History Plots as an IPM Tool

One of the basic requirements of a successful integrated pest management (IPM) program is monitoring your crops so that you can detect potential pests before they can become a serious problem. In the July, 1996 issue of FNN we discussed scouting techniques and in this issue I'd like to introduce history plots, which I feel can be an excellent IPM tool.

History plots are permanent monitoring plots that are established in sections of seedbed or in a group of containers at the time of sowing. Although history plots can serve many purposes in a nursery, one of their best uses is to detect and diagnose the causes of poor seedling growth and mortality. The design of a history plot is unique in that it features a paired-plot design which permits destructive sampling **(Figure 11).** Non-destructive, repetitive measurements such as live seedling counts and shoot measurement can be made throughout the crop cycle in Subplot A, whereas one-time destructive measurements involving seed and seedling excavation are done in Subplot B. In bareroot nurseries, history plots should be laid-out with the subplots side-by-side in the same seedbed with a narrow buffer zone between them. The subplots should extend across the full width of the seedbed to eliminate any possible variation between seed rows. The same concept can be applied to container nurseries; for example, one half of a styroblock could be designated as for destructive sampling and the other used for long-term monitoring.

The ability to excavate sown seeds is an essential feature of the concept. Although the approximate number of seeds that are sown per area of seedbed or container cavity can be estimated from sowing calculations, the only way to really know if to count them directly. Small seed can be difficult to locate and separate from the soil in bareroot beds, but coloring the seed coat has made this job much easier. Fluorescent powders are easy to apply to seeds and, because they are organic, do not interfere with germination (If you are interested, the address for the Day-Glo company is listed in Sources at the end of this article). Once the sown seeds are counted, they can be replanted in the container or seedbed. If they are carefully sown at the same depth, they will germinate and emerge normally. Container nurseries have a real advantage in that the sown seed can more easily be extracted and resown in the destructive sampling subplot.

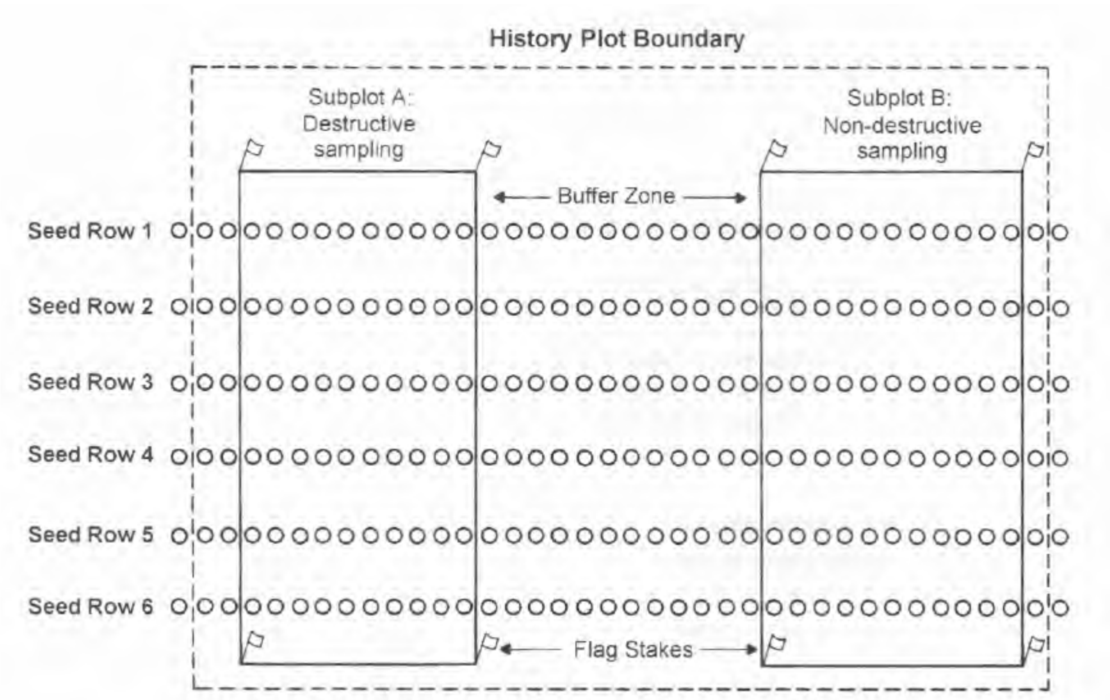

Figure 11. History plots feature a paired-plot sampling design so that destructive sampling can occur immediately adjacent to, but not disturb, the non-destructive long-term monitoring plot.

Table 4. Types of Integrated Pest Management (IPM) monitoring information that can be obtained with history plots

When to Monitor	*Type of Monitoring*	*Use in IPM*
	Subplot A: Destructive Sampling	
Post-sowing	Actual seed sowing density	True measure of potential seedling population
	Examination of ungerminated seed	Dormant or dead seed Pre-emergence damping-off
During growing season	Examination of root systems	Root rot: mycorrhizal inoculation
	Destructive seedling sampling	Development of growth curves, including root system; Seedling nutrient analysis
Prior to harvest	Destructive seedling sampling	Actual shippable seedling yield
	Subplot B: Non-destructive sampling	
Post-emergence	Seedling establishment	Actual causes of early seedling loss such as post. emergence damping-off
During growing season	Seedling growth data	Normal seedling growth rate curves; evidence of stunting
	Seedling injury and mortality during growing season	Actual causes of loss
	Entire History Plot	
During growing season	Weather station	Documented incidents of climatic damage
	Soil pathogen analysis	Diagnosis of root diseases; Effectiveness of fumigation or other pesticide treatments

History plots should be monitored at regular intervals beginning immediately after sowing and continuing until harvest **(Table 4).** The fate of the sown seed and emerged seedlings can be determined during each visit. After emergence is complete, the destructive plot can be sampled for ungerminated seed which can be bisected to determine if the seed is dormant or diseased (Figure 12). Decayed seed gives a direct and accurate measurement of pre-emergence damping-off, a statistic which could only be estimated by normal monitoring. Dead seedlings should be recorded and then removed during each visit to avoid possible confusion as to when the loss occurred. Damaged seedlings can be marked with colored toothpicks to see if they die between the monitoring visits. Close-up photographs during each visit will great aid in the diagnosis and, when viewed in sequence at the end of the growing season, present an excellent visual chronology of crop development. The history plot area can also be equipped with weather recording data which can be most useful in determining microsite conditions and cause of weather injury. Soil samples can be collected at the history plot locations during the growing season and analyzed for pathogen populations. This information can prove most useful in determining the efficacy of soil fumigation and other subsequent soil fungicide treatments later in the growing season **(Table 4).**

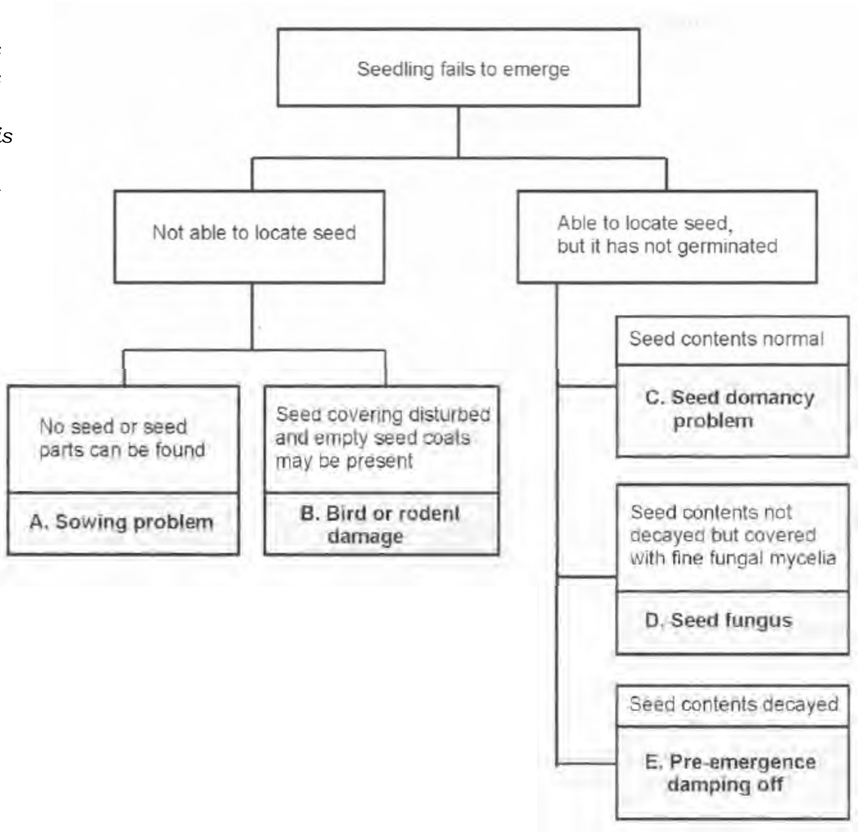

Figure 12. Excavating seed from the destructive subplots allows diagnosis of problems that occur prior to seedling emergence; for example, this is one of the only ways to distinguish between dormant seed and pre-emergence damping-off

One of my very first assignments after starting to work in nurseries was to determine what was causing severe seedling losses at a bareroot nursery. The nursery manager was complaining of irregular seedbed densities and high cull rates, but was unable to determine the exact cause and timing of these losses. So, we established a series of history plots in the seedbeds and monitored them throughout the growing season. Careful observations showed that the vast majority of the loss was occurring during the first few weeks of the growing season **(Figure 13a).** These close-up evaluations also revealed that bird predation was a major factor. The smaller-seeded *Engelmann spruce* was entirely consumed and so the true extent of this predation would not have been documented without the knowledge of the actual seed density from the destructive subplot sampling. Damage to the larger seeds of ponderosa pine were easier to diagnose because the germinants were clipped as soon as they emerged from the soil (Figure 13b). These terminally injured seedlings quickly dried-up and were not evident after a week or so.

Soil tests were also collected within the history plots and analyzed for the presence and population trends of the pathogenic fungi *Fusarium* spp. and *Pythium* spp. High levels of these pathogens along with the examination of the excavated seed showed that both pre-emergence and post-emergence damping-off were also common. Without the information from the history plots, the true cause of the seed and seedling losses would never have been known. In this nursery. the first seedling counts are not made until the first year inventory and, by that time, it was impossible to determine what happened to any missing seedlings.

Another useful application of history plots is for nurser) problem solving. Installing history plots in particularly troublesome areas of the nursery or in species or seedlots of unknown quality can be quite revealing. Without the focused perspective provided by history plots, nursery managers are often unable to determine the specific causes of seed and seedling losses.

So, I think that you can see that the history plot technique has many applications in forest and conservation nurseries and provides an excellent way to monitor seedlin g development and diagnose the true cause of injury and mortality. Although it is usually too late to do any corrective treatment during the first season, this information can show what types of controls are needed and when is the best time to apply them.

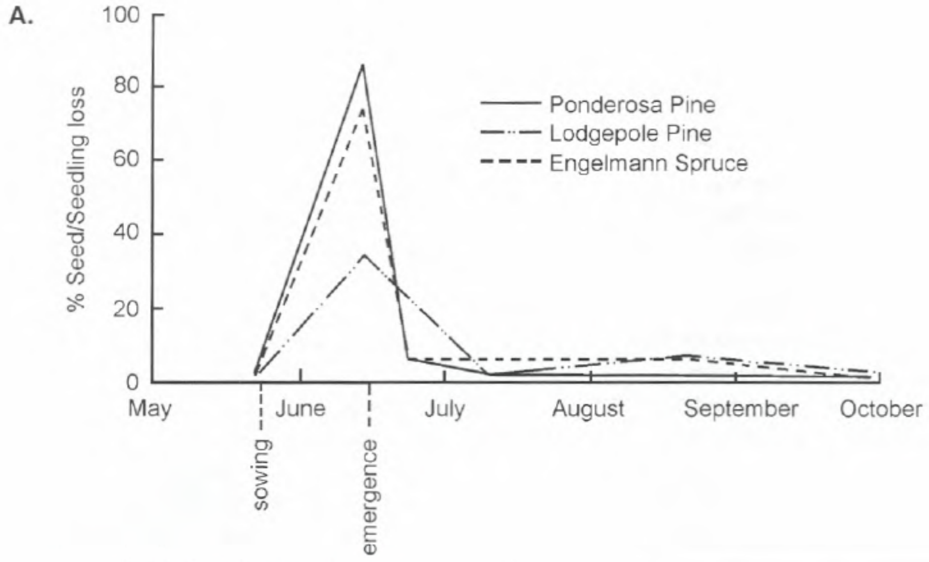

Figure 13. Careful monitoring of history plots revealed that the vast majority of seed and seedling losses were occurring within the first few weeks of the growing season (A), and that the cause was damping-off and bird predation (B).

Sources:

Belcher, E.W. Jr. 1964. The use of history plots in the nursery. Tree Planters' Notes 64: 27-31.

Day-Glo Color Corporation - Tel: 216/391-7070; Fax: 216/391-7751. WWW: www.dayglo.com. E-mail: dayglo@dayglo.com

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