# MICRO-IRRIGATION ALTERNATIVES FOR HYBRID POPLAR PRODUCTION, 2001 TRIAL

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## Summary

Hybrid poplar (cultivar OP-367), planted for sawlog production in April 1997 at the Malheur Experiment Station, received five irrigation treatments in 2001. Irrigation treatments consisted of three water application rates using microsprinklers and two water application rates using drip tape. Irrigation scheduling was by soil water potential at 8-inch depth with a threshold of -50 kPa for initiating irrigations. Reducing the water application rate at each irrigation from 2 inches to 1.54 or 0.77 inches reduced the annual growth in diameter at breast height (DBH) and stem volume for the microsprinkler-irrigated treatments. There was no significant difference between the microsprinkler-irrigated treatment with a water application rate of 2 inches and the drip-irrigated treatments with rates of 1.54 and 0.77 inches in terms of height, DBH, or stem volume annual increment. Irrigating at -50 kPa and applying 2 inches at each irrigation with microsprinklers or 1.54 inches with two drip tapes required 34 and 36 acre-inch/acre of applied water plus rainfall in 2001, respectively. Water use efficiency was higher with drip irrigation than with microsprinklers.

## Introduction

With timber supplies from Pacific Northwest public lands becoming less available, sawmills and timber products companies are searching for alternatives. Hybrid poplar wood has proven to have desirable characteristics for many nonstructural timber products. Growers in Malheur County have made experimental plantings of hybrid poplars for saw logs and peeler logs. Clone trials in Malheur County have demonstrated that the clone OP-367 (hybrid of *Populus deltoides* x *Populus nigra*) performs well on alkaline soils for at least 6 years. Other clones have higher productivity on soils with nearly neutral pH.

Hybrid poplars are known to have high growth rates (Larcher 1969) and transpiration rates (Zelawski 1973), suggesting that irrigation management is a critical cultural practice. Research at the Malheur Experiment Station during 1997-1999 determined optimum microsprinkler irrigation criteria and water application rates for the first 3 years (Shock et al. 2002). The objective of this study was to evaluate poplar water requirements in the fifth year and to compare microsprinkler irrigation to drip irrigation.

## Materials and Methods

The trial was conducted on a Nyssa-Malheur silt loam (bench soil) with 6 percent slope at the Malheur Experiment Station. The soil had a pH of 8.1 and 0.8 percent organic matter. The field had been planted to wheat for the 2 years prior to 1997 and to alfalfa before 1995. The field was marked using a tractor, and a solid-set sprinkler system was installed prior to planting. Hybrid poplar sticks, cultivar OP-367, were planted on April 25, 1997 on a 14-ft by 14-ft spacing. The sprinkler system applied 1.4 inches on the first irrigation immediately after planting. Thereafter the field was irrigated twice weekly at 0.6 inches per irrigation until May 26. A total of 6.3 inches of water was applied in nine irrigations from April 25 to May 26, 1997.

In late May, 1997, a microsprinkler system (R-5, Nelson Irrigation, Walla Walla, WA) was installed with the risers placed between trees along the tree row at 14-ft spacing. The sprinklers delivered water at the rate of 0.14 inches/hour at 25 psi and a radius of 14 ft. The poplar field was used for irrigation management research (Shock et al. 2002) and groundcover research (Feibert et al. 2000) from 1997 through 1999.

In March 2000 the field was divided into 20 plots, each of which was 6 tree rows wide and 7 trees long. The plots were allocated to five treatments arranged in a randomized complete block design and replicated four times (Table 1). The microsprinkler irrigation treatments used the existing irrigation system. For the drip-irrigation treatments, either one or two drip tapes (Nelson Pathfinder, Nelson Irrigation Corp., Walla Walla, WA) were laid on the surface along the tree row in early May 2000. The plots with two drip tapes per tree row had the drip tapes spread 2 ft apart, centered on the tree row. The drip tape had emitters spaced 12 inches apart and a flow rate of 0.22 gal/min/100 ft at 8 psi. Each plot had a pressure regulator (set to 25 psi for the microsprinkler plots and 8 psi for the drip plots) and ball valve allowing independent irrigation. Water application amounts were monitored daily by water meters in each plot.

Soil water potential (SWP) was measured in each plot by six granular matrix sensors (GMS; Watermark Soil Moisture Sensors model 200SS; Irrometer Co., Riverside, CA); two at 8-inch depth, two GMS at 20-inch depth, and two at 32-inch depth. The GMS were installed along the middle row in each plot and between the riser and the third tree. The GMS were previously calibrated (Shock et al. 1998) and were read at 8:00 a.m. daily starting on May 2 with a 30 KTCD-NL meter (Irrometer Co., Inc.). The daily GMS readings were averaged separately at each depth within each plot and over all plots in a treatment. Irrigation treatments were started on May 2.

The five irrigation treatments consisted of three water application rates for the microsprinkler-irrigated plots and two water application rates for the drip-irrigated plots (Table 2). All plots in the three microsprinkler-irrigated treatments were irrigated whenever the SWP at 8-inch depth for treatment 1 reached -50 kPa. The plots in each drip-irrigated treatment were irrigated whenever the SWP at 8-inch depth for the respective treatment reached -50 kPa. Irrigation treatments were terminated on September 30 each year.
Soil water content was measured with a neutron probe. Two access tubes were installed in each plot along the middle tree row on each side of the fourth tree between the sprinklers and the tree. Soil water content readings were made twice weekly at the same depths as the GMS. The neutron probe was calibrated by taking soil samples and probe readings at 8-inch, 20-inch, and 32-inch depth during installation of the access tubes. The soil water content was determined gravimetrically from the soil

samples and regressed against the neutron probe readings, separately for each soil depth. The regression equations were then used to transform the neutron probe readings during the season into volumetric soil water content. Coefficients of determination ($r^2$) for the regression equations were 0.89, 0.88, and 0.81 at P = 0.001 for the 8-inch, 20-inch, and 32-inch depths, respectively.

Leaf tissue analyses to monitor and correct nutrient deficiencies during the season consisted of a composite sample of the first fully developed leaf from the central canopy from each of the five middle trees in the middle row of all plots in the wettest sprinkler-irrigated treatment.

***2000 Procedures***

The side branches on the bottom 6 ft of the tree trunk had been pruned from all trees in February, 1999. In March of 2000, another 3 ft of trunk were pruned, resulting in 9 ft of pruned trunk. The pruned branches were flailed on the ground and the ground between the tree rows was disked on April 12. On April 24, Prowl at 3.3 lb ai/acre was broadcast for weed control. The field was irrigated using the existing microsprinkler system with an application of 0.7 inches of water to incorporate the Prowl. To control the alfalfa and weeds remaining from the previous years' groundcover trial in the top half of the field, Stinger at 0.19 lb ai/acre was broadcast between the tree rows on May 19, and Poast at 0.23 lb ai/acre was broadcast between the tree rows on June 1. On June 14, Stinger at 0.19 lb ai/acre and Roundup at 3 lb ai/acre were broadcast between the tree rows on the whole field.

On May 19 the trees received 50 lb N/acre as urea-ammonium nitrate solution injected through the microsprinkler system. Due to deficient levels of leaf nutrients in early July, the field had the following nutrients in pounds per acre injected in the irrigation systems: 0.4 lb boron, 0.6 lb copper, 0.4 lb iron, 5 lb magnesium, 0.25 lb zinc, and 3 lb phosphorus. The field was sprayed aerially for leafhopper control with Diazinon AG500 at 1 lb ai/ac on May 27 and with Warrior at 0.03 lb ai/acre on July 10.

***2001 Procedures***

In March of 2001, another 3 ft of trunk were pruned, resulting in 12 ft of pruned trunk. The pruned branches were flailed on the ground on April 2. On April 4, Roundup at 1 lb ai/acre was broadcast for weed control. On April 10, 200 lb N/acre, 140 lb P/acre, 490 lb S/acre, and 14 lb Zn/acre (urea, monoammonium phosphate, zinc sulfate and elemental sulfur) were broadcast. The ground between the tree rows was disked on April 12. On April 13, Prowl at 3.3 lb ai/acre was broadcast for weed control. The field was irrigated applying 0.8 inches of water to incorporate the Prowl.

A leafhopper, willow sharpshooter (*Graphocephala confluens*, Uhler), was monitored by three yellow sticky traps attached to the lower trunk of selected trees. Traps were checked weekly. From mid-April to early June only adults were observed in the traps. A willow sharpshooter hatch was observed on June 6 as large numbers of nymphs were noted in the traps and on the lower trunk sprouts. The field was sprayed aerially with Warrior at 0.03 lb ai/acre on June 11 for leafhopper control.

The heights and diameter at breast height (DBH, 4.5 ft from ground) of the central three trees in the two middle rows in each plot were measured monthly from May through September. Stem volumes (excluding bark and including stump and top) were calculated for each of the central six trees in each plot using an equation developed for poplars that uses tree height and DBH (Browne 1962). Annual growth increments for height, DBH, and stem volume for 2001 were calculated as the difference in the respective parameter between October 2000 and October 2001.

## Results and Discussion

The microsprinkler-irrigated treatment with 2 inches of water applied at each irrigation consumed 34 acre-inch/acre of water in 20 irrigations (Table 1). The drip treatment with 1.54 inches of water applied through 2 tapes consumed 36 acre-inch/acre applied in 19 irrigations. The drip treatment with 0.77 inches of water applied through 1 tape consumed only 25 acre-inch/acre in 28 irrigations.

In November 2001 (5th year), trees in the wettest sprinkler-irrigated treatment averaged 40 ft in height, 6.8 in DBH, and 788 $ft^3$ of stem volume (Table 1).

For the microsprinkler-irrigated treatments, the highest annual increment in DBH and stem volume was achieved with a water application rate of 2 inches (Table 2). The annual increment in tree height was not significantly different between the sprinkler-irrigation treatments. There was no significant difference between the microsprinkler-irrigated treatment with a water application rate of 2 inches and either of the drip-irrigated treatments in terms of height and stem volume annual increment. Drip irrigation with two tapes per tree row (water application rate of 1.54 inches) resulted in the highest DBH increment. Using one drip tape instead of two per tree row resulted in a reduction in DBH increment, but did not result in a significant reduction in stem volume increment, in spite of the large statistically significant difference in water applied, 25 acre-inch/acre vs. 36 acre-inch/acre.

There were positive linear relationships, with similar slopes, between total water applied and stem volume increment for both the drip and microsprinkler systems (Fig. 1). However, the line for the drip system was above the line for the microsprinkler system, reflecting the higher water use efficiency of the drip system. Reducing water applications with the microsprinkler system resulted in a substantial reduction in water use efficiency, in contrast to the drip system, probably reflecting the higher proportionate evaporative losses from the soil surface following shallow irrigations with the microsprinkler system (Table 1).
The soil water potential at 8-inch depth was reduced, as expected, with the reductions in water application rate in the sprinkler treatments (Fig. 2, Table 3). There was no significant difference in 8-inch average soil water potential among the two drip treatments and the sprinkler treatment with 2 inches of water application rate. The soil water potential at 8-inch depth in the drip treatments oscillated with a higher amplitude (became wetter) than in the sprinkler plots, as expected, since the wetted area was smaller with drip irrigation.

The volumetric soil water content at 8-inch depth over time and averaged over the season (Table 3) was highest for the drip plots and decreased with the reductions in water application rate in the sprinkler treatments. At 18-inch depth the soil water content was highest for the drip treatments. At 30-inch depth, the differences between treatments were smaller and only sprinkler treatment 2 had a lower soil water content than the drip treatments. The soil water content in the drip treatments oscillated with a higher amplitude than the sprinkler plots, especially at 18-inch and 30-inch depths, reflecting the much smaller application area than the sprinkler plots.

## **References**

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Table 1. Irrigation rates, amounts, and water use efficiency for hybrid poplars submitted to five irrigation regimes, Malheur Experiment Station, Oregon State University, Ontario, OR.

*Includes 1.43 inches of precipitation from May through September.
†Soil water potential at eight-inch depth.

Table 2. Height, diameter at breast height (DBH) and stem volume measurements in early November 2001 and 2001 growth increments for hybrid poplars submitted to five irrigation treatments, Malheur Experiment Station, Oregon State University, Ontario, OR.

Table 3. Average soil water potential and volumetric soil water content for hybrid poplars submitted to five irrigation treatments, Malheur Experiment Station, Oregon State University, Ontario, OR.

| | | | | Average volumetric soil | | |
|---|---|---|---|---|---|---|
| | 1st ft | 2nd ft | 3rd ft | 1st ft | 2nd ft | 3rd ft |
| | --------------- kPa --------------- | | | --------------- % -------------- | | |
| 1 | -34 | -43 | -72 | 15.8 | 12.5 | 13.4 |
| 2 | -54 | -88 | -99 | 12.9 | 10.4 | 9.9 |
| 3 | -119 | -91 | -103 | 9.0 | 12.5 | 12.9 |
| 4 | -26 | -28 | -41 | 20.6 | 15.6 | 15.2 |
| 5 | -32 | -42 | -40 | 17.5 | 14.4 | 15.6 |

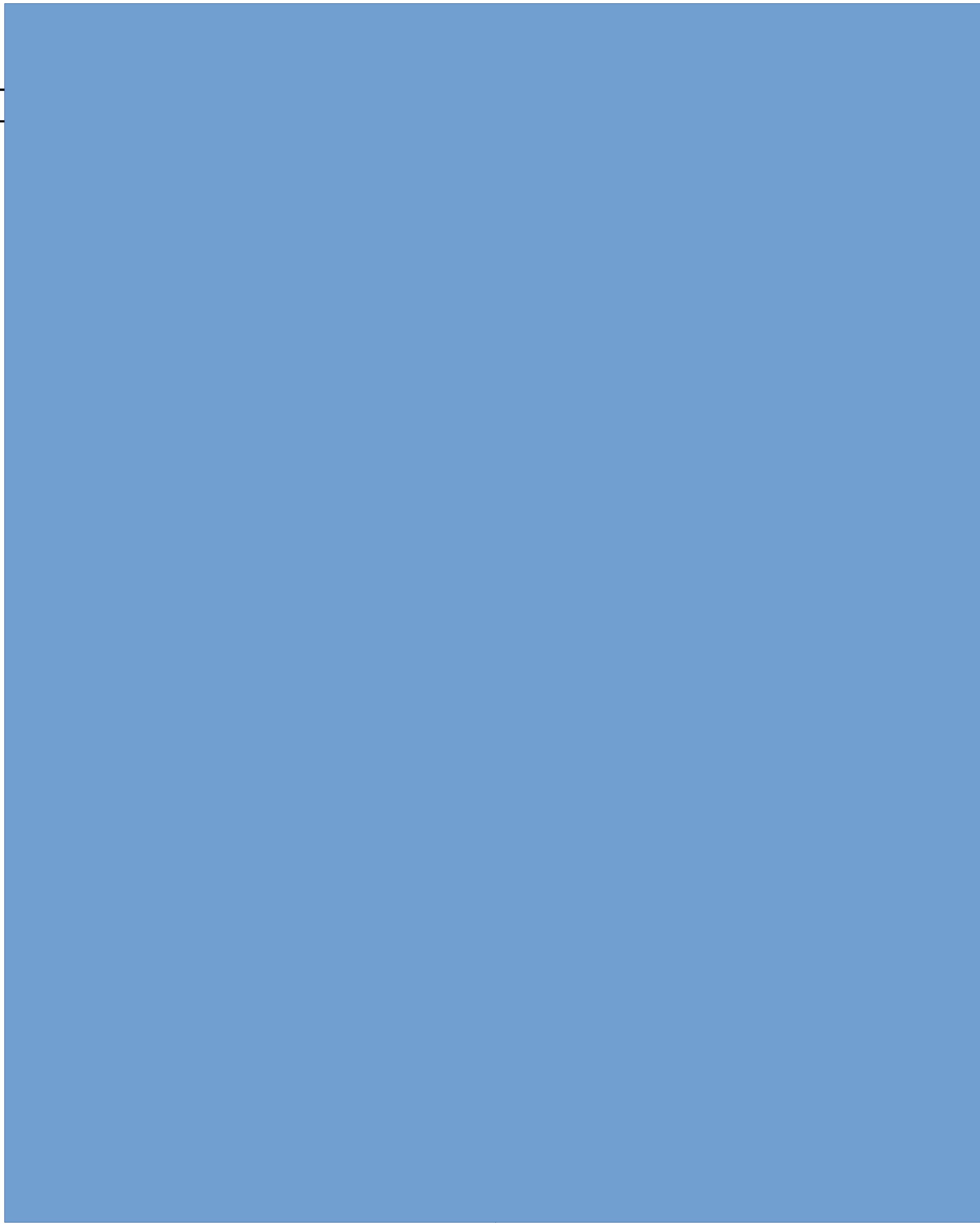

Figure 1. Response of stem volume increment to water applied for hybrid poplar using microsprinkler and drip irrigation. Malheur Experiment Station, Oregon State University, Ontario, OR.

Figure 2. Soil water potential at three depths using granular matrix sensors in a poplar stand submitted to five irrigation regimes. Malheur Experiment Station, Oregon State University, Ontario, OR.

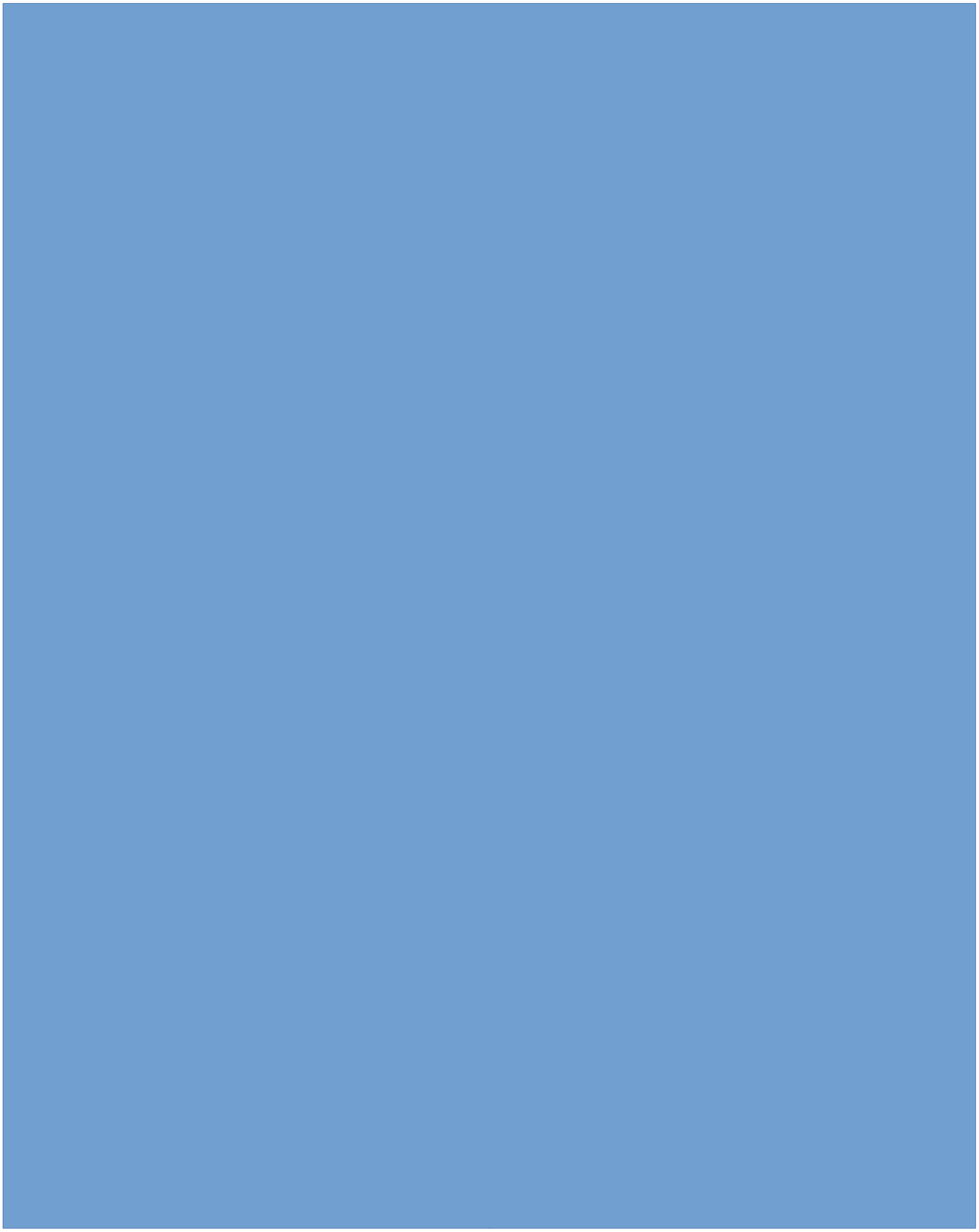

Figure 3. Soil water content at three depths using neutron probe in a poplar stand submitted to five irrigation regimes. Malheur Experiment Station, Oregon State University, Ontario, OR.