russian Poplar. Not counting the silver-leaved sorts, but few of which have been distributed, there seems to be only one of the Russians that merits special notice. This is *Populus certinensis*. This tree is a very rapid grower, and succeeds, like the box elder, on both high and low land, and in almost if not all soils. In habit it is more erect than cottonwood, growing tall and straight. Its leaf resembles the cottonwood, save that its serrate margin is curved in and out. It has been grown from one year old plants at the station, and thus far only good words can be said of it. The one drawback to its success is the cottonwood beetle, which seems rather to prefer this tree to the cottonwood itself. The wood is in its general nature like cottonwood, but is said to be superior to that tree. It is worthy extensive trial.

BLACK WILD CHERRY.—As regards growth during the present year, I should place this after the ash and elm. In the plantation there is one plat in which ash, elm, birch and wild cherry are alternated. The ash rows are uniformly good, though not so high as the elms. The elms are far more uneven in height than the ash, and a few are missing. The cherries seem healthy, but they have not grown as much on the average as the ash, nor is the stand as good as the elm. The variety is promising, and as no timber is more valuable for special uses, it will repay a little care.

WHITE OAK.—About a hundred trees of this species were placed in the plantation last spring. About half of them lived, but very few did more than grow a tuft of leaves, or a small branch from near the ground. In taking up specimen plants for the fair in September, I found that a good root growth had been made. About seven miles east of the College is a grove of oaks and walnuts, seven years of age, in which the white oaks average six feet in height. As will be seen in the tables, oaks in our seedling grove, two years from the acorn, are

now but ten inches high. This may seem like very slow progress, but if the oaks be planted among other trees of more rapid growth, they will in time be worth the waiting for. The burr oak (*Quercus macrocarpa*) and red oak (*Q. rubra*) are both native in this county, but I have not found the white oak (*Q. alba*). It is probable that the native species will succeed better under cultivation, especially as the white oak thrives best in a region of much greater rain fall than we have.

THE WALNUTS.—In growing from the seed, white walnut or butternut seems to be more difficult to germinate than black walnut, though I regard it as a more promising variety for Dakota growing, because its native range is farther north. Both trees are valuable, the black walnut timber being considered especially desirable for furniture making. The walnuts have grown strong tap roots, the greater growth thus far being below ground. I have seen healthy walnut trees six to eight feet high near the village of Aurora, in this county, and I am informed that the walnut is being successfully cultivated in Minnehaha county. The better plan is to plant the nuts where the tree is to stand, so as to avoid cutting the tap root.

WHITE PINE.—This is a most valuable species, but our brief experience does not give much encouragement for its planting in Dakota. Trees transplanted from our own nursery last spring, under most favorable conditions and with great care, have made but little growth and many of them have failed. None of the white pines in the lawn, placed there three and four years ago, are making good growth. It may be that in the plantation they will succeed; but thus far the indications show the tree to be out of its climate.

SCOTCH PINE.—This variety has grown far better than the white pine, in the lawn, the nursery, and the plantation. Two years ago seedling trees of white and Scotch pine, 4 to 8 inches high, were set in nursery and given the same treatment. Now the Scotch pine trees are from two to four times as large as the white pines. The Scotch pines that were transplanted last spring have made an excellent stand and a fair growth and have been in fine condition throughout the year. While this species does not equal the last in economic value, it is far superior to it for windbreaks—a use for which we must find some evergreen trees. The Scotch pines in the lawn have grown well; growth was somewhat checked by pruning lateral branches, and forming new leaders on many trees in which the leading branches had been injured. Thus far the Scotch pine seems well adapted to cultivation here.

OTHER VARIETIES.—Notes on other species, both of evergreens and deciduous trees, are withheld until their behavior under transplanting can be observed.

ERRATA.—In "Officers of the Experiment Station," for "James M. Aldrich, assistant librarian," read "assistant entomologist."