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4-1897

Forestry in South Dakota

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South Dakota Agricultural College

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Corbett, L.C., "Forestry in South Dakota" (1897). *Bulletins*. Paper 53.
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(SO. DAK. BUL. NO. 53.)

April, 1897.

Bulletin 53.

U. S.
EXPERIMENT STATION,
SOUTH DAKOTA.



IN CONNECTION WITH THE
SOUTH DAKOTA AGRICULTURAL COLLEGE.

FORESTRY IN SOUTH DAKOTA.

Department of Horticulture.

BROOKINGS, SOUTH DAKOTA.

OUTMER, BREE & STORDAARD, BROOKINGS, S. D.

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Any farmer of the state can have the Bulletins of this Station free upon application to the Director.

Forestry,

L. C. CORRETT.

Ever since the first true home builder staked out his claim on the great plains of the Northwest the problems of tree growth, both for fruit and protection, have been continual subjects of experimentation. Each person brought either seeds or plants from the South or East, depending upon the section whence he came. These plants were in a majority of cases failures or disappointments. History is said to repeat itself, and if we were to judge all history by the records of tree planting, both by the early pioneers of this country and by their descendants as they ventured into the interior, we should find that the later generation pursued the same plan as that tried by their forefathers. The colonial settlers brought seeds and plants from the mother country. The pioneers of the Northwest carried them from the mother state. In both cases, however, the results were practically the same,—both failures. The younger generation thought, perhaps, that because they were not going outside the limits of their own country, the experience which came to the Puritans would not come to them. It has taken years for this lesson to become firmly impressed upon the people, but the great majority have come to appreciate its importance. The unsuccessful attempts to import from the East forced those that were determined, to look about them and to see what nature had here provided. In the search for plants for groves and shelter belts, the native woodlands that border the rivers and lakes and have survived in the ravines, furnished the desired material, but the source from which to draw a *fruit* supply was not so easily found.

The pioneer in an unknown climate may accept it as an axiom that success will be attained much more quickly from the adoption of native plants than from the introduction of foreign ones. It would be a very extraordinary portion of this earth's surface which would, by nature, be supplied with all the plants needed to provide for the several wants of man. If we but reflect a

moment and consider the origin of the several cereal grains and fruits now considered as necessities and grown by the people of any one section of the United States, we cannot but be impressed with the great importance of the power of acclimatization and the extent to which it has acted upon plants. But while we fully appreciate the value of introduced species, yet for the more primitive necessities, such as shelter and fuel, we should look to native rather than to introduced plants. Another fault that was inherent in the methods pursued by the early tree planters on the great plains has already been mentioned in another place. It was the thoughtless way in which the cottonwood was scattered indiscriminately over the prairies, regardless of its fitness for the site chosen.

All this is now being rapidly overcome, as the following extracts from replies to a circular letter sent to the owners of the largest and most successful tree plantations in South Dakota will testify. These results are not confined to any one section of the commonwealth, but rather represent the present status of all portions. But as all parts of the state are not alike as regards the adaptability to tree culture, and a corresponding difference exists in the extent to which tree culture has been attempted, as well as the length of time the various sections have been settled, it seems best to divide the State into as many divisions or districts as will best suit the several requirements.

In the outset, it is not improper to briefly consider the distribution of the native timber of the region. First, and most important, from an economic standpoint, are the forests of the Black Hills. A great measure of the value of these forests is due to the mining industries there engaged in so extensively, and to the advantage of having "*prop timber*" near at hand. Beside their commercial value, these forests possess great scientific importance as marking the place where the forests of the East lose their predominance and give place to those of the Pacific Coast. Here representatives of both the eastern and the western flora are found growing in the same habitat.

Again, the forests which skirt the larger and longer streams are second only to the area above mentioned and possess considerable economic importance, not alone for the fuel which they annually supply, but also as a guide and a source from which future plantations may be made. Nearly all the perma-

nent small lakes which are scattered more or less generally over the eastern portion of the State, have a forest cover of some considerable extent. In some instances timber was afforded of sufficient size and abundance to warrant the early settlers in building log houses, but this practice was not general outside of great river bottoms such as those of the Missouri and Big Sioux.

For our present purpose the State may be divided into two great divisions, an eastern and a western, separated only by the Missouri river. The eastern portion must again be subdivided into at least three sections, an eastern and western as separated by the James or Dakota River. The portion east of this river is quite different, as regards its tree-producing power, from that westward of it and extending to the Missouri river. This western division of the eastern half, save at its most southern part, is as yet but sparsely settled, and tree growing has not assumed any considerable proportions. In fact, many "claims" which have received careful attention in this region have been far from successful, and even now the opinion is prevalent that trees cannot be grown in the region. But in such cases I believe the exceptions prove the rule. There are a few, thrifty, well cared for, and at the same time promising tree plantations in the area. The eastern portion of the eastern subdivision has, at its southern limits, the oldest settled portion of the State, outside of the "Hills region." Here tree planting, both for utility and ornament, has received attention from all classes, and the demand has justified the establishment of nurseries for the production of home grown stock. The interest manifest in this section of the State is in no small measure to be attributed to the success of one of the pioneers, Mr. A Carpenter, of Vermillion, who by persistent care and watchfulness has made a marked success both in growing large and small fruits, as well as in forest and shade trees. Here may be said to be the nucleus of the forest and fruit planting interests of the eastern subdivision of South Dakota. ● On the grounds of Mr. Carpenter are to be found in their season, well grown specimens of standard apples, plums, cherries, strawberries, raspberries, grapes and currants. Some of the apples are worthy of special mention as throwing some light upon the longevity of such trees in the section. The oldest orchard is now over thirty years of age and all varieties that have proven hardy are in a

thrifty condition. Soft maples planted about the same time, and now perhaps 35 years of age, are some of them over twenty inches in diameter. Timbers, recently used in constructing a farm barn, that squared eight inches, and were 60 feet in length, were taken from groves planted by Mr. Carpenter. These were cottonwood, but this cannot be said to be an unusual growth for this species. Black walnuts, now about 23 years of age from the date of seed planting, are in a vigorous condition and are at least nine inches in diameter. I wish to call especial attention to this, and to the fact that black walnuts are growing in Brookings, Kingsbury and Hand counties of the state, for one writer in "Garden and Forest" has stated that this tree does not survive in South Dakota. In this section, which ranks highest among the subdivisions of the eastern half of the State, the forest trees most generally planted, and which are of greatest economic importance, are ash, elm, soft maple (silver maple) and cottonwood among deciduous trees, and Scotch pine and red cedar among evergreens. A few white pines and bull pines (*P. ponderosa*) are met with, and a large number of catalpas (*C. speciosa*) and Japanese catalpas are to be found in the towns and cities of this section.

The northern portion of this most easterly division of the State is also more fortunate than any other section outside of "The Hills," and the most southeasterly counties. Here natural forests, rich in oak, linden, ash and hornbeam skirt the waters of Big Stone Lake, and the outlying country is not deprived of the same blessing as that immediately adjacent to the lake. From this region of comparatively limited area, southward until the northern limit of the first named division of the eastern section is reached, we find a region less favorable to the development and growth of trees. This section is, however, far more extensively planted than the corresponding region west of the James river and between it and the Missouri. Some native wood is found along the Big Sioux and about the small lakes, particularly Lake Oakwood. It is in this area that the South Dakota Agricultural College is situated. There are growing upon the grounds of this institution at least fifteen acres of young forest trees, nearly all of which are in a thriving condition.

After having carefully noted the character of the growth in all portions of South Dakota over which I have been fortunate

enough to travel, I addressed the following circular letter to the owners of the larger forestry plantations of the State:

BROOKINGS, S. D.

DEAR SIR:

I take the liberty of asking you the following questions relating to the cultivation of forest trees in this State. If you will fill out and return the same in the enclosed envelope it will do me a favor, as well as greatly aid the work.

Respectfully yours,

Horticultural Dept., State Agr. College. L. C. CORBETT.

1. What varieties of trees have stood best in general plantations, tree claims, etc.?

2. In planting groves, which has given best results, planting the seed where the trees are wanted, or planting young seedling trees?

3. What kind of cultivation is best?

4. How late in the season is it safe to cultivate?

5. Do you prune your trees? Does it benefit them? If so, how?

6. Give the names of any hedge plants that have given success in your locality?

7. What can you say of the hardiness, rapidity of growth, and longevity of cottonwood, box elder, green ash and elm?

8. How old must a grove be before it becomes profitable to the owner?

9. In what does the greatest value of a grove consist, in its fuel product or protective power?

10. Draw a line through the *name* of any tree of the following list that has *not* proven hardy with you, i. e., in your locality:

DECIDUOUS—Elm; ash, green or white; birch, white, yellow or canoe; Lombardy poplar; Russian poplar; cottonwood; quaking aspen; willow, white, golden, laurel-leaved; balm of Gilead; maple, soft (silver or red), hard; Am. Mt. ash; box elder; black walnut; butternut; honey locust; black locust; *Catalpa speciosa*; Japanese catalpa; burr oak; hack berry; Am. or European larch; black cherry; mulberry, Russian or native; iron wood; linden.

EVERGREENS—Scotch pine; white pine; pitch pine; Black Hills native pine; red cedar; arborvitae; white spruce; black

spruce; balsam fir; Col. blue spruce; Norway spruce; Austrian pine.

SHRUBS—Oriental hedge or Russian olive; barberry; buckthorn; strawberry bush; Japan quince; sumach; June berry; tamarisk. *Please sign name and County.*

The following replies were received and, for economy of space, the answers are denoted by numbers corresponding to those upon the original questions as shown by the copy of the letter just presented:

1.—C. THOMPSON, Pennington County, Black Hills:

1. What varieties of trees have stood best in general plantations, tree claims, etc.? "1. ash; 2. elm; 3. box elder; 4. cottonwood.

2. In planting groves which has given the best results, planting the seeds where the trees are wanted, or planting young seedling trees? "1 year old seedlings."

3. What kind of cultivation is best? "Deep—thorough."

4. How late in the season is it safe to cultivate? "As late as any weeds grow."

5. Do you prune your trees? "When young." Does it benefit them? If so, how? "Makes trees straight and finer bodied."

6. Give the name of any hedge plants that have given success in your locality. "Barberry, but not recommended. Lilac for ornament."

7. What can you say of the hardiness, rapidity of growth and longevity of cottonwood, box elder, green ash and elm? "Without irrigation cottonwood and box elder of very little value; ash and elm stand well."

8. How old must a grove be before it becomes profitable to the owners? "Four years old, or ten feet tall."

9. In what does the greatest value of a grove consist, in its fuel products, or protective power? "Depends on locality."

10. LIST OF TREES REPORTED HARDY—Elm, ash, birch, cottonwood, quaking asp, willow (white and laurel-leaved), balm of Gilead, soft maple, Am. Mt. ash, box elder, black walnut, burr oak, hack berry, larch, black cherry, Scotch pine, pitch pine, bull or native pine (*P. ponderosa*), red cedar, arborvita,

white spruce, black spruce, balsam fir, Col. blue spruce, Norway spruce, Austrian pine.

Barberry, buckthorn, strawberry bush, sumac, Juneberry, tamarisk.

2.—GEO. H. WHITING, Yankton County, Southern and Eastern:

1. Ash, elm, box elder and soft maple.
6. Buckthorn and red cedar.
7. For hardiness the following order: 1st, ash; 2nd, elm; 3rd, box elder, cottonwood. For rapidity of growth: Cottonwood, elm, box elder and ash, in order named.
10. Hard maple and Japanese catalpa are the only ones stricken from the list as not being hardy.

T. L. McCREA, Bon Homme County, South, near Missouri river:

1. Box elder and cottonwood have been most largely planted. Elm, black walnut, ash and soft maple all do well.
2. Two and three year old trees have given best satisfaction.
3. Clean.
4. As long as weeds continue to grow.
5. Yes. Yes, makes nice straight trees instead of unsightly bushes.
6. Oriental hedge (*Elaeagnus angustifolia*) is beautiful and proof against drouth and cold.
7. Cottonwood quick growth and short life; box elder next; ash and elm are long lived, but slower growers, but are most desirable and profitable. Cottonwoods are like 24 per cent mortgages,—a damage.
8. Depends on what it is wanted for.
9. For stock protection.
10. Those stricken out as not hardy are Lombardy poplar, balm Gilead, *Catalpa speciosa*, and Japanese catalpa and Japanese quince.

4.—A. Carpenter & Sons, Clay County, Southeastern corner:

1. Box elder, ash, black walnut, soft maple and cottonwood.
2. Young trees, except in the case of walnut and maple, are best.
3. Thorough culture and frequent thinning.
7. Cottonwood of quick growth, thins itself rapidly, but

some of the trees live to an old age. Very few trees die young when set in single rows.

Box elder of slow growth unless well cared for, but it repays care well and lives to a good age.

Green ash of rather slow growth, but perfectly hardy, and lives to good age.

White elm, while a little hard to move, is perfectly hardy, of medium growth and never dies of old age.

Red elm is easier than the white to move, a faster grower and lives as long.

10. (a) Not tested.

(b) Alkali seems to hurt hard maple.

(c) Do not do well.

(d) Native.

(a) elm, (d) ash green, white birch, (a) yellow birch, Russian poplar, (d) cottonwood, (a) quaking asp, willow (golden, laurel-leaved and white), balm Gilead, (d) maple (soft), (b) hard maple, American Mt. ash, (a) box elder, black walnut, butternut, honey locust, black locust, *Catalpa speciosa*, Japanese catalpa, burr oak, hackberry, Am. and European larch, black cherry, mulberry (native and Russian), Scotch pine, white pine, (a) pitch pine, Black Hills native pine, (d) red cedar, (c) arborvitæ, white spruce, (a) black spruce, (c) balsam fir, Colorado blue spruce, Norway spruce, Austrian pine, (a) oriental hedge, barberry, (d) buffalo berry, syringa, prickly ash, thorn apple (*cratægus*), dogwood, strawberry bush, Japan quince, sumach, (c) service or Juneberry, flowering currant, (d) wild grape, moon seed, Virginia creeper, wild cucumber.

5.—J. A. PIERSON, Yankton County, South:

1. Cottonwood, *blue ash, box elder, and soft maple.

2. Both do equally well.

3. Mulching with cow manure.

4. Cultivate early in season; leave ground level and then mulch.

5. Prune very little,—nature does her own pruning and we should confine ourselves to those laws.

6. No hedge plants have been tried.

7. All are rapid growers; cottonwood leads, box elder second,

*Undoubtedly green ash.

ash third, and elm a good fourth. Cottonwood does much better on low land than on prairie.

8. From three to five years, according to kind.

9. First, protection; second, fuel.

10. The only names cancelled from the list are the following: Black locust, *Catalpa speciosa*, Japanese catalpa, native mulberry, and arborvitæ.

6.—V. J. HLADKY, Yankton County, South:

1. Box elder, ash and elm. Cottonwoods were largely planted at first and grew well, but proved to be short lived and are now dying rapidly.

2. Young seedling trees.

3. Deep culture.

4. June.

5. Yes; gives them an upright habit and a more rapid growth.

6. Do not know any that have been a success.

7. Cottonwood makes a rapid growth for five or six years, then begins to die out. Next in rapidity of growth is box elder and it is long lived. Ash and elm are best, but are slow growers.

8. About five years.

9. Protective power, mainly for wind breaks.

10. Many of the sorts mentioned are strangers to me, and therefore am unable to give an answer.

7.—C. S. FARGO, Yankton County, South:

1. Cottonwood, box elder, ash and black walnut.

2. Young seedling trees.

3. Thorough.

4. Just as long as weeds grow, but not too close as the trees obtain size.

5. Yes. It makes them grow straighter, more pleasing in appearance, and also gives them more vigorous growth.

6. Barberry.

7. Cottonwood is the most rapid grower, box elder next; all are long lived and hardy, if not too thick.

8. Six years.

9. Protective power.

10. Elm, ash, cottonwood, willow, box elder, black walnut, butternut, *Catalpa speciosa*, burr oak, hackberry, mulberry, (Russian and native), iron wood, Black Hills pine, red cedar Norway spruce, oriental hedge, barberry.

8.—C. J. PUCKET, Bon Homme County, South:

1. Box elder, ash, elm and butternut or white walnut.
2. Young seedlings.
3. Plowing.
4. About the middle of July.
5. Think it better to prune, as when left to themselves some varieties branch too low.
6. Buckthorn.
7. Cottonwood is a rapid grower, but short lived except on low ground. Box elder, elm and ash are hardy.
8. A mixed grove when three years old.
9. Protection.
10. Cottonwood, black locust, *Catalpa speciosa* and arbovitæ are the only ones cancelled from the list sent out.

9.—J. LEWIS STRAIT, Gregory County, South and West of Missouri river:

1. Cottonwood, ash and box elder in order named.
2. Planting two year old seedlings.
3. Thorough where possible.
4. As late as August 15 in ordinary seasons.
5. Some sorts,—box elder is best when kept in shape by pruning, as it gives it an upward tendency and prevents it becoming scraggy.
6. Russian mulberry. (Osage orange a failure.)
7. I think all are strictly hardy, and that ash is longer lived than either cottonwood or box elder.
8. As soon as it is established.
9. First, a grove gives a place a home-like appearance; second, windbreak; third, after two or three years it is of value for fuel.

10.—H. A. BARKER, Yankton County, South:

1. Box elder, ash, elm, cottonwood, black walnut and soft maple. I think burr oak will do well.

2. Young seedlings, except in case of walnut or oak.
3. The same as for corn.
4. June or first of July.
5. No. The body will grow more rapidly in pruned trees, but I wait until the limbs make wood.
6. Gray willow and barberry.
7. Cottonwood will live to great age on the river bottom, but does not do well on the hills. Box elder, ash and elm all do well both on bottom and prairie land.
8. Three years if well cultivated.
9. First, protection; second, fuel; if planted thickly stove wood can be had in three years.

10.—A. NORBY, Lake County, E. Central:

1. Ash, white elm and cottonwood when there are only a few rows.
2. Seedlings.
6. Red cedar.
7. Elm and green ash are perhaps the most valuable forest trees for this section. Black wild cherry is promising, as is also the wild red cherry. Box elder is valuable only as a nurse tree. Cottonwood stands well with plenty of room.

10. The following are stricken from the general list as not reliable: Black walnut, butternut, black locust, *Catalpa speciosa*, and Japanese catalpa, Norway spruce, and among ornamentals, tamarisk.

11.—H. C. BOCKOVEN, Clark County, E. North:

1. Russian poplar, ash, elm, and cottonwood in low places. Some have succeeded with box elder.
2. Planting young seedling trees. There is not much difference in the rate of growth of the two kinds.
3. Shallow culture is best.
4. About July 10th.
5. Some. To give them better shape.
6. Barberry.
7. Cottonwood on low land is a rapid grower and long lived; many failures on high land. Box elder a success in some cases, usually grows rapidly during summer and kills down in winter. Ash and elm do not winter kill and both stand drouth well.
8. Varies according to rapidity of growth.

9. Protection.

10. Names cancelled are as follows: Lombardy poplar, all the maples, honey and black locust, black cherry, both mulberries and arborvitæ.

13.—A. HARKINS, Deuel County, E. North:

1. Box elder, ash, soft maple, willow, elm, balm Gilead, Russian mulberry, Lombardy poplar and black cherry.
2. Planting *seed*; box elder and maple grow best from seeds.
3. Shallow culture.
4. Not later than July 20th.
5. Yes. Makes trees grow taller and more sightly.
7. Cottonwood and box elder grow rapidly. Cottonwood sometimes dies young, but this is not true on all farms.
8. Six years.
9. First, protection; second, fuel.

10. Only a comparatively small number of different kinds of trees have been planted in this vicinity. I think the green ash best; soft maple, box elder, elm, balm Gilead, and willow are all hardy and good. But few evergreens have been tried. I spent considerable on both black walnuts and butternuts, but both were failures. I have some Russian mulberries. They are only a bush, but bear fruit. The catalpas are too tender for this locality.

14.—A. B. SMEDLEY, Grant County, Northeastern portion:

1. Box elder, elm and cottonwood in the order named.
2. Seedling trees. (a) Seedlings grow best.
3. Clean.
4. Not later than July 10th.
5. Yes. It makes a better shaped tree and gives them an upward tendency.
7. The cottonwood will, I think, last longer than the box elder.
8. Ten years.
9. Protection, first; fuel, second.
10. Trees that stand in this section are elm, ash, birch, Russian poplar, cottonwood, willow (white, laurel-leaved), balm Gilead, maple, mountain ash, box elder, burr oak, hackberry, black cherry, iron wood, Scotch pine, Black Hills native pine,

balsam fir, Colorado blue spruce, Austrian pine.

Shrubs:—Oriental hedge, barberry, buckthorn, strawberry bush, Japanese quince, sumach, Juneberry.

15.—JOHN H. MILLER, Beadle County, division 2, between eastern and western portions of the eastern half of State:

1. Willow, ash and box elder.
 2. Young seedling trees and cuttings.
 3. Both plowing and cultivating.
 4. Not later than August.
 5. Yea. It beautifies them, makes them more tree-like, advances the growth and keeps them from becoming scrubby.
 6. Buckthorn. I have a hedge of it and it is a perfect success in every particular. Russian olive is also a good hedge plant, is hardy and a rapid grower.
 7. Cottonwood is of very rapid growth and hardy where there is plenty of moisture, but is not successful in South Dakota where it has been so very dry. Box elder is naturally a low, bushy tree, hardy and a rapid grower. Ash has proven the best of all trees in this country as to hardiness and longevity. It is rather a slow grower at first from seedlings, but grows more rapidly as it gets older. Elm is a hardy tree, but does not seem to grow right here.
 8. Six to eight years in the way of shelter.
 9. In its protective power as a shelter and wind break.
 10. The trees crossed off the full list are as follows: Yellow and canoe birch, quaking aspen, hard maple, black walnut, butternut, black locust, *Catalpa speciosa*, Japanese catalpa, black cherry, Russian mulberry and native, white pine, pitch pine, arbovitæ, black spruce, strawberry bush, and Japan quince.
- NOTE.—Willow planted from cuttings is the first timber that any great benefit can be derived from in the way of fuel. Usually several stalks, or trees, spring up and grow from each cutting. In a few years quite a quantity of fuel is obtained by allowing all the shoots to grow. Before crowding becomes too severe a thorough thinning should be made, leaving only a single tree in each place. The thinning will yield a large amount of fuel. This can be very successfully carried out, although the willow does not stand continuous dry weather from year to year, so successfully as some other species mentioned.

In 1881 I planted twelve acres of seedlings and willow cuttings on my tree claim, mostly willows. This was during a period of plentiful rains. In 1888 they were thinned and the poles removed. Made fuel enough to supply one stove for two years and the trees left were thirty feet in or more height.

16.—H. C. WARNER, Sanborn County, on division line between East and West:

1. Ash and elm.

2. Young trees.

7. Unless grown in a moist situation the cottonwood soon dies. The same is true of box elder. Green ash and elm are hardy and stand drouth.

10. The only change in the list given is the crossing off of the names of black walnut, honey and black locust and *Catalpa speciosa*.

17.—ROBERT E. OWEN, Spink County, West and North in Eastern division:

1. Ash, box elder, elm.

2. Seed.

3. Same as for corn.

4. Do not cultivate later than July 1st.

5. No: they are better not pruned. (No reasons given.)

7. Ash is best; elm second; box elder third; and cottonwood fourth.

8. Eight years.

9. The value is about the same for fuel and protective purposes.

10. The list of evergreens and shrubs are both marked off, and of the deciduous trees the following are reported favorably: Green ash, elm, cottonwood, willow, balm Gilead, Am. Mt. ash, box elder, burr oak.

18.—D. ROBERTS, Faulk county, north and west of eastern division:

1. Box elder, cottonwood, Russian poplar, ash, elm and soft maple.

2. Young trees or cuttings.

3. Shallow culture, repeated at close intervals.

4. Middle of August.
5. Yes. Just enough to keep them in good form.
7. Box elder and cottonwood both rapid growers. Ash and elm are hardy, but slow of growth.
8. Five years.
9. Consider that the two uses are of equal value.
10. The following kinds are reported favorably from this locality: Elm, ash, birch, Russian poplar, cottonwood, willow (golden), soft maple, box elder, black walnut, black cherry, iron wood, Black Hills native pine.

19.—E. T. SHELDON, Hand County, western central part of east half:

1. Box elder and ash.
2. Very little difference between the two. It all depends on the care given.
3. Shallow.
4. July 1st.
5. Yes and no. It has been so dry for the past five years that no intelligent test could be made.
7. The cottonwood is not durable, i. e., it does not stand, but the others will live if they can get moisture enough.
8. In this country, twenty years.
9. Protection.
10. The list of evergreens and shrubs is excluded and the following deciduous trees are reported as giving promise: Elm, green ash, birch, Russian poplar, willow, balm Gilead, Am. Mt. ash, box elder, butternut, Japanese catalpa, burr oak, hackberry, larch, black cherry, iron wood, and linden.

FORESTRY.

One of the most important facts demonstrated by this correspondence is the superiority of native species over introduced sorts. The ash is given first place in a great majority of cases, the elm stands a close second, while the third place is contested by the box elder and soft maple.

The great preponderance of evidence in favor of seedling trees as against sowing the seed where the trees are wanted, can not be meaningless. Perhaps one of the most emphatic lessons

which it teaches that young plants can better be grown in nurseries or seed beds than in field culture. 2nd. It is more economical, both in labor and in cost of seed, to grow plants in the nursery and transplant them than to grow them in the field. 3rd. A better stand is, as a rule, obtained from transplanted plants than from sowing seeds, with the exception of a few of the nut bearing trees.

The almost total absence of satisfactory hedge plants is also a notable feature. The buckthorn is well spoken of in the northern central portion of the eastern half, while farther south the honey locust can be relied upon, not only as a hedge plant, but as a valuable post timber.

The subject of how deep and how late in the season trees should be cultivated is somewhat of a puzzle as yet. On general principles, however, it can be stated that frequent shallow culture ($2\frac{1}{2}$ to 3 in.) up to August 1st, may be taken as a safe guide.

On the subject of pruning only slight differences of opinion seem to exist. A great majority of the growers prune, and can give their reasons for so doing. Nearly all agree that in artificial plantations good bodied trees cannot be had without pruning. This varies, of course, with the species. The elm and ash require much less attention in this respect than the soft maple or the box elder. The cottonwood cleans its own bole early when at all crowded, but in the open attention must be given to proper pruning. The idea that in an artificial plantation nature will do better pruning than the grower can possibly do, is a theory not well grounded. Trees in a forest or grove that has been planted are as truly under artificial conditions, particularly during the first six to ten years of their life, as are trees in an orchard and should receive the same care in regard to pruning as do fruit trees.

The universal verdict that the cottonwood and box elder are both of short duration in upland groves, only serves to intensify the statement of the superiority of the ash and elm.

A very encouraging fact that comes from this study is the comparatively short time required to obtain a grove possessing value to its owner. The limit of the period ranges from three to ten years, and the majority of evidence favors six years. It is believed that this may safely be stated to be a good basis for

calculation. When six years old cottonwoods will be 12 to 18 feet, box elders 10 to 12 feet, ash 6 to 8 feet, and elms 8 to 10 tall. This height is sufficient to form a very valuable protection for fruit plantations, stock and farm buildings.

It is significant of the high appreciation in which trees are held when nearly a unanimous opinion favors the idea that the greatest value of the grove, or tree belt, on the prairie is its protective power rather than its fuel product.

The varieties suited to the various districts of the state are so well detailed in the answers above recorded that it would be presumptuous to attempt to re-arrange them. It will be noted, however, that a few sorts are reported favorably from every locality, while others have a very restricted range. It is worthy of further note that the list is quite large in the southern and eastern counties and also in the Black Hills, and it is smallest in the driest portions of the state. The northern area, bordering the Big Stone lake region, is decidedly richer than the intermediate region between it and Clay and Union counties.

TREES SUITED TO THE SEVERAL SECTIONS OF
THE STATE.

BLACK HILLS.

Elm, ash, birch, cottonwood, quaking asp, willow (white and laurel-leaved), balm Gilead, soft maple, American mountain ash, box elder, black walnut, burr oak, hackberry, larch, black cherry, Scotch pine, pitch pine, *Pinus ponderosa* or bull pine, red cedar, arborvitæ, white spruce, black spruce, balsam fir, Colorado blue spruce, Norway spruce, white spruce, and Austrian pine.

ORNAMENTALS.—Barberry, buckthorn, strawberry bush, sumach, Juneberry, tamarisk.

WESTERN DIVISION OF EASTERN SECTION.

This includes all that portion of the State between the Missouri and James, or Dakota river, except perhaps a portion of the southern extremity of the division in the angle between the Missouri and James rivers.

The trees reported as promising for the northern portion of the area are:

DECIDUOUS.—Green ash, elm, cottonwood, willow, balm Gilead, Am. Mt. ash, box elder, burr oak, birch, Russian poplar, soft maple, black walnut, black cherry, iron wood, butternut, Japanese catalpa, hackberry and linden.

EVERGREENS.—Black Hills native pine and Norway spruce.

The central and southern portion of the area admits of a somewhat more extended list as follows:

DECIDUOUS.—Elm, ash (green or white), birch, white, yellow, canoe or weeping; Lombardy poplar, Russian poplar, cottonwood, quaking aspen; willow, golden, laurel-leaved or white; balm Gilead; maple, soft or hard; American mountain ash, box elder, butternut, Japanese catalpa, burr or white oak, hackberry American or European larch, black cherry; mulberry, native and Russian; iron wood.

EVERGREENS.—Scotch pine, white pine, pitch pine (*Pinus rigida*), Black Hills native pine, red cedar, white spruce, black spruce, balsam fir, Colorado blue spruce, Norway spruce, Austrian pine.

SHRUBS.—Oriental hedge or Russian olive (*Elaeagnus angustifolia*), barberry, buckthorn, buffalo berry, syringa, prickly ash, thorn apple (*Crataegus*), dogwood (*Cornus*, 3 sp.), strawberry bush (*Waahoo*) (*Euonymus*), Japan quince, sumach, staghorn, service or June berry, tamarisk, cytissus, flowering currants (*Ribes aureum*, *floridum*).

CLIMBERS.—Native grape, moon seed, Virginia creeper (*A. quin que folia*, wild cucumber (*herbaceous*).

EASTERN DIVISION OF EASTERN HALF OF THE STATE—BIG STONE LAKE COUNTRY.

This section, as has already been remarked, contains the native timber of the Big Stone Lake basin, and small areas upon Cobb's creek and Yellow Banks. The sorts reported as hardy and promising by the correspondents are:

DECIDUOUS.—elm, ash, birch, Russian poplar, cottonwood, willow, white and laurel-leaved, balm Gilead, soft maple, mountain ash, box elder, burr oak, hackberry, black cherry, iron wood, Russian mulberry.

EVERGREENS.—Scotch pine, Black Hills native pine, balsam fir, Colorado blue spruce, Austrian pine.

CENTRAL DIVISION OF EASTERN HALF OF THE STATE—SIOUX VALLEY AND LAKE OAKWOOD.

The Agricultural College is located in this district. Some native timber borders the Sioux river and the larger lakes, such as the group at Lake Oakwood. The experience at the Experiment Station and the list received from correspondence justify us in recommending the following trees for this region:

DECIDUOUS.—Elm, green ash; birch, white, yellow and canoe; Lombardy poplar, Russian poplar, cottonwood, quaking aspen, willow, white, golden and laurel-leaved; balm Gilead; maple, soft, silver and red; Am. Mt. ash, box elder, black walnut, butternut, honey locust, burr oak, hackberry, *European larch (?), black cherry; mulberry, Russian and native; iron wood, linden.

EVERGREENS.—Scotch pine, *white pine (?), pitch pine, Black Hills native pine, red cedar, arborvitæ, white spruce, black spruce, balsam fir, Col. blue spruce, Norway spruce, Austrian pine.

SHRUBS.—Oriental hedge or Russian olive, barberry, buckthorn, strawberry bush, Japan quince, Juneberry, tamarisk, sumach.

SOUTHEASTERN DIVISION—BON HOMME, YANKTON AND CLAY COUNTIES.

The following list of trees, as compiled from the correspondence, may be taken as a safe guide by planters:

DECIDUOUS.—Elm, ash (green and white), birch (white, yellow and canoe), Lombardy poplar, Russian poplar, cottonwood, quaking aspen, willow (white, golden and laurel-leaved), balm Gilead, soft maple (silver and red), American Mt. ash, box elder, black walnut, butternut, honey locust, black locust, *Catalpa speciosa*, Japanese catalpa, burr oak, hackberry, American and European larch, black cherry, native and Russian mulberry, iron wood and linden.

*The larch is growing at the Station, but only a small proportion of the original planting is yet standing. The same is also true of white pine and for that reason the (?) follow the names of these species.

EVERGREEN.—Scotch pine, white pine, pitch pine, Black Hills native pine, red cedar, arborvitæ, white spruce, black spruce, balsam fir, Colorado blue spruce, Norway spruce and Austrian pine.

SHRUBS.—Oriental hedge or Russian olive, barberry, buckthorn, strawberry bush, Japanese quince, sumach, Juneberry, tamarisk.

THE INFLUENCE OF GROVES AND FOREST AREAS ON THE HUMIDITY OF THE AIR.

Much conjecture and speculation has entered into the discussions relating to the influence of woodlands upon climate. True, some valuable observations have been made in regard to the rate of growth, the protective influences of shelter belts and precipitation caused by cold currents of air set up by the great forest areas of the mountain regions.

In this country the work of Prof. King, of Wisconsin, stands out pre-eminently in the consideration of the protective influence of shelter belts and groves. He gives not only the rate of evaporation in the open, but compares with it the lessened rate of evaporation from soil protected by groves and other wind-breaks. The distance at which these obstructions act is a very important factor, for it is known that each foot added to the height of the wind-break increases its protective power 16 feet to the leeward.

In foreign countries some attention has been given to the rate of evaporation in the forest and outside. This is dependent upon the average percentage of the humidity of the air in the forest and in the open. The humidity of the atmosphere influences the temperature of the soil as well as of the air. For the purpose of determining the ratio existing between these several factors of climate, both in the forest area and in the open, a series of observations was begun by the writer on April 4, 1895.

EQUIPMENT AND CONDITIONS.

The instruments used in these observations were four accurately graduated chemical thermometers and two hygrometers of the same pattern as those used by the U. S. Weather Bureau, each provided with a wet bulb and a dry bulb thermometer,

from the readings of which the humidity of the air is computed.

Two cages, with a tight roof and latticed sides, were made to shelter and protect the instruments. One was placed in the open in an area of cultivated prairie about 400 feet from the edge of a grove of 15 acres extent. The other cage was located inside the forest area among a mixed lot of trees consisting of box elder, cherry, maple and Scotch pine. The trees had been planted 6 years. Two of the chemical thermometers were used in each cage. One was placed at the surface of the soil and the other carefully set at a depth of 2 in. below the surface. The wet and dry bulbs of the hygrometer were 18 in. above the surface of the soil.

Observations were made each day at 7 a. m. and 2 p. m. The former was for the purpose of noting the influence of the night conditions upon radiation and evaporation. The 2 o'clock observations were made in order to have the conditions both of air and soil during the most heated portion of the day. From these two sets of observations we are able to get at the variation in temperature of the soil as well as the variation of humidity of the air that takes place during the 24 hours. The average of these two observations gives a fair basis for getting an average humidity for the day under the two conditions. The table here presented is a complete record of the conditions as they existed from April 4 to Sept 28, 1895, at Brookings, S. D.

EXPLANATION OF TABLE.

Beginning at the left side of the sheet the day of the month is indicated by a single numeral—as April 4. Next the reading of the thermometer at the surface of the soil at 7 a. m. In the column headed *2 inches below* is recorded the temperature of the soil 2 inches below the surface at 7 a. m. The columns marked *wet* and *dry*, respectively, give the readings of these thermometers at 7 a. m. The next column gives the percentage of moisture in the air at 7 a. m. This order is repeated again on the same day at 2 o'clock p. m. and, after the humidity of the air at that hour was determined, the column marked *Average* was made. It represents the average humidity of the air for that particular day under forest conditions or in the open. In the second column from the extreme right named *Difference*, we have noted the difference existing be-

tween the percentage humidity of the forest and open. In the last column the rainy days, as well as those unusually windy, are recorded. In the column of differences all numbers not preceded by a minus sign indicate a difference of the number of degrees recorded in favor of the forest area, i. e., the atmosphere of the forest is 1, 2 or 10 per cent more moist than the atmosphere of the open. If, on the contrary, the difference is in favor of the open country, it is noted by a minus sign placed in front of the number set in *italics*.

TEMPERATURE AND HUMIDITY RECORD.

April, 1895.

Day.	Forest.					Open.					Difference.	Remarks.		
	Surface.	Two inches below.	Wet.	Dry.	Average humidity.	Surface.	Two inches below.	Wet.	Dry.	Average humidity.				
4	35	34	32	33	100	74.5	37	41	34	34	100	70.5	4.5	
5	49	37	35	36	49	58	52	49	46	52	51	51	7	
6	64	41	30	36	73	88	40	43	36	39	80	8	8	Rain p. m., .06.
7	47	39	50	52	83	96.5	52	48	44	51	100	96.5	0	a. m., .38.
8	44	38	46	47	83	71	47	44	46	47	93	67	4	
9	36	36	34	36	80	68	37	40	34	35	94	67	4	
10	36	37	32	34	80	61	61	50	51	65	40	59	10	
11	38	35	35	37	82	82.5	61	50	48	64	38	75	7.5	Rain, .63.
12	48	37	48	50	83	78	50	46	46	49	73	75	7.5	
13	37	37	36	36	100	66.5	40	41	32	38	100	70	8	
14	50	41	50	59	83	66.5	70	50	58	74	40	58	8.5	Very windy.
15	36	36	30	31	53	63	39	42	35	37	82	58	10	Filled tube.
16	46	40	52	66	42	63	58	52	48	66	34	53	10	
17	45	38	40	46	60	50	47	45	38	47	47	42.5	7.5	Rain a. m., .29.
18	48	43	48	49	93	88	68	56	50	68	38	98	-5	
19	41	41	36	40	61	64.5	48	49	40	47	93	61	3.5	
20	54	43	52	63	48	57.5	50	49	48	49	93	61	3.5	
21	37	39	28	30	79	57.5	61	52	50	62	41	61	3.5	
22	61	44	60	72	46	57.5	38	42	33	34	89	64.5	-7	
23	76	42	46	50	74	57	66	54	54	68	40	56	1	
24	63	47	58	71	40	57	50	47	47	51	74	56	1	
25	49	46	46	50	74	57.5	69	56	54	70	38	61	-3.5	
26	66	56	64	68	41	57.5	51	51	46	51	69	61	-3.5	
27	48	41	44	47	80	58.5	61	48	58	68	53	53	7	
28	70	51	62	81	37	58.5	50	49	44	48	73	51.5	7	
29	41	45	35	39	73	55	76	61	59	78	30	70	1.5	
30	60	47	49	64	37	55	41	46	35	39	70	53.5	1.5	
1	44	44	38	42	56	48.5	64	55	44	64	37	53.5	1.5	
2	66	48	57	72	41	48.5	44	46	36	42	56	38	10.5	
3	44	45	38	43	65	59.5	72	58	54	75	20	38	10.5	
4	73	50	62	82	34	59.5	44	46	44	58	38	31	28.5	
5	47	46	42	44	85	66	79	60	56	82	24	31	28.5	
6	69	51	71	79	47	66	48	51	42	45	75	62.5	3.5	
7	48	47	40	48	52	42.5	75	61	54	78	50	43	-5	
8	68	51	58	76	33	42.5	74	60	54	75	40	43	-5	
9	45	48	43	47	73	53	49	51	42	48	63	50.5	2.5	
10	74	52	66	84	33	53	77	62	59	80	38	50.5	2.5	
11	52	51	48	50	86	65	52	53	48	50	86	63	3.5	
12	72	56	64	78	44	65	75	64	60	76	40	63	3.5	
13	55	54	52	53	93	93	66	57	52	54	93	93	0	Rain a. m., .22.
14	58	54	56	57	93	93	58	58	57	58	93	93	0	
15	56	54	55	56	93	79.5	57	56	57	57	100	85.5	-6	Rain night, 1.02.
16	69	57	68	75	66	79.5	69	62	65	71	71	85.5	-6	
17	51	55	46	48	100	91.5	49	53	47	47	100	96	-3.5	Rain a. m., .41.
18	64	56	64	67	83	91.5	63	60	64	66	90	96	-3.5	

Average humidity for month: Forest, 67.9; open, 64.2. Difference, 3.7.

TEMPERATURE AND HUMIDITY RECORD.—Continued.

May, 1895.

Day.	Forest.					Open.					Difference.	Remarks.			
	Surface.	2 inches below.	Wet.	Dry.	Per cent humidity.	Average humidity.	Surface.	2 inches below.	Wet.	Dry.			Per cent humidity.	Average humidity.	
1	55	57	56	56	100	100	58	59	56	57	93	96.5	3.5	Rain, 1.25.	
2	62	57	61	61	100	92.5	62	59	56	60	100	91.5	1	Rain, .09.	
3	74	58	61	59	92	76.5	68	58	57	58	93	81.5	-.5	Rain, .52.	
4	62	60	61	61	100	85	64	62	60	61	93	90.5	4.5		
5	57	57	52	53	93	72.5	55	55	52	54	93	70	2.5	Rain, .08.	
6	69	67	60	60	95	78.5	66	62	60	62	93	74	4.5	Rain, .19.	
7	58	58	58	57	88	74	57	57	54	56	88	72.5	1.5		
8	71	61	67	76	60	68	68	63	64	73	57	66.5	1.5	Moved from Plat 4 to 10.	
9	59	58	56	58	93	68	58	57	56	59	83	61.5	-7.5		
10	81	64	74	92	43	54	79	67	74	87	50	61.5	-7.5		
11	59	59	52	58	65	78.5	60	59	54	60	67	84.5	-6		
12	68	60	58	72	43	78.5	75	67	56	76	56	84.5	-6		
13	46	51	41	42	93	74	36	52	42	42	100	72.5	1.5		
14	52	51	45	51	64	74	53	53	46	51	69	72.5	1.5		
15	40	44	34	35	91	74	38	43	34	34	100	48.5	9.5		
16	53	48	46	54	57	58	55	52	44	55	45	48.5	9.5		
17	47	45	42	46	74	66	48	45	42	48	63	65.5	.5		
18	61	51	52	65	42	58.5	67	57	49	67	34	58	42	5.5	
19	40	43	33	35	82	66	38	42	34	36	89	58	42	5.5	
20	54	49	48	58	50	71	58	52	46	58	42	58	42	5.5	
21	45	47	38	42	76	71	45	47	38	43	65	70.5	.5	Rain p. m., .05.	
22	61	55	48	61	41	78	61	55	48	61	41	76	2		
23	46	47	41	44	76	71	45	47	42	44	83	70.5	.5		
24	56	52	52	58	68	78	58	52	50	58	58	76	2		
25	46	48	41	42	83	65	44	47	41	42	93	61.5	3.5	Rain, .05.	
26	51	49	45	50	63	65	52	50	45	52	59	70	4.5		
27	46	47	40	42	82	65	44	47	40	42	82	61.5	3.5		
28	62	53	53	64	48	65	65	56	52	66	41	70	4.5		
29	41	46	36	37	90	74.5	39	43	36	37	90	70	4.5		
30	50	47	49	50	59	84	52	48	43	52	50	86.5	-2.5	Rain, .04.	
31	45	45	41	43	85	84	45	44	42	43	93	86.5	-2.5		
1	49	49	44	46	83	64.5	45	50	44	47	80	69	-4.5		
2	41	42	34	36	82	64.5	39	40	32	30	100	57	3		
3	53	49	44	54	47	80	57	57	44	57	38	57	3		
4	40	42	32	35	72	80	39	42	35	38	73	47.5	8		
5	57	50	51	62	48	58.5	62	53	49	62	41	47.5	8		
6	45	45	40	44	71	42.5	47	46	41	46	67	47.5	8		
7	67	55	55	70	40	42.5	73	60	52	74	28	47.5	5		
8	56	54	47	55	55	65.5	58	56	49	57	57	57.5	8		
9	80	66	58	81	30	65.5	75	61	61	80	38	57.5	8		
10	57	54	52	56	76	74.5	58	55	52	57	70	77.5	-3		
11	69	61	61	71	55	50.5	73	65	62	73	45	65.5	-2		
12	55	56	50	52	86	74.5	54	56	52	53	93	65.5	-2		
13	63	55	52	64	45	50.5	67	57	52	67	39	40	10.5		
14	56	53	48	54	64	50.5	57	55	48	56	56	40	10.5		
15	82	66	69	88	37		89	72	66	90	24				

TEMPERATURE AND HUMIDITY RECORD.—Continued.

May, 1895.—Concluded.

Day.	Forest.					Open.					Difference.	Remarks.		
	Surface.	Two inches below.	Wet.	Dry.	Per cent humidity.	Average humidity.	Surface.	Two inches below.	Wet.	Dry.			Per cent humidity.	Average humidity.
28	73	64	66	72	70	61.5	76	69	64	74	56	45	15.5	
29	79	68	68	81	54		83	73	63	63	33	35		
30	63	63	54	60	67	59	81	65	54	62	58	50	9	
31	71	65	60	71	51		74	69	58	73	42			
	56	58	62	63	69	81.5	55	57	52	53	53	53	5	
	66	60	60	64	74		65	61	60	65	73			
	65	62	62	63	93	75	65	68	62	64	85	63	12	
	71	64	62	71	57		71	65	60	71	51			

Average humidity for month: Forest, 69.8; open, 67.3. Difference, 2.5.

June, 1895.

1	57	55	52	53	93	66.5	56	55	50	55	69	53	13.5	Rain, .34.
	71	61	58	74	40		71	63	58	74	37			
2	59	59	55	57	86	82	59	59	55	54	75	74	8	
	66	61	62	66	78		67	63	62	67	73			
3	61	60	59	59	100	97	61	60	59	59	100	85	12	
	71	64	68	71	84		71	68	66	72	70			
4	53	53	48	49	93	82.5	51	54	48	49	93	77.5	5	
	60	56	54	59	72		60	57	53	59	62			
5	51	52	47	48	83	77	50	51	47	48	98	69.5	11.5	
	64	59	64	71	61		71	63	58	75	38			
6	61	58	60	60	67	59	61	58	54	60	67	54.5	5.5	Rain, .04.
	77	64	69	81	51		82	71	69	54	40			Rain, .07.
7	69	58	54	60	67	64.5	61	60	57	59	87	61	5	
	76	68	72	80	62		81	70	67	81	41			
8	65	64	61	63	87	67.5	66	65	60	64	78	62	5.5	Rain, .03.
	80	68	70	83	48		80	74	73	87	46			Rain, .04.
9	56	56	50	50	100	90.5	55	55	50	50	100	96.5	0	Rain p. m., .12.
	58	59	54	55	93		56	59	54	55	93			
10	53	55	48	50	83	78	46	54	48	50	83	68.5	9.5	
	68	59	59	64	73		62	59	56	64	54			
11	59	58	55	56	93	78	58	58	55	56	93	73	5	
	59	63	64	72	63		68	64	68	73	53			
12	60	58	54	56	86	68.5	59	58	54	58	75	59.5	9	
	76	65	69	81	51		77	66	68	83	44			
13	58	58	53	54	83	70	59	58	54	58	75	63.5	6.5	
	73	63	65	78	47		77	67	70	80	52			
14	63	61	59	61	81	72	64	63	59	62	81	76.5	-4.5	
	75	67	73	81	63		80	72	76	82	72			
15	65	64	62	64	86	72.5	66	65	63	66	83	77.5	-5	
	77	69	71	80	60		82	74	78	84	72			
16	66	64	62	66	78	70	68	66	62	68	68	72	-2	Rain, .73.
	75	69	70	78	62		79	74	75	80	76			
17	60	60	54	55	93	84	59	62	53	56	80	80	4	
	60	62	54	57	75		60	61	54	57	80			
18	54	56	48	50	83	68	53	54	48	51	80	76.5	-8.5	
	68	61	60	70	53		69	63	65	70	73			
19	56	57	52	53	83	72.5	57	57	52	55	80	71	1.5	
	73	63	66	77	52		71	66	72	80	62			
20	58	59	43	54	93	79.5	59	59	55	57	86	80.5	-1	
	73	65	67	74	66		73	67	70	75	75			
21	61	61	57	68	93	83	61	61	59	59	100	89	-6	
	68	64	62	67	73		69	65	65	69	78			

TEMPERATURE AND HUMIDITY RECORD.—Continued.
June, 1895.—Concluded.

Day.	Forest.					Average humidity.	Open.					Difference.	Remarks.	
	Surface.	Two inches below.	Wet.	Dry.	Per cent humidity.		Surface.	Two inches below.	Wet.	Dry.	Per cent humidity.			Average humidity.
22	58	58	53	54	93	76.5	59	59	56	58	86	81.5	-5	
23	75	62	63	77	100	80	64	62	62	80	85	82.5	-2.5	
24	61	68	63	60	61	78	76	69	74	74	100	83	-5	
25	62	69	73	61	63	76	64	64	64	84	79	73.5	2.5	Rain, .07.
26	71	66	63	70	66	85.5	71	66	64	71	61	88	-2.5	
27	54	56	51	52	78	82	64	64	64	79	83	83.5	4.5	Rain, .06.
28	65	60	59	64	68	80.5	65	61	60	67	64	81.5	-1	
29	53	51	48	49	93	88.5	70	56	61	53	80	61.5	27	
30	72	62	69	72	84	84	73	65	64	77	43	70	14	
	59	58	54	55	93		59	58	56	57	93			
	76	65	72	77	75	84	76	69	66	79	47			

Average humidity per month: Forest, 77.4; open, 73.9. Difference, 3.5.

July, 1896.

1	58	58	54	54	100	83.5	60	60	56	58	86	65	18.5	
2	76	67	69	77	67	76.5	76	71	65	79	44	64	12.5	
3	61	62	56	57	93	77.5	61	63	57	59	87	64	13.5	
4	79	69	70	79	69	80.5	79	72	65	80	41	64	10	
5	62	62	57	58	93	75	62	63	58	60	87	65	15	
6	72	70	70	78	62	77	80	75	65	80	41	64	10	
7	83	73	68	84	72	72	72	69	68	72	79	72	8.5	
8	73	70	69	70	94	75	82	75	71	82	65	65	10	
9	71	71	66	68	89	72	73	72	70	72	89	65	18	
10	83	74	71	82	55	59.5	72	72	66	70	78	54	15	
11	65	63	56	62	58	78	66	64	53	65	45	44.5	20	
12	73	67	62	70	61	75	73	69	59	72	44	58	15	
13	54	59	49	50	93	78	51	59	48	50	86	58	20	
14	67	62	58	65	63	77	65	64	52	68	30	67	10	
15	60	54	43	44	93	77	51	55	47	48	83	67	10	
16	69	62	60	68	61	78	71	65	57	72	41	67	10	
17	76	58	48	50	93	78	51	59	50	53	80	52	26	
18	52	51	49	50	93	65.5	54	59	50	54	75	24	48	
19	86	69	67	83	38	68.5	81	70	61	84	26	48	17.5	
20	59	60	52	63	89	68.5	60	62	53	56	80	55	13.5	
21	84	69	71	86	44	67.3	84	72	67	88	30	55	10	
22	61	61	54	56	79	70	64	63	56	60	76	57.5	10	Rain, .29.
23	85	71	70	87	36	81.5	85	74	65	88	39	78	3.5	Rain, .08.
24	69	68	65	66	93	81.5	68	69	65	65	100	78	14	
25	74	72	66	72	70	86	76	73	64	73	58	66.5	-5.5	
26	82	69	70	84	46	66	57	61	52	54	86	40	14	
27	65	64	58	63	72	57.5	66	65	58	65	63	43.5	14	
28	82	71	67	82	43	84	84	74	63	84	24			

TEMPERATURE AND HUMIDITY RECORD.—Continued.

July, 1895.—Concluded.

Day.	Forest.					Open.					Difference.	Remarks.		
	Surface.	2 inches below.	Wet.	Dry.	Per cent humidity.	Average humidity.	Surface.	2 inches below.	Wet.	Dry.			Per cent humidity.	Average humidity.
17	56	60	48	50	86	63	58	62	51	56	74	47	10	Rain, .65.
18	65	70	68	84	40	79	82	72	62	64	80	77.5	2	
19	77	81	51	51	100	77.5	66	66	62	64	85	72.5	5	Rain, .23.
20	80	71	71	79	83	78	66	66	62	64	85	72.5	5.5	
21	58	61	53	54	93	75	59	61	55	58	75	59	16	Rain, 1.74.
22	58	59	52	53	93	74.5	59	61	54	56	80	68.5	6	
23	59	81	54	55	93	72	62	63	56	59	82	59	13	
24	59	60	54	55	93	77.5	70	67	68	68	83	77.5	0	
25	58	58	52	53	93	74.5	57	60	53	54	82	71.5	3	
26	64	64	60	61	94	79.5	64	64	62	63	93	69.5	10	
27	65	66	62	62	100	83	65	65	62	62	100	78	5	
28	69	65	62	63	93	77	66	66	63	65	88	69.5	7.5	
29	68	69	65	65	100	80	65	69	64	68	81	69.5	10.5	
30	52	62	64	72	68	81.5	57	62	53	54	93	85.5	-4	
31	56	58	48	49	93	76.5	75	60	56	52	86	66	11.5	
	77	66	69	78	80		80	70	68	83	44			

Average humidity for month: Forest, 74.6; open, 64.6. Difference, 10.

August, 1895.

1	58	60	52	53	93	76.5	60	62	54	58	75	68	10.5
2	78	70	69	72	60		81	75	68	81	57		
3	63	64	68	69	91	72.5	84	66	60	62	87	63	9.5
4	57	61	52	57	70	60.5	87	75	72	89	39		
5	80	68	63	81	51		58	63	53	54	93	64.5	-4
6	66	63	60	62	88	70.5	86	73	70	86	36		
7	80	68	69	80	53		67	65	62	62	100	76.5	-6.5
8	66	66	66	74	62		62	71	72	82	53		
9	60	63	55	56	93	89	60	65	56	57	93	95.5	-6.5
10	67	64	62	64	85		67	65	63	65	88		
11	57	60	53	53	100	81	57	61	54	54	100	80	1
12	75	66	66	74	62		79	68	70	79	60		
13	57	60	51	53	86	67	58	61	53	54	93	72.5	-5.5
14	83	69	71	84	48		84	72	76	88	52		
15	65	66	62	62	100	84	66	66	62	63	93	80.5	3.5
16	81	71	75	82	68		81	72	77	84	68		
17	69	69	65	66	93	93	70	69	65	68	83	81	12
18	72	70	68	69	83		72	71	69	71	79		
19	55	60	50	51	93	79	54	60	48	49	93	77	2
20	70	64	62	66	60		71	68	62	70	81		

TEMPERATURE AND HUMIDITY RECORD.—Continued.
August, 1895.—Concluded.

Day.	Forest.						Open.						Difference.	Remarks.
	Surface.	2 inches below.	Wet.	Dry.	Per cent humidity.	Average humidity.	Surface.	2 inches below.	Wet.	Dry.	Per cent humidity.	Average humidity.		
11	61	60	56	58	87	75.5	62	60	58	60	87	68	-5	
12	54	79	67	67	80	78	81	68	70	59	82	51	-2	
13	75	58	67	73	93	78	79	79	70	74	81	67	4.5	
14	65	65	61	62	93	75.5	66	66	62	64	85	51	1	
15	91	73	78	78	92	68	91	76	80	83	51	68	4.5	
16	59	64	54	56	86	68	60	65	54	56	86	68	1	
17	72	67	62	73	82	69.5	71	65	59	70	50	68	1	
18	47	56	40	41	82	69.5	50	56	43	44	83	72	4.5	
19	73	65	66	79	47	77.5	80	67	69	81	51	65	13	
20	64	62	68	68	86	77.5	65	65	62	64	85	64.5	13	
21	54	73	73	75	86	77.5	57	75	74	89	44	65	5	
22	54	62	48	48	82	70	56	62	49	51	86	65	5	
23	78	67	68	78	47	70	78	69	67	81	44	65	5	
24	59	00	51	54	80	65	59	61	52	56	93	70.5	-5.5	
25	72	64	59	70	50	65	72	66	61	73	48	66.5	-4.5	
26	49	00	51	54	80	65	52	56	44	45	93	66.5	-4.5	
27	72	64	59	70	50	72.5	77	67	63	79	40	65	7.5	
28	50	56	44	45	93	72.5	52	58	46	48	86	65	7.5	
29	77	65	66	76	52	66.5	72	68	66	80	44	58.5	8	
30	62	62	58	60	87	66.5	64	63	59	61	81	58.5	8	
31	87	71	73	87	46	66.5	86	74	70	88	36	64.5	-1.5	
22	88	68	65	68	83	64	68	69	64	65	93	64.5	-1.5	
23	81	72	69	84	43	64	83	73	68	86	36	64.5	-1.5	
24	54	63	54	55	93	71.5	60	64	65	67	87	69	2.5	
25	79	69	67	79	50	68.5	78	72	68	80	51	64	4.5	
26	55	61	49	50	80	68.5	56	61	50	52	86	64	4.5	
27	63	63	66	80	44	56.5	79	70	66	81	42	52.5	4	
28	66	64	60	64	78	64.5	67	66	61	65	78	70.5	-6	
29	88	73	70	89	35	64.5	88	76	67	83	27	70.5	-6	
30	89	76	76	91	45	74	71	70	66	69	84	73.5	.5	
31	61	66	56	58	87	74	61	66	57	58	93	73.5	.5	
22	73	68	63	71	61	78.5	74	69	53	73	54	72.5	6	
23	52	59	47	48	93	78.5	33	59	48	49	83	62	9.5	
24	74	65	64	72	63	71.5	72	66	63	72	52	62	9.5	
25	52	57	45	46	83	71.5	53	58	47	49	86	62	9.5	
26	83	67	64	79	50	77	80	69	64	81	38	72.5	4.5	
27	60	61	54	56	86	77	61	62	54	57	80	72.5	4.5	
28	69	69	61	67	86	69	71	70	61	68	65	65.5	3.5	
29	41	53	33	34	89	69	43	53	35	36	91	65.5	3.5	Frost.
30	68	61	56	68	49	69	69	63	55	69	40	65.5	3.5	

Average humidity for month: Forest, 71.6; open, 69.6. Difference, 2.

September, 1895.

1	56	50	49	53	74	62.5	56	57	46	54	84	51	11.5	
2	81	68	68	81	51	73.5	82	71	68	83	38	71	2.5	
3	59	64	59	60	94	65.5	64	65	59	62	81	61	12.5	
4	83	71	72	82	53	65	81	73	72	81	61	53	18	
5	83	65	58	59	86	65	64	65	59	60	94	53	12.5	
6	81	72	67	83	38	65	84	75	63	97	12	47	18	
7	50	58	41	42	83	65	51	58	41	46	67	47	18	
8	85	70	69	88	37	65	85	74	66	88	27	47	18	

TEMPERATURE AND HUMIDITY RECORD.—*Concluded.*

September, 1895.—*Concluded.*

Day.	Forest.					Open.					Difference.	Remarks.		
	Surface.	Two inches below.	Wet.	Dry.	Per cent humidity.	Average humidity.	Surface.	Two inches below.	Wet.	Dry.			Per cent humidity.	Average humidity.
5	64	64	54	61	62	54.5	64	65	52	62	50	42	12.5	
6	59	71	76	60	47		62	77	72	81	54	39.5	43	
7	40	63	54	30	72	64.5	40	50	52	70	55	67.5	6	
8	64	58	53	49	54	64.5	64	61	51	63	45	68.5	3	
9	57	58	54	55	93	64.5	57	58	54	55	83	76.5	7	
10	63	60	61	51	100	63.5	64	64	61	62	80	80	15	
11	79	67	72	79	67	66	79	70	71	80	78	47	15	
12	62	74	75	65	45	66	62	71	68	96	16	54	12	
13	77	67	60	76	66	83	81	75	70	82	51	69	14	
14	62	64	58	58	93	74.5	62	63	58	60	87	69	5.5	
15	81	70	70	80	56	69.5	81	75	70	82	51	69.5	0	
16	65	66	61	62	93	65	65	66	61	62	48	69.5	0	
17	85	73	72	86	46	69.5	86	78	73	87	48	68.5	-2.5	
18	61	61	50	58	58	49	61	63	50	58	58	49	0	
19	72	66	58	71	40	66	73	70	60	75	40	68.5	-2.5	
20	83	73	70	87	88	66	80	62	68	81	51	52.5	5	Very hot west wind.
21	69	67	66	67	93	57.5	70	70	66	68	89	52.5	20	
22	96	74	73	99	22	72	97	81	60	101	16	52	20	
23	51	60	44	45	93	72	59	60	45	48	30	46	1.5	
24	81	69	64	82	51	47.5	89	76	62	88	24	46	6.2	
25	63	64	56	61	72	64.5	65	63	55	63	53	62	5	
26	94	75	72	97	13	64.5	93	70	62	86	53	62	6.2	
27	68	69	62	61	85	64.5	68	70	62	65	83	62	5	
28	77	71	65	76	52	64.5	78	74	62	78	41	5	3	Heavy frost.
29	66	64	61	64	88	64.5	61	64	57	58	89	89	16	
30	45	54	40	40	100	100	45	50	41	41	100	100	0	
31	45	44	44	44	100	100	44	48	40	40	100	100	0	
1	39	44	31	31	100	77	42	43	31	31	100	74	3	
2	57	51	52	61	54	62.5	56	52	52	63	48	57	56	
3	16	49	41	42	93	72	17	16	15	45	57	16	14	
4	64	56	60	71	51	71	77	59	61	74	45	56	16	
5	49	53	43	44	93	71	45	48	39	43	71	57	14	
6	61	56	54	65	49	62.5	59	54	48	59	43	57	5.5	
7	46	46	38	42	76	62.5	45	48	39	43	71	57	5.5	
8	55	52	48	58	49	62.5	59	54	44	59	43	67	-1.5	
9	39	44	30	31	84	66.5	38	44	32	33	99	67	-1.5	
10	57	56	50	61	47	66.5	62	54	50	63	41	67	-1.5	
11	44	46	37	40	76	68	44	47	38	40	84	67.5	-4.6	
12	51	50	43	52	50	68	53	51	44	53	51	67.5	-4.6	

Average humidity for month: Forest, 69.9; open, 61.8. Difference, 8.1.

DEDUCTIONS FROM OBSERVATIONS.

Early in the season the thermometers in the open indicate that nature employs from one to four degrees of bottom heat, which is maintained throughout the growing season. This remark applies to the forest conditions as well as to the open, but the differences are not so constant in the forest and they are not shown so early in the season as they are in the open.

During the month of April and the first days of May the soil at the surface in the forest is cooler than that of the open. This condition prevails throughout the season but is less marked as the season advances.

There is a greater range in the humidity in the open during the 24 hours than there is in the forest, i. e., there is more rapid evaporation in the open than in the forest.

Under some conditions the air of the open may contain more moisture than that of the forest, particularly is this true if the forest is young, as in the case with the one in which these tests were carried out.

There is a greater range of temperature both at the surface of the soil and at a depth of two inches in the open than under forest cover.

The average daily humidity of the air is greater in the forest than in the open, as is shown by the daily record, as well as the monthly mean.

The following summary shows the average daily humidity for the several months, as well as the differences:

Month.	Daily mean in forest.	Daily mean in open.	Mean difference.
April.....	67.9	64.2	3.7
May.....	69.8	67.3	2.5
June.....	77.4	73.9	3.5
July.....	74.6	64.6	10.
August.....	71.6	69.6	2.
September.....	69.9	61.8	8.1
Average.....	71.9	66.9	5.

The results here recorded are, without doubt, much lower than would have resulted from the same observations having been carried on under a coniferous forest of the same age, or an old, high forest of deciduous trees. As it is, however, the data clearly show the importance of planting groves, and also that it is not necessary that the trees be old and fully grown before their good influences are felt.

Erratum: Bulletin 51, page 6, line 2 from bottom, read 9.2 for 19.2.