

ABSTRACT

THE GROWING OF POPLARS

A paper with the above title (*) has recently come to hand and gives most interesting and useful data on the poplar and aspen species. It is written by K. F. Miron, a Russian silviculturalist, and deals with extensive experiments in certain regions of the U.S.S.R. Allowing for climatic, soil and other differences which exist between this country and Russia, the material in this article should be considered most useful, particularly from the silvicultural point of view, the aspect to which I have chiefly confined myself in my summary below. Little need be said concerning the usefulness of poplars economically, aesthetically and from a protective viewpoint. They produce probably a greater quantity of timber in a shorter space of time than any other hardwood except the eucalypts, and though this is so, the timber of many of the species is useful and strong. Packing-case material, waggon and cart bottoms, matchwood and paper manufacture are a few of the uses to which the timber can be put and to my mind their use in the manufacture of paper is most important, since thinnings can be made use of at the age of from 12 to 20 years for this purpose. The Black, White and Italian poplars are the least inflammable of all the woods and their use as shelter belts can easily be seen. Poplars on the whole are fairly accommodating as to soil, frost-hardy and wind firm, so there should be no reason for not growing them more extensively. The author of the above article mentions the following poplars—The White Poplar (*P. alba*), Bachofens Poplar, (*P. Bachofenii*), the Turkestan Pyramidal Poplar (*P. Bolleana*), the Naryn Poplar (*E. hybrida*), the Aspen (*P. tremula*), the Black Poplar (*P. nigra*), the Lombardy Pyramidal Poplar (*P. nigra var pyramidalis*), the Canadian Poplar (*P. canadensis Moench*), *P. deltoides, Marsch*), the Balsam Poplar (*P. balsamifera*), the Chinese or Eastern Poplar (*Simonii*), the Berlin Poplar (*P. berolinensis*). In describing these species the author quotes extracts from a book entitled "Poplars and their Cultivation," by P. L. Bogdanov. A brief description is given below of a few of the above species which are less well known in this country.

Bachofen's Poplar—*P. Bachofenii* Wierzbz.

Distinguished from *P. alba* by having large ovate buds up to $\frac{1}{2}$ " long, flattened leaf petioles and extremely leathery leaf surfaces. On the stool shoots the leaves are naked, with a white silvery felt below. It reaches large dimensions with a large spreading crown.

This poplar roots well from cuttings. The regions over which it is distributed are characterised by little forest cover and waste sands, indicating that this species might be good for the planting of sandy areas.

(*) The Growing of Poplars, by K. F. Miron. Published by "VNILKh," Moscow, 1939.

The Tufkestan Pyramidal Poplar—*P. Bolleana* Lauch.

A tall tree with a narrow pyramidal crown and light grey bark and differs from the previously-mentioned poplar only by its pyramidal crown. It grows rapidly and develops a well-shaped stem. Can be grown in regions subject to drought but gets frosted towards the north. It is useful for shelter belts.

This species may be grown from root cuttings and root suckers; stem cuttings have a low percentage survival.

The Naryn Poplar—*P. Hybrida* M.B.

The leaves of this species are like *P. alba*. The matured shoots are pubescent and root shoots quite glabrous. Aspen-like flattened leaf petioles, buds small, bark yellowish and somewhat scaly. Twigs have at first grey down covering but are later glabrous.

The Laurel-Leaved Poplar—*P. Laurifolia*, Ledeb.

A tree which reaches a height of 82 ft. with a thick, fairly smooth, tapering stem and a branchy, broad crown. Bark, grey and fissured deeply. The young greyish-yellow or straw-yellow shoots are strongly ribbed, due to longitudinal corky growths. The buds are brownish green, up to 3", acuminate and viscid. The leaves are ovate or lanceolate, tapering gradually, rounded at the base, glabrous, with glandular teeth along the margin, green on top, shining, dull whitish below. The flowering and leaf flushing take place simultaneously. The male catkins are purple, the style has a two-lobed stigma with revolute lobes.

This poplar usually grows along river valleys and sometimes on lake shore sandhills. It is tolerant regarding climatic conditions and grows well from cuttings. Its tolerance and capacity for growing large well-shaped stems, indicates that this tree might be used for growing timber.

The Chinese or Eastern Poplar—*P. Simonii*, Carr.

Not a particularly large-growing tree. The young reddish-brown shoots turn yellowish-brown when more mature; they are strongly ribbed at their attachment to the leaves and have large lenticels. Traces of the ribs, in the form of a peculiar design, remain for a long time on the smooth, steel-grey colour of the bark. The brownish-tinged buds are large, adpressed and viscid. The leaves on the lateral shoots are usually thin and somewhat pendant; on the twigs they are large and oval, tapering to both ends; on leading shoots and stool shoots they are larger and broadly oval. The prominent red nerves on the upper light-green surfaces of the leaves are typical for this species; the lower surface is lighter in colour. The petioles are very short.

Due to a long vegetation period, it suffers from early autumn frost. Stem cuttings root well. It grows well on a clay loam and is characterised by a deep root system which makes it useful in preventing erosion.

The Berlin Poplar—*P. Berloninensis*, Dipp.

This is a hybrid between *P. laurifolia* and *P. nigra* var. *pyramidalis* and it is remarkable for its growth rapidity, resistance against cold and the ready rooting capacity of its stem cuttings. The crown is broadly pyramidal and the mature shoots are greenish yellow, first ribbed, later cylindrical and densely leaf-covered. The leaves are elongate ovate, tapering to a long point, shining and light green on the upper surface (it is the lightest green of all the poplars), dull below. Buds almost lacking in stickiness, acuminate, dark brown towards the tip. Leaf petioles flattened.

Growth continues late but this species is frost-hardy and reproduces well from stem cuttings which root to an extent of 80%.

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THE TECHNIQUE OF VEGETATIVE PROPAGATION OF POPLARS FROM THE PARENT STOCK IN THE FORM OF PLANTATIONS.

The Object in View.

Poplar parent stock plantations are established specially for the growing of stool shoots for cuttings and rooted cuttings. The stool shoots may be cut or: stumps that are cut low down, but the best shoots obtain-

able are those which are cut from the crowns of trees. It has been proved experimentally that cuttings taken from stocks which have originally been grown from seedlings and not from cuttings, are the best and it therefore follows that parent stock plantations should be formed by planting out seedlings. This method is however still in its infancy and the parent stock plantation will have to be formed by planting out cuttings.

The Soil and its Preparation.

The soil must be very fertile and the moisture conditions satisfactory. The soil under the plantation is worked in the same way as that under nursery stock.

It is recommended that the cuttings be planted at the following spacings:—

- (a) For growing rooted cuttings in the course of a single year—2' between the rows and 10' in the rows (26,000 per acre).
- (b) For growing rooted cuttings over a period of two years—30" between the rows and 10" in the rows (19,600 per acre).
- (c) For growing one year stool shoots for cuttings by stumping them back annually—30" to 40' between and in the rows. (4,350 to 3,670 per acre).

The above dimensions completely meet the needs of mechanical working in tending the plantation and lifting the material.

Stem cuttings should be taken from selected parent poplars distinguished by the most rapid growth, well-shaped stems, slight branchiness, frost-hardiness, immunity from diseases and capacity to resist drought.

The cuttings should be 8" to 10" long in sufficiently moist regions and 12" to 14" in dry regions.

The Technique of Lining Out.

The cuttings are inserted vertically with the morphologically lower or thicker end beneath. Above the surface the end of the cutting protrudes $\frac{3}{4}$ " to 1 $\frac{1}{2}$ " with one normally developed undamaged bud. The cuttings should be well firmed. The opening of the line to receive the cuttings should be done with an iron dibble.

Lining out should take place when the buds begin to swell, i.e., about the second or third week in April, and it should cease when the buds commence to flush.

Weeding and loosening of the soil should be done three or four times during the growing season—care should be taken not to damage the surface roots of certain species. In prolonged drought the plantations should be watered copiously.

The treatment of the stool shoots consists in thinning them out annually, commencing from the second stumping. There should be five or six well-developed shoots left on the stumps.

PREPARATION OF POPLAR STEM CUTTINGS.

Place and Method of Collection.

The shoots of poplars for cuttings, as we have seen, can be supplied in the parent stock poplar plantations either by stumping the stool shoots which have grown up in the form of bushes from rooted cuttings or seedlings, or by pollarding the crowns of special parent trees.

The stumping of the stool shoots or the pollarding of the crowns must be done annually because one-year stool shoots are required for cuttings, as that ensures a large out-turn of cuttings and their highest survival capacity.

Stool shoots which have been grown in the form of bushes from rooted cuttings, in the first year are severed from the stump no higher than 2 $\frac{3}{4}$ " to 4" from the parent cutting, and each succeeding year no higher than 2" to 3 $\frac{3}{4}$ " from the stubs of the previous cut.

In the plantations, those rooted cuttings are not cut from the stumps which are to be the future parent poplars for the provision of cuttings by the method of crown pollarding. The future trees are left at an equal spacing between the rows and in rows of from 19 to 23 feet. In the first year in the case of rooted cuttings which are to make the future

trees, one of the best developed straight shoots is left. On it, from below upwards to half-way, the lateral branches are pruned off. Pollarding of the trees should be begun from two years of age and continued annually thereafter.

Shoots for cuttings may be taken throughout the whole winter from autumn, provided that the leaves have begun to fall. Early spring however, is the best time for taking shoots for cuttings, before the visible swelling of the buds. Shoots taken in early spring also shorten the period of storage.

Cuttings must be taken from one year shoots and as far as possible from the longer, straighter, clean, fully-ripened ones with the best-developed buds, free from mechanical damage. Thin twigs are no use.

Collected shoots must be stored before time for lining out, the object being to prevent the buds from swelling and loss of moisture. If this is not done, the subsequent cuttings will lose much of their vitality.

Shoots taken in early spring can be stored in cold buildings, cellars, ice houses (humidity not to be lower than 80% cent and temperature not higher than plus 3 degrees C.)

Shoots should be graded into 20, 30 and 40 inch long bundles of 50 to 100 each; avoid any mechanical damage doing this. The bundles of shoots should have their butt ends on an earthen floor and are also covered with moss.

Cuttings which of necessity have had to be taken in November and December, can be stored during the winter time in trenches 2 ft. deep, in open elevated places. Lay the bundles of cuttings in a single row along the bottom of the trench and cover over with soil to a depth of 8" to 10"; cover the tops with straw.

Severing the Cuttings from Shoots.

Severance of the cuttings from the shoots should be done on the day that the cuttings are lined out or not earlier than two days before lining out, when they should be stored in wet moss during that period.

In moist conditions, the length of the cuttings should be from 8" to 10", and in dry conditions 12" to 14". The shoots must be cut into cuttings in such a way that the top end of the cutting lies not more than a half or threequarters of an inch above the last normally-developed sound bud, which, when the cutting is lined out, will remain above the surface; this ensures that the new shoot will rise vertically and not at the side. The cut should be smooth and slightly oblique.

Grading of Cuttings.

This is done at the same time as the shoots are being divided into cuttings and it is desirable owing to the fact that the quality of the cuttings falls off in the direction of their distribution from the butt to the tip of the shoot.

Grade I—Cuttings with an upper cross section diameter of 5/16" and over, taken from the butts to the middle portion of one-year-old shoots, collected in the spring before the swelling of the buds. These have the highest survival percentage and the most energetic growth.

Grade II—Cuttings with an upper cross section diameter of 3/16" to 9/32," taken from the top part of the shoot. To this grade also belong cuttings taken from shoots which have to be taken in the autumn and winter. These have average survival percentage but less energetic growth.

Culls — Cuttings with a cross section diameter of 5/32" and less, taken from the top part of the shoot, and also include leading shoots. These have the lowest survival percentage.

TECHNIQUE OF TAKING GREEN CUTTINGS OF POPLARS

The essential point in this consists in the growing of rooted cuttings from green summer cuttings, taken in summer from the growing young shoots.

This practice should be resorted to when it is necessary rapidly to multiply some species of poplar from which a large number of cuttings cannot be taken. Its main advantage lies in the fact that a great number

of green cuttings can be taken even from young trees and rooted cuttings can be grown from them during the course of a single incomplete vegetative period.

According to investigations, green cuttings of Canadian, Balsam and Chinese poplar root to an extent of 90%; Berlin and Laurei-leaved poplars 60%; Black poplar to an extent of only from 10 to 15%.

Higher temperatures for external conditions are necessary than in the case of the normal growth of the plant dealt with, satisfactory moisture supplies and good soil aeration. To prevent the cuttings from withering before root formation, shading from the sun's rays is necessary, or even to reduce evaporation by moistening the air heavily.

The best time for taking green cuttings is during the first ten days in June, though they can be taken during the summer all through the growing period. Cuttings taken in June develop more stoutly, do not suffer from early autumn frost, successfully survive the winter and if well developed, can be planted out in the planting areas.

Preparation of Forcing-beds to take Cuttings.

This is carried out in cold forcing beds i.e. without manure. The usual size beds are used i.e. $4\frac{1}{2}'$ by $6\frac{1}{2}'$ and 8" to 10" high, on three frames. Compost to a depth of 4" to 6" is put in the bottom of the bed, and a 4" to 6" layer of coarse sand to top this. Prepare the forcing beds one to two days before cuttings are put in and keep under glass frames.

Growing leafy young shoots are severed from the tree with a sharp knife, and cut up under water into cuttings of not more than 4" to $4\frac{1}{2}"$ long, in such a way that the cutting comprises 2 or 3 internodes; it is essential the upper cut is made not more than $2/5"$ above the last axillary bud with a leaf and the lower cut immediately below the leaf cushion of the lowest leaf, as this is the point of really active cambial concentration.

The leaves on the cuttings are all removed except the top one and this is halved if it is a big one.

The sand in the beds is plentifully watered and an hour before setting the cutting. The surface is then marked off with a special board fitted with some rows of pegs (short), at distances between the rows of 4" and in the rows of 2". The places marked with the pegs are deepened with wooden pins to a depth shallower by $\frac{1}{2}"$ or $\frac{3}{4}"$ than the length of the cutting.

The thick ends of the cuttings are then inserted, so that the top end of the cutting projects $\frac{1}{2}"$ or $\frac{3}{4}"$ along with the axillary bud and leaf blade. The cuttings are well firmed and the surface is again sprinkled with water through a fine rose.

Timely watering is essential, and for the first 20 to 25 days after the setting out, the forcing beds must be watered on dull or showery days once in the morning, and on dry sunny days—morning and evening. It should be possible to keep the lower compost layer up to 50% of its full moisture capacity.

To prevent scorching on hot sunny days, the forcing beds must be shaded with solid unbroken screens and in cloudy weather with screens in the proportion of light to shade of 1 to 1.

On hot sunny days the temperature in the beds should not be allowed above what it is in the shade in the open air. If the contrary occurs the frames must be opened for about five minutes in order to reduce the temperature.

With the formation of rootlets and shoot development, watering should be reduced so that the compost now contains not less than 30 to 35% of its full moisture capacity. The forcing beds should now be left open, 2 to 3 hours every morning. At the end of about 35 days the edge of the frame should be left open at night to a height of about 12" to 16"; when the tips of the plants reach the glass of the frames, the latter are gradually removed and when the plants are exposed to the open on hot sunny days, they are shaded with screens. At the end of two months, the cuttings are grown without any shading on the beds.

COLLECTING SEEDS OF POPLARS AND ASPEN AND PREPARING THEM FOR SOWING.

Place and Time for Seed Collection.

The seeds of these species are enclosed in seed capsules on long catkins and are equipped with down (winglets). The catkins must be gathered from the very best trees from 15 to 25 years of age and *when the first seed with down in the catkin capsules have begun to show themselves and escape.* The catkins must be collected before their wholesale opening out. The falling of the seed continues in the case of poplars for 5 to 10 days and in the case of aspen for 3 to 5 days.

The seed of poplar usually ripens in the first ten days of June and that of aspen about the second ten days of May, with a variation of ten days in some years, of delay or acceleration.

Method of Collecting Catkins and Cleaning Seed.

The catkins must be severed from the ends of the twigs on the trees, carried into a well-ventilated dry room and laid on a tarpaulin in a layer of not more than 1½" thick.

At a temperature of 18 to 20 degrees C., the majority of capsules open up in 24 to 48 hours, the remainder opening in 2 or 3 days. The largest of the capsules open in the first day and as the seed from these are the best they should be collected and not be allowed to mix with the later opening and smaller capsules, which have not as good a quality. The seeds are separated from the air-dry down by gently rubbing them through a sieve.

The catkins can also be sown, but best results are obtained by sowing pure seed

Storing the Seed.

The cleaned seed should be stored before sowing in open glass vessels in exsiccators with crystalline calcium chloride (CaCl₂). Although poplars can be stored for three months this way and aspen for one, without germination reduction, it is recommended to sow immediately after collection in order to make use of the vegetative period for raising the seedlings.

Quality of the Seed.

Freshly gathered seed of aspen and poplars are flesh-coloured. The shape varies from ovate, as with aspen to elongated oval. The average weight of 1,000 seeds of poplar ranges from 0.85 to 1.1 grammes and of aspen from 0.09 to 0.14 grams. In 1 gm, there are about 1,000 seeds of Canadian poplar, 1,300 seeds of balsam poplar, 1,050 seeds of black poplar and 6,600 to 8,500 seeds of aspen.

After collection, seeds of poplar and aspen have a germinating capacity of 100%.

GROWING SEEDLINGS OF POPLARS AND ASPENS IN NURSERIES

Preparation of the Soil.

Deep sandy loams and light clay loams are best nursery soils for raising seedlings of aspen and poplar and in all circumstances the soil must have optimal moisture conditions and be well aerated.

The nursery soil is worked in the very same way as the ground under poplar plantations, that is, it is worked in the same way as for any nursery forest stock. Under ample moisture conditions, the seed beds are raised above the alleys to a height of 4" to 5"; and in dry regions they are level with the soil. The beds are prepared the evening before sowing and just before sowing the surface of the beds is broken with a rake and well watered. The moisture content of the soil must be raised to about 40% of its full moisture capacity, so that a sample of soil can readily be squeezed into lumps.

Sowing of Cleaned Seed.

Immediately after the watering of the bed, the seeds are sown by hand either along or across the bed, in bands of 2" wide and spacing between the middle of the bands of 8." The bands are indicated on the beds by light marking. When it is oozing down into the soil the water

takes the seed with it and covering of the seed with earth is not permissible. Occasionally a light pressing of the seed with a board is necessary.

The seed of poplars are sown pure, those of aspen are sown with sand or the remains of withered capsules which have come through the sieve. They are sown in three doses in order to secure even distribution.

With a width of bed of $3\frac{1}{4}'$, bands of 2" wide, and a distance between their middle of 8" and a germinative capacity of not less than 85% pure seeds of the poplars should be sown at the rate of .6 to .9 ozs. per square yard and of aspen of .9 to 1.2 ozs. per square yard of productive area of seed bed with the 5 sown bands mentioned above. Seeds of 100% germinative capacity should be sown at approximately half these rates.

Sowing of Catkins.

This method, though less effective, gives good results. The bed is prepared in the same way as for pure seed.

The full catkins should be sown in the mornings in calm, sunny weather, spread out in 3 or 4 rows in bands from $\frac{1}{2}"$ to $3\frac{1}{4}"$ wide with 8" between the centres. From 5 to 7 catkins are laid out in a row depending on their length. In order to prevent the removal by wind of the down with the seeds, the catkins are protected by light leafless twigs.

In sunny weather the catkins open in 3 to 4 hours and free the seed—the best quality seed. In order to make the down adhere with the seed to the soil, the bands should be watered with a fine rose on the watering can.

The seedlings appear about the 2nd or 3rd day after sowing, and the twigs should be removed carefully. The wet down lying over the seedlings should be carefully picked off. On the 4th and 5th days the down is removed from the seedlings and laid between them so as to cover the bed—it is removed at the first weeding.

Covering the Seed Beds.

In order to prevent rapid drying up, packing straw and, after that, wood sawdust makes the best covering material.

Under moist conditions, the soil should be able to be seen through the covering; under dry conditions, the straw may be increased to a thickness of about $1\frac{1}{4}"$ and the sawdust to a thickness of $3/16"$. With the mass appearance of the seedling (about three days after sowing) the covering is thinned out and pushed between the rows until the third pair of leaves appear on the seedlings, after which, under sufficient moisture conditions, it is removed at the first weeding, when the soil is loosened between the rows. It is left longer under dry conditions. During the growing period, the rows can be covered with mulch or laths in order to preserve moisture.

In the case of catkin sowing, the catkin remains and the down fulfil the covering necessity.

Watering.

In the case of poplars the moisture content of the soil must be kept up about 35% of its full moisture content for about ten days after sowing and in the case of aspen for about 20 days. This is achieved by watering at about 8 o'clock in the morning and after 6 o'clock in the evening, at the rate of 1 to $1\frac{1}{2}$ gallons of water per square yard of productive surface. After appearance of third pair of leaves the moisture content of the soil must not fall below 20% of its capacity, in which case watering once per day or on alternate days is necessary. This watering continues for 11 days after the seed sowing, after which only slight watering is done on dry periods and no watering is done in August.

Shading the Seedlings.

Poplar seedlings and especially aspen seedlings must be protected from sun scorch and heavy rain downpour, over a period after sowing of 60 to 80 days for aspen and 10 to 15 days for poplar.

The screens are made of laths about $9/32"$ wide in equal proportions of light and shade, a suitable size of a screen being about $4'$ to $6\frac{1}{2}'$.

The screens are fixed horizontally on props at a height of about 18" above the seed bed surface. The seedlings are gradually accustomed to the light of day by removing the screens and replacing them, for lengthening periods in the mornings and afternoons, until finally they are all removed.

Treatment of the Soil.

This consists in removing weeds and loosening the soil several times during the growing period, especially during June, July and first half of August.

Tending the Young Plants.

The aim here is bring the density of the young plants in good time to the optimum and complete ripening off. To achieve this, poplar seedlings should be thinned from 20 to 25 days after their appearance and aspen seedlings in 10 days. The thinning should leave about 125 plants to a square yard of seed bed.

Young plants of poplars can be planted out in a permanent site after the age of one year, and the lifting should be done in early spring provided the soil has thawed out. The plants are graded and packed, etc., in the usual silvicultural manner.

Principal Diseases and Pests of Poplar and Aspen Seedlings.

It has been found that Canadian, balsam and black poplars are more resistant to fungoid attack than the other poplars.

A. Fusarium type of fungus attacks the plumules and the seedlings begin to die off in patches, becoming widespread later. The affected seedlings should be removed and the beds then sprayed periodically with Bordeaux mixture.

Rust fungi, notably *Phytophthora*, attack aspen seedlings and young plants quite often. In the middle of July the leaves blacken on the seedlings and the seedlings die.

The rust fungus, *Melampsora pinitorqua* Rostr., usually begins to attack the leaves in mid-August at the time of leaf fall commencement. This weakens the young plants but does not kill them. White poplar suffers less than aspen. The remedy is the same as for *Fusarium*, a 1% Bordeaux mixture being used. Die-back accompanies this disease though this withering may be caused by a fungus *Fusicladium*, in which case the same treatment is used.

Prophylactic measures against fungoid attack on white poplar and aspen are:—

- (1) Growing aspen away from the alternative rust fungus host such as aspens, poplars, Scots Pine, Larch, Cherry, Rowan, Apple and Juniper.
- (2) Growing young plants in unshaded places in nursery.
- (3) Timely thinning of seedlings.
- (4) Regular watering and intermittent spraying.

Insect damage is caused by:—

Melolontha hippocastani and the caterpillar of the Pine Owlet Moth, both of which eat the roots of the seedlings and are dealt with by collection of the larva and insect or a paradichlorbenzole injection in the soil.

Several species of caterpillars do damage by eating the leaves of poplar and aspens and are dealt with by collecting the adults and spraying the plants with toxic chemicals.

NOTE—When using Bordeaux as recommended above, the mixture should not reach the roots of the plants as this causes death.

THE CULTIVATION OF POPLARS IN THE FOREST.

This is a new business and the technique is still in need of prolonged investigation. What data there are come from various experimental plantations laid down by different persons. All of these have shown that it is essential for full growth development to have light, well-moistened soil and deep working.

Highest survival proportion of the cuttings and the best growth of poplar plantations, have been found on deeply worked soil or on soils

which have been used agriculturally. In order to have abundant rooting in planted poplars, sufficient aeration and moisture are necessary in well worked up soil.

It has not yet been ascertained which is the more successful, the planting out of rooted cuttings or the planting out of unrooted cuttings, that is without their being in the nursery at all. Much of the data to hand has shown that the planting out of unrooted cuttings *in situ* has yielded as satisfactory results as the planting out of the rooted ones which have been developed in the nursery, as well as the fact that this method is economically cheaper since it does away with lining out and such-like operations. It is, however, too soon to come to any definite decision regarding either of these two ways.

The particular types of poplar plantations is also a matter which will have to be dealt with cautiously and very little is so far known about it. The growing of such poplar plantations is recommended by some, while underwood mixtures such as willow, elder and shrubs of all kinds is recommended by others.

The Aim in View.

Plantations of poplars should serve the following objects:—

While providing useful timber for industry, they should as far as possible meet the water-conservation and soil-protection roles of the forest. They should be grown as a protective canopy in advance, for such species as pines and other more economical species, as wind-breaks, shelter belts, edgings and the like and should also serve to arrest erosion and landslides in plantations grown with such an object in view. They should be widely used for parks and such-like places.

Poplar stands grow best in low-lying sites and river valleys where the water is near the surface, on well watered sands, sandy loams and light clay loams. They grow less successfully on elevated sites under infertile conditions and even on fresh soils, if the ground water level is deep down in these soils.

Types of Poplar Plantations.

In respect of the object of management a distinction should be made between poplar plantations for forestry purposes and those for rural improvement, such as shelter belts, windscreens, anti-erosion stands.

The working out of poplar stands for forestry purposes is new and the technique of establishing them has not been sufficiently investigated. When growing poplars for forestry purposes one must take into account the aim in view of the stands, their economies, local conditions, light demands, soil moisture, and soil aeration, etc. The following shows the type of tree species and shrubs which will grow with poplars under favourable climatic and soil conditions for the latter.

(a) Tree Species.

Norway Spruce—*Picea excelsa* LK.
Small leaved lime—*Tilia parvifolia* Ehrh.
Hornbeam—*Carpinus Betulus* L.
Wild Apple—*Pirus Malus* L.
Wild Pear—*Pirus communis* L.
Field Maple—*Acer campestre* L.

(b) Woody Shrubs.

Guelder rose—*Viburnum Opulus* L.
Hazel—*Corylus avellana* L.
Tatarian maple—*Acer tataricum*.

(c) Fruit-bearing Shrubs.

Red Currant
Black Currant.
Golden Currant.
Warty spindle tree—*Euonymus verrucosa* Scop.

Poplars and the species mixed with them must be planted at such a distance to allow the following in the early years of their growth:—

It must be possible to handle the soil mechanically by horse-drawn implements or tractors; to allow full illumination to the poplar crowns and finally to avoid, if possible, competition between the roots.

These requirements are best met with by planting the plants $6\frac{1}{2}$ ft. between the rows and $3\frac{1}{4}$ ft. between the plants in the rows.

Pure stands of poplars are recommended to be planted thus:—

P	P	P	P
P	P	P	P
P	P	P	P

P = Poplar.

Poplar with shrubs are recommended thus:—

P	S	P	S	P	S
S	P	S	P	S	P
P	S	P	S	P	S

P = Poplar.
S = Shrub.

Poplar with shrubs and a shade-bearing species are recommended to be planted thus:—

P	S	P	S	P	
S	I	S	I	S	
P	S	P	S	P	

P = Poplar.
S = Shrub.
I = Intermediate species

The distances apart are as mentioned above, for all three types of plantations.

Working of the Soil.

This consists in improving the physical and chemical condition of the soil, removing weedy vegetation and its root stocks, accumulating and regulating stores of water in the soil and inducing crumbly structure.

The idea is to strive to aim at conditions as far as possible akin to the conditions of the poplar stock plantations; this should certainly be the case when planting out unrooted poplar cuttings and, to a less extent, when planting out rooted ones; plants from seedlings have a better chance on unprepared soil. How far is it necessary to work up the soil for planting cuttings? Distinction should be made between complete soil preparation and partial soil preparation under poplar stands; the former is, of course, the better.

Complete mechanised soil preparation can only be carried out on areas which are free from stumps and all such hindrances, while partial soil preparation can be carried out when it is impossible to do the former.

The complete working up of soil which has only been slightly grassed over is carried out in autumn with a tractor or horse-drawn ploughs, to a depth of 10" in moist regions and about 11" in dry regions. The ploughed areas are unharrowed from the winter and should be given three or four harrowings as soon as it is possible to work the soil later on.

Old felled areas which are strongly grassed over and waste lands should be given over to temporary con-acre for one or two years or they should be left during the preceding year under bare fallow. Under dry climatic conditions it is recommended that grassed-over soils be twice ploughed. The first ploughing, to a depth of 5', should be done during hot weather—June and July—which furthers the burning off and death of the sward. According to weather conditions and the time taken for the weeds to wither, a harrowing is carried out with toothed harrows or, if the weeds are considerable, with spring harrows. The vegetation collected from the harrows should be removed from the planting area. A second ploughing to a depth of about 11" is carried out in autumn and is followed by a harrowing in spring.

Partial working of the soil in a form of belts is done by horse ploughs which make a furrow to a width of not less than $3\frac{1}{4}$ ft. or by hand with spades to the same depth, accompanied by lifting out roots and weedy vegetation. The season and order of working the ground is the same as for complete preparation mentioned above, as also are the depths of working. According to the type of planting adopted for the stands the distance between the belts equals in width the intervals between the rows of the plantation ($6\frac{1}{2}$ ft. and so on). Along ravines, the belts should be worked strictly along the contours. Partial soil preparation for established stands on places which carry natural regeneration is done by plots which measure from $3\frac{1}{4}'$ by $3\frac{1}{4}'$ to $4'$ by $4'$ with a spacing between the centres of $13'$ by $13'$. Working is done by hands and the technique is the same as that for the belts.

The Planting Material.

Planting of poplars should be planted out with well-graded material—with seedlings and rooted cuttings from 1 to 2 years of age and with stem cuttings of the highest grade.

Planting according to the belt method and on ravine slopes should be done with well-rooted seedling stocks, or if these are unavailable, with rooted cuttings.

Planting material for species to be intermixed with poplar should be put out from 1 to 2 years of age.

Early spring is the best time for planting. The plants must be put out before the buds burst, better still before they begin to swell.

Planting Technique.

This is done by making pits with a spade, in the case of seedlings and cuttings which have developed a fibrous root system. Cuttings of poplar are planted out with a special dibble exactly as in the parent stock plantations.

Tending the Stands.

This has for its object the loosening of the soil between the plants and between the rows and the maintenance of it in bare fallow condition for the first two or three years under ample moisture and preserves aeration.

The loosening of the soil must be done four or five times during the growing season, depending on the growth of weeds and crusts formed after rainfall. This treatment can be carried out with a tractor or horse-drawn disc cultivator or planet and horse hoes.