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# Testing of Mechanical and Chemical Methods for Weed Control in Poplar (*Populus deltoides* Bartr.) Nurseries

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## ABSTRACT

Two set of three experiments each for mechanical and chemical methods of weed control were tried in poplar nurseries and their results are presented here. The mechanical methods indicated that hoeing of soil at frequent intervals effectively check weed population and helps in better growth and survival in poplar sapling production. Application of pre-emergent herbicides was not very effective, whereas, spray of some herbicides especially Pentara (0.4-0.6%) and Glycil (0.03%) was effective in checking the growth of weed population in poplar nurseries. Application of Atrazine as pre-emergent herbicide had shown phytotoxic effect on poplar plants and its application is therefore not recommended. The results of these experiments call for integration of mechanical and chemical methods for weed management in poplar nurseries. Mechanical methods are more desirable at the begining of poplar nursery production and the chemical methods during the latter parts especially around rains when heavy growth of weeds could be controlled by application of selective weed killers.

**Key words:**

Chemical control, herbicides, hoeing, mechanical control, weeds

## INTRODUCTION

Growing poplar nurseries is a commercial activity in North India. Around 2-3 crore poplar saplings are annually planted by around 40 to 60 thousand farmers. Depending on demand for planting stock, which significantly fluctuates from year to year, around 2.5 to 4.5 crore poplar saplings are annually grown in the country. Bulk of which are supplied to growers, some of them are used for making next year nurseries while some stock that remain unsold is damaged in many nurseries. Most of this nursery growing activity is in the private sector and is therefore purely an economic activity for most of nursery growers. Poplar nurseries are planted from stem cuttings during the month of Jan./Feb. and also by planting the plants, grown in containers, any time before rainy season. These plants attain plantable height by winters when they are field planted on uprooting from nurseries. The main growth of poplar plants in nurseries takes place from March to Oct. months depending on weather and climatic conditions. This is also the period when weeds growth is very fast in poplar nurseries. Weeds form a large mass of above- and below-ground biomass which competes with nursery plants for light, space, water and nutrients (Kojic et al. 1972). They seldom check plant growth, deteriorate plant quality, induce chlorosis, and reduce resistance to plant diseases and pests, and death of individual parts of branches or apical

shoot in weed infected nurseries (Zekic 1983).

Unlike many forest nurseries, poplar planting stock production demands heavily on land, labour, technical support and cultural inputs for better nursery production. Effective weed management is very essential to produce quality plants in poplar nurseries (Gokdemir 2003). Weeding in poplar nurseries include physical removal (uprooting, cutting back or scraping), killing (by herbicides or weed killers) and their ploughing back in the soil (hoeing with pickaxe and mechanical weeder) of all unwanted plants other than planted poplar. Presently, mechanical methods, especially hoeing/weeding, are the dominant operations to control weeds and for producing quality planting stock in poplar nurseries. This paper is based on the results of two sets of three experiments each for mechanical and chemical methods which were conducted for weed control in poplar nurseries.

**MATERIAL AND METHODS**

The present study is based on the series of experiments those were conducted for weed control in poplar nurseries at R & D Centre of Wimco Limited (Wimco Seedlings: Division) situated at 28$^0$N latitude, 78$^0$E longitude and at an attitude of 200 above mean sea level. The centre is located in the Tarai Region, Kichha Tehsil of District Udham Singh Nagar, Uttarakhand. Annual rainfall and relative humidity of the locality varies from 1,500 mm to 1,800 mm and from 66 to 97 percent respectively. The soil of experimental site is clay loam. The details of the experiments for mechanical and chemical methods for weed control are given in Table 1 and 2 respectively. There were two sets of three nursery experiments for each of mechanical and chemical methods during different years.

Poplar nurseries were established with 30 cm long plantlets raised from 2- 3 budded 8-10 cm long mini cuttings in root trainers and field planted at 70 cm x 40 cm spacing during the month of April to July as per details given in Table 1 and Table 2. A block of beds in the existing nurseries was earmarked for the experiments in which the specified treatments were applied, and growth traits of saplings were recorded. The control (traditional method) for weed management in these experiments includes a combination of hoeing, weeding and earthing up operations together at regular intervals. The practice includes three hoeing with pickaxe, one weeding with sickle or khurpi (scraper) and one or two earthing ups (mounding soil around sapling rows) with the help of spade preferably towards monsoon rains. First hoeing/weeding is generally done in three weeks period, 2nd during 4th -5th week and third hoeing after 1.5 months of nursery planting. By this stage plants generally attain a height of over 1.25 m and cover most of the ground when earthing up operation is done near monsoon rains to avoid their dislodging by winds. Many a times, another weeding by cutting weeds with sickles is also carried out post-rainy season when weeds invades beds, if these operations, get delayed because of rains, soil workability etc. Hoeing plough backs weeds in soil, whereas, weeding (mechanical means in the present study) includes scrapping weeds with khurpi or cutting back tall weeds with sickles. Hoeing is a regular operation and weeding is done only when weeds cannot be controlled through hoeing. In third experiment, local tools used in agricultural operations were tried for hoeing to control weeds. Economical aspect of hoeing/weeding operation was also studied by recording costs of operations in experiment No. 3 of mechanical method and experiment No. 2 of chemical methods.

For chemical methods, two separate experiments were conducted on spray of herbicides to kill weeds existing inside nursery beds, whereas, third experiment involves application of pre-emergent herbicides those were applied before planting the plants. An inventory of weed species occurring in the nursery area was recorded. There was dominance of eleven weed species in the experiment area. These include *Eleusine indica*, *Commelina difusa*, *Echinochloa colona*, *Ageratum conijoides*, *Bracharia ramose*, *Dactylotenium aegyptium*, *Achyranthes aspera*, *Panicum maximum*, *Cuperus rotundus*, *Cynodon dectylon* and *Chenopodium album*. Collar diamer was recorded for those saplings which were shorter in height and diameter at breast height (DBH) for those taller enough to record this trait. The data for

sapling height, diameter survival and weed fresh weight were recorded and statistically analyzed by using the analysis of variance (ANOVA) and inferences drawn.

## RESULTS AND DISCUSSION

### *Mechanical control*

Data given in Table 3 clearly establishes that nursery beds having frequent hoeing operations produced sapling with better growth and survival. Mean values for height, and collar diameter were maximum for saplings grown under 5 days hoeing interval in both years and also for both months of data recording and these values, with a few exceptions, were significantly more than those from control plots. For example, survival in control plots of 2009 trial was non-significantly different with 5 days hoeing interval but significantly different with those produced with traditional method of hoeing/weeding operation. For 2008 trial, survival was significantly better than that recorded in control plots and traditional weed control operations. The average values for height, diameter and survival were also significantly better than the traditional operations carried out in the poplar nurseries when compared with control plots, whereas, these values at 10 and 15 days intervals were at par with the traditional method of weed control. As the interval of hoeing operations was decreased, the values for all the parameters of plant height, diameter and survival increased, though in some cases non-significantly. The present results are in line with the findings of Singh and Dhiman (1999) who reported better growth of poplar saplings with repeated soil working in poplar nurseries.

The weighted average of saplings height and collar diameter for both Sept. and Nov. months for 2008 and 2009 trials is given in Fig.1 which shows that 5 days interval weeding produced better saplings in term of height and diameter growth. The weighted average survival for both trials of 2008 and 2009 ranged from 82.0% to 92.5%, maximum being 92.5% for 5 days hoeing interval followed by 87.5% for traditional operations, 85% for 10 days interval, 83.5% for 20 days interval, 82% for 15 days interval and 68% for control plots.

The results of third experiment (Table 3) indicate significant differences for plant height and survival but non-significant differences for diameter due to hoeing with different tools. Weed control with use of pickaxe and pickaxe + khurpi produced significantly taller plants compared to that by mechanical weeder. Survival of plants was maximum in plots weeded with fork and mechanical weeder (rotovator), whereas, it was minimum (70%) for control plots. Mean values for collar diameter were maximum in plots where hoeing was carried out with cycle hoe which again differed non-significantly with other treatments. Hoeing, in addition to destruction of weeds, also maintains better soil structure for providing optimum water-air regime in soil layers where root system develops (Roncevic et al. 2002).

Observations recorded for height, diameter, survival of saplings and fresh weight of weeds after 10 days of spraying the herbicides given in Table 5 produced non-significant differences in height, collar diameter and survival of plants among the two concentrations of Pentara indicating that the chemical did not affect plant growth and survival. However, there were non-significant differences in the fresh weight of weeds before spray but significantly different after 10 days of spraying indicating that the effect of herbicides was effective on weeds. Weed fresh weight was significantly low in plots sprayed with 0.6% and 0.4% Pentara when compared that with the control plots.

The results also indicates non-significant differences in mean values for poplar plant height, diameter at breast height before sprays and there was no change in their status including that in survival (100%) after spray in all cases further indicating a selective affect of herbicides on weeds and not on poplar plants. Weed population which was significantly at par in all the three plots had shown significant reduction in plots sprayed with herbicides indicating that these treatments could also be applied for weed control. Singh and Dhiman (1999) suggested application of low concentrations of Glyphosate in poplar nurseries during the advanced stages of sapling production. Glyphosate is a systematic herbicides which kills plants of almost all species by its translocation into the

plants and its application has to be very careful to avoid any damage to poplar saplings.

***Application of Pre-emergent herbicides***

The effect of pre-emergent herbicides on poplar plants and weed weight given in Table 7 indicates significant impact on all the recorded traits due to the treatments in which Basaline produced saplings with maximum plant height, DBH and survival of plants and significantly less fresh weight of weeds compared to that in control plots. Atrazine treated plots though had maximum affect in reduction in fresh weight of weeds after 30 days of its application, it also had an adverse affect on poplar plants. Immediately on planting poplar plants in the nursery, Atrazine started showing adverse impact on poplar with burning of leaves due to phytotoxic effect and death of many of them, as a result survival was significantly less in these plots. Many plants recovered after some time but they remained stunted, as is indicated by less mean values of their height and DBH(cm) .

***Costs of weed control***

The cost on weed control with different tools indicates variable costs from Rs. 3200 with use of mechanical weeder to Rs. 7300 through Khurpi and sickle (Table 4). The value (cost) of each tool used in these trials vary widely from less than Rs. 100 for simple tools of sickles and khurpies to over Rs. One lakh for mechanical weeder (rotovator) and the tool costs were not included in the above calculations. Hoeing/weeding is an important operation in poplar nurseries and the cost of these operations collectively vary from Rs. 3750 to Rs. 4500 per acre. Poor availability of labour especially during onset of monsoon rains, when weed becomes a serious problem, encourages nursery growers to adopt costly means like mechanical weeders for hoeing and weed control. The operational cost with mechanical weeder though low becomes very high if the value (cost) of machines is also included. It pulverized soil along with weeds but also requires a semi-skilled operator for its effective use, whereas, all other operations are carried out by local labour who are well versed with agricultural operations. The cost of chemical control of weeds is very less (Rs. 600-700/ single operation) and could be repeated based on the status of weeds an growth of poplar plants in the nurseries (Table 6).

**Table1. Details of experiments on mechanical methods for weed management**

| Experiment No. | 1 | 2 | 3 |
|---|---|---|---|
| Experiment type | Hoeing frequency | Hoeing frequency | Efficacy of hoeing tools |
| Planting time | June 2008 | July 2009 | July 2009 |
| Treatment time | July-Dec., 2008 | July-Dec, 2009 | July-Dec. 2009 |
| Clone | WSL 22 | WSL 32 | Wimco 110 |
| Spacing(cm) | 70x40 | 70x40 | 70x40 |
| Design | RBD | RBD | RBD |
| Treatments/ Replications. | 6 | 6 | 5 |
| T1 | Traditional | Traditional | Pick axe (kassi) |
| T2 | 5 | 5 | Fork (punja) |
| T3 | 10 | 10 | Rotovator |
| T4 | 15 | 15 | Cycle hoe |
| T5 | 20 | 20 | Kassi + khurpi (control) |
| T6 | Control | Control | |

**Table 2.** Details of the nursery experiments on chemical methods for weed management

| Experiment Number and type | 1<br>Herbicide spray | 2<br>Herbicide spray | 3<br>Pre-emergent herbicides |
|---|---|---|---|
| Planting time | June 2009 | April 2009 | 27-5-2008 |
| Treatment time | July 2009 | Oct. 2009 | 22-5-2008 |
| Clone | Wimco 81 | WSL 22 | G48 |
| Spacing(cm) | 70X40 | 70X40 | 70X40 |
| Design | RBD | RBD | RBD |
| Treatments\Replications | 4 | 6 | 5 |
| T1 | Pentara (0.4%) | Gramoxine @0.03% | Atrazine 50 EC @7.5 litres/ha |
| T2 | Pentara (0.6%) | Glycel@0.03% | Alchor @2 litres/ha |
| T3 | Control | Control | Pendamethalene 30% EC @2.5 litres/ha |
| T4 | | | Basaline @ 1.2 litres/ha |
| T5 | | | Control |

**Table 3.** Effect of hoeing on sapling height collar diameter and survival during 2008 and 2009 trials

| Trial | 2008 | | | | | 2009 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Hoeing after days | Height (m) | | Collar diameter (cm) | | Survival (%) | Height (m) | | Collar diameter (cm) | | Survival (%) |
| | Month | | | | | Month | | | | |
| | Sept | Nov. | Sept | Nov. | Nov. | Sept | Nov. | Sept | Nov. | Nov. |
| Traditional | 2.4 | 2.6 | 0.9 | 1.1 | 80 | 1.4 | 2.21 | 1 | 1.5 | 95 |
| 5 | 2.8 | 3.0 | 1.1 | 1.3 | 95 | 2.0 | 2.95 | 1.4 | 2.1 | 90 |
| 10 | 2.6 | 2.8 | 1.0 | 1.1 | 81 | 1.75 | 2.68 | 1.2 | 1.8 | 90 |
| 15 | 2.2 | 2.5 | 0.9 | 1.0 | 79 | 1.65 | 2.58 | 1.2 | 1.7 | 85 |
| 20 | 2.1 | 2.4 | 0.8 | 1.0 | 77 | 1.58 | 2.33 | 1.1 | 1.5 | 90 |
| Control | 1.4 | 1.9 | 0.4 | 0.7 | 66 | 1.4 | 2.07 | 0.9 | 1.3 | 70 |
| Mean | 2.2 | 2.5 | 0.8 | 1.0 | 80 | 1.63 | 2.47 | 1.1 | 1.6 | 87 |
| SE Diff. | 0.15 | 0.14 | 0.1 | 0.08 | 3.33 | 0.17 | 0.23 | 0.12 | 0.27 | 11.25 |
| CD 0.005 | 0.32 | 0.3 | 0.21 | 0.17 | 7.1 | 0.37 | 0.49 | 0.26 | 0.58 | 23.8 |

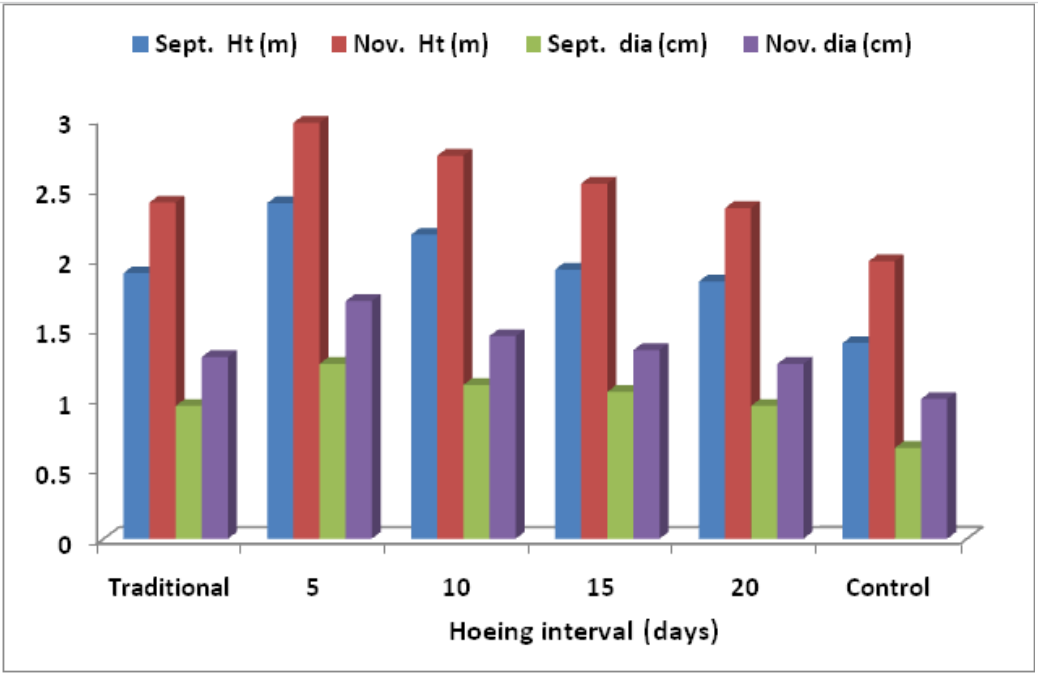


**Fig.1.** Effect of hoeing frequency on weighted average of height and collar diameter growth

**Table 4.** Effect of different tools on sapling production and cost of production

| Treatment | No. of hoeings | Height (m) | | Collar Diameter (cm) | | Survival (%) | Operational cost |
|---|---|---|---|---|---|---|---|
| | | Sept | Nov. | Sept | Nov. | Nov. | (Rs./acre) |
| Pick-axe (Kassi) | 5 | 1.78 | 2.71 | 1.0 | 1.9 | 90 | 4562 |
| Fork(Punja) | 24 | 1.66 | 2.53 | 1.4 | 1.9 | 100 | 7300 |
| Mechanical weeder (rotovator) | 4 | 1.44 | 2.20 | 1.2 | 1.5 | 100 | 3200 |
| Cycle hoe | 24 | 1.54 | 2.53 | 1.1 | 2.0 | 75 | 3650 |
| Kassi+khurpi(control) | 6(4+2) | 1.70 | 2.62 | 1.2 | 1.9 | 70 | 5780 |
| Mean | | 1.62 | 2.52 | 1.10 | 1.8 | 87 | |
| SE Diff. | | 0.09 | 0.14 | NS | NS | 9.83 | |
| CD 0.05 | | 0.19 | 0.31 | | | 21.41 | |

Weeds are one of the most limiting factors for the success of nursery production, their control need to be approached very seriously (Vasic and Konstantinovic 2008). Poplar is intolerant to all forms of weeds and its nurseries need to be maintained weed free during growth phase in order to avoid disease and insect infestation and to produce quality saplings. Poplar nurseries are repeatedly grown in some fields for many years where root suckers also form part of weeds which are removed during hoeing/weeding and other cultural operations. Poplar plants favorably responds to weed control especially deep hoeing as is established from the present studies. The results

**Table 5.** Effect of herbicides spray on poplar sapling growth, survival and fresh weight of weeds

| Treatment | Height (m) increment after 10 days of spraying | Diameter (cm) increment after 10 days of spraying | Fresh weight of Weeds (k g/m$^2$) At the time of spraying | After 10 days of spraying | Survival % |
|---|---|---|---|---|---|
| Pentara (0.4%) | 0.30 | 0.28 | 0.352 | 0.403 | 100 |
| Pentara (0.6%) | 0.34 | 0.30 | 0.325 | 0.378 | 100 |
| Control | 0.45 | 0.30 | 0.467 | 1.263 | 100 |
| Mean | 0.37 | 0.30 | 0.382 | 0.682 | 100 |
| SEM | NS | NS | NS | 0.12 | NS |
| CD (5%) | | | | 0.27 | |

**Table 6.** Effect of herbicides of poplar sapling growth, survival and fresh weight of weeds

| Treatment | Plant Height (m) | Final diameter (cm) | Fresh weight of Weeds (Kg/m$^2$) At the time of spraying | After 35 days of spraying | Survival % After 35 days of spraying | Input cost Rs./acre |
|---|---|---|---|---|---|---|
| Gramoxine @0.03% | 2.96 | 1.36 | 0.336 | 0.012 | 100 | Rs. 660/- |
| Glycel@0.03% | 2.63 | 1.22 | 0.328 | 0.016 | 100 | Rs. 595/- |
| Control | 2.51 | 1.08 | 0.391 | 0.564 | 100 | Rs. 1350/- |
| Mean | 2.70 | 1.22 | 0.351 | 0.197 | 100 | |
| SEM | NS | NS | NS | 0.045 | NS | |
| CD (5%) | | | | 0.101 | | |

of the series of experiments as given above calls for an integrated approach for weed management in poplar nurseries. Application of pre-emergence herbicides does not appear to be good option as the soil of nursery beds get disturbed while planting the cuttings and hence the weeds appear on breaking the film of herbicides made on soil surface on planting of cuttings and on effecting other cultural operations. The beginning period of nursery production favours application of mechanical means (soil working) to check weed population and also to create aeration in the rhizosphere for root development of poplar plants. Heavy infestation of weeds limits the application of mechanical methods and hence chemical weed killers could be applied whenever needs arise for keeping costs under control and for improving hygiene in nurseries.

**Table 7.** Effect of application of pre-emergent herbicides on growth of poplar plants and weed growth.

| Treatment | Height (m) November | DBH (cm) November | Final Survival (%) | Fresh weight of Weeds ($kg/m^2$) 30 days after application of herbicides |
|---|---|---|---|---|
| Atrazine 50 EC @7.5 litres/ha | 0.8 | 0.05 | 77 | 0.261 |
| Alchor @2 litres/ha | 1.8 | 0.6 | 95 | 0.571 |
| Pendamethalene 30% EC @2.5 litres/ha | 1.8 | 0.7 | 95 | 0.627 |
| Basaline @ 1.2 litres/ha | 2.0 | 0.8 | 95 | 0.518 |
| Control | 1.8 | 0.8 | 95 | 1.172 |
| Mean | 1.6 | 0.6 | 92 | 0.630 |
| SEM | 0.20 | 0.17 | 5.07 | 0.126 |
| CD (5%) | 0.42 | 0.36 | 10.75 | 0.267 |

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