RESEARCH AND EXPERIMENT (ENGLAND AND WALES)

PROGRESS REPORT - OCTOBER 1935

This report records the progress of the nursery work during the past season both at Kennington and in various divisional nurseries. The section dealing with Kennington Nursery is based on reports by Mr. W.G. Gray while the other sections have been prepared from reports submitted by the experimental forester and by foresters in charge of various divisional nurseries.

In previous years it has been possible to include in this report some information as to the progress of the field experiments. Reports on these, however, have not yet all come to hand and it has been decided, therefore, to limit this progress report to an account of the nursery experiments.

Kennington Nursery

1. General condition

This on the whole has been good, and it has been possible to keep the area free from perennial weeds. Owing to the heavy stocking it was impossible to have a sufficient area under green crop or fallow, and the weather conditions at certain times made working difficult.

Seedling growth is up to the average standard but the transplants have not done so well as in previous years.

The water supply which has been laid on has proved to be of very great service and the cost of the water used is low, averaging about ten shillings per quarter.

2. Weather conditions

There was an adequate rainfall during the winter of

1934-35 but there were spells of dry weather in March and in May accompanied by drying north-easterly winds which did some damage in the newly-sown seed-beds. On the 25th of June there was an exceptionally heavy fall of rain (1.35 inches in 40 minutes) and this had serious effects on the surface soil conditions. The soil, especially in the transplant lines, became packed, and with dry weather following during July and August, the ground set hard so that weeding and cultivation became impossible and the Rototiller, for example, could not be made to enter the soil. There was very little growth in the transplant lines during this period. The dry weather came to an end with the rain on August 22nd, and until the end of September conditions were moist and favourable.

Photograph 34

The winter was much milder than that of the previous year and late spring frosts were not abnormally troublesome. It is interesting to record that the great frost of May 1935 was scarcely felt at Kennington, only 6° being recorded, although in the surrounding district considerable damage was done. The only species seriously damaged in the nursery was Picea jezoensis.

The following table gives details of the rainfall since the end of September 1934.

	Month	No. of days with .01 inch and over.	Total rainfall. inches
1934	October	15	1.46
	November	11	1.64
	December	27	5.39
1935	January	5	0.53
	February	15	2.17
	March	9	0.32
	April	19	3.57
	May	10	1.81
	June	20	4.14
	July	5	0.68
	August	9	1.74
	September	20	4.64
		Total	28.19

The total, 23.19 inches, compares with 15.28 inches for the same period in 1934-35 and with an average annual rainfall in the district of about 29 inches.

Details of the temperature are given in the following table.

		Stevenson Screen			Grass Minimum
	Month	Min. 32°F. and under. days	Max. 70°F. and over. days	Max. 80°F. and over. days	32°F. and under. days
1934	October	1	-	-	6
	November	4	-	-	14
	December	4	-	-	11
1935	January	8	-	-	17
	February	8	-	-	12
	March	9	-	-	15
	April	2	-	-	11
	May	3	-	-	8
	June	-	8	2	-
	July	-	20	5	-
	August	-	23	8	-
	September	-	3	-	-

The highest temperatures recorded were:

86° July 13.

85° June 22, July 14, August 7, August 8, August 21.

84° June 24

83° July 15, August 6, August 20, August 22.

The lowest temperatures recorded were:

18° January 9.

19° November 1.

36° May 17, May 18, May 19.

3. Reports on Experiments

Experiment 86, P.34. Density of Sowing.

A report on this experiment was submitted last year and in that report it was stated that so far as could be seen then the following densities were suitable for seedlings to be lifted at the end of the first year: for Scots pine, 375 sq.ft. per lb., European larch 300 sq.ft. per lb., and Japanese larch 405 sq.ft. per lb. - all sown broadcast. These densities gave a slight overstocking and led to some competition among the seedlings but were otherwise satisfactory.

Of the three species tried in this experiment, two, namely European larch and Japanese larch were lifted at the end of the first season and the seedlings were graded and counted. The Scots pine were left in the seed-bed and at the end of the second season they had become in all treatments large, densely crowded, drawn-up seedlings. All the densities tried, namely, 250, 375, 500 and 750 sq.ft. per lb., were thus all quite unsuitable for raising 2-year seedlings of this species at Kennington. This result, however, is not of much practical importance as Scots pine can always be lifted at the end of the first year in this nursery.

The larches, which were lifted and assessed as one-year seedlings, were sown broadcast in the different treatments at the following rates.

Square feet per pound of seed.

	A	B	C	D
European larch	400	600	300	200
Japanese larch	540	810	405	270

The assessment of the European larch gave the following results.

Seedlings per sq.yard

Grades	A	B	C	D	Ed E	Difference required for a 20 to 1 probability.
1. Over 3½ in.	205.2	181.2	214.3	210.3	± 20.88	± 55.682
2. 3½ in. & under	266.2	182.2	448.2	697.2	± 22.59	± 58.079

Percentage of culls

A	B	C	D
5.6	3.8	7.0	10.4

Number of usable seedlings per pound of seed.

	A	B	C	D
Grade 1	9,000	12,000	7,000	4,600
Grade 2	11,800	12,000	14,900	15,400
Total	20,800	24,000	21,900	20,000

For Japanese larch the following figures were obtained:

Seedlings per sq.yard

Grades	A	B	C	D	Ed	Difference required for a 20 to 1 probability.
1. Over 3 in.	164.8	126.3	180.2	211.5	± 15.49	± 39.825
2. 3 in. & under	322.8	254.7	430.5	606.7	± 24.02	± 61.755

Percentage of culls

A	B	C	D
9.8	6.0	10.6	15.5

Number of usable seedlings per pound of seed

	A	B	C	D
Grade 1	9,800	11,300	6,000	6,300
Grade 2	19,300	21,000	19,300	18,200
Total	29,100	32,300	25,300	24.500

Conclusions:-

1. The dense sowings have increased the number of seedlings per square yard in each species and the more open sowing

has led to a reduction in the numbers.

2. The number of grade 1 seedlings per square yard has not been increased with denser sowing in the European larch nor has it been significantly reduced by the more open sowing. The sowing of Japanese larch at the rate of 270 sq.ft. per lb. has given an increase in the number of grade 1 plants per sq.yard, but the other variations on the standard density have not led to any significant difference in the number of grade 1 plants per sq.yard.

3. In both species the density of sowing has affected the number of grade 2 plants per sq.yard, the dense sowings having given greatly increased numbers and the less dense sowings significantly lower numbers.

4. The percentage of culls is lowest in the less densely sown treatments and increases with density of sowing. The differences, however, are not great.

5. In both species, the least dense sowing (600 sq.ft. per lb. for European larch and 810 sq.ft. per lb. for Japanese larch) has given the highest yield of grade 1 seedlings per pound of seed. The total production of usable seedlings has also been increased by this treatment.

Experiment 104, P.35. Density of Sowing.

In this experiment Norway spruce, Sitka spruce and Japanese larch were sown at different densities with the standard density as a control, the object being to discuss the optimum sowing density for the production of 2-year seedlings.

The densities were as follows:

Square feet per pound of seed

	Broadcast				Drill			
	A	B	C	D	A	B	C	D
N.S.	405	270	540	810	540	360	720	1080
S.S.	765	510	1020	1530	1035	690	1380	2070
J.L.	540	360	720	1080	765	510	1020	1530

At the end of the first growing season the condition of the beds is satisfactory and differences in stocking are well defined. No assessment will be made until next year but certain observations have been made and a count carried out of the seedlings in the different treatments.

Seedlings per square yard at end of first season.

	Broadcast				Drill			
	A	B	C	D	A	B	C	D
N.S.	624	894	471	358	479	761	368	239
S.S.	1245	1632	954	619	778	1100	573	396
J.L.	478	705	356	234	320	448	230	168

At the present time treatment A appears likely to give a reasonable stocking of 2+0 Norway spruce but would seem to be too dense both for Sitka spruce and Japanese larch. Treatment B is overstocked for all species, while treatment C appears to be a little understocked in Norway spruce and Japanese larch but about right for Sitka spruce. Treatment D appears to be too thin for practical purposes in all species and with both methods of sowing.

Experiment 76, P.34. Stratification of seed of Douglas fir.

An account of this experiment was given in last year's report where it was shown that a short period of stratification in sand led to improved germination in the first year.

A second assessment was carried out when the seedlings

were lifted, and the results are given below.

Treatments:

A. Autumn sowing.

C. Stratification in sand on January 30th.

D. Spring sowing.

Number of seedlings per sq.yard. Spring 1935.

Grade	A	C	D	Sd	Difference required to give a 20 to 1 probability.
1. Over 3½ in.	158.75	265.0	11.0	± 16.33	± 51.962
2. 3½ in.& under	216.0	367.0	29.75	± 38.59	± 122.793

Percentage of culls

A	C	D
8.5	9.1	46.0

Production per pound of seed

	A	C	D
Grade 1	5,200	8,800	360
Grade 2	7,200	12,200	990
Total	12,400	21,000	1,350

These figures confirm the conclusions arrived at on the basis of seedling counts in the first year and they show clearly the advantage of stratification.

The high proportion of culls in treatment C is due to the delayed germination with this method of treatment.

Experiment 77, P.34.

This experiment, which was similar to No. 76 except that the seed was stratified in flower-pots, was likewise reported on last year and has also been assessed for the second time when the seedlings were lifted. The result of this new assessment is given below.

Number of seedlings per square yard

Grade	A	C	D	Sd	Difference required to give a 20 to 1 probability.
1. Over 3½ in.	112.75	214.0	1.5	± 26.85	± 85.437
2. 3½ in. & under	216.0	450.75	17.0	± 27.63	± 87.919

Percentage of culls

A	C	D
6.7	6.2	60.0

Production per pound of seed

	A	C	D
Grade 1	3,700	7,000	50
Grade 2	7,200	14,300	560
Total	10,900	21,300	610

These results agree with those of Experiment 76 and confirm the conclusions of the previous year.

Experiment 95, P.35. Stratification of Seed.

A small unregistered experiment with old seed of Japanese larch in 1934 indicated that stratification might be useful as a means of improving the germination of seed which had been dry stored for a number of years, and it was therefore decided to proceed with this experiment. Seed of Scots pine and of Douglas fir, Ident. Nos. 31/91 and 31/39 respectively, was used and the following treatments applied.

A. Seed dry-stored and sown in the spring (March 27th).

B. Seed stratified in sand on 30th January and sown as in A.

C. Seed stratified in sand on 28th February and sown as in A.

Germination took place much earlier in treatment B than in the other treatments, and the seed of Scots pine in this

treatment was actually germinating in the pit before sowing.

A count made in the Douglas fir beds on June 17th brings this out clearly. The figures were as follows:

Average number of seedlings per 3 sq.ft.

A	B	C
10.8	48.5	86.6

An assessment was carried out at the end of the first growing season with the following results.

Scots pine

Average number of seedlings per 1.25 sq.ft.

A	B	C	Sd	Difference required for a 20 to 1 probability.
110	129	187	± 7.423	± 19.084

Number of seedlings per square yard.

A	B	C
790	920	1340

Production per pound of seed

A	B	C
26,400	30,900	44,700

Douglas fir

Average number of seedlings per 3 sq.ft.

A	B	C	Sd	Difference required for a 20 to 1 probability.
59.8	94	106.3	± 8.112	± 20.865

Number of seedlings per square yard

A	B	C
179	281	318

Production per pound of seed

A	B	C
5,970	9,390	10,600

So far as the Douglas fir is concerned, the results bear

out previous work. What is interesting, however, is the beneficial effect on old seed of Scots pine of short periods of stratification. We have no experimental evidence as to the effect of stratification on fresh seed of this species and it will be necessary to clear up this point in next season's work. If, however, as is likely, Scots pine like Norway spruce and Corsican pine does not respond to stratification when fresh seed is used, this method of dealing with old seed may prove of some service in actual practice.

If seed of Norway spruce and Corsican pine is available, it is proposed to test these species in this way next season.

Experiment 96, P.35. Stratification of seed.

This experiment was planned as a further trial of the effect of stratification on the seed of Corsican pine and Norway spruce. Previous work had shown that no beneficial result followed on stratification with these species.

Two treatments were applied as follows:

A. Seed dry-stored and sown in the spring.

B. Seed stratified in sand on 30th January and sown as in A.

Counts of seedlings at the end of the first growing season gave the following figures.

	Corsican pine		Norway spruce	
	A	B	A	B
Seedlings per sq.yard	482	299	558	666
" " lb. of seed	10,700	6,600	24,800	29,600

Stratification has again reduced the production of seedlings in Corsican pine, and although it has given a slight increase with Norway spruce, it is doubtful whether this is significant. A further assessment will be made when the seedlings are lifted.

Experiment 97, P.35. Stratification of seed.

In this experiment further work was carried out with birch and alder. Previous work with these species had indicated that while birch benefitted from stratification, alder did not, and it was considered necessary to make another test.

Three treatments were applied as follows:

A. Seed dry-stored and sown in the spring (March 27th).

B. Seed stratified in sand on December 19th and sown as in A.

C. Seed stratified in sand on January 30th and sown as in A.

A count of seedlings at the end of the first season gave the following results.

Birch

Average number of seedlings per 1.6 sq.ft.

A	B	C	Sd	Difference required to give a 30 to 1 probability.
816	1050	1006	± 24.442	± 62.840

Alder

A	B	C	Sd	Difference required to give a 30 to 1 probability.
269	262	286	± 11.657	± 29.970

A further assessment will be made when the seedlings are lifted.

Conclusions:

1. Stratification has markedly increased the production of seedlings of birch, both long and short periods of stratification being equally effective.
2. Stratification has had no effect on the production of seedlings of alder.

These conclusions are in agreement generally with the results of earlier experiments.

Intensive Seedling Cultivation Experiment, 1932. Production of large seedlings.

Work was continued in this experiment along the original lines in sections A and B.

Section A. Species - Sitka spruce.

There were two treatments, (a) normal nursery soil, (b) a 50/50 mixture of nursery soil and broadleaved humus to a depth of 3 inches. Both treatments were worked on a one year rotation and were fallowed and dressed with farmyard manure at the rate of 1 cubic foot per 33 sq.feet of bed in alternate years. The fallows were cropped with lettuce and beet-root.

1934 sowings.

A preliminary report on these sowings, based on counts at the end of the first season, was submitted last year. A second assessment was made at the time of lifting when the seedlings were graded and lifted. The figures are as follows:

Average number of seedlings per sq.yard.

	Grades		
	1	2	Culls
Nursery soil	513	568	123
Soil & broadleaved humus	515	477	133

Production of usable plants per pound of seed.

	Nursery soil	Soil and broadleaved humus.
Grade 1	31,300	31,500
Grade 2	34,000	29,100
Total	65,300	60,600

Shoot limits for grading - Grade 1, over 1⅝ inches; Grade 2, 1⅝ inches and under.

There has thus been little difference between the treatments.

One unit bed in this section was differently treated and the plants, instead of being lifted at the end of the first year, were thinned out to a density of about 400 per sq.yard and left to become two-year seedlings. The object of this treatment was to find out whether by thinning out the beds a two-year seedling fit for planting could be produced. The seedlings have made good growth and are now from 3-13 inches in height but they are rather crowded and poorly branched. The density to which they were thinned has been obviously too great.

1935 sowings.

The seed was sown broadcast on March 19th at a density of 1 pound to 765 sq.feet. At the end of the season the seedlings in the broadleaved humus treatment averaged 2¾ inches with a maximum of 4½ inches, and in the nursery soil section 1¾ and 5½ inches respectively. The number of seedlings per square yard and the production per pound of seed are as follows:

	Seedlings per sq.yard.	Production per pound.
Nursery soil	921	78,300
Soil and broadleaved humus	907	77,100

Section B. Species - European larch.

There were two treatments, (a) nursery soil to which an annual dressing of basic slag at the rate of ½ lb. per sq.yard was applied, and (b) a 50/50 mixture of nursery soil and broadleaved humus. The fallowing and rotation were carried out as in Section A.

1934 sowings.

Last year's report gave information as to the progress of this section during the first growing season. The

seedlings were lifted in the spring of 1935, graded and counted, and the figures obtained are summarised below.

Average number of seedlings per square yard.

	Grades 1	2	Culls
Soil and slag	189	493	45
Soil and broadleaved humus	264	297	33

Production of usable plants per pound of seed.

	Soil & slag.	Soil & humus.
Grade 1	7,300	10,200
Grade 2	19,100	11,600
Total	26,400	21,800

Shoot limits for grading - Grade 1, over 4½ inches; Grade 2, 4½ inches and under.

The yield of good plants is thus slightly higher with the soil and slag treatment, but there was little difference between this and the other treatment so far as general vigour and root development were concerned.

1935 sowings.

The seed was sown broadcast on March 19th at the rate of 1 pound to 405 sq.feet. At the end of the season the average shoot growth with both treatments was 4½ inches, rather less than last year, with a maximum of 7½ inches. The number of seedlings per pound and per square yard were as follows:

	Seedlings per sq.yard.	Production per pound.
Soil and slag	295	13,200
Soil and humus	279	12,500

Section C.

1934 sowings.

In this section a commencement was made last year with various mixtures of peat and soil, and the preliminary stage of this work was described in the 1934 report. A further assessment was made when the seedlings were lifted. The results are given in the following tables.

Average number of seedlings per sq.yd.

Treatment	Norway spruce				Sitka spruce				Pinus contorta			
	Grades				Grades				Grades			
	1	2	Culls	Total	1	2	Culls	Total	1	2	Culls	Total
Nursery soil	63	346	13	422	36	112	58	206	18	112	31	161
Seed compost	0	54	9	63	0	9	0	9	0	0	4	4
Soil & mustard compost	4	550	22	576	4	198	13	215	4	81	31	116
Sorbex peat & soil	535	175	28	738	400	144	36	580	670	400	54	1124
Beddgelert peat & soil	639	130	40	809	184	144	49	377	301	76	18	395
Moss peat & soil	603	153	4	760	117	85	18	220	477	202	9	688

Production of usable plants per pound of seed.

	Norway spruce			Sitka spruce		
	Grades			Grades		
	1	2	Total	1	2	Total
Nursery soil	2,600	15,400	18,200	2,200	6,800	9,000
Seed compost	0	2,400	2,400	0	550	550
Soil & mustard compost	200	24,600	24,800	275	12,100	12,375
Sorbex peat & soil	23,800	7,800	31,600	24,400	8,800	33,200
Beddgelert peat & soil	28,400	5,800	34,200	11,200	8,800	20,000
Moss peat & soil	26,800	6,800	33,600	7,100	5,200	12,300

Production of usable plants per pound of seed.

Pinus contorta

	Grades 1	2	Total
Nursery soil	2,400	7,500	9,900
Weed compost	0	0	0
Soil & mustard compost	300	5,400	5,700
Sorbex peat & soil	44,700	26,700	71,400
Beddgelert peat & soil	20,100	5,100	25,200
Moss peat & soil	31,800	13,500	45,300

Shoot limits for grading:

	Grade 1	Grade 2
M.S.	Over 1¼ in.	1¼ in. & under
S.S.	" 1½ "	1½ " " "
P.C.	" 1½ "	1½ " " "

These figures bring out very clearly the beneficial effect of the peat mixtures.

The germination in the weed compost beds was inhibited by the application of a sodium chlorate solution used as a weed killer. The mustard compost beds presented some difficulty as the material did not settle down very well and germination was affected in a number of the beds.

1935 sowings.

The mustard compost was replaced by a mixture of broadleaved humus and soil but the other mixtures were left. The beds were re-sown on March 19th, and at the end of the season the following figures were obtained.

	Norway spruce		Sitka spruce		Pinus contorta	
	Per sq.yd.	Per lb.	Per sq.yd.	Per lb.	Per sq.yd.	Per lb.
Nursery soil	799	35,900	1053	89,500	1105	82,800
Weed compost	727	32,700	867	73,700	702	52,600
Broadleaved humus	612	27,500	824	70,000	684	51,300
Sorbex peat	482	21,700	1152	97,900	1215	91,100
Beddgelert peat	441	19,800	1116	94,800	1112	73,400
Moss peat	486	21,800	1051	89,300	860	64,500

Shoot length at the end of the first season was as follows.

	Norway spruce		Sitka spruce		Pinus contorta	
	Mean ins.	Max. ins.	Mean ins.	Max. ins.	Mean ins.	Max. ins.
Nursery soil	1½	3½	1¾	4	2	3½
Seed compost	2	3½	1¾	3	2	3½
Broadleaved humus	2¼	3½	2½	4	3	4
Borbex peat	2	3½	2½	4	2½	4½
Beddgelert peat	2	3½	2½	5½	2¾	4½
Moss peat	2	3	2	4½	2½	4½

This section of the experiment will be assessed in detail when the seedlings are lifted.

Section D.

Various species have been sown in this section.

1934 sowings.

Seed of Ash, Pinus contorta and P. resinosa was sown in 1934. The two species first mentioned were lifted as one-year seedlings in the spring of 1935, graded and counted with the following results.

Production of usable plants per pound of seed.

	Pinus contorta			Ash		
	Gde 1	Gde 2	Total	Gde 1	Gde 2	Total
Broadleaved humus & slag	39,900	22,500	62,400	350	570	920
Nursery soil	34,600	33,300	67,900	250	619	869

The Pinus resinosa, now 2-year old seedlings, have not yet been assessed. It is satisfactory to note that they have survived and have grown well. They are from 3 to 6 inches in height. Any appearance of Lophodermium was checked by applications of Bordeaux mixture.

1935 sowings.

The following species were sown - Pinus nigra var germanica, Styrax officinalis, Cedrus brevifolia, Betula papyrifera and Tsuga heterophylla. No germination was obtained from the Pinus and the Styrax but the seed are still good and should germinate next year. 24 seedlings of Cedrus have been obtained from 1½ ounces of seed, and from 1.2 grammes of seed 60 seedlings of Betula have been raised. These vary from 3 to 13 inches in height. The Tsuga which were sown at the rate of 1 lb. to 1000 sq.feet broadcast have germinated well and on a basis of the August count have yielded 134,000 seedlings per lb. on the nursery soil and 184,000 on the broadleaved humus. The average shoot length is 1½ inches with a maximum of 3 inches.

Experiment 108, P.35. Production of large seedlings.

A further trial of Beddgelert peat was made in this experiment on Norway spruce, Sitka spruce and Pinus contorta. Four treatments were applied:

A. Control. Nursery soil. No peat.

B. Peat and nursery soil in a 50/50 mixture.

C. Peat and nursery soil in a 25/75 mixture.

D. Peat and nursery soil in a 40/60 mixture.

Sowing at the standard density for each species was carried out on March 19th in boarded-in beds. Germination was satisfactory and growth throughout the season was good, the control sections being rather better than usual.

A count of the seedlings in each section was made at the end of August and yielded the following information.

Average number of seedlings

	Norway spruce		Sitka spruce		Pinus contorta	
	Per sq.yd.	Per lb.	Per sq.yd.	Per lb.	Per sq.yd.	Per lb.
Control	927	41,700	852	74,900	1206	90,400
50/50	792	35,600	1296	110,100	1015	76,100
25/75	691	31,100	1323	112,400	1170	87,700
40/60	806	36,200	1224	104,000	882	66,100

Shoot length of the spruces in the control sections is appreciably less than in the treated sections. This difference is not so well marked in Pinus contorta.

This experiment will be finally assessed when the seedlings are lifted. There seems little doubt, however, that the Beddgelert peat has reduced the number of seedlings of Norway spruce and has led to an increase with Sitka spruce. This confirms the figures obtained in the 1955 sowings in the Intensive Seedling Cultivation experiment. The effect on Pinus contorta appears to be variable and, with the available information, difficult to interpret.

Experiment 109, F.35. Production of large seedlings.

Sorbex peat was used in this experiment in place of peat from Beddgelert but the same mixtures of peat and soil were tested. The species were Norway spruce, Sitka spruce, Pinus contorta and Corsican pine.

Broadcast sowing took place on March 18th at the standard densities. Germination was satisfactory and growth was good throughout the season.

A count of the seedlings at the end of the summer gave the following results.

Seedlings per 1.25 sq.ft.

	A	B	C	D	Ed	Difference required for a 20 to 1 probability.
N.S.	67	65	71	71	± 5.277	± 16.791
S.S.	116	136	143.5	158	± 8.640	± 27.492
P.C.	123	169	149.5	151	± 5.696	± 18.125
C.P.	41.25	47.5	48.25	50.75	± 4.822	± 15.344

The yield per sq.yard and per pound of seed is as follows:

Treatment	Norway spruce		Sitka spruce	
	Per sq.yd.	Per lb.	Per sq.yd.	Per lb.
A	482	21,700	632	70,700
B	466	21,000	979	83,200
C	511	23,000	1033	87,800
D	511	23,000	1094	93,000
	Pinus contorta		Corsican pine	
A	882	66,100	295	10,300
B	1213	90,900	342	11,900
C	1077	80,700	342	11,900
D	1084	81,300	364	12,700

There is relatively little difference in shoot length between the treatments, the controls being particularly good. The early sowing is no doubt responsible for this as well as for the good results in the control section of Experiment 108, and it would be advisable in repeating this work to test the effect of sowings at a later date, say in April.

The experiment will be fully assessed when the plants are lifted, but from the preliminary assessment it may be concluded that while the peat treatments have significantly increased the yield of Sitka spruce and Pinus contorta, they have had no effect at all in this direction on Norway spruce and Corsican pine.

Experiment 85, P.34. Production of large seedlings.

A preliminary report on this experiment was given last year and it was then shown that early sowing gave good crops of seedlings of Japanese larch, Sitka spruce and Pinus contorta whereas late sowing in that dry season led to partial failure. A second assessment which was carried out at the time of lifting confirms the results of the counts in the first summer. The results of the second assessment are as follows.

Production of usable seedlings per pound of seed.

	Japanese larch			Sitka spruce		
	Ode 1	Ode 2	Total	Ode 1	Ode 2	Total
Early sowing 22.3.34	22,400	14,200	36,600	24,000	39,600	63,600
Late sowing 8.5.34	1,800	8,800	10,600	270	4,800	5,070

	Pinus contorta		
Early sowing 22.3.34	41,700	18,900	60,600
Late sowing 8.5.34	700	2,000	2,700

Experiment 100, P.35. Production of large seedlings.

This experiment is a repetition of Experiment 85, P.34, the same species being used.

Two treatments were applied as follows:

(a) Early sowing on March 12th.

(b) Late sowing on May 4th.

At the end of the first season there was a considerable difference between the shoot lengths in the early and late sown beds but this difference was not so well marked as in 1934. This is the result of the more favourable conditions in 1935. (Photographs 1-3)

The maximum and average shoot lengths at the end of October were as follows:

	Early sowing		Late sowing	
	Max. ins.	Mean ins.	Max. ins.	Mean ins.
J.L.	6	3½	4	2½
S.S.	2	1½	1½	1
P.C.	3	2	1½	1

The production of seedlings per pound of seed at the end of the first season was as follows:

	J.L.	S.S.	P.C.
Early sowing	43,090	79,560	56,940
Late sowing	39,130	77,040	30,160

A further assessment will be made when the seedlings are lifted.

Conclusions:

1. Early sowing has increased the size of the seedlings of all three species but not to the same degree as in a dry season.
2. Early sowing this year has not led to an increase in the number of seedlings either of Japanese larch or of Sitka spruce. It has, however, given an increased production with Pinus contorta which is a species subject to delayed germination.

Experiment 81, P.34. Production of large seedlings.

In this experiment various species were sown on beds made up with different composts supplied by Dr. Rayner. Owing to the late arrival of the composts the sowing was delayed and germination in consequence was very poor all over. During 1935 there has been a second germination in most of the

beds and these are now very irregular. No difference is visible between any of the treatments. The plants will be lifted and assessed later in the year.

Experiment 91, P.34. Production of large seedlings.

In this experiment Scots pine, European larch and Sitka spruce were sown on a specially prepared moraine seed-bed with ordinary nursery soil as a control.

The assessment at the end of the first growing season showed that the control beds gave larger and more numerous seedlings and this has been confirmed by the second assessment carried out when the plants were lifted. The figures are as follows:

Production of usable plants per pound of seed

	Moraine			Control		
	Ode 1	Ode 2	Total	Ode 1	Ode 2	Total
S.P.	400	18,800	19,200	24,000	10,800	34,800
S.S.	220	2,200	2,420	11,100	15,700	26,800
E.L.	420	7,800	8,220	9,600	10,700	20,300

The photographs (4 - 6) show that the root systems are not markedly different except in the European larch where the moraine bed has given a deeper rooting habit.

Experiment 103, P.36. Production of large seedlings.

This is a continuation of Experiment 91, P.34, the moraine and control beds being re-sown with the same species.

A count of seedlings at the end of the first growing season gave the following figures:

	Seedlings per sq.yd.		Seedlings per lb. of seed	
	Moraine	Control	Moraine	Control
S.P.	864	972	38,400	43,200
S.S.	1881	1755	117,000	109,200
E.L.	513	441	15,900	13,100

The maximum and average heights of the seedlings in the different sections at the end of the first season were as follows:

	Moraine		Control	
	Mean ins.	Max. ins.	Mean ins.	Max. ins.
S.P.	1-1½	2½	1½-2	3
S.S.	¾-1	1½	¾-1	2
E.L.	¾-2	5	1½-3	5½

A further assessment will be made on lifting and an examination of the roots will then be carried out.

Conclusions:

1. There is no difference between the treatments in respect of the number of seedlings produced.
2. There is little difference between the treatments in respect of height growth during the first season.
3. When serious drought conditions (as in 1934) occur, the moraine type of seed-bed is definitely harmful, but with normal conditions it does not affect the production or the growth of the different species.
4. The results do not warrant the use of an expensive method of this kind.

Experiment 87, P.34. Weed control.

A full report based on counts at the end of the first growing season was given last year. This report summarises the additional information which has come to hand.

Five treatments were applied as follows:

A. Control.

B. 1% sodium chlorate solution 7 days after sowing.

C. Aluminium sulphate sprinkled over the surface of the bed at the rate of ½ oz. per sq.foot.

D. 1 in 80 solution of sulphuric acid immediately after sowing.

E. 1 in 80 solution of sulphuric acid 7 days after sowing.

The species were Scots pine and Norway spruce.

Scots pine

A fourth weeding was necessary in the Scots pine beds in October and this was timed with the following result.

Annual Weeds

Time in minutes taken by 1 man to weed 81 sq.feet.

A	B	C	D	E	Ed	Difference required to give a 20 to 1 probability.
5.4	7.4	3.8	4.2	4.6	± .6419	± 1.782

Perennial Weeds

0.3	0	0.1	0	0	± .0932	± .2587

The seedlings of this species were lifted, graded and counted in the spring of 1935. The following figures were obtained:

Average number of seedlings per sq.yard.

Grades	A	B	C	D	E	Ed	Difference required to give a 20 to 1 probability
1. Over 1½ in.	822	0	758	743	796	± 49.88	± 138.5
2. 1½ in. & under	193	0	326	375	301	± 33.39	± 92.69

Percentage of culls

3.0	0	2.8	4.0	2.6

Norway spruce.

The seedlings of this species were left to grow on for a second year and three additional weedings have been necessary, one in the late autumn of 1934 and two in the summer of 1935. These were timed in the usual way with the following results.

Annual Weeds

Time in minutes taken by one man to weed 21 sq.feet.

Weedings	A	B	C	D	E	Sd	Difference required to give a 20 to 1 probability.
24.10.34	5.2	5.0	4.6	4.4	4.6	± .555	± 1.54
9.5.35	4.2	3.0	2.9	3.9	3.3	± .608	± 1.688
29.7.35	2.0	3.0	1.6	1.8	1.4	± .485	± 1.345
			Perennial Weeds				
24.10.34	0.2	0	0	0.5	0.3	± .1682	± .4669
9.5.35	0.2	0.2	0.3	1.5	0.3	± .5354	± 1.4863
29.7.35	0.8	1.05	1.3	2.0	1.1	± .3731	± 1.0357

A final assessment will be made when the seedlings are lifted.

Additional conclusions.

1. None of the treatments has any beneficial effect on late weedings in the first year or on weedings in the second season.
2. All treatments with the exception of the sodium chlorate have given a significant increase in the number of grade 2 seedlings of Scots pine but have had no effect on the number of grade 1 plants.

Experiment 90, P.34. Weed Control.

The seedlings of common alder in this experiment were

lifted and graded during last winter and counts were then made. Details are given below for each of the three treatments (A. Control. B. 1% sodium chlorate. C. 1 in 80 sulphuric acid.).

Average number of seedlings per 3 sq.ft.

Grades	A	B	C	Sd	Difference required to give a 20 to 1 probability.
1. Over 2½ in.	15.5	7.5	23.3	± 3.97	± 10.21
2. 2½ in. & under	187	51.8	155.5	± 14.33	± 36.84

Percentage of culls.

61.6 35.3 45.5

Experiment 101, P.35. Weed Control. (Photographs 7-8).

Four treatments were applied to seed-beds of Scots pine, Norway spruce and Douglas fir.

A. Control.

B. Aluminium sulphate as in Expt. 87, P.34, 7 days after sowing.

C. ½ per cent. solution of sodium chlorate 7 days after sowing.

D. 1 per cent. solution of sodium chlorate 7 days after sowing.

Scots pine.

The seed was sown broadcast on April 27th and was covered with nursery soil. The chemicals were applied on May 4th. Germination began on May 9th. On May 24th, in consequence of lack of rain, the surface of the beds was beginning to dry out and it was noticed that in the sodium chlorate treatments many of the young seedlings had withered at the root collar and had fallen over in a manner suggestive of damping-off.

A count of living and dead seedlings in each of the treatments was made on this date with the following results.

Average number of seedlings per 3 sq.ft.

Treatment	Alive	Dead
A	97.7	0
B	100.5	0
C	15.2	16.7
D	2.7	34.0

With the recurrence of moist conditions, further germination took place and additional losses were not observed.

The effect of the treatments on germination based on a count made during the summer is given below..

Average number of seedlings per 3 sq.ft.

A	B	C	D	Ed	Difference required to give a 20 to 1 probability
382.7	427.3	309.0	215.5	± 8.9816	± 28.579

Seedlings per sq.yard.

1148	1282	927	646

Two weedings took place for annuals on June 21st and July 26th respectively and one for perennials on the latter date. The results were as follows:

Annual Weeds

Time in minutes taken by one man to weed 21 sq.ft.

No. & date of weeding.	A	B	C	D	Ed	Difference required to give a 20 to 1 probability.
1. 21.6.35	29.5	38.5	9.0	8.0	± 3.7094	± 11.8033
2. 26.7.35	4.75	5.0	3.25	3.25	± 1.1340	± 3.6084

Perennial Weeds

1. 26.7.35	.3125	.0625	.0625	0	± .06	± .1909

Norway spruce.

The seed was sown on April 25th and the chemicals were applied on May 2nd. Germination commenced on May 27th but no damage to seedlings was observed in the sodium chlorate plots although the newly germinated weeds had withered.

A count of seedlings in July gave the following result.

Average number of seedlings per 8 sq.ft.

A	B	C	D	Sd	Difference required to give a 20 to 1 probability.
211	247.5	222.75	199	± 4.6368	± 14.754

Seedlings per sq.yard

A	B	C	D
633	742	668	597

Two weedings for annuals and one for perennials were carried out. The results are as follows:

Annual Weeds

Time taken by one man to weed 21 sq.feet (minutes)

No. & date of weeding.	A	B	C	D	Sd	Difference required to give a 20 to 1 probability.
1. 20.6.35	9.5	9.5	6.5	5.75	± 1.0261	± 3.2714
2. 26.7.35	2.6	2.1	2.5	1.9	± .3797	± 1.2082

Perennial Weeds

1. 26.7.35	0.25	0	0	0	± .0721	± .2294

Douglas fir.

The seed was sown on April 27th and the chemicals applied on May 2nd. Germination commenced sporadically on May 27th but there was no damage to seedlings by sodium chlorate.

A count of seedlings in July gave the following results.

Average number of seedlings per 3 sq.ft.

A	B	C	D	Sd	Difference required to give a 20 to 1 probability.
39	29	36.25	42.25	± 6.2753	± 19.968

Seedlings per sq.yard

A	B	C	D
117	87	108	126

Two weedings for annuals and one for perennials were carried out.

Annual Weeds

Time in minutes taken by one man to weed 21 sq.ft.

No. & date of weeding	A	B	C	D	Sd	Difference required to give a 20 to 1 probability.
1. 19.6.35	17.75	16.25	5.5	6.25	± 1.9882	± 6.3264
2. 26.7.35	2.25	3.25	3.13	2.63	± .5354	± 1.7036

Perennial Weeds

1. 26.7.35	0.56	0.5	0.25	0	± .1794	± .5708

The experiment will be finally assessed when the seedlings are lifted.

Conclusions.

1. Aluminium sulphate has had no effect on the weeding times. In 1934 a significant reduction was obtained with this species and it is possible that the drier conditions may have contributed to this result.
2. Aluminium sulphate appears to have increased slightly the germination of Scots pine and Norway spruce. It has had no significant effect on the germination of Douglas fir.
3. Sodium chlorate applied both as a 1 per cent. and as ½ per cent. solutions has had the effect of reducing the number of seedlings in Scots pine but has not adversely affected the germination of Norway spruce or of Douglas fir. Last

year it had a bad effect on Norway spruce, and it is probable that this is connected with drought conditions. In the 1935 experiment the only species which suffered was Scots pine which germinates more rapidly than either Norway spruce or Douglas fir, and the time of germination happened to coincide with a period of dry conditions. The Norway and the Douglas germinated towards the end of that dry spell and were no doubt saved by the rain which followed at the end of May.

4. Sodium chlorate has reduced the weeding times for all species in the first weeding of annuals only. It has had no effect on the second weeding or on perennials. Last year the effect was noticeable into the third weeding.

5. In a moist year sodium chlorate seems to be less effective as a weed killer but less dangerous to tree seedlings.

Experiment 102, P.35. Weed Control. (Photographs 9-11).

This experiment marks a continuation of previous work carried out with various chemicals as a means of weed control in seed-beds of birch and alder.

Four treatments were applied:

A. Control.

B. 1 in 80 sulphuric acid applied immediately after sowing.

C. ½ per cent. solution of sodium chlorate applied 7 days after sowing.

D. 1 per cent. solution of sodium chlorate applied 7 days after sowing.

The seed was sown on April 9th, the acid applied on April 10th, and the sodium chlorate on April 17th.

Birch.

Germination took place more rapidly in the beds treated

with sulphuric acid, and this treatment has given the best results all through. The effect of the different treatments on germination is brought out by the following figures which were obtained by a count in July.

Average number of seedlings per 1.8 sq.ft.

A	B	C	D	Sd	Difference required to give a 20 to 1 probability.
147.5	496.5	243	253	± 19.46	± 61.889

Seedlings per sq.yard

A	B	C	D
885	2979	1458	1518

Three weedings of annuals were carried out and two for perennials. The results are as follows:

Annual Weeds

Time in minutes taken by one man to weed 21 sq.ft.

No. & date of weeding	A	B	C	D	Sd	Difference required to give a 20 to 1 probability.
1. 29.6.35	31.25	2.0	2.88	1.88	± 1.7866	± 5.6849
2. 2.7.35	7.5	2.0	3.75	7.25	± .6455	± 2.0539
3. 16.8.35	0.13	0	0.50	0.75	± .2372	± .7548
			Perennial Weeds			
1. 2.7.35	0.50	0.38	0.38	0.50	± .0722	± .2297
2. 16.8.35	.375	.375	0.50	0.25	± .2602	± .8279

Alder.

There was no marked difference between the treatments in respect of germination but all the sections were over stocked as a result of favourable conditions.

The following figures were obtained from a count of seedlings in July.

Average number of seedlings per 1.5 sq.ft.

A	B	C	D	Ed	Difference required to give a 20 to 1 probability.
959	891.6	948.3	843.5	± 34.857	± 110.915

Seedlings per sq.yard

A	B	C	D
5754	5349	5689	5061

Weedings were carried out at the same time as in the beds of birch with the following results.

Annual Weeds

Time in minutes taken by one man to weed 21 sq.ft.

No. & date of weeding	A	B	C	D	Ed	Difference required to give a 20 to 1 probability.
1. 29.6.35	45.0	0.63	0.75	0.38	± 4.4848	± 14.2706
2. 2.7.35	30.5	6.0	17.5	8.0	± 1.3229	± 4.2094
3. 16.8.35	0.13	0	0.50	0.25	± .1875	± .5966

Perennial Weeds

1. 2.7.35	0.50	0.25	0.13	0.25	± .3208	± 1.0208
2. 16.8.35	0.88	0.38	0.50	0.13	± .2135	± .6795

The experiment will be finally assessed when the plants are lifted.

Conclusions:

1. Sulphuric acid has increased the production of birch but not of alder.
2. Sodium chlorate in both concentrations has given a significantly greater production in birch. The ½ per cent. solution has not affected the yield of alder but the 1 per cent. solution has led to a reduction which is just significant.
3. Sulphuric acid has markedly reduced the weeding times for annual weeds in the first and second weedings. It has not

affected the third weeding or the perennials.

4. Sodium chlorate (½ per cent. and 1 per cent.) solutions have markedly reduced the weeding times for the first weeding of annuals in both species. In birch they have had no effect on the second and third weedings of annuals or on the perennial weedings, but in alder they have given a significantly better result in the second weeding of annuals.

Experiment 92, P.34. Bedding out of Scots pine.

A preliminary report on this experiment was given last year. The plants were lifted and assessed at the end of one season and the results of the assessment are given below:

The bedding out densities were as follows:

A. Normal bedding. 1 inch between plants (42 per row of 3½ ft.).

B. 400 per row of 3½ ft.

C. 200 per row of 3½ ft.

The seedlings were bedded out as 1-year old plants.

Grading of the bedded-out plants was carried out on general form and shoot development.

Number of plants per row of 3½ ft.

Grade	A	B	C	Sd	Difference required to give a 20 to 1 probability.
1	29.25	83.5	75.0	± 4.61	± 14.67
2	7.5	110.5	57.25	± 4.899	± 15.59

Percentage of culls

A	B	C
8.2	31.0	27.7

Percentage of deaths

3.5	19.5	6.0

The grade 1 plants could all be used for planting although those in B and C were less vigorous than those in A. Grade 2 plants of treatment A could also be planted but those in B and C are fitted at the best only for relining.

The percentage of the number originally bedded out fit for planting in each treatment is thus as follows:

A	87.0
B	20.9
C	37.5

These results seem hardly to justify dense bedding out.

Experiment 93, P.34. Bedding out of Sitka spruce.

This experiment also was the subject of a preliminary report last year and on this occasion the results of the assessment of the plants on lifting will be given.

There were four treatments:

A. Normal bedding out. 42 plants per row of 3½ ft.
B. 500 plants per row of 3½ ft.
C. 250 " " " " 3½ ft.
D. 100 " " " " 3½ ft.

The plants bedded out were 2-year seedlings.

The results after one year's bedding out are as follows:

Number of plants per row of 3½ ft.

Grade	A	B	C	D	Sd	Difference required to give a 20 to 1 probability.
1	30	52.25	60.0	47.75	± 2.248	± 7.144
2	4	44.25	53.75	23.25	± 2.936	± 9.343

Percentage of culls

A	B	C	D
18.7	18.5	30.0	36.7

Percentage of deaths

0	62.2	24.7	2.2

The grade 1 plants in treatments A and D were suitable for planting. Those from B and C could also be used although they are of poorer quality. The grade 2 plants in A could be used for planting and those in D for re-lining, but plants of this grade in treatments B and C were very poor and unsuitable even for lining out again.

The percentage of the original number fit for planting in each treatment is as follows:

A	81
B	10
C	24
D	48

The results of dense bedding out are thus unsatisfactory.

Experiment 98, P.35. Bedding out of Sitka spruce.

Experiment 99, P.35. Bedding out of Scots pine.

These experiments are repetitions of Expts. 92 and 93, P.34. They will be assessed in full when the plants are lifted and will be reported on next year.

Experiment 94, P.35. Nursery treatment of seedlings of Scots and Corsican pines.

This experiment was based on a suggestion put forward by Mr. Story for the nursery treatment of seedlings of Corsican pine.

Three treatments were applied as follows:

A. Seedlings lifted during October, the roots pruned to within 3-4 inches of the collar. The plants were then heeled in until the spring in nursery soil when they were removed for planting.

B. As for A but the seedlings were heeled in in small

trenches partly filled with leaf-mould so that the entire root system was in contact with the mould.

C. Control. Seedlings left undisturbed in the beds until spring when they were removed for planting with those of treatments A and B.

In the nursery during the period of heeling in the following death percentages were recorded.

	Scots pine	Corsican pine
A	1.2	6.0
B	-	5.7

Photographs 12-15 give an impression of the root systems of average plants at the beginning and at the end of the period of heeling in.

The plants from this experiment were put out into the forest at Thetford in the spring of this year (Thetford, Expt. 26, P.35) and the following report has been obtained from the foreman there.

Almost all the Scots and Corsican commenced to shoot after planting but the combination of drought and hot sun in May caused a heavy death rate among the Corsican. The Scots pine, however, stood very well and made 1-3 inch shoots. Surviving Corsican have shoots of from ½-2 inches.

Further deaths among the Corsican took place in July as a result of drought.

The following are the death percentages in the different treatments at the end of the first season.

Treatment	Scots pine	Corsican pine
A	6	67
B	5	60
C	6	76

The special treatments appear to have little or no effect on survival after planting.

Experiment 59, P.33. Nursery treatment of hardwoods.

The object of this experiment was to test the value of stumping as a means of improving the quality of a number of old badly grown transplants of oak.

Three treatments were used as follows:

A. Control. No stumping. 1+3 transplants lined out.

B. Transplants as in A. Primary roots cut back to 8 inches and secondaries to 3 inches. Leading shoot cut back to 3 inches from the collar.

C. Primary roots cut back to 6 inches and secondaries to 1 inch. Shoot cut back to 3 inches.

These plants were left for two years in the lines and were lifted and sent for planting in the spring of this year. During the first season after lining out, plants in treatment A made practically no growth whereas in B and C the shoot growths averaged 3 inches. In 1934 the plants in A had an average shoot length of 26.2 in., in B of 14.5 in., and in C of 11.8 in.

No report has yet come in as to the progress of these plants in the forest.

Photographs 16-21 show typical root systems at lining out and at lifting. In treatment C relatively little root development has taken place and it is possible that this treatment has been too severe.

Experiment 72, P.33. Nursery treatment of hardwoods.

Details of this experiment were given in the report of 1933. The object was to test the effect of manuring and of wide spacing on the development of transplants of oak in the nursery. One-year seedlings were lined out in the spring of 1933, the following treatments being applied.

A. Seedlings lined out at 10 inches by 2. Farmyard manure applied.

B. Seedlings lined out at 10 inches by 6. Farmyard manure applied.

C. Seedlings lined out at 10 inches by 6. No manure.

D. Seedlings lined out at 10 inches by 2. No manure.

At the end of the first year there was no difference between the treatments except that the plants in the manured sections had a slightly better colour. Height growth was the same all over and averaged 10 inches.

At the end of the second season in the transplant lines the average height was as follows:

A	B	C	D
19.4 in.	19.7 in.	11.5 in.	15.5 in.

The manured sections have thus a slightly better height growth.

The percentage of culls in the different sections was as follows:

A	B	C	D
14.1	5.4	4.4	30.3

The wider spacing has thus reduced the number of culls, and the plants in the widely spaced sections were on the whole stronger and better furnished. One effect of the close spacing was the suppression of weed growth which was quite strong in the widely spaced plots. Root growth in the manured sections was more vigorous and the roots went much deeper than in the unmanured sections.

Experiment 73, P.33. Nursery treatment of hardwoods.

A preliminary report on this small experiment was given in 1933. One-year seedlings of oak were lined out in 1933,

the following treatments being applied.

A. Control. Seedlings lined out at 9 inches by 3.

B. Seedlings lined out as in A but a three-inch layer of decomposed weed compost was placed in the trench at the time of lining out.

At the end of the first year there was little difference between the treatments, the average height in each case being about 8 inches, but during the second season the beneficial effect of the compost became marked. At the end of the second season the control plants averaged 14.1 inches as against 19.9 inches in the treated plots.

The weed compost produced sturdier as well as taller plants and deeper going root systems. These are illustrated in the photographs (22-23).

Experiment 74, P.33. Nursery treatment of hardwoods.

In this experiment, which was also the subject of a preliminary report in 1933, the object was to determine the effect of various manurial treatments applied to 2-yr. seedlings of ash at the time of lining out.

The following treatments were applied:

A. Control. Normal nursery practice.

B. A layer of well decomposed leaf mould placed in the bottom of the lining-out trench before lining out.

C. Lime and superphosphate applied to the soil before lining out at 10 cwt. and 3½ cwt. per acre respectively. After lining out and when the plants were commencing to flush, the area was top dressed with ammonium sulphate at the rate of 1 cwt. per acre.

At the end of the first season the beneficial effect of the leaf mould was well marked but there was no sign of any

improvement as a result of the application of the artificial manures. At the end of the second season when the plants were lifted as 2+2 transplants the assessment gave the following result.

	Treatments A	B	C
Mean height - inches	16.6	25.3	18.8
Max. " "	37.0	46.0	42.0

The leaf mould has thus been more effective in improving height growth than the artificial manures.

Photographs 24-26 show the different types of root system that have been produced. In treatment B there was a marked development of fibrous roots in the humus layer in the soil but this has not been very clearly brought out in the photograph. The root systems in A and C were very similar, and in treatment C there was a tendency to form a cluster of fibrous roots near the surface. This is probably a reaction to the top dressing.

Experiment 110, P.35. Nursery treatment of hardwoods.

The object of this experiment was to carry out on a small scale a manurial trial with ash using as a basis for the application of manures the figures published by Manshard in the Tharandter Forstliches Jahrbuch, Vol. 84, p.149, 1933. These figures refer to quantities of various nutrients taken out by plants of various species and ages. For 2-year seedling ash they are as follows:

	Kg per hectare.	Kg per 1000 seedlings.	Lb. per 1000 seedlings.
CaO	331	0.40	0.88
MgO	70	0.08	0.18
P_2O_5	108	0.13	0.29
K_2O	319	0.39	0.86
N	255	0.31	0.68

Three treatments were planned as under:

A. Control. No manures applied.

B. Artificial manures applied based on the assumption of a production of 3000 2+0 seedlings per pound of seed, as under:

Buxton ground limestone (90% CaO)	2 lbs.
Magnesium sulphate	10 ozs.
Superphosphate (18% P_2O_5)	3 lb. 4 ozs.
Sulphate of potash (48.6% K_2O)	4 lb. 11 ozs.
Nitrate of soda (15% N)	9 lb. 2 oz.

All manures with the exception of nitrate of soda were applied at the time of sowing, being worked into the upper 3 inches of the soil. The nitrate of soda to be applied as a top dressing on three separate occasions, namely, (1) soon after germination, (2) halfway through the first growing season, (3) at the beginning of the second season.

C. The seed-bed was made up with a 50/50 mixture of Sorbex peat and nursery soil to a depth of 3 inches.

The manures were applied and seed sown in drills on March 19th. Germination commenced on March 26th, becoming general on May 7th and appearing complete on May 27th when the first application of nitrate of soda was applied. This caused burning of the foliage and the subsequent loss of a few of the small seedlings from a late germination. The second application was given on July 19th but no burning was observed on this occasion. On August 1st the manurial treatment had produced the most vigorous growth; the foliage also was a deeper green in colour. The Sorbex peat was less advanced than the control and produced a slightly irregular crop. This position was maintained throughout the remainder of the season.

At the end of the first year, the average number of

seedlings per drill together with the shoot growth was as follows:

Mean number of seedlings per drill

A	B	C
29	27	27

	Mean shoot growth	Max. shoot growth
A	3–5 in.	8 in.
B	4–7 in.	10 in.
C	2½–3 in.	9 in.

The experiment will remain for another year before being assessed.

Experiment 83, P.34. Nursery treatment of hardwoods.

As was reported last year, this experiment was planned to determine a suitable method of treatment for a number of large badly-grown transplants of black walnut which came to the nursery from Howard Spence, Sussex. These trees were from 2½–3½ feet in height.

Two treatments were applied:

A. Control in which the plants were lined out with the roots fairly heavily pruned.

B. Plants root and shoot pruned and lined out as stumps.

Half the plants in each treatment were lined out in manured ground and half in ground which was unmanured.

In last year's report it was stated that while the stumped plants had made excellent growth with shoots of from 10–20 inches, the control plants had made little new shoot growth.

During the second season the control plants did much

better and some have made shoots up to 30 inches in length. The plants in treatment B have continued to make good progress and have thrown out vigorous leading and lateral shoots. Leaf size was also excellent and individual leaves measured 24 inches in length. At the end of the second season the heights and shoot lengths were measured with the following result.

Root and shoot pruned

	Total height ins.		1935 shoot ins.	
	Mean	Max.	Mean	Max.
Control	39.3	52	26.5	38
Manured	48.3	63	33.1	46

The manure has thus had an appreciable effect on shoot development.

The plants in this experiment are illustrated in photographs 27-28.

Experiment 107, P.35. Nursery treatment of hardwoods.

The response of the walnut in Expt. 85, P.34, to stumping suggested further work of this kind with a view to discovering whether it could not be used in general practice. Accordingly in this experiment one-year seedlings of common walnut were taken from Expt. 84, P.34, and subjected to the following treatments:

A. Seedlings raised in Expt. 84 in nursery soil with no manure were lined out. Half of these were put in manured ground and half in unmanured ground.

B. As in A but the seedlings were stumped.

C. Seedlings raised in Expt. 84 in nursery soil plus leaf mould. Treated as in A.

D. Seedlings raised as in C. Treated as in B.

At the end of the first season there was no difference between the manured and the unmanured sections. The stumped plants made moderately good shoots but appear to be lacking in vigour. It is probable that the one-year seedling is too small for this type of treatment.

Experiment 105, P.35. Nursery treatment of hardwoods.

This experiment is similar in detail to Expt. 107 except that Black walnut was used instead of the European species.

At the end of the first season the stumped plants were in many cases equal in vigour to the untreated controls. Manuring had no effect on the height growth. This experiment suffered to a certain extent from frost damage in the spring and numerous deaths occurred during the summer. These, however, were as frequent among the untreated plants as amongst those which had been stumped.

Experiment 106, P.35. Nursery treatment of Poplars (Aspen).

The object of this experiment was to develop a nursery technique by which aspen might be raised under practical conditions. This experiment is a continuation of the work commenced in 1934.

Two treatments were planned as under:

A. Seed sown in untreated nursery soil in boarded seed-beds. The surface of the bed was finished with a thin layer of finely sifted soil. The seed was pressed into the soil but not covered.

B. The seed-bed prepared to a depth of 3 inches with a 50/50 mixture of broadleaved humus and nursery soil over

which was placed a thin layer of finely sifted sand and nursery soil mixed in equal proportions. The seed was sown as in A.

The supply of seed for this work was limited. Locally it was a poor seed year, and the amount of seed obtainable was inadequate for a satisfactory trial. From the small amount of seed sown it was observed that the surface of the bed in B was too coarse for the root hairs to make contact with the soil during germination, even though the soil and sand were passed through a culinary sieve, and that finely sifted nursery soil only was sufficient. The seed was also easily washed away in heavy rain, and it is sensitive during germination to water dropping on to the surface of the bed either from heavy rain or from shelters.

Raising in a soil-humus mixture has definitely stimulated shoot growth.

Seed was also sown in boxes, remaining under cover until the seedlings were established. By this method satisfactory crops were obtained.

Experiment 111, P.35. Nursery treatment of cuttings - Poplar.

This experiment was planned to test the effect of soaking cuttings of Populus robusta in water previous to lining out. Six treatments were applied as under:

A. Cuttings prepared and lined out immediately after the material had been removed from the parent tree.

B. Cuttings prepared at the same time as A and soaked in cold water for 48 hours previous to lining out.

C. Cuttings prepared as for A, packed for transit and subjected to similar conditions as would be experienced in transit for a period of 2 days previous to lining out.

D. As for C but the cuttings were soaked in cold water for 48 hours previous to lining out.

E. As for C but the cuttings remained for 4 days previous to lining out.

F. As for E but the cuttings were soaked in cold water for 48 hours previous to lining out.

Cuttings 9 inches long were prepared. Treatment A was lined out on 7th February and treatment F on 13th February. Flushing was taking place on 11th April. Growth was inclined to be irregular but there was no difference between treatments. The young growths were reduced to a single shoot per plant on 10th July.

A count of the living plants at the end of the first year is shown below as a percentage of the total lined out.

A	B	C	D	E	F
66%	74%	70%	70%	62%	70%

Miscellaneous 1935. Control of oak mildew.

This experiment was designed at the request of Dr. R.C. Woodward of Imperial Chemical Industries to test the effect of Shirlan spray solution against a sulphur spray as a means of control of mildew on oak transplants in the nursery.

Three treatments were applied as under:

A. Control. No spraying.

B. Precipitated sulphur was sprayed on the plants at the rate of 3 lb. per 100 gallons of water. Calcium caseinate at the same rate was used as a spreader.

C. Shirlan A.C. was sprayed as in B at the rate of 6 lb. per 10 gallons of water.

Primary infection was first observed on occasional plants

on May 9th and secondary infection on June 5th. Owing to the wet spring, satisfactory deposits were not obtained until July. Four sprayings took place on June 6th, June 18th, July 1st and July 22nd, and further spraying after this date did not appear necessary. The amount of spray solution used on each occasion was at the rate of 9.6 gallons per 100 square yards of transplant lines.

An assessment on infection was carried out in September and the following are the data.

Percentage of plants infected

	A	B	C	Ed	Difference required for a 20 to 1 probability.
Pedunculate oak 1+1	95	17	38	± 6.851	± 29.316
Sessile oak 1+1	72	47	58	± 25.141	± 108.182

Shirlan A.G. spray solution is convenient to handle but is inclined to froth after shaking before use, making the measurement of small amounts difficult.

There was no evidence of burning of foliage.

Mycological Experiments, P.35.

Two experiments were carried out for Mr. T.R. Peace. The first on the control of Melampsoridium betulinum on birch by means of various sprays indicated that Sulsol and Shirlan had some effect in controlling the disease.

The other experiment was designed to test the value of formaldehyde and potassium permanganate in the control of damping-off in the seed-bed. No damping-off, however, was met with.

Miscellaneous Notes.

Covering Materials for Seed-beds. Photograph 29.

A trial of various covering materials was carried out on seed of Sequoia gigantea. The materials used were as follows:

A. Nursery soil.

B. Bedford sand.

C. Limestone chippings ¼ inch as used in the Forest of Dean.

D. Mixture composed of 1 part broadleaved humus and 2 parts limestone chippings.

E. Coarse washed Thames ballast sand.

F. Mixture composed of 1 part broadleaved humus and 2 parts coarse washed Thames ballast sand.

The seed was sown broadcast on April 29th at the rate of 1 pound to 175 sq.feet. Water was applied when necessary as in normal practice. The effect of the various types of seed covering on production at the end of the first year is shown in the following table.

Types of covering.	Production per pound.	Seedlings per sq.yd.
A. Nursery soil	350	16
B. Bedford sand	2900	151
C. Limestone chippings	940	48
D. Broadleaved humus and limestone chippings	430	22
E. Coarse washed Thames ballast sand	850	44
F. Broadleaved humus and coarse washed Thames ballast sand	630	32

Compost Heaps. Photographs 30-31.

An attempt was made to reduce the subsequent amount of fertile weed seeds in compost heaps by introducing green

vegetable matter together with the weeds.

On July 26th one heap was prepared with nursery weeds free from soil and lawn mowings arranged in layers. Ground limestone and ammonium sulphate were also used. Approximately 160 cubic feet of both loose weeds and grass were employed together with 120 pounds of ground limestone and 28 pounds of ammonium sulphate. Water was applied during preparation and after when necessary. The heap when prepared measured 134.75 cubic feet. Fermentation commenced immediately and the heap was eventually much reduced, measuring at the end of the year 64.75 cubic feet.

The average temperature of the heap recorded by maximum thermometer during the first 12 days was 132.8°F with a maximum of 140°F. Similar readings were also taken in a normal compost heap from the time of formation, commencing on June 19th, when the average temperature for the first 13 days was 94.7°F with a maximum of 105°F.

Comparative samples from both heaps will later be tested for weed content.

Various Species.

Whitebeam was successfully raised in the first year by washing the seed from the fruit and sowing immediately. One pound of fruits gave 768 seeds.

English elm seed imported from Spain and sown immediately gave a very complete crop.

Eucalyptus gunnii was successfully raised and up to the end of October had not been affected by frost, frosts of 7° and 14° being recorded. The bed was protected with boarded sides and lath shelters. (Photograph 38).

Robinia pseudacacia gave a full crop by placing the seed in hot water and soaking overnight, and also by soaking the seed for half an hour in a 50% solution of sulphuric acid previous to sowing.

Good germinations have also been obtained of Arbutus menziesii and a small lot of Paulownia imperialis.

Poplar cultivation.

Cuttings of various lots of poplar raised in 1934 were cut back and planted in unmanured ground spaced 2 feet within and 3 feet between the rows. Vigorous growth took place with shoots from 31 to 82 inches during the season. Side branches were retained and were only reduced in instances where competition was taking place with the leading shoot. (Photograph 33).

A further point of interest in this work has been the increased number of straight shoots produced in the first year from 9-inch cuttings taken from well-ripened current year's growths compared with imported cuttings taken from old wood.

Santon Downham Nursery

An experiment on the undercutting of Corsican pine was carried out at Santon Downham. The following treatments were proposed:

1.	Sown in March.	No Sorbex.	Not undercut.
2.	" " "	Sorbex.	" "
3.	" " "	No Sorbex.	Undercut 14 days after germination.
4.	" " "	Sorbex.	" " " " "
5.	Sown in April.	No Sorbex.	Not undercut.
6.	" " "	Sorbex.	" "
7.	" " "	No Sorbex.	Undercut 14 days after germination.

8.	Sown in April.	Sorbex.	Undercut 14 days after germination.
9.	" " "	No Sorbex.	Undercut 28 days after germination.
10.	" " "	Sorbex.	" " " "
11.	" " "	No Sorbex.	Undercut 14 days after germination and again 42 days after.
12.	" " "	Sorbex.	Undercut 14 days after germination and again 42 days after.
13.	Sown in May.	No Sorbex.	Not undercut.
14.	" " "	Sorbex.	" "
15.	" " "	No Sorbex.	Undercut 14 days after germination.
16.	" " "	Sorbex.	" " " "

The Sorbex was mixed with the mineral soil in the usual 50/50 proportion in the top 4 inches of the bed.

For various reasons, modifications had to be made in the working plan and an account of these and of the progress of the experiment is given in the following report by M. Nimmo, the foreman in charge of experimental work at Thetford.

March sowings (undercutting 56 days after germination).

Sown March 15th followed by quite favourable weather for eight days, then very dry until April. These sowings were severely damaged by mice and birds; 37 mice were caught in 8 days. Germination was very slow and extremely thin owing to heavy losses. General germination took place about April 24th.

Trial digging showed that the average root growth did not exceed 6 inches until mid June, so the first undercutting was done on June 19th (66 days after general germination instead of 14 as suggested in the working plan).

Both early and late May were very dry and some seedlings were lost owing to hot sun and drought.

April sowings (undercutting 56, 77 and 98 days after germination).

Sown April 15th followed by favourable weather until early May which was very dry. The erection of mice netting and fruit

netting prevented a repetition of the losses in the March sowings. Germination was more rapid and had generally taken place on May 7th. Root growth was again slow, and although an average depth of about 6 inches appeared to have been reached about June 22nd, the first undercutting was delayed until July 2nd thereby again giving a 56 day period after general germination.

The two other dates for undercutting the April sowings were spaced at 21 days * (i.e. 77 and 98 days after general germination).

While making trials of the root depth, it was observed that the Sorbex peat definitely encouraged side roots even when the seedling root was only about 3 inches long. This applied to March and May sowings equally.

May sowings (undercutting 56 days after germination).

Sown May 15th, followed by a week's favourable weather then very dry until June. Germination was both more rapid and more complete than either the March or April sowings and had generally taken place by about June 1st.

Root development was similar to that of the April sowings, and at the time of undercutting (56 days after general germination) the roots appeared to average about 7 inches long, the longest occurring in the units without Sorbex as was also the case with the previous sowings. Owing to the small number of seedlings dug up, no exact figure could be given, but from the few measured it appeared that the Sorbex seedlings were quite 30% shorter in the root than the control section seedlings, but this did not hold good at the end of the season.

---

* i.e. Treatments 7 & 8 undercut at 56 days.
" 9 & 10 " " 77 "
" 11 & 12 " " 56 and 98 days.

Undercutting.

No wholly satisfactory method of undercutting was found. Two factors mainly accounted for the difficulty:

(1) The frequent occurrence of flints below the surface.

(2) The lightness and dryness of the extremely sandy soil.

Four tools were tried:-

(i) Swan-necked turfing iron.

By digging a small trench between the seed-beds this tool could be inserted at 6 inches deep and could only be forced under the bed for about 10 inches from each side. If sufficient force was applied to move the iron further the surface of the bed was disturbed and fissured and the edge tended to fall in the trench. When stones were encountered they pushed up the surface of the bed. With seed-beds only 18 inches apart there is little working space to use this tool.

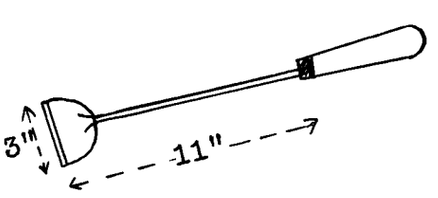
(ii) A sharpened ordinary spade.

With drills 5 inches apart a spade, inserted at an angle between the drills, was found quite unsatisfactory, its rather thick and slightly curved blade causing far too much disturbance of the bed surface and the angle of insertion too uncertain.

(iii) A specially constructed tool for drawing through the soil at a depth of 6 inches was tried but failed owing to stones.

(iv) A small hand hoe.

The tool eventually used was a small Brade's carrot hoe with a blade 3 inches wide and with the curved iron part straightened out:-



With the aid of a plain bit of beard cut off at the correct angle, this hoe could be inserted between the drills at the slant indicated by the wooden gauge with little disturbance to the soil and sufficiently rapidly to ensure cutting and not pulling the roots. Difficulties with this tool were that considerable care was required if the point of undercutting was to be within a little of 6 inches and stones were very apt, by diverting the blade, to cause much deeper or shallower undercutting than was intended.

On October 24th specimen seedlings were carefully excavated from all treatments. Notes were made and photographs taken (Nos. 36-42).

Perhaps the most surprising feature noted was how short the roots were and how little difference the undercutting made to the actual length of the roots. The Sorbex definitely tended to produce stronger and more fibrous roots, especially where no undercutting took place. The control plants (normal soil and not cut) had the worst type of root but, when undercut, some of them were almost as good as the average Sorbex plant.

Scarcely any difference was visible between the plants undercut once and undercut twice. It seemed that although there was a 42 days' interval between the first and second undercutting, many of the plants had made little growth below the 6-inch depth, and a further point which nullified the double undercutting was the fact that about 25% of the seedlings had not more than 6 inches of root 56 days after germination and consequently were not cut at all in the first undercutting operation.

There was no difference between the plants undercut once (at 56 days) and those undercut once (at 77 days) except that at the earlier date more cases occurred where the root was not

6 inches long and was therefore missed altogether.

Owing to mice and bird damage, the March sowings were spoilt for fair comparison, but the May sowings produced both the strongest plants and the largest number.

In all three months the Sorbex plots contained the best plants and could be picked out by eye. The control plants averaged approx. 1 inch, the Sorbex 1½ inches from soil to bud.

In the Sorbex beds rather more plants died shortly after germination, and a count after eight weeks showed that there were 15% less living plants in the Sorbex beds than in the normal soil.

The undercutting had small effect on the mortality of the seedlings. Over the whole experiment deaths, from the date of undercutting to the completion of a year's growth, were 13.7% in the control and 13.9% in the undercut. The twice undercut plots gave a death percentage of 20, but this figure is deceptive because chafers happened to attack two of these beds rather badly probably accounting for quite 5%.

The average lengths of roots were as follows:

	March	April	May
Control undercut	10 in.	10 in.	11 in.
" not cut	12 "	12 "	13 " (Max. 20 in.)
Sorbex undercut	9 "	9 "	9 "
" not cut	10 "	10 "	11 "
Control cut twice	-	9 "	-
Sorbex " "	-	9 "	-

Number of seedlings per drill (3½ ft. long) eight weeks after germination:

March	April	May
8	17	24

(March deficiency due to mice and birds).

Broadly speaking, the Sorbex appears to have had a more definite effect than the undercutting, and the treatment differences do not merit separate lining out other than keeping the normal soil and Sorbex soil lots apart.

The plants are rather small for lining out this winter and might be left another year if possible.

Wykehem Nursery

Experiment 1, P.35.

In this experiment the effect of various mixtures of Sorbex peat and nursery soil was tested, the species being Pinus contorta and Corsican pine.

The following treatments were applied:

A. Control. Nursery soil.

B. Seed-bed made up to a depth of 3 inches with peat and nursery soil in a 50/50 mixture.

C. As in B but 25% peat to 75% soil.

D. As in B but 40% peat to 60% soil.

The beds suffered from strong drying winds soon after sowing, part of the covering material being removed, and they were also damaged by partridges.

At the end of the season there was little difference between the treatments. The Pinus contorta seedlings averaged 1¼ inches with a maximum of 2 inches, and the Corsican seedlings one inch with a maximum of 1½ inches.

The following are the numbers of seedlings per sq.yard based on a count made in September.

	Treatment			
	A	B	C	D
Pinus contorta	183	104	154	111
Corsican pine	240	187	252	171

Experiment 2, P.35.

The object of this experiment was to determine the optimum sowing density for the production of 2-year seedlings of Norway and Sitka spruce.

Both drill and broadcast sowing were carried out.

A report on this experiment will be submitted next year. At present the condition on the whole is satisfactory.

Various Divisional Nurseries

A trial of Sorbex peat in seed-beds was carried out in various divisional nurseries. Reports on this experiment have already been submitted.

A number of photographs illustrate the type of seedling produced.

Research Officer (E. & W.)
11.12.35